DOE/EIA-0484(2009)

# International Energy Outlook 2009

May 2009

**Energy Information Administration**
Office of Integrated Analysis and Forecasting
U.S. Department of Energy
Washington, DC 20585

**This publication is on the WEB at:**
**www.eia.doe.gov/oiaf/ieo/index.html.**

# Contacts

The *International Energy Outlook* is prepared by the Energy Information Administration (EIA). General questions concerning the contents of the report should be referred to John J. Conti, Director, Office of Integrated Analysis and Forecasting (john.conti@eia.doe.gov, 202-586-2222), or Glen E. Sweetnam, Director, International, Economic, and Greenhouse Gases Division (glen.sweetnam@eia.doe.gov, 202-586-2188). Specific questions about the report should be referred to Linda E. Doman (202-586-1041) or the following analysts:

| | | | |
|---|---|---|---|
| **World Energy Demand and Economic Outlook** | Linda E. Doman | (linda.doman@eia.doe.gov, | 202-586-1041) |
| Macroeconomic Assumptions | Kay A. Smith | (kay.smith@eia.doe.gov, | 202-586-1132) |
| **Liquid Fuels** | Lauren Mayne | (lauren.mayne@eia.doe.gov, | 202-586-3005) |
| | John Staub | (john.staub@eia.doe.gov, | 202-586-6344) |
| Biofuels Production | Emre Yucel | (emre.yucel@eia.doe.gov | 202-586-9503) |
| **Natural Gas** | Justine Barden | (justine.barden@eia.doe.gov | 202-586-3508) |
| | Aloulou Fawzi | (aloulou.fawzi@eia.doe.gov | 202-586-1344) |
| | Phyllis Martin | (phyllis.martin@eia.doe.gov, | 202-586-9592) |
| **Coal** | Michael Mellish | (michael.mellish@eia.doe.gov, | 202-586-2136) |
| | Diane Kearney | (diane.kearney@eia.doe.gov, | 202-586-2415) |
| | Stephanie Kette | (stephanie.kette@eia.doe.gov, | 202-586-3627) |
| **Electricity** | Linda Doman | (linda.doman@eia.doe.gov, | 202-586-1041) |
| Renewable Generation | Brian Murphy | (brian.murphy@eia.doe.gov, | 202-586-1398) |
| Solar Technologies | Marie LaRiviere | (marie.lariviere@eia.doe.gov, | 202-586-1475) |
| **Industrial Sector** | Kenneth Vincent | (kenneth.vincent@eia.doe.gov, | 202-586-6582) |
| **Transportation Sector** | Barry Kapilow-Cohen | (bcohen@eia.doe.gov, | 202-586-5359) |
| **Energy-Related Carbon Dioxide Emissions** | Perry Lindstrom | (perry.lindstrom@eia.doe.gov, | 202-586-0934) |

The following also contributed to production of the *IEO2009* report: Randal Cook, Adrian Geagla, and John Holte.

### Electronic Access and Related Reports

*IEO2009* will be available on CD-ROM and on the EIA Home Page (*http://www.eia.doe.gov/oiaf/ieo/index.html*) by May 2009, including text, forecast tables, and graphics. To download the entire publication in Portable Document Format (PDF), go to *http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2009).pdf*.

For ordering information and questions on other energy statistics available from EIA, please contact EIA's National Energy Information Center. Addresses, telephone numbers, and hours are as follows:

National Energy Information Center, EI-30
Energy Information Administration
Forrestal Building
Washington, DC 20585

Telephone: 202/586-8800
TTY: For people who are deaf or hard of hearing: 202/586-1181
9 a.m. to 4 p.m., eastern time, M-F

E-mail: *infoctr@eia.doe.gov*
World Wide Web Site: *http://www.eia.doe.gov*
Gopher Site: *gopher://gopher.eia.doe.gov*
FTP Site: *ftp://ftp.eia.doe.gov*

# Contents


Page

**Preface** ..... **ix**

**Highlights** ..... **1**
World Energy Use by Fuel Type ..... 2
World Delivered Energy Use by Sector ..... 5
World Carbon Dioxide Emissions ..... 6

**World Energy Demand and Economic Outlook** ..... **7**
Outlook for World Energy Consumption by Source ..... 9
Delivered Energy Consumption by End-Use Sector ..... 12
World Economic Outlook ..... 13
Major Sources of Uncertainty in the Projections ..... 17
References ..... 19

**Liquid Fuels** ..... **21**
World Liquids Consumption ..... 22
World Oil Prices ..... 23
World Liquids Production ..... 25
Oil Reserves and Resources ..... 31
References ..... 32

**Natural Gas** ..... **35**
World Natural Gas Demand ..... 35
World Natural Gas Production ..... 38
Natural Gas Import Dependence ..... 41
World Natural Gas Reserves ..... 44
References ..... 46

**Coal** ..... **49**
World Coal Consumption ..... 49
World Coal Production ..... 54
World Coal Trade ..... 55
World Coal Reserves ..... 59
References ..... 60

**Electricity** ..... **63**
Electricity Supply by Energy Source ..... 63
Regional Outlook ..... 70
References ..... 82

**Industrial Sector Energy Consumption** ..... **85**
Energy-Intensive Industries ..... 87
Regional Outlook ..... 90
References ..... 94

**Transportation Sector Energy Consumption** ..... **97**
OECD Countries ..... 100
Non-OECD Countries ..... 103
References ..... 106

**Energy-Related Carbon Dioxide Emissions** ..... **109**
Reference Case ..... 110
Alternative Macroeconomic Growth Cases ..... 116
Alternative Oil Price Cases ..... 116

## Appendixes


A. Reference Case Projections . . . . . 119
B. High Economic Growth Case Projections . . . . . 137
C. Low Economic Growth Case Projections . . . . . 153
D. High Oil Price Case Projections . . . . . 169
E. Low Oil Price Case Projections . . . . . 185
F. Reference Case Projections by End-Use Sector and Country Grouping . . . . . 201
G. Projections of Liquid Fuels and Other Petroleum Production in Five Cases . . . . . 223
H. Reference Case Projections for Electricity Capacity and Generation by Fuel . . . . . 245
I. Comparisons With International Energy Agency and *IEO2008* Projections . . . . . 265
J. Models Used To Generate the *IEO2009* Projections . . . . . 271
K. Regional Definitions . . . . . 273


## Tables


1. World Marketed Energy Consumption by Country Grouping, 2006-2030 . . . . . 7
2. World Gross Domestic Product by Country Grouping, 2006-2030 . . . . . 14
3. World Liquid Fuels Production in the Reference Case, 2006-2030 . . . . . 22
4. World Oil Reserves by Country as of January 1, 2009 . . . . . 31
5. World Natural Gas Production by Region and Country, 2006-2030 . . . . . 39
6. World Natural Gas Reserves by Country as of January 1, 2009 . . . . . 46
7. World Coal Production by Region, 2006-2030 . . . . . 54
8. World Coal Flows by Importing and Exporting Regions, Reference Case, 2007, 2015, and 2030 . . . . . 56
9. World Recoverable Coal Reserves as of January 1, 2006 . . . . . 59
10. OECD and Non-OECD Net Electricty Generation by Energy Source, 2006-2030 . . . . . 64
11. OECD and Non-OECD Renewable Electricty Generation by Energy Source, 2006-2030 . . . . . 67
12. OECD and Non-OECD Industrial Energy Consumption by Source, 2006-2030 . . . . . 85
13. World Energy Consumption for Transportation by Country Grouping, 2006-2030 . . . . . 97
14. World Energy-Related Carbon Dioxide Emissions in Selected Annex I Areas, 1990, 2006, and 2010 . . . . . 110
15. World Energy-Related Carbon Dioxide Emissions by Region, 1990-2030 . . . . . 111
16. Carbon Dioxide Intensity by Region and Country, 1980-2030 . . . . . 114
17. Energy-Related Carbon Dioxide Emissions per Capita by Region and Country, 1990-2030 . . . . . 115


## Figures


1. World Marketed Energy Consumption, 2006-2030 . . . . . 1
2. World Marketed Energy Use by Fuel Type, 1980-2030 . . . . . 1
3. World Oil Prices in the *IEO2009* and *IEO2008* Reference Cases, 1980-2030 . . . . . 2
4. World Liquids Production, 2006-2030 . . . . . 2
5. Net Change in World Natural Gas Production, 2006-2030 . . . . . 3
6. World Electricity Generation by Fuel, 2006-2030 . . . . . 4
7. World Renewable Electricity Generation by Energy Source, 2006, 2015, and 2030 . . . . . 4
8. Net Increase in Industrial Energy Use by Region, 2006-2030 . . . . . 5
9. World Carbon Dioxide Emissions, 2006-2030 . . . . . 6
10. World Marketed Energy Consumption, 1980-2030 . . . . . 7
11. World Marketed Energy Consumption: OECD and Non-OECD, 1980-2030 . . . . . 8
12. Marketed Energy Use by Region, 1990-2030 . . . . . 8
13. Marketed Energy Use in the Non-OECD Economies by Region, 1980-2030 . . . . . 8
14. World Marketed Energy Use by Fuel Type, 1980-2030 . . . . . 9
15. Coal Consumption in Selected World Regions, 1980-2030 . . . . . 10
16. World Electricity Generation by Fuel, 2006-2030 . . . . . 10
17. World Renewable Electricity Generation by Source, 2006-2030 . . . . . 10
18. Renewable Electricity Generation in China by Fuel, 2006-2030 . . . . . 11
19. World Nuclear Generating Capacity by Region, 2006, 2015, and 2030 . . . . . 11
20. World Marketed Energy Consumption in Three Economic Growth Cases, 1980-2030 . . . . . 17
21. World Oil Prices in Three Price Cases, 1980-2030 . . . . . 18
22. World Marketed Energy Consumption in Three Oil Price Cases, 2006-2030 . . . . . 18
23. World Marketed Energy Consumption in Three Oil Price Cases, 2030 . . . . . 18

## Figures (Continued)


24. World Liquids Consumption in Three Price Cases, 2030 . . . . . 19
25. World Liquids Consumption by Region and Country Group, 2006 and 2030 . . . . . 21
26. World Liquids Supply in Three Cases, 2006 and 2030 . . . . . 21
27. World Production of Unconventional Liquid Fuels, 2006-2030 . . . . . 23
28. World Liquids Consumption by Sector, 2006-2030 . . . . . 23
29. World Oil Prices in Three Cases, 1980-2030 . . . . . 24
30. Non-OPEC Conventional Liquids Production by Region, 2006 and 2030 . . . . . 26
31. OPEC Conventional Liquids Production by Region, 2006 and 2030 . . . . . 29
32. World Proved Oil Reserves by Geographic Region as of January 1, 2009 . . . . . 31
33. World Natural Gas Consumption, 1980-2030 . . . . . 35
34. Natural Gas Consumption in North America by Country and Sector, 2006 and 2030 . . . . . 36
35. Natural Gas Consumption in OECD Asia by Country and Sector, 2006 and 2030 . . . . . 37
36. Natural Gas Consumption in Non-OECD Europe and Eurasia, 1992-2030 . . . . . 37
37. Natural Gas Consumption in Non-OECD Asia, 2006-2030 . . . . . 38
38. Imports as Share of OECD Natural Gas Consumption by Market, 2006-2030 . . . . . 41
39. Imports as Share of Non-OECD Natural Gas Consumption by Country, 2006-2030 . . . . . 45
40. World Natural Gas Reserves by Country Grouping, 1980-2008 . . . . . 45
41. World Natural Gas Reserves by Geographic Region as of January 1, 2009 . . . . . 45
42. World Coal Consumption by Country Grouping, 1980-2030 . . . . . 49
43. Coal Share of World Energy Consumption by Sector, 2006, 2015, and 2030 . . . . . 49
44. OECD Coal Consumption by Region, 1980, 2006, 2015, and 2030 . . . . . 50
45. Non-OECD Coal Consumption by Region, 1980, 2006, 2015, and 2030 . . . . . 51
46. Coal Consumption in China by Sector, 2006, 2015, and 2030 . . . . . 51
47. Coal Imports by Major Importing Region, 1995-2030 . . . . . 58
48. Growth in World Electric Power Generation and Total Energy Consumption, 1990-2030 . . . . . 63
49. World Net Electric Power Generation, 1980-2030 . . . . . 65
50. Non-OECD Net Electricity Generation by Region, 1980-2030 . . . . . 65
51. World Electricity Generation by Fuel, 2006-2030 . . . . . 65
52. World Net Electricity Generation from Nuclear Power by Region, 2006-2030 . . . . . 66
53. Net Electricity Generation in OECD North America, 1980-2030 . . . . . 70
54. Net Electricity Generation in OECD North America by Fuel, 2006 and 2030 . . . . . 71
55. Renewable Electricity Generation in OECD Europe by Fuel, 2006-2030 . . . . . 73
56. Net Electricity Generation in OECD Asia, 2006-2030 . . . . . 75
57. Net Electricity Generation in Non-OECD Europe and Eurasia, 2006-2030 . . . . . 76
58. Net Electricity Generation in Non-OECD Asia by Fuel, 2006-2030 . . . . . 76
59. Net Electricity Generation in the Middle East by Fuel, 2006-2030 . . . . . 78
60. Net Electricity Generation in Africa by Fuel, 2006-2030 . . . . . 80
61. Net Electricity Generation in Brazil by Fuel, 2006-2030 . . . . . 80
62. Net Electricity Generation in Other Central and South America by Fuel, 2006-2030 . . . . . 81
63. OECD and Non-OECD Industrial Sector Energy Consumption, 2006-2030 . . . . . 86
64. World Industrial Sector Energy Consumption by Fuel, 2006 and 2030 . . . . . 86
65. World Industrial Sector Energy Consumption by Major Energy-Intensive Industry Shares, 2005 . . . . . 87
67. OECD Industrial Sector Energy Consumption by Fuel, 2006 and 2030 . . . . . 89
66. OECD and Non-OECD Major Steel Producers, 2007 . . . . . 89
68. Non-OECD Industrial Sector Energy Consumption by Fuel, 2006 and 2030 . . . . . 91
69. OECD and Non-OECD Transportation Sector Liquids Consumption, 2006-2030 . . . . . 97
70. World Liquids Consumption by End-Use Sector, 2006-2030 . . . . . 99
71. OECD and Non-OECD Liquids Consumption by End-Use Sector, 2006 and 2030 . . . . . 99
72. Average Annual Growth in OECD and Non-OECD Gross Domestic Product and Transportation Sector Delivered Energy Use, 2006-2030 . . . . . 99
73. Change in OECD Transportation Sector Liquids Consumption by Region, 2006-2030 . . . . . 100
74. Average Annual Change in Gross Domestic Product, Population, and Energy Consumption for Transportation by OECD Region, 2006 to 2030 . . . . . 101
75. Energy Consumption for Transportation in OECD Europe, 2006-2030 . . . . . 102
76. Average Annual Change in Gross Domestic Product, Population, and Energy Consumption for Transportation by Non-OECD Region, 2006 to 2030 . . . . . 103
77. Non-OECD Asia and World Transportation Sector Liquids Consumption, 2006-2030 . . . . . 103

## Figures (Continued)


78. Energy Consumption for Passenger Transportation per Capita in China, India, and South Korea, 2006-2030 . . . 104
79. Personal and Public Transportation Shares of Total Passenger Miles Traveled in OECD Asia and Non-OECD Asia, 2006 and 2030 . . . 105
80. World Energy-Related Carbon Dioxide Emissions, 2006-2030 . . . 109
81. World Energy-Related Carbon Dioxide Emissions by Fuel Type, 1990-2030 . . . 109
82. U.S. Energy-Related Carbon Dioxide Emissions by Fuel in *IEO2008* and *IEO2009*, 2006, 2015, and 2030 . . . 111
83. Average Annual Growth in Energy-Related Carbon Dioxide Emissions in the OECD Economies, 2006-2030 . . . 112
84. Average Annual Growth in Energy-Related Carbon Dioxide Emissions in the Non-OECD Economies, 2006-2030 . . . 112
85. World Carbon Dioxide Emissions from Liquids Combustion, 1990-2030 . . . 112
86. World Carbon Dioxide Emissions from Natural Gas Combustion, 1990-2030 . . . 113
87. World Carbon Dioxide Emissions from Coal Combustion, 1990-2030 . . . 113
88. World Carbon Dioxide Emissions per Capita, 1990-2030 . . . 115
89. Non-OECD Carbon Dioxide Emissions per Capita by Country and Region, 1990-2030 . . . 115
90. OECD Carbon Dioxide Emissions per Capita by Country and Region, 1990-2030 . . . 116
91. Carbon Dioxide Emissions in Three Economic Growth Cases, 2006 and 2030 . . . 116
92. Carbon Dioxide Emissions in Three Oil Price Cases, 2006 and 2030 . . . 117
K1. Map of the Six Basic Country Groupings . . . 273


## Appendix Tables


A1. World Total Primary Energy Consumption by Region, Reference Case, 1990-2030 . . . 121
A2. World Total Energy Consumption by Region and Fuel, Reference Case, 1990-2030 . . . 122
A3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Reference Case, 1990-2030 . . . 124
A4. World Gross Domestic Product (GDP) by Region Expressed in Market Exchange Rates, Reference Case, 1990-2030 . . . 125
A5. World Liquids Consumption by Region, Reference Case, 1990-2030 . . . 126
A6. World Natural Gas Consumption by Region, Reference Case, 1990-2030 . . . 127
A7. World Coal Consumption by Region, Reference Case, 1990-2030 . . . 128
A8. World Nuclear Energy Consumption by Region, Reference Case, 1990-2030 . . . 129
A9. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Reference Case, 1990-2030 . . . 130
A10. World Carbon Dioxide Emissions by Region, Reference Case, 1990-2030 . . . 131
A11. World Carbon Dioxide Emissions from Liquids Use by Region, Reference Case, 1990-2030 . . . 132
A12. World Carbon Dioxide Emissions from Natural Gas Use by Region, Reference Case, 1990-2030 . . . 133
A13. World Carbon Dioxide Emissions from Coal Use by Region, Reference Case, 1990-2030 . . . 134
A14. World Population by Region, Reference Case, 1990-2030 . . . 135
B1. World Total Primary Energy Consumption by Region, High Economic Growth Case, 1990-2030 . . . 139
B2. World Total Energy Consumption by Region and Fuel, High Economic Growth Case, 1990-2030 . . . 140
B3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, High Economic Growth Case, 1990-2030 . . . 142
B4. World Liquids Consumption by Region, High Economic Growth Case, 1990-2030 . . . 143
B5. World Natural Gas Consumption by Region, High Economic Growth Case, 1990-2030 . . . 144
B6. World Coal Consumption by Region, High Economic Growth Case, 1990-2030 . . . 145
B7. World Nuclear Energy Consumption by Region, High Economic Growth Case, 1990-2030 . . . 146
B8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, High Economic Growth Case, 1990-2030 . . . 147
B9. World Carbon Dioxide Emissions by Region, High Economic Growth Case, 1990-2030 . . . 148
B10. World Carbon Dioxide Emissions from Liquids Use by Region, High Economic Growth Case, 1990-2030 . . . 149
B11. World Carbon Dioxide Emissions from Natural Gas Use by Region, High Economic Growth Case, 1990-2030 . . . 150
B12. World Carbon Dioxide Emissions from Coal Use by Region, High Economic Growth Case, 1990-2030 . . . 151

## Appendix Tables (Continued)


C1. World Total Energy Consumption by Region, Low Economic Growth Case, 1990-2030 . . . . . 155
C2. World Total Energy Consumption by Region and Fuel, Low Economic Growth Case, 1990-2030 . . . . . 156
C3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Low Economic Growth Case, 1990-2030 . . . . . 158
C4. World Liquids Consumption by Region, Low Economic Growth Case, 1990-2030 . . . . . 159
C5. World Natural Gas Consumption by Region, Low Economic Growth Case, 1990-2030 . . . . . 160
C6. World Coal Consumption by Region, Low Economic Growth Case, 1990-2030 . . . . . 161
C7. World Nuclear Energy Consumption by Region, Low Economic Growth Case, 1990-2030 . . . . . 162
C8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Low Economic Growth Case, 1990-2030 . . . . . 163
C9. World Carbon Dioxide Emissions by Region, Low Economic Growth Case, 1990-2030 . . . . . 164
C10. World Carbon Dioxide Emissions from Liquids Use by Region, Low Economic Growth Case, 1990-2030 . . . . . 165
C11. World Carbon Dioxide Emissions from Natural Gas Use by Region, Low Economic Growth Case, 1990-2030 . . . . . 166
C12. World Carbon Dioxide Emissions from Coal Use by Region, Low Economic Growth Case, 1990-2030 . . . . . 167

D1. World Total Primary Energy Consumption by Region, High Oil Price Case, 1990-2030 . . . . . 171
D2. World Total Energy Consumption by Region and Fuel, High Oil Price Case, 1990-2030 . . . . . 172
D3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, High Oil Price Case, 1990-2030 . . . . . 174
D4. World Liquids Consumption by Region, High Oil Price Case, 1990-2030 . . . . . 175
D5. World Natural Gas Consumption by Region, High Oil Price Case, 1990-2030 . . . . . 176
D6. World Coal Consumption by Region, High Oil Price Case, 1990-2030 . . . . . 177
D7. World Nuclear Energy Consumption by Region, High Oil Price Case, 1990-2030 . . . . . 178
D8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, High OIl Price Case, 1990-2030 . . . . . 179
D9. World Carbon Dioxide Emissions by Region, High Oil Price Case, 1990-2030 . . . . . 180
D10. World Carbon Dioxide Emissions from Liquids Use by Region, High Oil Price Case, 1990-2030 . . . . . 181
D11. World Carbon Dioxide Emissions from Natural Gas Use by Region, High Oil Price Case, 1990-2030 . . . . . 182
D12. World Carbon Dioxide Emissions from Coal Use by Region, High Oil Price Case, 1990-2030 . . . . . 183

E1. World Total Energy Consumption by Region, Low Oil Price Case, 1990-2030 . . . . . 187
E2. World Total Energy Consumption by Region and Fuel, Low Oil Price Case, 1990-2030 . . . . . 188
E3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Low Oil Price Case, 1990-2030 . . . . . 190
E4. World Liquids Consumption by Region, Low Oil Price Case, 1990-2030 . . . . . 191
E5. World Natural Gas Consumption by Region, Low Oil Price Case, 1990-2030 . . . . . 192
E6. World Coal Consumption by Region, Low Oil Price Case, 1990-2030 . . . . . 193
E7. World Nuclear Energy Consumption by Region, Low Oil Price Case, 1990-2030 . . . . . 194
E8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Low Oil Price Case, 1990-2030 . . . . . 195
E9. World Carbon Dioxide Emissions by Region, Low Oil Price Case, 1990-2030 . . . . . 196
E10. World Carbon Dioxide Emissions from Liquids Use by Region, Low Oil Price Case, 1990-2030 . . . . . 197
E11. World Carbon Dioxide Emissions from Natural Gas Use by Region, Low Oil Price Case, 1990-2030 . . . . . 198
E12. World Carbon Dioxide Emissions from Coal Use by Region, Low Oil Price Case, 1990-2030 . . . . . 199

F1. Total World Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030 . . . . . 203
F2. Total OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030 . . . . . 204
F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2006-2030 . . . . . 205
F4. Delivered Energy Consumption in Canada by End-Use Sector and Fuel, 2006-2030 . . . . . 206
F5. Delivered Energy Consumption in Mexico by End-Use Sector and Fuel, 2006-2030 . . . . . 207
F6. Delivered Energy Consumption in OECD Europe by End-Use Sector and Fuel, 2006-2030 . . . . . 208
F7. Delivered Energy Consumption in Japan by End-Use Sector and Fuel, 2006-2030 . . . . . 209
F8. Delivered Energy Consumption in South Korea by End-Use Sector and Fuel, 2006-2030 . . . . . 210
F9. Delivered Energy Consumption in Australia/New Zealand by End-Use Sector and Fuel, 2006-2030 . . . . . 211
F10. Total Non-OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030 . . . . . 212
F11. Delivered Energy Consumption in Russia by End-Use Sector and Fuel, 2006-2030 . . . . . 213
F12. Delivered Energy Consumption in Other Non-OECD Europe and Eurasia by End-Use Sector and Fuel, 2006-2030 . . . . . 214

## Appendix Tables (Continued)


F13. Delivered Energy Consumption in China by End-Use Sector and Fuel, 2006-2030 . . . . . 215
F14. Delivered Energy Consumption in India by End-Use Sector and Fuel, 2006-2030 . . . . . 216
F15. Delivered Energy Consumption in Other Non-OECD Asia by End-Use Sector and Fuel, 2006-2030. . . . . 217
F16. Delivered Energy Consumption in the Middle East by End-Use Sector and Fuel, 2006-2030 . . . . . 218
F17. Delivered Energy Consumption in Africa by End-Use Sector and Fuel, 2006-2030 . . . . . 219
F18. Delivered Energy Consumption in Brazil by End-Use Sector and Fuel, 2006-2030. . . . . 220
F19. Delivered Energy Consumption in Other Central and South America by End-Use Sector and Fuel, 2006-2030 . . . . . 221

G1. World Total Liquids Production by Region and Country, Reference Case, 1990-2030. . . . . 225
G2. World Conventional Liquids Production by Region and Country, Reference Case, 1990-2030 . . . . . 226
G3. World Unconventional Liquids Production by Region and Country, Reference Case, 1990-2030 . . . . . 228
G4. World Total Liquids Production by Region and Country, High Oil Price Case, 1990-2030 . . . . . 229
G5. World Conventional Liquids Production by Region and Country, High Oil Price Case, 1990-2030 . . . . . 230
G6. World Unconventional Liquids Production by Region and Country, High Oil Price Case, 1990-2030 . . . . . 232
G7. World Total Liquids Production by Region and Country, Low Oil Price Case, 1990-2030 . . . . . 233
G8. World Conventional Liquids Production by Region and Country, Low Oil Price Case, 1990-2030 . . . . . 234
G9. World Unconventional Liquids Production by Region and Country, Low Oil Price Case, 1990-2030. . . . . 236
G10. World Total Liquids Production by Region and Country, High Economic Growth Case, 1990-2030. . . . . 237
G11. World Conventional Liquids Production by Region and Country, High Economic Growth Case, 1990-2030 . . . . . 238
G12. World Unconventional Liquids Production by Region and Country, High Economic Growth Case, 1990-2030 . . . . . 240
G13. World Total Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030 . . . . . 241
G14. World Conventional Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030. . . 242
G15. World Unconventional Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030. . . . . 244

H1. World Total Installed Generating Capacity by Region and Country, 2006-2030. . . . . 247
H2. World Installed Liquids-Fired Generating Capacity by Region and Country, 2006-2030 . . . . . 248
H3. World Installed Natural-Gas-Fired Generating Capacity by Region and Country, 2006-2030 . . . . . 249
H4. World Installed Coal-Fired Generating Capacity by Region and Country, 2006-2030. . . . . 250
H5. World Installed Nuclear Generating Capacity by Region and Country, 2006-2030 . . . . . 251
H6. World Installed Hydroelectric Generating Capacity by Region and Country, 2006-2030 . . . . . 252
H7. World Installed Wind-Powered Generating Capacity by Region and Country, 2006-2030. . . . . 253
H8. World Installed Geothermal Generating Capacity by Region and Country, 2006-2030. . . . . 254
H9. World Installed Other Renewable Generating Capacity by Region and Country, 2006-2030 . . . . . 255
H10. World Total Net Electricity Generation From Central Producers by Region and Country, 2006-2030. . . . . 256
H11. World Net Liquids-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 257
H12. World Net Natural-Gas-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 258
H13. World Net Coal-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030. . . . 259
H14. World Net Nuclear Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 260
H15. World Net Hydroelectric Generation From Central Producers by Region and Country, 2006-2030 . . . . . 261
H16. World Net Wind-Powered Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 262
H17. World Net Geothermal Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 263
H18. World Net Other Renewable Electricity Generation From Central Producers by Region and Country, 2006-2030 . . . . . 264

I1. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Region, 2006-2015 . . . . . 265
I2. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Region, 2015-2030 . . . . . 267
I3. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Fuel, 2006-2015. . . . . 267
I4. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Fuel, 2015-2030. . . . . 268
I5. Comparison of *IEO2009* and *IEO2008* Total World Energy Consumption, Reference Case, 2015 and 2030 . . . . 269
I6. Comparison of *IEO2009* and *IEO2008* World Energy Consumption by Fuel, Reference Case, 2015 and 2030 . . 270

# Preface

***This report presents international energy projections through 2030, prepared by the Energy Information Administration, including outlooks for major energy fuels and associated carbon dioxide emissions.***

The *International Energy Outlook 2009* (*IEO2009*) presents an assessment by the Energy Information Administration (EIA) of the outlook for international energy markets through 2030. U.S. projections appearing in *IEO2009* are consistent with those published in EIA's *Annual Energy Outlook 2009* (*AEO2009*), in March 2009. A revised, updated *AEO2009* reference case projection was released on April 17, 2009. It reflects the impact of provisions in the American Recovery and Reinvestment Act of 2009 (ARRA2009), enacted in mid-February 2009, on U.S. energy markets. The revised *AEO2009* reference case includes updates for the U.S. macroeconomic outlook, which has been changing at an unusually rapid rate in recent months. Throughout *IEO2009*, significant changes to the U.S. outlook relative to the published *AEO2009* reference case are noted for the reader's reference.

*IEO2009* is provided as a service to energy managers and analysts, both in government and in the private sector. The projections are used by international agencies, Federal and State governments, trade associations, and other planners and decisionmakers. They are published pursuant to the Department of Energy Organization Act of 1977 (Public Law 95-91), Section 205(c).

Projections in *IEO2009* are divided according to Organization for Economic Cooperation and Development members (OECD) and non-members (non-OECD). There are three basic country groupings in the OECD: North America (United States, Canada, and Mexico); OECD Europe; and OECD Asia (Japan, South Korea, and Australia/New Zealand) (see Appendix K for complete regional definitions). Non-OECD is divided into five separate regional subgroups: non-OECD Europe and Eurasia, non-OECD Asia, Africa, Middle East, and Central and South America. Russia is represented in non-OECD Europe and Eurasia; China and India are represented in non-OECD Asia; and Brazil is represented in Central and South America.

*IEO2009* focuses exclusively on marketed energy. Non-marketed energy sources, which continue to play an important role in some developing countries, are not included in the estimates. The *IEO2009* projections are based on U.S. and foreign government laws in effect on January 1, 2009. The potential impacts of pending or proposed legislation, regulations, and standards are not reflected in the projections, nor are the impacts of legislation for which the implementing mechanisms have not yet been announced.

The report begins with a review of world trends in energy demand and the major macroeconomic assumptions used in deriving the *IEO2009* projections, along with the major sources of uncertainty in the forecast. The time frame for historical data begins with 1980 and extends to 2006, and the projections extend to 2030. High economic growth and low economic growth cases were developed to depict a set of alternative growth paths for the energy projections. The two cases consider higher and lower growth paths for regional gross domestic product (GDP) than are assumed in the reference case. *IEO2009* also includes a high oil price case and, alternatively, a low oil price case. The resulting projections—and the uncertainty associated with international energy

### Objectives of the *IEO2009* Projections

The projections in *IEO2009* are not statements of what will happen, but what might happen given the specific assumptions and methodologies used. The projections provide an objective, policy-neutral reference case that can be used to analyze international energy markets. As a policy-neutral data and analysis organization, EIA does not propose, advocate, or speculate on future legislative and regulatory changes.

Models are abstractions of energy production and consumption activities, regulatory activities, and producer and consumer behavior. The projections are highly dependent on the data, analytical methodologies, model structures, and specific assumptions used in their development. Trends depicted in the analysis are indicative of tendencies in the real world rather than representations of specific real-world outcomes. Even where trends are stable and well understood, the projections are subject to uncertainty. Many events that shape energy markets are random and cannot be anticipated, and assumptions concerning future technology characteristics, demographics, and resource availability are necessarily uncertain.

projections in general—are discussed in Chapter 1, "World Energy Demand and Economic Outlook."

Regional projections for energy consumption by fuel—liquids (primarily petroleum), natural gas, and coal—are presented in Chapters 2, 3, and 4, along with reviews of the current status of each fuel on a worldwide basis. Chapter 5 discusses the projections for world electricity markets—including nuclear power, hydropower, and other commercial renewable energy resources—and presents forecasts of world installed generating capacity. Chapter 6 provides a discussion of industrial sector energy use. Chapter 7 includes a detailed look at the world's transportation energy use. Finally, Chapter 8 discusses the outlook for global energy-related carbon dioxide emissions.

Appendix A contains summary tables for the *IEO2009* reference case projections of world energy consumption, GDP, energy consumption by fuel, carbon dioxide emissions, and regional population growth. Summary tables of projections for the high and low economic growth cases are provided in Appendixes B and C, respectively, and projections for the high and low oil price cases are provided in Appendixes D and E, respectively. Reference case projections of delivered energy consumption by end-use sector and region are presented in Appendix F. Appendix G contains summary tables of projections for world liquids production in all cases. Appendix H contains summary tables of reference case projections for installed electric power capacity by fuel and regional electricity generation by fuel. Appendix I includes a set of comparisons of projections from the International Energy Agency's *World Energy Outlook 2008* with the *IEO2009* projections. Comparisons of the *IEO2009* and *IEO2008* projections are also presented in Appendix I. Appendix J describes the models used to generate the *IEO2009* projections, and Appendix K defines the regional designations included in the report.

# Highlights

***World marketed energy consumption is projected to increase by 44 percent from 2006 to 2030. Total energy demand in the non-OECD countries increases by 73 percent, compared with an increase of 15 percent in the OECD countries.***

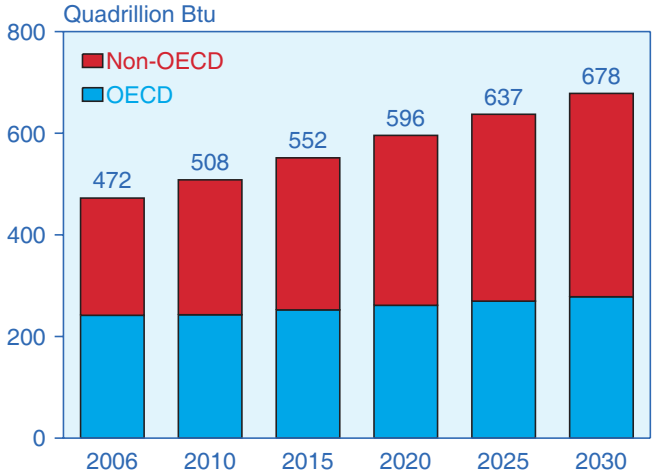
In the *IEO2009* reference case—which reflects a scenario in which current laws and policies remain unchanged throughout the projection period—world marketed energy consumption is projected to grow by 44 percent over the 2006 to 2030 period. Total world energy use rises from 472 quadrillion British thermal units (Btu) in 2006 to 552 quadrillion Btu in 2015 and then to 678 quadrillion Btu in 2030 (Figure 1). The current worldwide economic downturn dampens world demand for energy in the near term, as manufacturing and consumer demand for goods and services slows. In the longer term, with economic recovery anticipated after 2010, most nations return to trend growth in income and energy demand.

The most rapid growth in energy demand from 2006 to 2030 is projected for nations outside the Organization for Economic Cooperation and Development (non-OECD nations). Total non-OECD energy consumption increases by 73 percent in the *IEO2009* reference case projection, as compared with a 15-percent increase in energy use among the OECD countries. Strong long-term GDP growth in the emerging economies of the non-OECD countries drives the fast-paced growth in energy demand. In all the non-OECD regions combined, economic activity—measured by GDP in purchasing power parity terms—increases by 4.9 percent per year on average, as compared with an average of 2.2 percent per year for the OECD countries.

The *IEO2009* reference case projects increased world consumption of marketed energy from all fuel sources over the 2006 to 2030 projection period (Figure 2). Fossil fuels (liquid fuels and other petroleum,[1] natural gas, and coal) are expected to continue supplying much of the energy used worldwide. Liquids supply the largest share of world energy consumption over the projection period; however, their share falls from 36 percent in 2006 to 32 percent in 2030, as projected high world oil prices lead many energy users, especially in the industrial and electric power sectors, to switch away from liquid fuels when feasible.

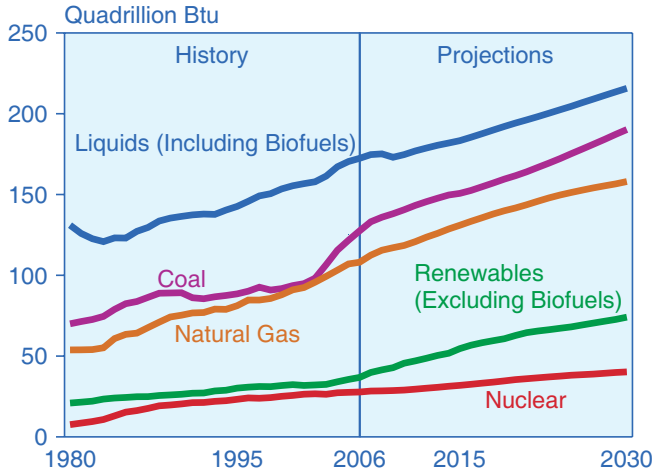
Average world oil prices[2] increased each year between 2003 and 2008. Spot prices reached $147 per barrel (in nominal dollars) in mid-July 2008, when they were well

**Figure 1. World Marketed Energy Consumption, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 2. World Marketed Energy Use by Fuel Type, 1980-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[1]Liquid fuels and other petroleum include petroleum-derived fuels and non-petroleum-derived fuels, such as ethanol and biodiesel, coal-to-liquids, and gas-to-liquids. Petroleum coke, which is a solid, is included. Also included are natural gas liquids, crude oil consumed as a fuel, and liquid hydrogen.

[2]The world oil price reported in *IEO2009* is for light sweet crude oil delivered to Cushing, Oklahoma. This price series is consistent with spot prices for light, sweet crude oil reported on the New York Mercantile Exchange (NYMEX). All oil prices are in real 2007 dollars per barrel, unless otherwise noted.

above the historical inflation-adjusted record price for a barrel of oil, which was set in the early 1980s. After reaching the July 2008 high mark, however, prices fell sharply. As the world's economies recover, world oil prices are assumed to rebound and rise in real terms through 2030. In the *IEO2009* reference case, the price of light sweet crude oil in the United States (in real 2007 dollars) rises from $61 per barrel in 2009 to $110 per barrel in 2015 and $130 per barrel in 2030.

## World Energy Use by Fuel Type

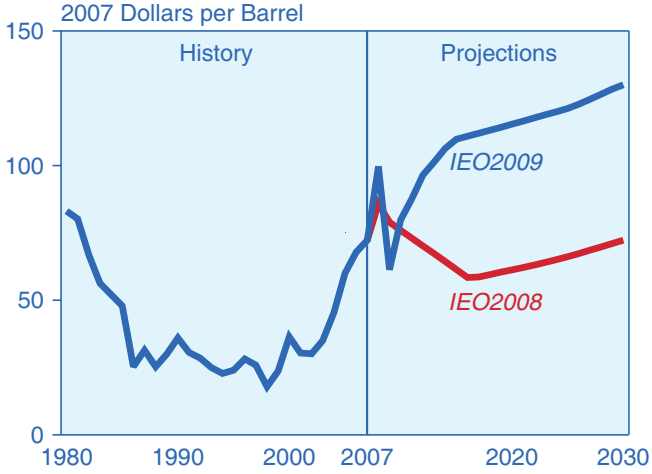
Liquids are expected to remain the world's dominant energy source throughout the *IEO2009* reference case projection, given their importance in the transportation and industrial end-use sectors. World use of liquids and other petroleum grows from 85 million barrels per day in 2006 to 91 million barrels per day in 2015 and 107 million barrels per day in 2030. Only in the transportation sector are liquids relatively unaffected by the projected high world oil prices. Although world oil prices in 2030 in the *IEO2009* reference case are 80 percent higher than projected in *IEO2008* (Figure 3), liquids consumption in the world transportation sector in 2030 is only 9 percent lower in this year's outlook, reflecting the expectation that, absent significant technological advances, liquids will continue to be the primary energy source in the world's transportation sector.

To meet the increment in world liquids demand in the *IEO2009* reference case, total supply in 2030 is projected to be 22.0 million barrels per day higher than the 2006 level of 84.6 million barrels per day. The reference case assumes that OPEC will maintain a share of approximately 40 percent of total world liquids production through 2030, consistent with recent trends. Increasing volumes of conventional liquids (crude oil and lease condensate, natural gas plant liquids, and refinery gain) from OPEC members contribute 8.2 million barrels per day to the total increase in world liquids production, and conventional liquids supplies from non-OPEC countries add another 3.4 million barrels per day (Figure 4).

Unconventional resources (including oil sands, extra-heavy oil, biofuels, coal-to-liquids, and gas-to-liquids) from both OPEC and non-OPEC sources are expected to become increasingly competitive in the reference case. World production of unconventional resources, which totaled only 3.1 million barrels per day in 2006, increases to 13.4 million barrels per day and accounts for 13 percent of total world liquids supply in 2030.

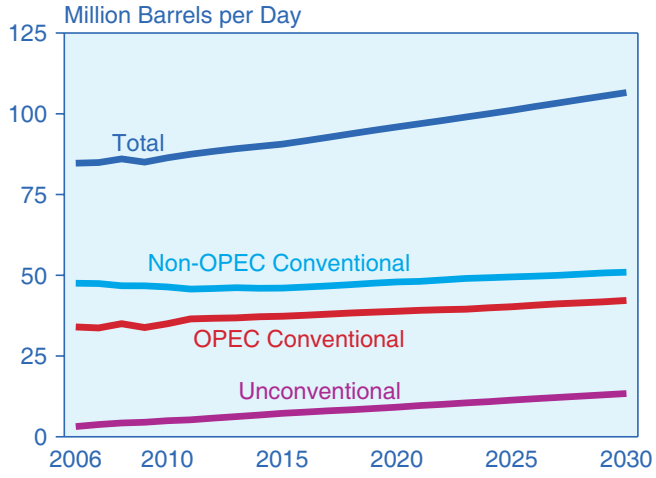
Biofuels, including ethanol and biodiesel, will be an increasingly important source of unconventional liquids supply, reaching 5.9 million barrels per day in 2030. Particularly strong growth in biofuels consumption is projected for the United States, where production of biofuels increases from 0.3 million barrels per day in 2006 to 1.9 million barrels per day in 2030, supported by legislation in the Energy Independence and Security Act of 2007 that mandates increased U.S. use of biofuels. Other regions with sizable projected increases in biofuels production include OECD Europe, non-OECD Asia, and Central and South America. Those regions, together with the United States, account for 75 percent of the world increase in biofuels production.

**Figure 3. World Oil Prices in the *IEO2009* and *IEO2008* Reference Cases, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. ***IEO2008*:** EIA, *International Energy Outlook 2008*, DOE/EIA-0484(2008) (Washington, DC, September 2009), web site www.eia.doe.gov/oiaf/ieo/ieoarchive.html. ***IEO2009*:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), web site www.eia.doe.gov/oiaf/aeo.

**Figure 4. World Liquids Production, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, Generate World Oil Balance Model (2009).

Natural gas consumption worldwide increases in the *IEO2009* reference case from 104 trillion cubic feet in 2006 to 153 trillion cubic feet in 2030. With world oil prices rebounding from their early 2009 level, as the world economy recovers from the current downturn, and then continuing to grow in real terms through the end of the projection period, consumers opt for comparatively less expensive natural gas for their energy needs whenever possible. As a result, natural gas remains a key energy source in the industrial sector and for electricity generation. The industrial sector currently consumes more natural gas than any other end-use sector, and this is expected to remain true in the reference case through 2030, when 40 percent of the world's natural gas supply is used for industrial purposes. Electricity generation accounts for 35 percent of the world's total natural gas consumption in 2030, up from 32 percent in 2006.

To meet the projected growth in demand for natural gas, the world's producers will need to increase annual production in 2030 to a level that is 49 trillion cubic feet higher than the 2006 total. Much of the increase in natural gas production is expected to come from the non-OECD countries. In the *IEO2009* reference case, natural gas production in the non-OECD nations in 2030 is 41 trillion cubic feet higher than in 2006, accounting for about 84 percent of the total increase in world supply. By region, the Middle East, non-OECD Europe and Eurasia, and non-OECD Asia each supplies about 20 percent of the increase (Figure 5). Africa, which is an important source of new natural gas production, provides 15 percent of the total world increment.

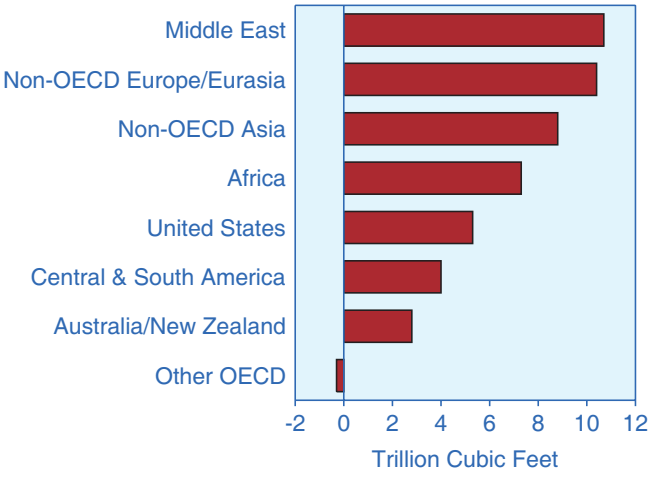
Natural gas production from the OECD nations is projected to increase by 7.8 trillion cubic feet from 2006 to 2030 in the reference case. The largest increase among the OECD nations is projected for the United States, at 5.3 trillion cubic feet. Unconventional natural gas is the largest contributor to the growth in U.S. production, as rising prices and improvements in drilling technology provide the economic incentives necessary for exploitation of more costly resources. Unconventional natural gas production—both from natural gas in tight sand formations and from shale formations—increases from 47 percent of the U.S. total in 2006 to 56 percent in 2030.

In the absence of national policies and/or binding international agreements that would limit or reduce greenhouse gas emissions, world coal consumption is projected to increase from 127 quadrillion Btu in 2006 to 190 quadrillion Btu in 2030, an average annual rate of 1.7 percent. Much of the projected increase in coal use occurs in the non-OECD Asia region, which accounts for nearly 90 percent of the total world increase in coal use from 2006 to 2030. In fact, much of the region's increase in energy demand is expected to be met by coal, particularly in the electric power and industrial sectors. For example, installed coal-fired generating capacity in China is projected to nearly triple from 2006 to 2030, and coal use in China's industrial sector grows by nearly 60 percent. The development of China's electric power and industrial sectors will require not only large-scale infrastructure investments but also substantial investment in both coal mining and coal transportation infrastructure.

World net electricity generation increases by 77 percent in the reference case, from 18.0 trillion kilowatthours in 2006 to 23.2 trillion kilowatthours in 2015 and 31.8 trillion kilowatthours in 2030. Although the current economic downturn is expected to dampen electricity demand in the near term, the *IEO2009* reference case assumes that growth in electricity demand will return to trend after 2010. In general, the growth in OECD countries, where electricity markets are well established and consuming patterns are mature, is slower than in the non-OECD countries, where a large amount of potential demand remains unsatisfied. In the reference case, total net generation in the non-OECD countries increases by an average of 3.5 percent per year, compared with an average of 1.2 percent per year in the OECD nations.

The rapid increase in world energy prices from 2003 to 2008, combined with concerns about the environmental consequences of greenhouse gas emissions, has led to renewed interest in the development of alternatives to fossil fuels. With high world oil prices expected to return and growth in demand for liquids and other energy expected to resume when economies begin to recover from the current global downturn, renewable energy is the fastest-growing source of world electricity generation in the *IEO2009* reference case, supported both by the expected high prices for fossil fuels and by government incentives for the development of alternative energy sources.

**Figure 5. Net Change in World Natural Gas Production, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

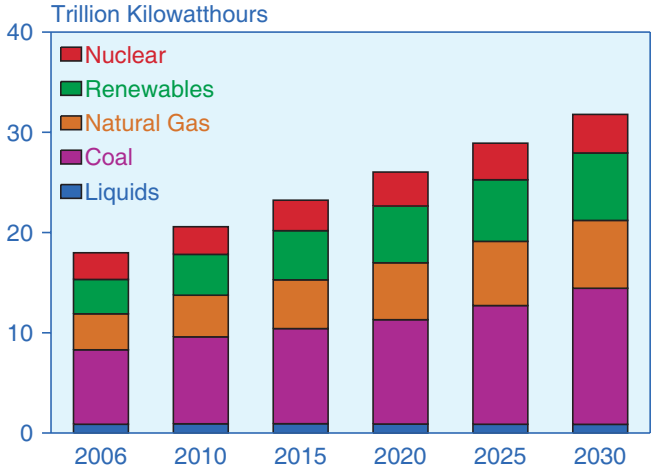
From 2006 to 2030, world renewable energy use for electricity generation grows by an average of 2.9 percent per year (Figure 6), and the renewable share of world electricity generation increases from 19 percent in 2006 to 21 percent in 2030.[3] Natural gas and coal are the second and third fastest-growing energy sources for electricity generation in the projection; however, the outlook for coal, in particular, could be altered substantially by any future legislation that would reduce or limit the growth of greenhouse gas emissions.

Much of the world increase in renewable electricity supply is fueled by hydropower and wind power. Of the 3.3 trillion kilowatthours of new renewable generation added over the projection period, 1.8 trillion kilowatthours (54 percent) is attributed to hydropower and 1.1 trillion kilowatthours (33 percent) to wind. Except for those two sources, most renewable energy technologies are not economically competitive with fossil fuels over the projection period, outside a limited number of niche markets. Solar power, for instance, typically is uneconomical but can be economical where electricity prices are high and government incentives are available. In fact, government incentives or policies typically provide the primary support for construction of any renewable generation facilities.

The mix of renewable fuels consumed differs between the OECD and non-OECD regions in the *IEO2009* reference case projection. In the OECD nations, the majority of economically exploitable hydroelectric resources already have been used, and there are few large-scale hydroelectric power projects planned for the future (Figure 7). As a result, most of the growth in renewable energy use in the OECD countries is expected for other sources, led by wind and biomass. In the non-OECD nations, hydropower is the predominant source of renewable energy growth, with mid- to large-scale hydroelectric plants expected to be completed in China, India, Brazil, and a number of nations in Southeast Asia, including Vietnam and Laos. Wind-powered electricity generation also is expected to grow significantly in the non-OECD countries, including substantial additions of wind electricity to the grid in China.

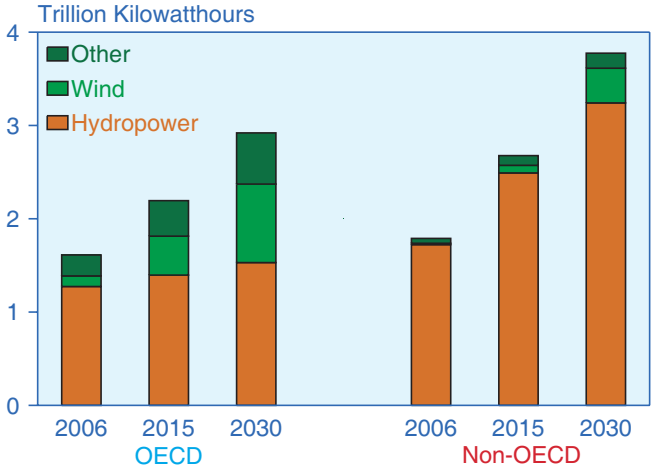
Electricity generation from nuclear power is projected to increase from about 2.7 trillion kilowatthours in 2006 to 3.8 trillion kilowatthours in 2030, as concerns about rising fossil fuel prices, energy security, and greenhouse gas emissions support the development of new nuclear generation capacity. Higher fossil fuel prices allow nuclear power to become economically competitive with generation from coal, natural gas, and liquids despite the relatively high capital and maintenance costs associated with nuclear power plants. Moreover, higher capacity utilization rates have been reported for many existing nuclear facilities, and it is anticipated that most of the older nuclear power plants in the OECD countries and non-OECD Eurasia will be granted extensions to their operating lives.

**Figure 6. World Electricity Generation by Fuel, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 7. World Renewable Electricity Generation by Energy Source, 2006, 2015, and 2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[3]The *IEO2009* reference case does not reflect the provisions of American Recovery and Reinvestment Act of 2009 (ARRA2009). In the *updated AEO2009* reference case (April 2009), a significant expansion in the use of renewable fuels for U.S. electricity generation is projected, particularly in the near term. An extension of key Federal tax credits and a new loan guarantee program in ARRA2009 both stimulate increased renewable generation relative to the *published* reference case (March 2009). In 2030, U.S. renewable electricity generation in the *published* reference case accounts for 14.2 percent of total U.S. net generation; but in the *updated* reference case, renewables account for 15.8 percent of total U.S. net generation in 2030, or about 67 billion kilowatthours more than projected in the *published* reference case.

Despite the growing worldwide interest in nuclear power development, there is considerable uncertainty associated with this energy source. Issues that could slow the expansion of nuclear power in the future include plant safety, radioactive waste disposal, and concerns that weapons-grade uranium may be produced from facilities installed to enrich uranium for civilian nuclear power programs. These issues continue to raise public concerns in many countries and may hinder the development of new nuclear power reactors. Nevertheless, the *IEO2009* reference case incorporates the improved prospects for world nuclear power. The *IEO2009* projection for nuclear electricity generation in 2025 is 25 percent higher than the projection published in *IEO2004* only 5 years ago.

On a regional basis, the *IEO2009* reference case projects the strongest growth in nuclear power for the countries of non-OECD Asia, where nuclear power generation is projected to grow at an average rate of 7.8 percent per year from 2006 to 2030. Nuclear generation is projected to increase by 8.9 percent per year in China and by 9.9 percent per year in India. Outside Asia, the largest increase in installed nuclear capacity among the non-OECD nations is projected for Russia, with increases in nuclear power generation averaging 3.5 percent per year. In contrast, OECD Europe—where some national governments, including Germany and Belgium, still have plans in place to phase out nuclear programs entirely—is expected to see a small decline in nuclear power generation.

## World Delivered Energy Use by Sector

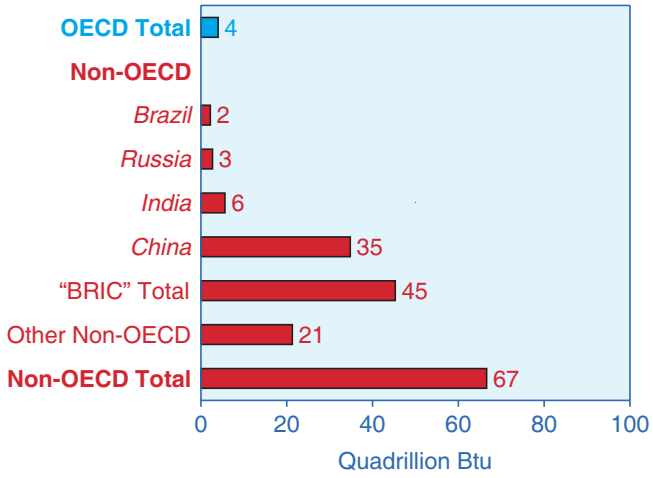
The industrial sector uses more energy than any other end-use sector, currently consuming about one-half of the world's total delivered energy. Energy is consumed in the industrial sector by a diverse group of industries—including manufacturing, agriculture, mining, and construction—and for a wide range of activities, such as processing and assembly, space conditioning, and lighting. Worldwide, industrial energy consumption is expected to grow from 175.0 quadrillion Btu in 2006 to 245.6 quadrillion Btu in 2030.

Industrial energy demand varies across regions and countries of the world, based on levels and mixes of economic activity and technological development, among other factors. About 94 percent of the world increase in industrial sector energy consumption is projected to occur in the non-OECD economies, where—driven by rapid economic growth—industrial energy consumption grows at an average annual rate of 2.1 percent in the reference case. The key engines of non-OECD growth in the projection are the so-called "BRIC" countries (Brazil, Russia, India, and China), which account for more than two-thirds of the growth in non-OECD industrial energy use through 2030 (Figure 8). Because the OECD nations have been undergoing a transition from manufacturing economies to service economies in recent decades and have relatively slow projected growth in economic output, industrial energy use in the OECD region as a whole grows by an average of only 0.2 percent per year from 2006 to 2030.

The transportation is second only to the industrial sector in terms of world energy use, and it is of particular importance given the role of liquid fuels in meeting transportation demand. The transportation share of total liquids consumption increases from 51 percent in 2006 to 56 percent in 2030 in the *IEO2009* reference case, accounting for nearly 80 percent of the total increase in world liquids consumption. Much of the growth in transportation energy use is projected for the non-OECD nations, where rapidly expanding economies are expected to see strong growth in liquids consumption as transportation systems become motorized and rising per-capita incomes increase the demand for personal motor vehicle ownership. Non-OECD transportation energy use increases by an average of 2.7 percent per year from 2006 to 2030.

Major urban areas in the non-OECD nations are expected to address transportation congestion and strains on infrastructure with a variety of solutions, including development of mass transit (bus and/or rail) and urban design that reduces vehicle-miles traveled, among other improvements in transportation networks. In non-OECD Asia, for example, the reference case projects that energy use for personal motor vehicles (light-duty cars and trucks, as well as two- and three-wheel vehicles)

**Figure 8. Net Increase in Industrial Energy Use by Region, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

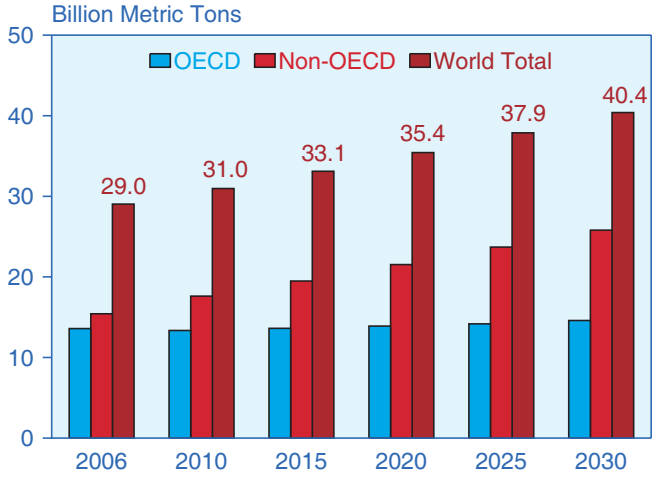
will increase by 3.6 percent per year from 2006 to 2030, while energy use for public passenger travel (rail and bus) also shows robust growth in energy use, averaging 2.9 percent per year.

In the OECD nations, transportation energy consumption grows by a relatively modest average of 0.3 percent per year over the projection period. Transportation infrastructure in the OECD countries generally is well established. Roads and highways connect most population centers, and motorization levels (vehicles per 1,000 people), which already are high, probably will reach saturation by 2030. As the OECD economies have become more service-oriented, the link between income and the transportation of goods has weakened, and their relatively slow rates of GDP growth and population growth in the *IEO2009* reference case lead to the expectation that total transportation energy demand in the OECD countries will increase only modestly from 2006 to 2030.

## World Carbon Dioxide Emissions

World carbon dioxide emissions are projected to rise from 29.0 billion metric tons in 2006 to 33.1 billion metric tons in 2015 and 40.4 billion metric tons in 2030—an increase of 39 percent over the projection period. With strong economic growth and continued heavy reliance on fossil fuels expected for most of the non-OECD economies, much of the increase in carbon dioxide emissions is projected to occur among the developing, non-OECD nations. In 2006, non-OECD emissions exceeded OECD emissions by 14 percent. In 2030, however, non-OECD emissions are projected to exceed OECD emissions by 77 percent (Figure 9).

**Figure 9. World Carbon Dioxide Emissions, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

# Chapter 1
# World Energy Demand and Economic Outlook

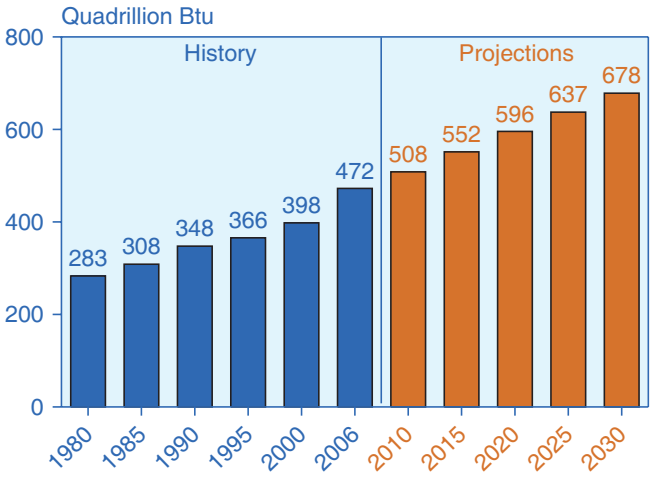
***In the IEO2009 projections, total world consumption of marketed energy is projected to increase by 44 percent from 2006 to 2030. The largest projected increase in energy demand is for the non-OECD economies.***

In the *IEO2009* reference case, world energy consumption increases from 472 quadrillion Btu in 2006 to 552 quadrillion Btu in 2015 and 678 quadrillion Btu in 2030—a total increase of 44 percent over the projection period (Figure 10 and Table 1). Total world energy use in 2030 is about 2 percent lower than projected in the *International Energy Outlook 2008* (*IEO2008*), largely as the result of a slower overall rate of economic growth in this year's reference case.

The current economic downturn dampens world demand for energy in the near term, as manufacturing and consumer demand for goods and services slow. *IEO2009* assumes, however, that most nations will begin to return to trend growth within the next 12 to 24 months.

OECD member countries,[4] for the most part, have the world's most established energy infrastructures. In combination, they account for the largest share of current world energy consumption. The situation is expected to change over the projection period, however, with more rapid growth in energy demand in emerging non-OECD economies. In 2006, 51 percent of world energy consumption was in the OECD economies; but in 2030 their share falls to 41 percent in the reference case.

**Figure 10. World Marketed Energy Consumption, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table 1. World Marketed Energy Consumption by Country Grouping, 2006-2030**
(Quadrillion Btu)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | **241.7** | **242.8** | **252.4** | **261.3** | **269.5** | **278.2** | **0.6** |
| North America | 121.3 | 121.1 | 125.9 | 130.3 | 135.6 | 141.7 | 0.6 |
| Europe | 81.6 | 82.2 | 84.8 | 87.9 | 90.0 | 91.8 | 0.5 |
| Asia | 38.7 | 39.5 | 41.8 | 43.1 | 43.9 | 44.6 | 0.6 |
| **Non-OECD** | **230.8** | **265.4** | **299.1** | **334.4** | **367.8** | **400.1** | **2.3** |
| Europe and Eurasia | 50.7 | 54.0 | 57.6 | 60.3 | 62.0 | 63.3 | 0.9 |
| Asia | 117.6 | 139.2 | 163.2 | 190.3 | 215.4 | 239.6 | 3.0 |
| Middle East | 23.8 | 27.7 | 30.3 | 32.2 | 34.6 | 37.7 | 1.9 |
| Africa | 14.5 | 16.2 | 17.7 | 19.1 | 20.6 | 21.8 | 1.7 |
| Central and South America | 24.2 | 28.3 | 30.3 | 32.5 | 35.2 | 37.7 | 1.9 |
| **Total World** | **472.4** | **508.3** | **551.5** | **595.7** | **637.3** | **678.3** | **1.5** |

Note: Totals may not equal sum of components due to independent rounding.
Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[4]For consistency, OECD includes all members of the organization as of March 1, 2009, throughout all the time series included in this report.

OECD energy use grows slowly over the projection period, averaging 0.6 percent per year, as compared with 2.3 percent per year for the emerging non-OECD economies (Figure 11).

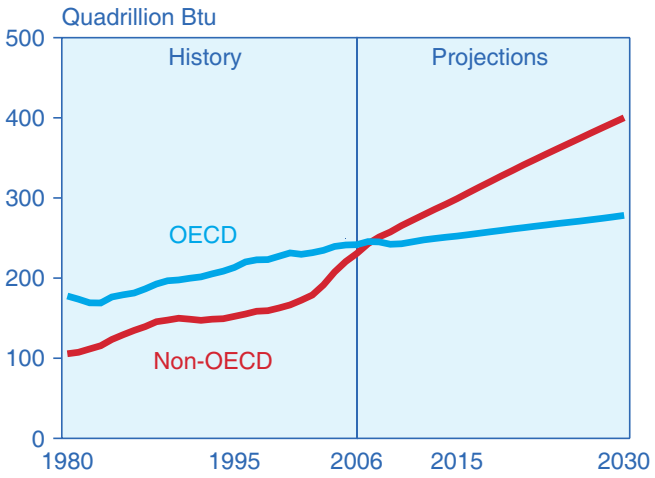
China and India are the fastest-growing non-OECD economies, and they will be key world energy consumers in the future. Since 1990, energy consumption as a share of total world energy use has increased significantly in both countries. China and India together accounted for about 10 percent of the world's total energy consumption in 1990, but in 2006 their combined share was 19 percent. Strong economic growth in both countries continues over the projection period, with their combined energy use increasing nearly twofold and making up 28 percent of world energy consumption in 2030 in the reference case. In contrast, the U.S. share of total world energy consumption falls from 21 percent in 2006 to about 17 percent in 2030 (Figure 12).

Non-OECD Asia shows the most robust growth of all the non-OECD regions, with energy use rising by 104 percent from 2006 to 2030 (Figure 13). Energy consumption in other non-OECD regions also grows strongly over the projection period, with projected increases of around 60 percent for the Middle East and for Central and South America and 50 percent for Africa. A smaller increase, about 25 percent, is expected for non-OECD Europe and Eurasia (including Russia and the other former Soviet Republics), as declining population and substantial gains in energy efficiency result from the replacement of inefficient Soviet-era capital equipment.

This chapter presents an overview of the *IEO2009* outlook for global marketed energy consumption by energy source. It includes discussions of the major assumptions that form the basis for the *IEO2009* projections, including macroeconomic assumptions for the key OECD and non-OECD regions.

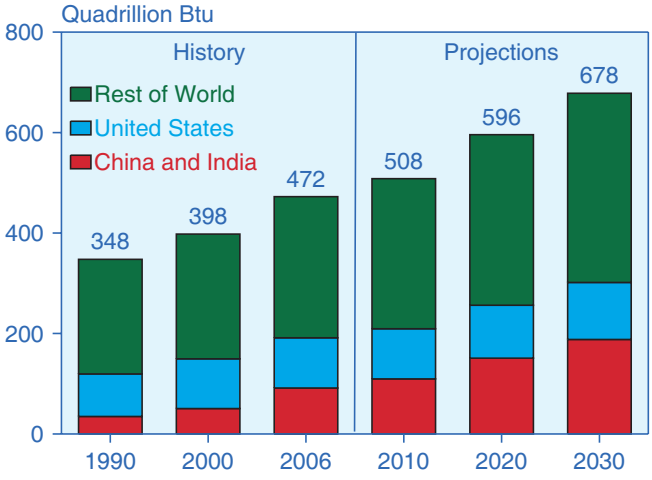
As with any set of projections, there is significant uncertainty associated with the *IEO2009* energy projections. Two sets of sensitivity cases, which vary some of the assumptions behind the projections, are also examined in this chapter: the high and low economic growth cases and the high and low world oil price cases. The sensitivity cases are intended to illustrate alternative scenarios rather than to identify any bounds on uncertainty, which can also be affected by policy and technology developments as well as by price and growth paths.

**Figure 11. World Marketed Energy Consumption: OECD and Non-OECD, 1980-2030**



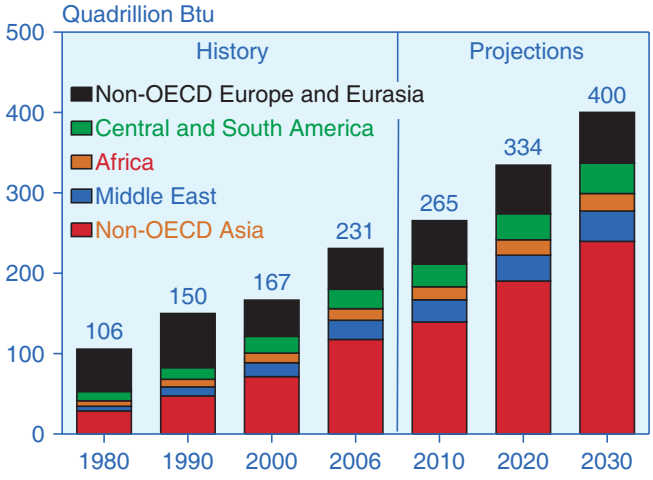

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 12. Marketed Energy Use by Region, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 13. Marketed Energy Use in the Non-OECD Economies by Region, 1980-2030**



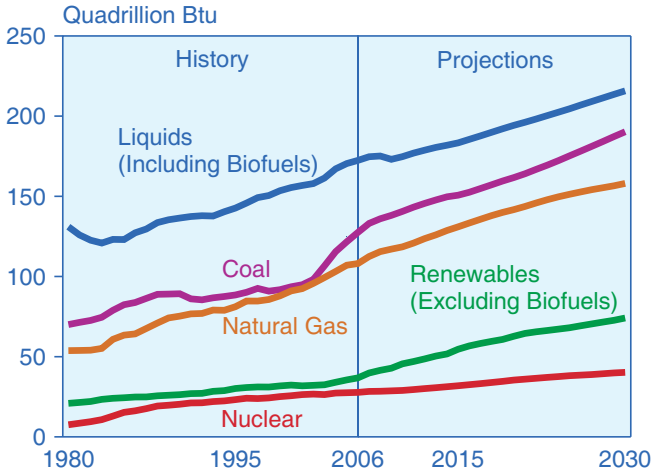

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

## Outlook for World Energy Consumption by Source

The use of all energy sources increases over the time frame of the *IEO2009* reference case (Figure 14). Given expectations that world oil prices will remain relatively high through most of the projection period, liquid fuels and other petroleum[5] are the world's slowest growing source of energy: liquids consumption increases at an average annual rate of 0.9 percent from 2006 to 2030. Renewables are the fastest-growing source of world energy, with consumption increasing by 3.0 percent per year. Projected oil prices, as well as rising concern about the environmental impacts of fossil fuel use and strong government incentives for increasing renewable penetration in most countries around the world, improve the prospects for renewable energy sources worldwide.

Although liquid fuels are expected to remain the largest source of energy, the liquids share of world marketed energy consumption declines from 36 percent in 2006 to 32 percent in 2030. The reference case assumes that world oil prices lead many energy users, especially in the industrial and electric power sectors, to switch from liquid fuels and other petroleum when feasible. From 2006 to 2030, liquids consumption in the residential, commercial, and electric power sectors declines on a worldwide basis. For example, the projections show a steady decline of 0.3 percent per year in total world use of liquids for electricity generation. Nonetheless, the countries of the Middle East continue to rely on liquids for a sizable portion of their electricity supply, remaining near 25 percent in 2030.

**Figure 14. World Marketed Energy Use by Fuel Type, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

In the transportation sector, liquids consumption is relatively unaffected by projected world oil prices in the reference case. Although world oil prices in the *IEO2009* reference case are 80 percent higher in 2030 than the projected prices in the *IEO2008* reference case, the world's consumption of liquids for transportation in 2030 is only 9 percent lower in *IEO2009*. In the absence of significant technological advances, liquids continue to dominate the world's transportation markets.

In the industrial sector, growth in liquids consumption is slower than projected in last year's outlook. Efficiency gains and fuel substitution slow the growth of liquids consumption in the industrial sector, especially in the non-OECD regions, where there are more opportunities for fuel switching. World liquids consumption for energy in the industrial sector, which was projected to increase by 1.1 percent per year from 2005 to 2030 in the *IEO2008* reference case, increases by 0.7 per year over the same period in *IEO2009*.

Natural gas remains an important fuel for electricity generation worldwide, because it is more efficient and less carbon-intensive than other fossil fuels. In the *IEO2009* reference case, total natural gas consumption increases by 1.6 percent per year on average, from 104 trillion cubic feet in 2006 to 153 trillion cubic feet in 2030, and its use in the electric power sector increases by 2.1 percent per year. With world oil prices assumed to rebound following the current economic downturn and then rise through 2030, consumers are expected to choose less expensive natural gas to meet their energy needs whenever possible, particularly in the industrial sector, where, for example, newly constructed petrochemical plants are expected to rely increasingly on natural gas as a feedstock.

World coal consumption increases by 1.7 percent per year on average from 2006 to 2030 (growing by 23 quadrillion Btu from 2006 to 2015 and another 40 quadrillion Btu from 2015 to 2030) and accounts for 28 percent of total world energy consumption in 2030. In the absence of policies or legislation that would limit the growth of coal use, the United States, China, and India are expected to turn to coal in place of more expensive fuels. Together, the three nations account for 88 percent of the projected net increase in coal consumption from 2006 to 2030 (Figure 15). The only decreases in coal consumption are projected for OECD Europe and for Japan, where populations are either growing slowly or declining, electricity demand growth is slow, and renewable

[5]In *IEO2009*, "liquid fuels and other petroleum" includes a full array of liquid product supplies, both conventional and unconventional. Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain; unconventional liquids include biofuels, gas-to-liquids, coal-to-liquids, and unconventional petroleum products (extra-heavy oils, oil shale, and bitumen) but do not include compressed natural gas (CNG), liquefied natural gas (LNG), or hydrogen.

energy sources, natural gas, and nuclear power are likely to be chosen over coal for electricity generation.

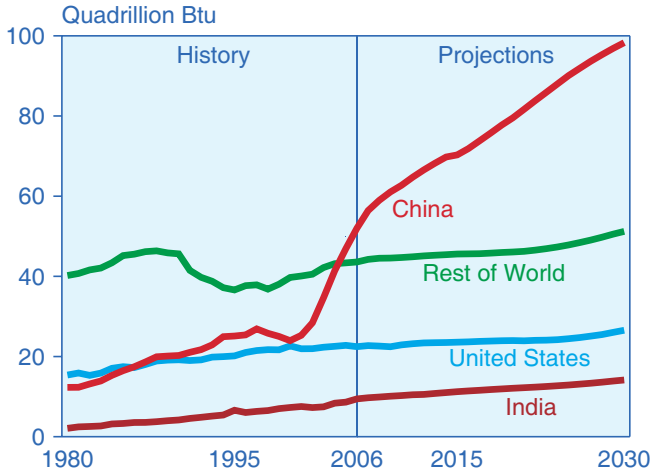
Net electricity generation worldwide totals 31.8 trillion kilowatthours in 2030 in the reference case, 77 percent higher than the 2006 total of 18.0 trillion kilowatthours. The strongest growth in electricity generation is projected for the non-OECD countries. Non-OECD electricity generation increases by 3.5 percent per year in the reference case, as rising standards of living increase demand for home appliances and the expansion of commercial services, including hospitals, office buildings, and shopping malls. In the OECD nations, where infrastructures are well established and population growth is relatively slow, much slower growth in generation is expected, averaging 1.2 percent per year from 2006 to 2030.

Currently, natural gas and coal together account for the largest share of total world electricity generation, at more than 60 percent of global electricity supply. They remain the world's most important sources of supply in 2030, with a 64-percent share of total generation (Figure 16). In non-OECD Asia, where coal resources are ample, higher prices for oil and natural gas make coal a more economical source of energy for electricity generation.

Renewable energy sources are the fastest-growing energy source for world electricity generation in the *IEO2009* reference case, increasing by an average of 2.9 percent per year from 2006 to 2030. Much of the growth is in hydroelectric power and wind power. Of the 3.3 trillion kilowatthours of new renewable generation added over the projection period, 1.8 trillion kilowatthours (54 percent) is attributed to hydroelectric power and 1.1 trillion kilowatthours (33 percent) to wind power (Figure 17). Other than hydroelectric power, most renewable technologies are not able to compete economically with fossil fuels over the projection period, except in a limited number of niche markets. Government policies and incentives typically are the primary drivers for the construction of renewable generation facilities.

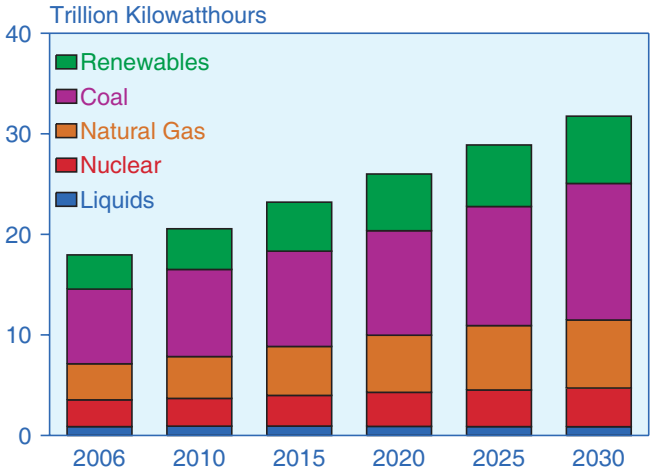
As renewable energy use increases worldwide, the mix of fuels in the OECD and non-OECD regions differs in the reference case. In the OECD nations, the majority of economically exploitable hydroelectric resources already have been developed. With the exception of Canada and Turkey, there are few large-scale hydroelectric

**Figure 15. Coal Consumption in Selected World Regions, 1980-2030**



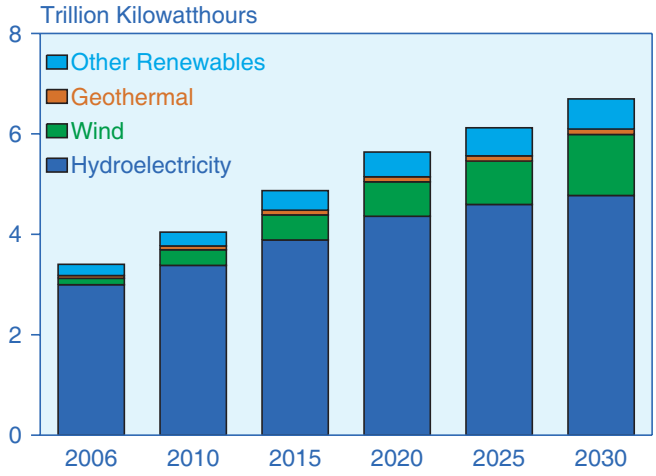

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 16. World Electricity Generation by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 17. World Renewable Electricity Generation by Source, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

power projects planned for the future. Instead, most renewable energy growth in the OECD countries is expected to come from nonhydroelectric sources, especially wind and biomass. Many OECD countries, particularly those in Europe, have government policies, including feed-in tariffs,[6] tax incentives, and market-share quotas, that encourage the construction of renewable electricity facilities.

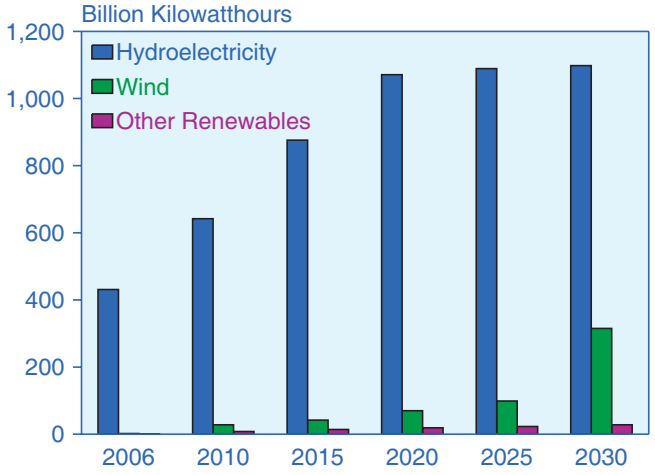
In contrast to the OECD countries, hydroelectric power is expected to be the predominant source of renewable energy growth in the non-OECD nations. Strong growth of hydroelectric generation, primarily from mid- to large-scale power plants, is expected in China, India, Brazil, Vietnam, and Laos. Growth rates for wind-powered electricity generation also are expected to be high in the non-OECD countries, with the largest increment in China, which accounts for 88 percent of the total increase in non-OECD wind generation. From 2 billion kilowatthours in 2006, generation from wind plants in China increases to 315 billion kilowatthours in 2030. Still, the total increase in China's wind-powered generation is only about one-half the expected increase in the country's hydroelectric generation (Figure 18).

Electricity generation from nuclear power worldwide increases from 2.7 trillion kilowatthours in 2006 to 3.0 trillion kilowatthours in 2015 and 3.8 trillion kilowatthours in 2030 in the *IEO2009* reference case, as concerns about rising fossil fuel prices, energy security, and greenhouse gas emissions support the development of new nuclear generating capacity. Higher capacity utilization rates have been reported for many existing nuclear facilities, and it is expected that most of the older plants now operating in OECD countries and in non-OECD Eurasia will be granted extensions to their operating lives.

There is still considerable uncertainty about the future of nuclear power, however, and a number of issues could slow the development of new nuclear power plants. Plant safety, radioactive waste disposal, and the proliferation of nuclear weapons, which continue to raise public concerns in many countries, may hinder plans for new installations, and high capital and maintenance costs may keep some countries from expanding their nuclear power programs. Nevertheless, the *IEO2009* projection for world nuclear electricity generation in 2025 is 25 percent higher than the projection in *IEO2004* just 5 years ago.

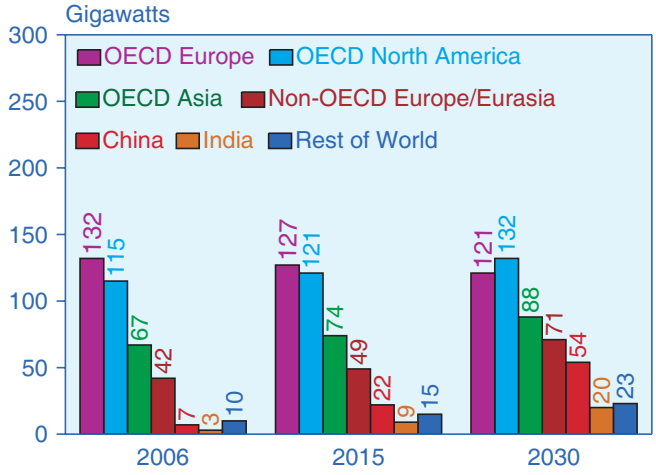
Most of the expansion of installed nuclear power capacity is expected in non-OECD countries (Figure 19). China, India, and Russia account for almost two-thirds of the projected net increment in world nuclear power capacity between 2006 and 2030. In the reference case, China adds 47 gigawatts of nuclear capacity between 2006 and 2030, India 17 gigawatts, and Russia 21 gigawatts. Several OECD nations with existing nuclear programs also add new net capacity in the reference

**Figure 18. Renewable Electricity Generation in China by Fuel, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 19. World Nuclear Generating Capacity by Region, 2006, 2015, and 2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2015 and 2030:** EIA, World Energy Projections Plus (2009).

[6]A feed-in tariff is an incentive structure to encourage the adoption of renewable energy through government legislation. Under a feed-in tariff structure, regional or national electric utilities are obligated to purchase renewable electricity at a higher rate than retail, in order to allow renewable energy sources to overcome price disadvantages.

case, including South Korea with 13 gigawatts, Japan with 8 gigawatts, and the United States with 12 gigawatts.[7]

In the United States, Title XVII of the Energy Policy Act of 2005 (EPACT2005, Public Law 109-58) authorizes the U.S. Department of Energy to issue loan guarantees for innovative technologies that "avoid, reduce, or sequester greenhouse gases." In addition, subsequent legislative provisions in the Consolidated Appropriation Act of 2008 (Public Law 110-161) allocated $18.5 billion in guarantees for nuclear power plants [*1*]. That legislation, along with high fossil fuel prices, results in expected increases of 12.7 gigawatts of capacity at newly built nuclear power plants between 2006 and 2030 and 3.7 gigawatts from uprates at existing plants, offset in part by the retirement of 4.4 gigawatts of capacity at older nuclear power plants.

## Delivered Energy Consumption by End-Use Sector

Understanding patterns in the consumption of energy delivered to end users is important to the development of projections for global energy use. Outside the transportation sector, which at present is dominated by liquid fuels, the mix of energy use in the residential, commercial, and industrial sectors varies widely by region, depending on a combination of regional factors, such as the availability of energy resources, levels of economic development, and political, social, and demographic factors.

### Residential Sector

Energy use in the residential sector, which accounted for about 15 percent of world delivered energy consumption in 2006, is defined as the energy consumed by households, excluding transportation uses. For residential buildings, the physical size of the structures is one key indicator of the amount of energy used by their occupants. Larger homes require more energy to provide heating, air conditioning, and lighting, and they tend to include more energy-using appliances, such as televisions and laundry equipment. Smaller structures usually require less energy, because they contain less space to be heated or cooled, produce less heat transfer with the outdoor environment, and typically have fewer occupants. For instance, residential energy consumption is lower in China, where the average residence currently has an estimated 300 square feet of living space or less per person, than in the United States, where the average residence has an estimated 680 square feet of living space per person [*2*].

The type and amount of energy used by households vary from country to country, depending on income levels, natural resources, climate, and available energy infrastructure. In general, typical households in OECD nations use more energy than those in non-OECD nations, in part because higher income levels allow OECD households to have larger homes and purchase more energy-using equipment. In the United States, for example, GDP per capita in 2006 was about $43,000 (in real 2005 dollars per person), and residential energy use per capita was estimated at 36.0 million Btu. In contrast, China's per-capita income in 2006, at $4,550, was only about one-tenth the U.S. level, and residential energy use per capita was 4.0 million Btu.

Although the *IEO2009* projections account for marketed energy use only, households in many non-OECD countries still rely heavily on traditional, nonmarketed energy sources, including wood and waste, for heating and cooking. Much of Africa remains unconnected to power grids, and the International Energy Agency estimates that the majority of households in sub-Saharan Africa still rely on fuelwood and charcoal for cooking. More than 95 percent of rural households in Angola, Benin, Cameroon, Chad, Congo (Kinshasa), Ethiopia, Ghana, Sudan, and Zambia among others still use fuelwood and charcoal for cooking. [*3*]. Some areas of China and India also rely heavily on fuelwood, wood waste, and charcoal for cooking. In China, about 55 percent of the rural population uses biomass for cooking, as does 87 percent of the rural population in India. Regional economic development should displace some of that use as incomes rise and marketed fuels, such as propane and electricity, become more widely accessible.

### Commercial Sector

The commercial sector—often referred to as the services sector or the services and institutional sector—consists of businesses, institutions, and organizations that provide services. The sector encompasses many different types of buildings and a wide range of activities and energy-related services. Examples of commercial sector facilities include schools, stores, correctional institutions, restaurants, hotels, hospitals, museums, office buildings, banks, and sports arenas. Most commercial energy use occurs in buildings or structures, supplying services such as space heating, water heating, lighting, cooking, and cooling. Energy consumed for services not associated with buildings, such as for traffic lights and city water and sewer services, is also categorized as commercial energy use.

[7] Additional incentives for renewable energy and improved energy efficiency measures included in ARRA2009 lower the prospects for U.S. nuclear power. In the *updated AEO2009* reference case (April 2009), the projection for U.S. nuclear generating capacity in 2030 is 2.5 gigawatts lower than in the *published AEO2009* reference case (March 2009), and the net addition to U.S. installed nuclear capacity between 2006 and 2030 is 9.9 gigawatts, bringing the 2030 total to 110.1 gigawatts in the *updated AEO2009* reference case, as compared with 112.6 gigawatts in the *published* reference case.

Economic trends and population growth drive commercial sector activity and the resulting energy use. The need for services (health, education, financial, and government) increases as populations increase. The degree to which additional needs are met depends in large measure on economic resources—whether from domestic or foreign sources—and economic growth.

Economic growth also determines the degree to which additional activities are offered and utilized in the commercial sector. Higher levels of economic activity and disposable income lead to increased demand for hotels and restaurants to meet business and leisure requirements; for office and retail space to house and service new and expanding businesses; and for cultural and leisure space such as theaters, galleries, and arenas. In the commercial sector, as in the residential sector, energy use per capita in the non-OECD countries is much lower than in the OECD countries. Non-OECD commercial energy consumption per capita averaged only 1.3 million Btu in 2006, compared with the OECD average of 16.3 million Btu.

Slow population growth in most of the OECD nations contributes to slower anticipated rates of increase in commercial energy demand. In addition, continued efficiency improvements moderate the growth of energy demand over time, as energy-using equipment is replaced with newer, more efficient stock. Conversely, continued economic growth is expected to include growth in business activity, with its associated energy use, in areas such as retail and wholesale trade and business, financial services, and leisure services. The United States is the largest consumer of commercial delivered energy in the OECD and remains in that position throughout the projection, accounting for about 44 percent of the OECD total in 2030.

In the non-OECD nations, economic activity and commerce are expected to increase rapidly, fueling additional demand for energy in the service sectors. Population growth also is expected to be more rapid than in the OECD countries, portending increases in the need for education, health care, and social services and the energy required to provide them. The energy needed to fuel growth in commercial buildings will be substantial, with total delivered commercial energy use among the non-OECD nations projected to grow by 2.7 percent per year from 2006 to 2030.

### Industrial Sector

Energy is consumed in the industrial sector by a diverse group of industries—including manufacturing, agriculture, mining, and construction—and for a wide range of activities, such as processing and assembly, space conditioning, and lighting. Industrial energy demand varies across regions and countries of the world, based on the level and mix of economic activity and technological development, among other factors. Industrial energy use also includes natural gas and petroleum products used as feedstocks to produce non-energy products, such as plastics. In aggregate, the industrial sector uses more energy than any other end-use sector, consuming about one-half of the world's total delivered energy.

The OECD economies generally have more energy-efficient industrial operations and a mix of industrial output that is more heavily weighted toward non-energy-intensive sectors than in the non-OECD countries. As a result, the ratio of industrial sector energy consumption to total GDP tends to be higher in the non-OECD economies than in the OECD economies. On average, industrial sector energy intensity in the non-OECD countries is double that in the OECD countries.

### Transportation Sector

Energy use in the transportation sector includes the energy consumed in moving people and goods by road, rail, air, water, and pipeline. The road transport component includes light-duty vehicles, such as automobiles, sport utility vehicles, minivans, small trucks, and motorbikes, as well as heavy-duty vehicles, such as large trucks used for moving freight and buses for passenger travel. Growth rates for economic activity and population are the key factors for transportation sector energy demand. Economic growth spurs increases in industrial output, which requires the movement of raw materials to manufacturing sites, as well as the movement of manufactured goods to end users.

For both the non-OECD and OECD economies, steadily increasing demand for personal travel is a primary factor underlying projected increases in energy demand for transportation. Increases in urbanization and in personal incomes have contributed to increases in air travel and motorization (more vehicles per capita) in the growing economies. Modal shifts in the transport of goods are expected to result from continued economic growth in both OECD and non-OECD economies. For freight transportation, trucking is expected to lead the growth in demand for transportation fuels. In addition, as trade among countries increases, the volume of freight transported by air and marine vessels is expected to increase rapidly.

## World Economic Outlook

Economic growth is among the most important factors to be considered in projecting changes in world energy consumption. In the *IEO2009* projections, assumptions about regional economic growth—measured in terms of real GDP in 2005 U.S. dollars at purchasing power parity rates—underlie the projections of regional energy

demand. Although it is difficult to assess the full extent of the current global economic downturn, many analysts have stated that the world is in the midst of the worst recession since World War II [*4*]. Nevertheless, the *IEO2009* projections assume that the global downturn will not be protracted and that in the mid- to long term potential trend growth will return.

Over the 2006 to 2030 period, the world's real GDP growth on a purchasing power parity basis is projected to average 3.5 percent annually in the reference case (Table 2). In the long term, it is the ability to produce goods and services (the supply side) that determines the growth potential of any country's economy. Growth potential is influenced by population growth, labor force participation rates, capital accumulation, and productivity improvements. In addition, for the developing economies, progress in building human and physical capital infrastructures, establishing credible regulatory mechanisms to govern markets, and ensuring political stability play relatively more important roles in determining their medium- to long-term growth potential.

Annual growth in world GDP over the 24-year projection period is about the same as the rate recorded over the past 25 years. Growth in the more mature industrialized economies of the OECD is expected to be slower in the future; but growth in the emerging non-OECD economies is projected to be higher in the future than in the past. For the OECD, combined GDP increased by an annual average of 2.9 percent from 1982 to 2006 but is projected to average 2.2 percent per year from 2006 to 2030. In contrast, non-OECD GDP increased by an annual average of 4.1 percent over the past 25 years but is projected to average 4.9 percent per year from 2006 to 2030, based in large on the projected strong growth in China and India. With the non-OECD economies accounting for an increasing share of world GDP, their more rapid economic growth rates offset the slower growth rates for the OECD economies in the reference case.

Although many non-OECD economies—particularly those strongly dependent on exports for revenues—have been slowed by the economic downturn that began in the OECD economies, a number of significant reforms that have been implemented over the past years in key non-OECD nations have improved and are likely to continue improving their prospects for recovery and strong long-term growth. Improved macroeconomic policies, trade liberalization, more flexible exchange rate regimes, and lower fiscal deficits have lowered their national inflation rates, reduced uncertainty, and improved their overall investment climates. More microeconomic structural reforms, such as privatization and regulatory reform, have also played key roles. In general, such reforms have resulted in growth rates over much of the past decade that are above historical rates in many of the developing economies. Those trends are expected to resume when the OECD countries recover from the current recession and to continue into the next decades.

## OECD Economies

In the *IEO2009* reference case, U.S. economic growth slows considerably in the near term as a result of the recent downturn in financial markets, with negative real GDP growth in 2009 in spite of the expectation that the economy will begin to recover in the fourth quarter of 2009. The recession is expected to be more severe than the two most recent U.S. recessions, which began in 1991 and 2001. The rate of growth in real GDP depends

**Table 2. World Gross Domestic Product by Country Grouping, 2006-2030**
(Billion 2005 Dollars)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | **35,221** | **37,133** | **42,403** | **47,466** | **52,996** | **59,264** | **2.2** |
| North America | 15,331 | 16,073 | 18,789 | 21,341 | 24,283 | 27,802 | 2.5 |
| Europe | 14,224 | 15,015 | 16,839 | 18,811 | 20,894 | 23,105 | 2.0 |
| Asia | 5,667 | 6,045 | 6,775 | 7,314 | 7,819 | 8,357 | 1.6 |
| **Non-OECD** | **24,717** | **31,723** | **41,529** | **52,907** | **65,062** | **78,220** | **4.9** |
| Europe and Eurasia | 3,159 | 3,940 | 4,865 | 5,725 | 6,536 | 7,381 | 3.6 |
| Asia | 13,408 | 17,934 | 24,606 | 32,726 | 41,428 | 50,834 | 5.7 |
| Middle East | 2,053 | 2,484 | 3,030 | 3,621 | 4,300 | 5,102 | 3.9 |
| Africa | 2,341 | 2,870 | 3,612 | 4,384 | 5,182 | 5,958 | 4.0 |
| Central and South America | 3,757 | 4,495 | 5,415 | 6,450 | 7,615 | 8,945 | 3.7 |
| **Total World** | **59,939** | **68,856** | **83,932** | **100,373** | **118,058** | **137,484** | **3.5** |

Note: All regional real GDP numbers presented in this table are based on purchasing power parity terms.
Sources: IHS Global Insight, Inc., *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington DC, March 2009).

mainly on assumptions about labor force growth and productivity. In the reference case, growth in real GDP averages 2.4 percent per year from 2006 to 2030.[8]

Like much of the rest of the world, Canada saw its economic growth slow precipitously in 2008, to an estimated 0.5 percent for the year, after several years in which its economy expanded by nearly 3.0 percent per year. The country's economy was strongly affected both by the global economic downturn and by the rapid retreat of world energy prices, which sharply curtailed output and revenues from its energy sector [*5*]. Canada's relatively conservative banking system has limited its exposure to the "toxic assets" revealed by the financial crisis in 2007-2008, but in the short run it is unlikely to avoid the negative economic impact of global recession [*6*].

The strong economic ties between Canada and the United States, in addition to depressed world energy prices starting in the second half of 2008, lead to slower growth in the near term for Canada's economy. After 2010, when the world economies are expected to be in recovery and oil prices are expected to begin rising (favoring an expansion of production from the country's oil sands), Canada's GDP growth averages about 2.2 percent per year through 2030 in the reference case.

Similarly, Mexico's close relationship to the U.S. economy means that it too is likely to see a negative impact from the current downturn. About 80 percent of Mexico's exports are sent to the United States, and in combination with depressed world oil prices and the global credit crunch, its dependence on the U.S. economy has slowed the growth of the Mexican economy. A return to high world oil prices and recovery of the U.S. economy after 2010 are expected to support a return to Mexico's trend growth, with GDP increasing by an average of 3.4 percent per year from 2006 to 2030.

For the economies of OECD Europe, prospects in the short term are dimmed by the current turbulence in international financial markets and global economic recession. Their combined GDP growth is estimated to have slowed sharply, from 3.4 percent in 2006 and 3.1 percent in 2007 to 1.4 percent in 2008 and an anticipated contraction of 0.2 percent in 2009. Over the long term, OECD Europe's GDP growth is projected to average 2.0 percent per year from 2006 to 2030, in line with what the OECD considers to be potential output growth [*7*]. According to the International Monetary Fund, OECD Europe's long-term growth prospects depend on its ability to accelerate improvements in labor productivity that have been lagging potential (in part because of the region's aging population), as well as improvements in the structural flexibility of the various national economies [*8*].

After maintaining relatively robust economic growth of about 2.0 percent per year between 2003 and 2007, Japan's GDP growth rate slowed to 0.4 percent in 2008. In the fourth quarter of 2008, exports declined by 14 percent and industrial output fell by an annual rate of 20 percent [*9*]. Although GDP growth should return as the rest of the world's economic situation improves after 2010, the continuing decline in Japan's aging labor force is expected to slow its economic growth to average annual rates of 1.3 percent from 2008 to 2015 and 0.5 percent from 2015 to 2030.

More robust economic growth is projected for the rest of OECD Asia. In South Korea, GDP growth is projected to average 3.3 percent per year from 2006 to 2030. The global downturn has led to sharp declines in exports and domestic demand [*10*], and although the Bank of Korea has tried to ease the pressure on its financial markets—both by lowering interest rates six times between October 2008 and February 2009, to 2.0 percent, and by raising the cap on its low-rate commercial loans to $6.73 billion (10 trillion Korean won) from $6.00 billion (9 trillion won) [*11*]—the country is widely believed to be in its first recession since the banking crisis of 1998 [*12*]. As world demand begins to improve after 2010, South Korea's GDP growth is expected to return to trend. In the long term, however, its growth is expected to taper off as the growth of its labor force slows.

GDP growth in Australia/New Zealand averages 3.0 percent per year from 2006 to 2030 in the reference case. Although economic growth in both Australia and New Zealand has slowed markedly with the collapse of commodity prices, the Reserve Bank of Australia and the Reserve Bank of New Zealand have eased monetary policies, helping to cushion the impact of the global downturn [*13*]. Prospects in both countries are relatively healthy, given their consistent track records of fiscal prudence and structural reforms aimed at maintaining competitive product markets and flexible labor markets.

### Non-OECD Economies

From 2006 to 2030, economic growth in non-OECD Europe and Eurasia as a whole average 3.6 percent per year. For the past several years, the non-OECD nations of Europe and Eurasia have largely been sheltered from global economic uncertainties, recording strong economic growth in every year since 2000, primarily as a result of robust domestic demand, the growth bonus associated with ascension of some countries (including

[8]GDP growth rates in the short term are substantially lower in the *updated AEO2009* reference case (April 2009), but the long-run growth rate over the 24 year projection period is lower by less than 0.1 percentage point than in the *published* reference case (March 2009). Investment and exports show the largest downward revisions, resulting from higher projections for U.S. inflation and interest rates and lower projections for economic growth in other countries.

Estonia, Latvia, Lithuania, and Slovenia) to the European Union, and the impacts of rising oil prices on oil-exporting nations (including Russia, Kazakhstan, Azerbaijan, and Turkmenistan).

In the wake of the recent problems in the global financial system, it became more difficult for banks and other entities in non-OECD Europe and Eurasia to gain access to foreign loans, particularly in Russia, Kazakhstan, and Ukraine. The impact was softened somewhat by higher world market prices for commodity exports [***14***], but with the subsequent collapse of commodity prices and worsening global economic situation, the region's economic growth is projected to decline in the near term. In the mid- to long term, a return to high world oil prices stimulates investment outlays, especially in the energy sector of the Caspian region. Given the volatility of energy market prices, however, it is unlikely that the economies of non-OECD Europe and Eurasia will be able to sustain the growth rates recently achieved until they achieve more broad-based diversification from energy production and exports. The long-term growth prospects for the former Soviet Republic economies of Eurasia hinge on their success in economic diversification, as well as further improvements in domestic financial and product markets.

Much of the growth in world economic activity between 2006 and 2030 is expected to occur among the nations of non-OECD Asia, where regional GDP growth is projected to average 5.7 percent per year. China, non-OECD Asia's largest economy, is expected to continue playing a major role in both the supply and demand sides of the global economy. *IEO2009* projects an average annual growth rate of approximately 6.4 percent for China's economy from 2006 to 2030—the highest among all the world's economies.

Although some analysts expected that China's economy might be decoupled from those of the United States and OECD Europe and thus might avoid any significant impact from the economic downturn in those countries, it seems clear that this has not been the case [***15***]. Exports account for 35 percent of China's GDP, with the United States, Europe, and Asia taking 70 percent of its total exports. As a result, while there is some evidence that domestic consumer demand has remained relatively strong even as the world recession continues, manufacturing and export growth have declined sharply, leading to a reduction in near-term economic growth.

Structural issues that have implications for economic growth in China in the medium- to long term include the pace of reform affecting inefficient state-owned companies and a banking system that is carrying a significant amount of nonperforming loans. In the *IEO2009* reference case, development of domestic capital markets is expected to continue, providing macroeconomic stability and ensuring that China's large domestic savings are used more efficiently.

Although India's economy is not as dependent on export revenues as China's is, its growth still has slowed as the result of downturns in output from its industrial and agricultural sectors. Nearly two-thirds of Indian households depend on agriculture for their income [***16***]. India's GDP growth is expected to slow in the near term, but prospects for its economy are positive in the mid-term, as it continues to privatize state enterprises and increasingly adopts free market policies. In the *IEO2009* reference case, GDP growth in India averages 5.6 percent per year from 2006 to 2030.

Accelerating structural reforms—including ending regulatory impediments to the consolidation of labor-intensive industries, labor market and bankruptcy reforms, and agricultural and trade liberalization—remain essential for stimulating potential growth and reducing poverty in India over the medium to long term. With its vast and relatively inexpensive English-speaking labor force, India is well positioned to reap the benefits of globalization.

Outside China and India, the impacts of the global recession on the countries of non-OECD Asia are likely to vary. The economies of export-dependent countries (including Hong Kong, Singapore, and Taiwan) are expected to weaken in the near term, as demand in the United States, Europe, and Asia declines [***17***]. For nations where domestic demand remains healthy (including Vietnam and the Philippines), the impact of the global recession may be less severe [***18***]. Overall, long-term economic activity in the nations of non-OECD Asia is expected to remain robust. From 2006 to 2030, national economic growth rates for the region—excluding China and India—average 4.8 percent per year, as labor force growth rates decline and economies mature.

Rising oil production and prices have helped boost economic growth in the oil-exporting countries of the Middle East, many of which have also benefited from spillover effects on trade, tourism, and financial flows from the region's oil exporters. In recent years, real GDP growth rates in the Middle East have averaged around 6 percent. Although the sharp decline in world oil prices will slow economic growth in the near term, as prices recover in the mid-term, prospects for the region remain favorable. The region's reliance on oil revenues is expected to continue for much of the projection period.

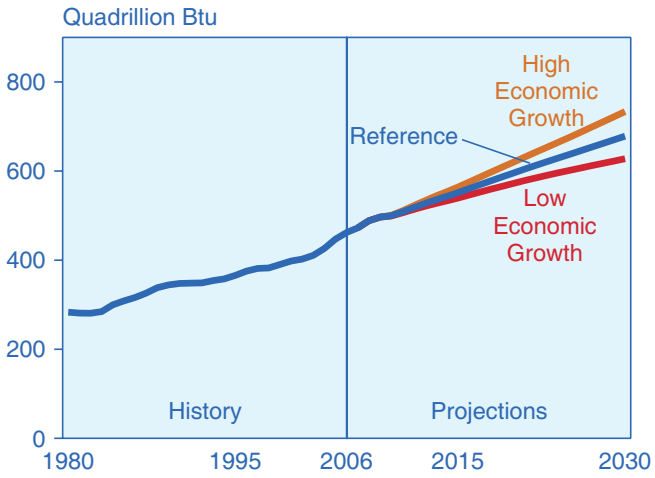
Substantially lower commodity prices and weak import demand in the United States, OECD Europe, and Asia are expected to dampen near-term growth potential in much of Africa. Africa's national economies were able to maintain a healthy pace of aggregate economic growth, in excess of 5 percent per year, from 2000 to 2007 largely because of increased earnings from fossil fuel exports,

strong global demand and favorable international prices for some other export commodities, vigorous domestic demand, and significant foreign direct investment and foreign aid [***19***]. If the global recession results in a slowdown of foreign direct investment in the region, long-term economic growth may be affected.

In the *IEO2009* reference case, Africa's combined economy grows at an average annual rate of 4.0 percent from 2006 to 2030—somewhat lower than *IEO2008* projection of 4.5 percent. The *IEO2009* projection still is optimistic by historical standards. It is supported by the region's strong economic activity over the past 5 years, resulting from expansion of primary exports and robust domestic demand in many of Africa's national economies. Nevertheless, both economic and political factors—such as low savings and investment rates, lack of strong economic and political institutions, limited quantity and quality of infrastructure and human capital, negative perceptions on the part of international investors, protracted civil unrest and political disturbances, and especially the impact of disease (notably HIV/AIDS)—present formidable obstacles to growth in a number of African countries.

The nations of Central and South America registered a combined 6-percent increase in GDP in 2004, which was their best performance in 20 years; however, their growth prospects have been hampered by a weak international credit environment and by domestic economic and/or political problems in a number of countries. The proximity of the region to the United States and the trade relationships of its national economies with the slowing U.S. economy will lead to slower economic growth in the short term, but the long-term prospects for Central and South America remain positive. Most countries in the region have flexible exchange-rates regimes, positive trade balances, and relatively low fiscal deficits and public debts. Regional inflation is lower than it was in the mid-1990s, and its relatively young labor force supports the region's economic growth prospects over the next 30 years. Economic growth in Central and South American averages 3.7 percent per year from 2006 to 2030 in the reference case, as the region benefits from the expected recovery in world economic growth after 2010 and foreign capital flows are revived.

**Figure 20. World Marketed Energy Consumption in Three Economic Growth Cases, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

## Major Sources of Uncertainty in the Projections

### Alternative Economic Growth Cases

Expectations for the future rates of economic growth are a major source of uncertainty in the *IEO2009* projections. To illustrate the uncertainties associated with economic growth trends, *IEO2009* includes a high economic growth case and a low economic growth case in addition to the reference case. The two alternative growth cases use different assumptions about future economic growth paths, while maintaining the same relationships between changes in GDP and changes in energy consumption that are used in the reference case.

In the high economic growth case, 0.5 percentage point is added to the growth rate assumed for each country or country grouping in the reference case. In the low economic growth case, 0.5 percentage point is subtracted from the reference case growth rate. The *IEO2009* reference case shows total world energy consumption reaching 678 quadrillion Btu in 2030—278 quadrillion Btu in the OECD countries and 400 quadrillion Btu in the non-OECD countries. In the high growth case, world energy use in 2030 totals 733 quadrillion Btu—55 quadrillion Btu (about 27 million barrels oil equivalent per day) higher than in the reference case. In the low growth case, total world energy use in 2030 is 51 quadrillion Btu (25 million barrels oil equivalent per day) lower than in the reference case. Thus, the projections for 2030 in the high and low economic growth cases define a range of uncertainty equal to 106 quadrillion Btu (Figure 20).

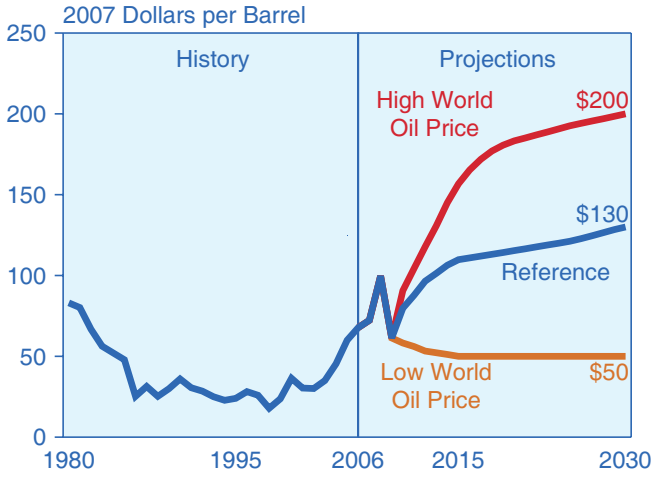
### Alternative World Oil Price Cases

Assumptions about world oil prices are another important factor that underscores the considerable uncertainty in long-term energy market projections. The effects of different assumptions about future oil prices are illustrated in *IEO2009* by two alternative oil price cases. In the high price case, world oil prices (in real 2007 dollars) climb from $68 per barrel in 2006 to $200 per barrel in 2030; in the low price case, they decline to $50 per barrel in 2015 and remain at about that level through 2030. In

comparison, world oil prices rise to $130 per barrel in 2030 in the reference case (Figure 21).

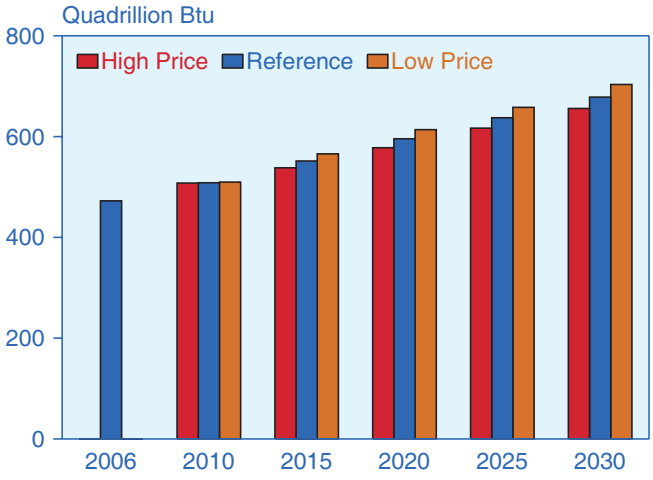
Although the difference in world oil prices between the high and low oil price cases is considerable, at $150 per barrel in 2030, the projections for total world energy consumption in 2030 do not vary substantially among the cases. There is, however, a larger impact on the mix of energy fuels consumed. The projections for total world energy use in 2030 in the high and low oil price cases are separated by 48 quadrillion Btu (Figure 22), as compared with the difference of 106 quadrillion Btu between the low and high economic growth cases.

**Figure 21. World Oil Prices in Three Price Cases, 1980-2030**




Source: Energy Information Administration (EIA), *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, June 2009), web site www.eia.doe.gov/oiaf/aeo.

**Figure 22. World Marketed Energy Consumption in Three Oil Price Cases, 2006-2030**



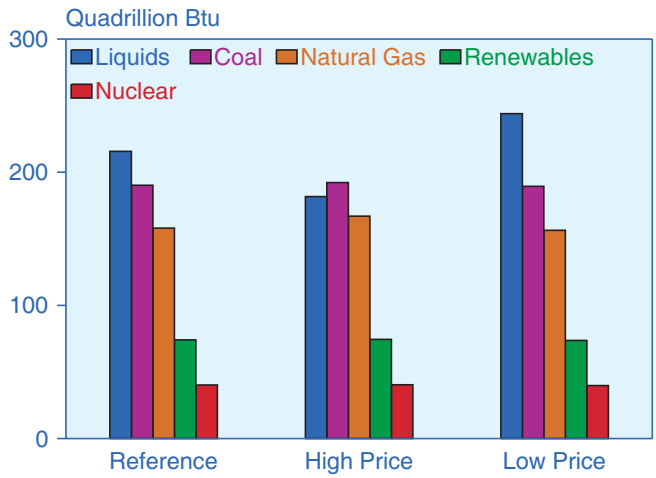

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

The potential effects of higher and lower oil prices on world GDP can also be seen in the low and high price cases. In the long run, on a worldwide basis, the projections for economic growth are not affected substantially by the price assumptions. There are, however, some relatively large regional impacts. The most significant variations are GDP decreases of around 2.0 percent in the high price case relative to the reference case in 2015 for some regions outside the Middle East and, in the oil-exporting Middle East region, a 5.5-percent increase in GDP in 2015. The regional differences persist into the long term, with GDP in the Middle East about 6.2 percent higher in 2030 in the high oil price case than in the reference case and GDP in some oil-importing regions (such as OECD Europe and Japan) between 2.0 percent and 3.0 percent lower in the high price case than in the reference case.

The most substantial impacts of the high and low oil price assumptions are on the mix of energy fuels consumed in each region—particularly, fossil fuels (Figure 23). In the high price case, total world liquids consumption in 2030 is about 34 quadrillion Btu lower than projected in the reference case, natural gas consumption in 2030 is 9 quadrillion Btu higher, and coal consumption is 2 quadrillion Btu higher than in the reference case. The differences for nuclear power and renewable energy consumption between the two cases is very small, especially in the near to mid-term, primarily because both energy sources are strongly influenced by government policies and incentives, and prices do not have a large impact on their development.

In the low oil price case, consumers increase their use of liquids for transportation, and there is less incentive for movement away from liquids to other energy sources in sectors where fuel substitution is fairly easy to achieve

**Figure 23. World Marketed Energy Consumption in Three Oil Price Cases, 2030**

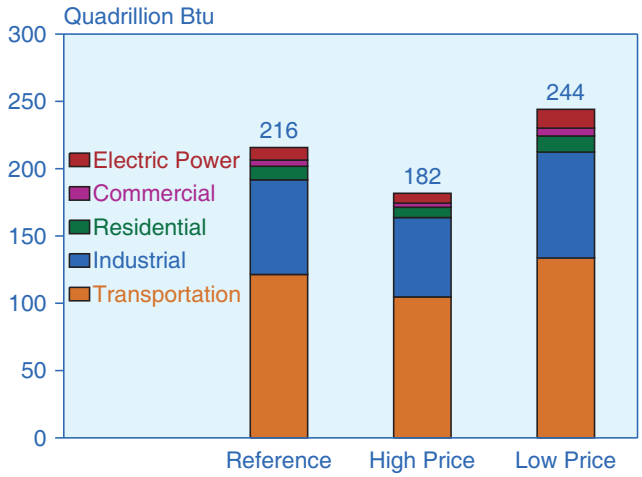



Source: Energy Information Administration, World Energy Projections Plus (2009).

(as opposed to the transportation sector, where there are few alternatives to liquid fuels). Total liquids consumption in 2030 is 28 quadrillion Btu higher in the low price case than projected in the reference case, reflecting increased demand in all the end-use sectors. The transportation sector shows the largest increase in liquids consumption (12 quadrillion Btu) in 2030 in the low price case relative to the reference case (Figure 24), followed by the industrial sector (8 quadrillion Btu) and the electric power sector (5 quadrillion Btu).

In the *IEO2009* reference case, world oil prices begin to rise after 2010 and reach $130 per barrel in 2030. As a result, liquids consumption is curtailed in countries that have other fuel options available—especially in the electric power sector, where coal and other fuels can be substituted. Worldwide use of liquids for electricity generation falls by 0.8 quadrillion Btu from 2006 to 2030 in the reference case. In the low price case, consumption of liquids for electricity generation increases by 3.9 quadrillion Btu, as the non-OECD countries retain their oil-fired generating capacity in the lower price environment.

**Figure 24. World Liquids Consumption in Three Price Cases, 2030**




Source: Energy Information Administration, World Energy Projections Plus (2009).

## References


1. U.S. Department of Energy, Loan Guarantee Program, "Key Documents: Title XVII. Incentives for Innovative Technologies" (August 8, 2005), web site www.lgprogram.energy.gov.
2. After conversion (1 square meter = 10.76 square feet). Source: *China Statistics 2006: Data from the National Bureau of Statistics of the Peoples Republic of China*, "Floor Space Completed and Housing Conditions of Urban and Rural Residents," web site www.allcountries.org/china_statistics/10_32_floor_space_completed_and_housing.html.
3. International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), pp. 357 and 365.
4. See, for example, IHS Global Insight, Inc., *Global Executive Summary* (Lexington, MA, January 2009), p. 1; and International Monetary Fund, *World Economic Outlook: Update* (January 28, 2009), web site www.imf.org/external/pubs/ft/weo/2009/update/01/index.htm.
5. IHS Global Insight, Inc., *Global Executive Summary: The Worst Recession in the Postwar Era* (Lexington, MA, January 2009), p. 8.
6. International Monetary Fund, "Transcript of a Conference Call on Canada's 2009 Article IV Consultation" (Washington, DC, March 2009), web site www.imf.org/external/np/tr/2009/tr031109.htm.
7. Organization for Economic Cooperation and Development, *OECD Economic Outlook No. 80* (Paris, France, November 2006), Annex Table 21, "Potential GDP, Employment and Capital Stock," web site www.oecd.org/dataoecd/5/49/37841330.xls.
8. International Monetary Fund, *World Economic Outlook October 2008* (Washington, DC, October 2008), pp. 55-56, web site www.imf.org/external/pubs/ft/weo/2008/02/pdf/text.pdf.
9. IHS Global Insight, *Global Executive Summary: The Global Outlook Has Darkened Again* (Lexington, MA, February 2009), p. 3.
10. Seo Eun-kyung, "Update 2—Bank of Korea Holds Rates Amid Unease Over Currency," *Reuters India News Release* (March 12, 2009), web site http://in.reuters.com.
11. "Bank of Korea Freezes Key Rate at 2%," *The Korea Times* (March 12, 2009), web site www.koreatimes.co.kr; and M. Hadi, "The Bank of Korea's Conundrum," *The Wall Street Journal Online* (March 12, 2009), web site http://online.wsj.com/article/SB123686058646506849.html.
12. Seo Eun-kyung, "Update 2—Bank of Korea Holds Rates Amid Unease Over Currency," *Reuters India News Release* (March 12, 2009), web site http://in.reuters.com.
13. International Monetary Fund, *World Economic Outlook October 2008* (Washington, DC, October 2008), pp. 62-63, web site www.imf.org/external/pubs/ft/weo/2008/02/pdf/text.pdf.
14. IHS Global Insight, *Global Executive Summary: The Worst Recession in the Postwar Era* (Lexington, MA, January 2009), p. 10.
15. E.J. Young, "Which Way Ahead for China?" *Energy Strategies for a Turbulent Economy: Perspectives from*

*CERAWEEK 2009* (March 2009), web site www.cera.com (subscription site).

16. C. Innes, "Country Intelligence—Analysis: India: Growth Slows to Near Six-Year Low in India" (IHS Global Insight, Inc., February 27, 2009), web site www.globalinsight.com (subscription site).
17. IHS Global Insight, *Global Executive Summary: The Worst Recession in the Postwar Era* (Lexington, MA, January 2009), p. 11.
18. J. Hoookway, "In Vietnam, Domestic Demand Helps Cushion Downturn's Blow," *The Wall Street Journal* (March 16, 2009), p. A2.
19. United Nations, *World Economic Situation and Prospects 2008* (New York, NY, 2008), web site www.un.org/esa/policy/wess/wesp2008files/wesp2008.pdf.

# Chapter 2
# Liquid Fuels

***World liquids consumption in the IEO2009 reference case increases from 85 million barrels per day in 2006 to 107 million barrels per day in 2030. Unconventional liquids, at 13.4 million barrels per day, make up 12.6 percent of total liquids production in 2030.***

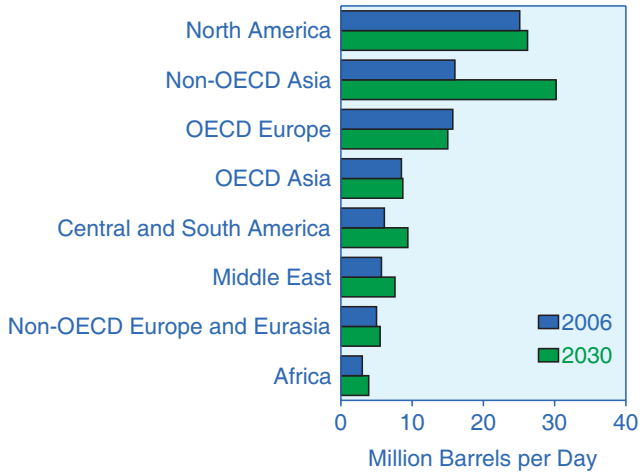
Demand for liquid fuels and other petroleum[9] increases from 85.0 million barrels per day in 2006 to 106.6 million barrels per day in 2030 in the *IEO2009* reference case, despite world oil prices that remain above $100 per barrel (in real 2007 dollars) from 2013 through the end of the projection period. More than 80 percent of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where strong economic growth is expected (Figure 25). The transportation sector accounts for the largest increment in total liquids demand, at nearly 80 percent of the total world increase.

To satisfy the increase in world demand, liquids production—including conventional and unconventional petroleum and nonpetroleum liquids—increases by 22 million barrels per day from 2006 to 2030 in the reference case (Figure 26 and Table 3). Sustained high world oil prices in the reference case allow for the economical development of unconventional resources and the use of enhanced oil recovery technologies to increase production of conventional resources. High oil prices also permit the development of additional conventional resources through technically difficult, high-risk, and very expensive projects, including those located in ultra-deep water and the Arctic.

The countries making the most significant contributions to growth of non-OPEC production in the reference case are the United States and Brazil, as total non-OPEC production in 2030 rises to nearly 13 million barrels per day above the 2006 level and represents 59 percent of the total world increase. OPEC producers,[10] in this case, are assumed to keep their investments in incremental production capacity below the levels that would be justified by high prices, providing only about 40 percent of the world's total liquids supply over the 2006-2030 period.

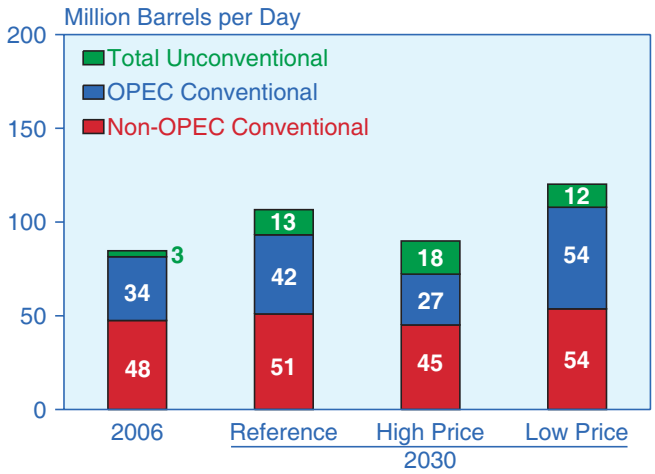
In 2006, world production of unconventional liquids totaled 3.1 million barrels per day. In 2030,

**Figure 25. World Liquids Consumption by Region and Country Group, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

**Figure 26. World Liquids Supply in Three Cases, 2006 and 2030**




Sources: **2006:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **2030:** EIA, Generate World Oil Balance Model (2009).

[9] Liquid fuels and other petroleum (also referred to as "liquids") include all petroleum products, natural gas liquids, biofuels, and liquids derived from other hydrocarbon sources (coal to liquids and gas to liquids). Not included are compressed natural gas (CNG), liquefied natural gas (LNG), and hydrogen.

[10] Indonesia officially suspended its membership in OPEC on January 1, 2009. In this chapter, all references to OPEC exclude Indonesia. In addition, all time series have been updated to reflect country groupings as of January 1, 2009, so that Indonesia's liquids production is excluded from the OPEC totals for 1980 through 2030.

unconventional liquids production in the reference case totals 13.4 million barrels per day and accounts for more than 12 percent of total world liquids production, as unconventional resources from both OPEC and non-OPEC sources become increasingly competitive. Although production of unconventional petroleum liquids, such as Canada's oil sands and Venezuela's extra-heavy oil, is limited somewhat by environmental concerns and investment restrictions, production of unconventional nonpetroleum liquids, such as biofuels, coal-to-liquids (CTL), and gas-to-liquids (GTL), is spurred by sustained, relatively high prices both in the reference case and in the high oil price cases (Figure 27). Development of nonpetroleum liquids production also will depend on country-specific programs or mandates.

## World Liquids Consumption

World liquids consumption in the *IEO2009* reference case increases from 85 million barrels per day (173 quadrillion Btu) in 2006 to 107 million barrels per day (216 quadrillion Btu) in 2030. Although world demand for liquids is dampened in the near term as a result of the global economic recession that began in 2008 and continues into 2009, a return to trend growth is expected over the long term as national economies recover. In particular, the developing economies of non-OECD Asia and the Middle East are expected to return to strong economic growth, accompanied by growing demand for energy to fuel transportation and industrial activity.

**Table 3. World Liquid Fuels Production in the Reference Case, 2006-2030**
(Million Barrels per Day)

| Source | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OPEC** | | | | | | | |
| Conventional Liquids[a] | 34.0 | 35.0 | 37.3 | 38.8 | 40.2 | 42.3 | 0.9 |
| Extra-Heavy Oil | 0.6 | 0.6 | 0.7 | 0.8 | 1.0 | 1.2 | 2.8 |
| Bitumen | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 18.3 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **OPEC Total** | **34.7** | **35.6** | **38.1** | **39.9** | **41.4** | **43.8** | **1.0** |
| **Non-OPEC** | | | | | | | |
| Conventional Liquids[a] | 47.5 | 46.3 | 46.1 | 47.9 | 49.4 | 50.9 | 0.3 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 14.3 |
| Bitumen | 1.2 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Coal-to-Liquids | 0.1 | 0.2 | 0.3 | 0.5 | 0.8 | 1.2 | 9.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 13.9 |
| Biofuels | 0.8 | 1.9 | 2.8 | 3.8 | 5.0 | 5.8 | 8.6 |
| **Non-OPEC Total[b]** | **49.9** | **50.7** | **52.5** | **56.0** | **59.6** | **62.8** | **1.0** |
| **World** | | | | | | | |
| Conventional Liquids[a] | 81.5 | 81.3 | 83.4 | 86.7 | 89.6 | 93.1 | 0.6 |
| Extra-Heavy Oil | 0.6 | 0.7 | 0.7 | 0.9 | 1.0 | 1.2 | 3.0 |
| Bitumen | 1.2 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Coal-to-Liquids | 0.1 | 0.2 | 0.3 | 0.5 | 0.8 | 1.2 | 9.0 |
| Gas-to-Liquids | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 19.3 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 13.9 |
| Biofuels | 0.8 | 1.9 | 2.8 | 3.9 | 5.1 | 5.9 | 8.6 |
| **World Total** | **84.6** | **86.3** | **90.6** | **95.9** | **101.1** | **106.6** | **1.0** |

[a]Includes conventional crude oil and lease condensate, natural gas plant liquids (NGPL), and refinery gain.
[b]Includes some U.S. petroleum product stock withdrawals, domestic sources of blending components, other hydrocarbons, and ethers.
OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** Generate World Oil Balance Model (2009).

The increasing cost-competitiveness of other energy sources causes many current users of liquids outside the transportation sector to switch to other fuels, and as a result the transportation share of total liquids consumption increases over time (Figure 28). In 2030, the transportation sector consumes 56 percent of total liquids supplied, with the increase in volume consumed accounting for 79 percent of the total increase in liquids consumption across all sectors from 2006 to 2030.

Strong expansion of liquids use is projected for the non-OECD countries, fueled by a return to robust economic growth, burgeoning industrial activity, and rapidly expanding transportation use. The largest increase in regional non-OECD consumption between 2006 and 2030 is projected for non-OECD Asia, at 14.1 million barrels per day. By country, China (8.1 million barrels per day) and India (2.0 million barrels per day) show the largest increases in demand in the region, and the projected growth in China's liquids demand is the largest for any country worldwide. Large increases in liquids consumption are also expected in the Middle East region (3.3 million barrels per day) and Central and South America (1.9 million barrels per day) (see Figure 25).

Liquids consumption in the OECD region generally grows more slowly, reflecting expectations of slowly growing or declining populations and relatively slow economic growth in most of the OECD nations, as compared with the non-OECD nations, over the next two decades. In Japan and OECD Europe, liquids consumption declines by an average of 0.4 and 0.2 percent, respectively.

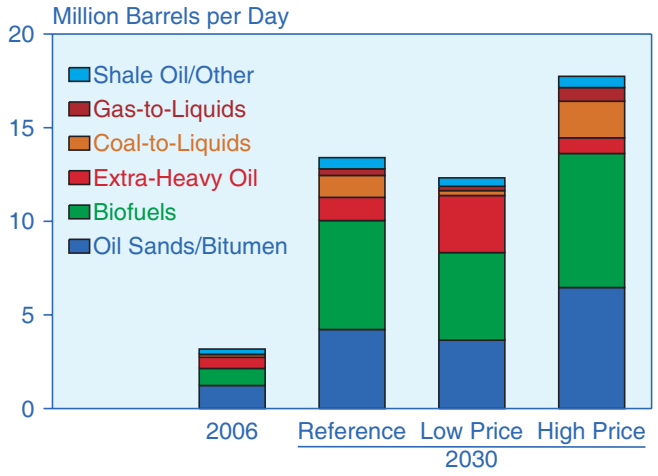
The different growth trends projected for the non-OECD and OECD regions mean that total liquids demand in the non-OECD countries surpasses that in the OECD countries in 2021, when demand in non-OECD Asia exceeds that in North America. In 2030, the United States still consumes more liquids than China does, but the difference between the two is less than one-half the difference in 2006.

## World Oil Prices

A major factor in the *IEO2009* projections is the assumption for future world oil prices. The impacts of world oil prices on energy demand are a considerable source of uncertainty in the projections. In the reference case, the average world oil price rises from $61 per barrel in 2009[11] to $110 per barrel in 2015 and $130 per barrel in 2030 ($189 per barrel in nominal terms) (Figure 29). In the low price case, oil prices average $50 per barrel in 2030 ($73 per barrel in nominal terms), compared with $200 per barrel ($289 per barrel in nominal terms) in the high price case. The projections for total liquids consumption in 2030 range from 90 million barrels per day in the high price case to 120 million barrels per day in the low price case, reflecting the substantial range of uncertainty in the projections. The three world oil price paths in *IEO2009* are consistent with those in the *Annual Energy Outlook 2009*.

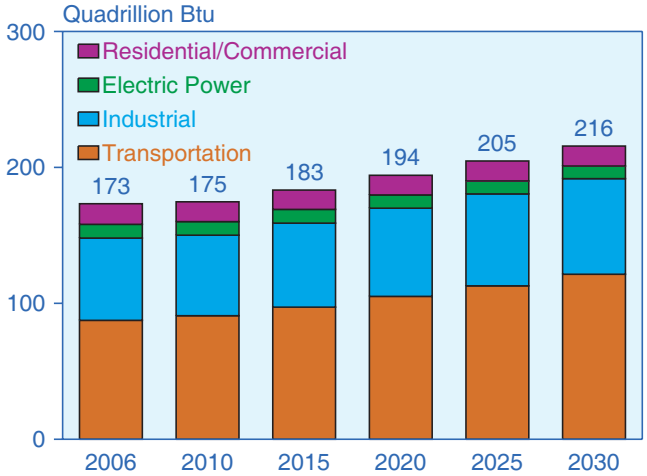
The three oil price cases are distinct scenarios, each reflecting alternative assumptions about the sources and costs of world oil supplies. The reference case reflects an assumed decision by OPEC member countries to

**Figure 27. World Production of Unconventional Liquid Fuels, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **2030:** EIA, Generate World Oil Balance Model (2009).

**Figure 28. World Liquids Consumption by Sector, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[11] The world oil price reported in *IEO2009* is for light sweet crude oil delivered to Cushing, Oklahoma. All oil prices are in real 2007 dollars per barrel, unless otherwise noted.

maintain the organization's aggregate production at approximately 40 percent of world liquids supply. As a result, roughly 60 percent of the projected increase in liquid fuels consumption in the reference case comes from non-OPEC production, including high-cost projects and projects in countries with unattractive fiscal or political regimes.

The high oil price case assumes that several non-OPEC countries further restrict access to or increase taxes on production from prospective areas, and that the OPEC member countries reduce their production substantially below current levels. Oil prices rise above the reference case levels, dampening demand for liquid fuels and enabling increased production from those high-cost conventional and unconventional non-OPEC resources that still are accessible and attractive for exploration and development.

The low oil price case assumes greater access to, and more attractive fiscal regimes in, several prospective non-OPEC areas, including Russia and the Caspian region, as well as increased production from OPEC member countries. Consequently, oil prices fall below reference case levels, resulting in increased world demand for liquid fuels and decreased production from conventional and unconventional resources in non-OPEC countries that currently have attractive fiscal regimes.

Recent events illustrate some of the ways in which supply of and demand for liquids affect oil prices. The first 6 months of 2008 saw a continuation of the previous 5 years of increasing oil prices, which spurred company commitments to relatively high-cost exploration and production projects, such as those in ultra-deep water and oil sands, even though high demand for steel, engineers, oil field services, and other inputs were driving up costs. An apparent lack of demand response to high prices in developing countries (China and India, in particular) led to expectations of continuing high oil prices. Rising demand and lagging supply led some analysts to believe that a price of $200 per barrel was plausible in the near term [*1*].

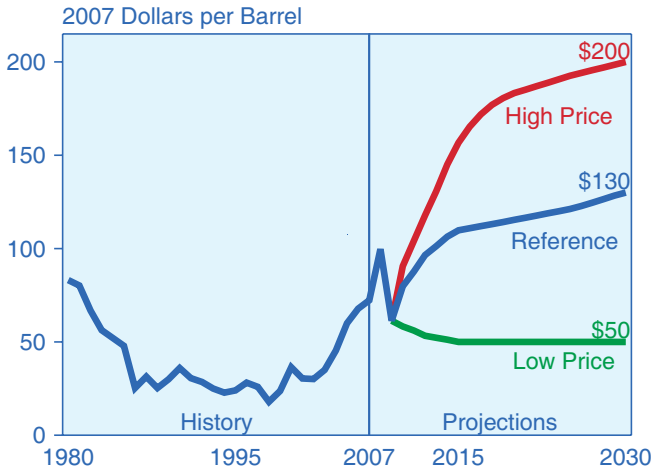
By July 2008, when world oil prices neared $150 per barrel, it had become apparent that petroleum consumption in the first half of the year was lower than anticipated and that economic growth also was slowing [*2*]. August saw the beginning of the current financial crisis and a further weakening of demand [*3*]. Since September 2008, the global economic downturn has reduced consumers' current and prospective near-term demand for oil.

In the second half of 2008, producer and consumer expectations regarding the imbalance of supply and demand in the world oil market were essentially reversed. Before August, market expectations for the future economy indicated that demand would outpace supply despite planned increases in production capacity. After September, expectations became so dismal that OPEC's announcement of a 1.5-million-barrel-per-day production cut was followed by a drop in oil prices [*4*].

Although the impacts of the current economic downturn and financial crisis on petroleum demand are likely to be large in the near term, they also are likely to be relatively short-lived. National economies and oil demand are expected to begin recovering in 2010. In contrast, their impacts on oil production capacity probably will not be realized until 2010-2013, when current investments in new capacity, should they be made, will begin to increase oil production [*5*]. As a result, just at the time when demand is expected to recover, physical limits on production capacity could lead to another wave of price increases, in a cyclical pattern that is not new to the world oil market.

Developments in the past year demonstrate how quickly and drastically the fundamentals of oil prices and the world liquids market as a whole can change. Within a matter of months, the change in current and prospective world liquids demand has affected the perceived need for additional access to conventional resources and development of unconventional liquids supply and reversed OPEC production decisions. Rather than attempting to forecast how supply and demand fundamentals and perceptions will change between now and 2030, *IEO2009* uses the three oil price cases to reflect different assumptions about future liquids supply levels, sources, and costs.

**Figure 29. World Oil Prices in Three Cases, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, June 2009), web site www.eia.doe.gov/oiaf/aeo.

## World Liquids Production

In the *IEO2009* reference case, world liquids production in 2030 exceeds the 2006 level by 22 million barrels per day. Increases in production are expected for both OPEC and non-OPEC producers; however, 59 percent of the total increase is expected to come from non-OPEC areas, with 44 percent from non-OPEC unconventional liquids production alone. In 2030, OPEC production totals 44 million barrels per day and non-OPEC production totals 63 million barrels per day in the reference case.

The reference case assumes that OPEC producers will choose to maintain their market share of world liquids supply and will invest in incremental production capacity to maintain an approximate 40-percent share of total global liquids production through 2030. Increasing volumes of conventional liquids (crude oil and lease condensates, natural gas plant liquids [NGPL], and refinery gain) from OPEC members contribute 8.3 million barrels per day to the total increase in world liquids production from 2006 to 2030, while conventional liquids supplied from non-OPEC nations contribute 3.3 million barrels per day.

Unconventional liquids represent the largest share of growth over the projection period, because high oil prices make them more competitive economically. Unconventional fuels account for 47 percent of the increase in total production from 2006 to 2030, or 10.4 million barrels per day, of which 9.6 million barrels per day comes from non-OPEC sources. High oil prices, improvements in exploration and extraction technologies, emphasis on recovery efficiency, and the emergence and continued growth of unconventional resource production are the primary factors leading to the growth of non-OPEC liquids production in the reference case.

The *IEO2009* projections are based on a two-stage analytical approach. Projections of liquids production before 2015 are based largely on a project-by-project assessment of production volumes and associated scheduling timelines, with consideration given to the decline rates of active projects, planned exploration and development activity, and country-specific geopolitical situations and fiscal regimes. The extensive and detailed information available about such projects, including project scheduling and the investment and development plans of companies and countries, make it possible to take a detailed approach to modeling supply. There are often lengthy delays, however, between the point at which supply projects are announced and when they begin producing. In addition, many projects have been delayed recently as a result of lower expectations for growth in world liquids demand in the near term because of the global economic slowdown and the difficulty of obtaining credit to finance production projects during the global credit crisis.

Because projects generally are not publicized more than 7 to 10 years before their first production, project-by-project analyses are unlikely to provide a complete representation of company or country production plans and achievable production volumes. Instead, production decisions made after 2015 are assumed to be based predominantly on resource availability and the resulting economic viability of production. Geopolitical and other "above-ground" constraints[12] are not assumed to disappear entirely after 2015, however. Longstanding above-ground factors for which there are no indications of significant future changes—for instance, the government-imposed investment conditions currently in place in Iran, or OPEC adherence to production quotas—are expected to continue to affect world supplies long after 2015. Moreover, even if above-ground constraints were minimized, expansion of production capacity still could be delayed, depending on technical difficulty and scheduling constraints for the types of projects likely to be developed in different countries.

For some resource-rich countries it is assumed that current political barriers to increasing production will not continue after 2015. For instance, both Mexico and Venezuela currently have legislation that restricts foreign ownership of hydrocarbon resources. Their nationalization of resources has discouraged investment—both foreign and domestic—and hindered their ability to increase or even maintain historical production levels. In the reference case, both Mexico and Venezuela are assumed to ease restrictions at some point after 2015, allowing some additional foreign investment or involvement in their oil sectors that will facilitate increases in liquids production, including from deepwater prospects in Mexico and extra-heavy oils in Venezuela's Orinoco belt.

Iraq is another resource-rich country where currently there are significant impediments to investment in the upstream hydrocarbon sector. Liquids production in Iraq dropped substantially in 2003 after the U.S.-led invasion. From 2002 to 2003 production declined from 2.0 million barrels per day to 1.3 million barrels per day. Since then, Iraq's production has recovered to approximately pre-invasion levels, although the recovery has been slow and inconsistent. Although Iraq's production levels are not expected to increase substantially in the near term, it is assumed that current levels of infrastructure destruction and political, as well as legal,

[12] "Above-ground" constraints refer to those nongeological factors that might affect supply, including: government policies that limit access to resources; conflict; terrorist activity; lack of technological advances or access to technology; price constraints on the economical development of resources; labor shortages; materials shortages; weather; environmental protection actions; and other short- and long-term geopolitical considerations.

uncertainty will be diminished, leading to renewed investment and development activity and followed by fairly significant growth in production from 2015 through 2030.

### Non-OPEC Production

The return to and maintenance of high oil prices projected in the *IEO2009* reference case are expected to encourage producers in non-OPEC nations to continue investment in conventional liquids production capacity and increase investment in enhanced oil recovery (EOR) projects and unconventional liquids production. Non-OPEC production increases steadily in the projection, from 50 million barrels per day in 2006 to 63 million barrels per day in 2030, as high prices attract investment in areas previously considered uneconomical, and fears of supply restrictions encourage some net consuming nations to expand unconventional liquids production from domestic resources, such as coal and biomass.

Despite the maturity of most non-OPEC producing basins, conventional liquids production in the reference case increases from 48 million barrels per day in 2006 to 51 million barrels per day in 2030, led by production gains in Brazil, Russia, Kazakhstan, and the United States. Among non-OPEC producers, the lack of many prospects for new, large conventional petroleum liquids projects and declines in production from existing conventional fields result in heavy investment in the development of smaller fields. Producers are expected to concentrate their efforts on more efficient exploitation of fields already in production, either through the use of more advanced technology for primary recovery efforts or through EOR. Those efforts are expected to allow most non-OPEC producers to maintain or slow production declines but not to raise production volumes.

Large increases in non-OPEC production of conventional petroleum liquids are expected to come from the relatively few regions with recent large discoveries or high undiscovered resource potential. Significant gains in conventional production are projected for the Caspian area (Kazakhstan) and South America (Brazil) (Figure 30). Canada is expected to be a major non-OPEC supplier of liquids, with its unconventional bitumen (oil sands) production more than compensating for projected declines in its conventional oil production.

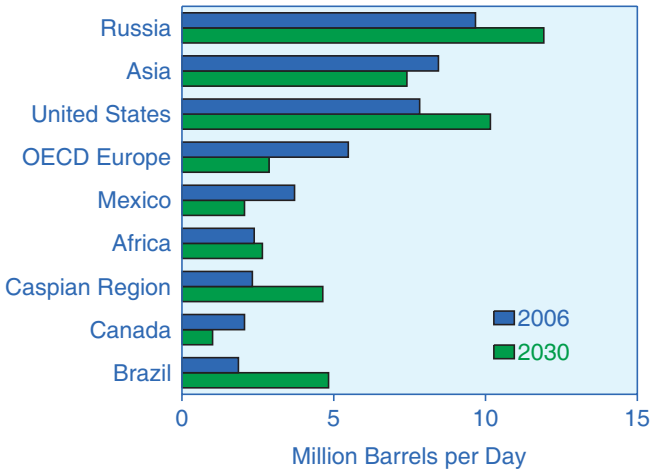
In the reference case, unconventional liquids production from non-OPEC suppliers rises to 6 million barrels per day in 2015 and 12 million barrels per day in 2030. In the high oil price case, non-OPEC unconventional liquids production rises to 17 million barrels per day in 2030, as significantly higher prices encourage the development of alternative fuel sources, up to the limits imposed by expected environmental protection measures and industry expansion in general. In the low oil price case, fewer unconventional resources become economically competitive, and non-OPEC production of unconventional liquids in 2030 totals only 9 million barrels per day.

The most significant decline in non-OPEC liquids production is projected for the North Sea (which includes offshore production from Norway, the United Kingdom, the Netherlands, and Germany), where there are diminishing prospects for new discoveries capable of compensating for the decline of existing fields. All the countries currently producing North Sea oil are expected to continue encouraging investment and providing open access to development.

The second-largest decline in non-OPEC liquids production is projected for Mexico, where liquids production drops to approximately 1.9 million barrels per day in 2020 before rebounding slowly to 2.3 million barrels per day in 2030—still 1.4 million barrels per day below the 2006 production volume. The projected rebound depends entirely on the development of potential resources in the deepwater Gulf of Mexico, which must begin some years in advance of any increase in production.

The outlook for Mexico's liquids production is markedly different from the projection 2 years ago in *IEO2007*, which had a low point of about 3.0 million barrels per day in 2012 followed by a long-term recovery from 2013 to 2030. The lower projection this year is based on declines in production from the Cantarell basin that have been more severe than expected, along with more pessimistic assumptions about future investment, both foreign and domestic, in Mexico's deepwater production. It is assumed, however, that Mexico will have the

**Figure 30. Non-OPEC Conventional Liquids Production by Region, 2006 and 2030**




Sources: **2006:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **2030:** Energy Information Administration, Generate World Oil Balance Model (2009).

resources to support a long-term recovery in its total liquids production, primarily because of the potential for new resource discoveries in the Gulf of Mexico. The extent and timing of the expected recovery will depend on the level of economic access granted to foreign investors, because the national oil company, PEMEX, currently does not have the technical capability or financial means to develop potential deepwater resources in the Gulf of Mexico.

Canada's production of conventional liquids declines by just over 1.0 million barrels per day from 2006 to 2030. Unconventional petroleum liquids from oil sands are expected to more than offset the decline, however, so that total production increases by 2.1 million barrels per day in the reference case, to 5.4 million barrels per day in 2030.

The largest increase in non-OPEC total liquids production is projected for the United States, where conventional production increases from 7.8 million barrels per day in 2006 to 10.2 million barrels per day in 2030. Although U.S. production of conventional liquids has been in decline for many years, it is expected to grow in the projection, both as a result of deepwater offshore projects that are scheduled to begin producing in the near term, and because application of enhanced oil recovery (EOR) technologies will increase production in the long term. Thus, total U.S. production of crude oil offshore increases from 1.4 million barrels per day in 2006 to about 2.0 million barrels per day in 2010 and 2.7 million barrels per day in 2030 in the reference case, as oil production using EOR increases more than fivefold, from 0.3 million barrels per day in 2006 to 1.7 million barrels per day in 2030.

Unconventional liquids also are projected to be an increasingly important source of domestic supply in the United States. In 2030, liquid fuels production from unconventional sources includes 257 thousand barrels per day from CTL, 1,880 thousand barrels per day from biofuels (ethanol and biodiesel), and 144 thousand barrels per day from oil shale.

U.S. ethanol production alone is projected to increase to 1.4 million barrels per day, in part because of the Federal renewable fuels standard (RFS). Progress toward meeting the RFS is complicated, however, by slowing growth in U.S. petroleum consumption through 2030. The push for more fuel-efficient automobiles, which slows the increase in motor gasoline consumption in the reference case, also slows progress toward meeting the RFS, because more efficient gasoline motors and the growing penetration of hybrids reduce the demand for ethanol in gasoline fuel blends. In addition, a 10-percent limit on ethanol in gasoline for most of the current fleet of passenger vehicles delays further market penetration until more E85-compatible vehicles are in use and the market infrastructure for E85 and other biofuels is expanded to accommodate the distribution and sale of larger volumes.

U.S. crude oil production is sensitive to projected oil prices. In 2030, offshore crude oil production is 3.0 million barrels per day in the high oil price case and 2.1 million barrels per day in the low oil price case. Similarly, onshore crude oil production is 4.8 million barrels per day in the high oil price case in 2030 and 3.0 million barrels per day in the low oil price case.

The second-largest contribution to non-OPEC liquids production in the reference case comes from Brazil, where total production increases by 3.7 million barrels per day from 2006 to 2030, with 3.0 million barrels per day of the increase coming from conventional liquids production. This strong growth in Brazil's conventional liquids production results in part from expansions at producing fields that currently are either in progress or planned. In addition, recent discoveries in the Campos and Santos basins, including the massive Tupi and related Guara and Iara subsalt discoveries,[13] add to production in the mid- and long term and suggest the presence of other large fields in the same formation. The vast size of the subsalt potential in Brazil, and the shortfalls of the current licensing and bidding structure associated with block boundary issues created by the geographic distribution of each of the subsalt deposits, have caused Brazil to consider restructuring its licensing and bidding process and the terms for foreign investment.

Although Petrobras has repeatedly proven itself as a leader in deepwater development and is known to have the technical capabilities to develop subsalt prospects, it is not expected to have the resources (financial, labor, etc.) or ultimate inclination to develop them on its own. The *IEO2009* high and low oil price cases assume different investment terms offered by Brazil to foreign investors and hence different rates of subsalt development, with the high price case assumption of tighter terms of access resulting in average annual growth in conventional liquids production of 3 percent and additional production of 2.1 million barrels per day in 2030. The low price case assumes very open terms of access, resulting in average annual growth of 5 percent and additional production of 4.1 million barrels per day in 2030.

In addition to the expected growth in Brazil's conventional liquids production, its ethanol production increases to 0.9 million barrels per day in 2030 in the reference case, as a result of steady increases in yields and expansion of crop production. Brazil's major ethanol production is derived from sugar cane, which currently is the highest yielding and least expensive feedstock for ethanol. Brazil also has a large amount of previously

[13] "Subsalt" refers to rock formations that lie beneath long, horizontal layers of salt and may contain hydrocarbons.

cleared but underutilized pasture land available for sugar cane cultivation. The country's domestic consumption is not expected to keep pace with its expanding ethanol production, making Brazil a net ethanol exporter; therefore, its production will depend largely on other countries' policies and demand for ethanol. The current U.S. tariff on imported ethanol makes imports from Brazil prohibitively expensive.

In the high oil price case, Brazil's ethanol production totals 1.3 million barrels per day in 2030, reflecting higher demand for ethanol both at home and abroad and reduced import tariffs in other countries. The low oil price case assumes reduced domestic and international demand for ethanol, resulting in 0.8 million barrels per day of production in 2030. The projected reduction in Brazil's domestic demand in the low price case is relatively small, however, because ethanol currently accounts for almost 50 percent of the fuel used by its gasoline-powered vehicles, and because Brazil has a mandatory minimum of 25 percent ethanol in gasoline blends.

Russia and Kazakhstan are the other prominent sources of growth in non-OPEC liquids production in the *IEO2009* reference case. Both are located in non-OECD Europe and Eurasia, a region prone to territorial disputes, transportation blockages, contractual changes, and political intervention. Russia's production is expected to decline in the near term because of tax policies that have caused companies to operate at a net financial loss—a large disincentive for investment in resource development. After declining to less than 9.2 million barrels in 2011, Russia's liquids production begins a slow increase to 9.5 million barrels per day in 2015, as cautious investors, who are continuously dealing with adjustments in taxation levels, respond to an expected stabilization of taxes and a rising world oil price. As a result, production increases to 10.9 million barrels per day in 2020 and 11.9 million barrels per day in 2030 in the reference case.

Russia's production varies significantly across the oil price cases, according to different assumptions about the levels of economic access granted to both foreign and domestic investors in the long term. Production increases from 2015 to 2030 are projected to be less than 0.5 million barrels per day in the high price case and 4.7 million barrels per day in the low price case. Although exploration in eastern Siberia is expected during the projection period, exploration in the Arctic is not expected.

Mid-term growth in Kazakhstan's liquids production will depend predominantly on the resources of the Kashagan and Tengiz oil fields and the ability of investors to transport production from those projects to the world market. Although known and potential resources are sufficient to support production growth, a current lack of easily accessible export routes could hinder their development [***6***]. Currently, exports are limited to five routes. The two primary transportation modes are by pipeline (operated by the Caspian Pipeline Consortium) and by rail, which together allow for a total of 0.8 million barrels per day to be shipped to Russia. In addition, a pipeline from Kazakhstan to China currently has a capacity of 0.2 million barrels per day, and barge shipments to Azerbaijan and to Iran provide a combined export capacity of approximately 0.1 million barrels per day. Over the next few years, pipeline capacity to Russia and China and the capacity of barge shipments to Iran are expected roughly to double.

Because of Kazakhstan's geographical position, its export potential depends not only on resource availability and extractability but also on the construction of export routes—a task that will require regional cooperation. Although transportation of extracted resources is a significant concern that could possibly limit increases in production levels, it is not the only potential problem. Kazakhstan has previously demonstrated a lack of regard for contract sanctity and has forced renegotiation of investment returns. The high oil price case assumes that Kazakhstan will again change the terms of project returns and effectively discourage high levels of additional foreign investment. Thus, the country's liquids production in 2030 ranges from 2.9 million barrels per day in the high price case to 3.9 million barrels per day in the low price case.

### OPEC Production

Total liquids production from OPEC member countries increases at an average annual rate of 1.0 percent, resulting in the production of 43.8 million barrels of liquids per day in 2030, of which 29.5 million barrels per day originates in the Middle East (Figure 31). Throughout the projection, Saudi Arabia remains the largest liquids producer in OPEC, with production increasing from 2006 levels by 1.3 million barrels per day, to 12.0 million barrels per day in 2030 in the reference case. The increase in total production equates to an average annual growth rate of only 0.5 percent, based on the assumption that Saudi Arabia will continue with currently announced plans (albeit on delayed project timelines) and will seek to maintain spare production capacity above 2.0 million barrels per day.

OPEC decisions regarding investment in additional production capacity are the primary difference between the three *IEO2009* oil price cases. The low price case assumes that OPEC countries will increase investment either through their own national oil companies or by allowing greater economic access to foreign investors, depending on the country. OPEC is assumed to expand production capacity in an attempt to maximize government revenue through production levels rather than by price controls. In this case, production levels increase by

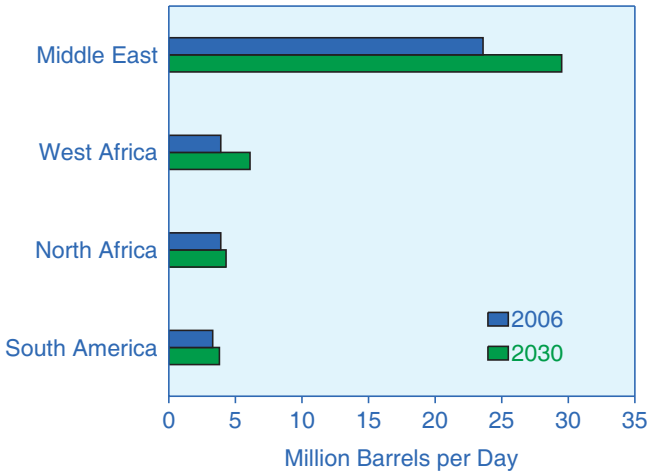
22.8 million barrels per day, to 57.4 million barrels per day in 2030, or approximately 48 percent of total world liquids production in the low price case.

In the high oil price case, the cartel nature of OPEC is assumed to strengthen over time. In this case, OPEC member countries contribute to the maintenance of record high prices by further restricting their production targets each year. As a result, production levels decline by 6.4 million barrels per day, to 28.2 million barrels per day in 2030, or 31 percent of total world liquids production.

Iraq is projected to increase its liquids production by an average of 3.9 percent per year in the reference case, for the highest annual growth rate in total liquids production among all producers. The projection is based on an assumption that the conflict in Iraq will be resolved in the long term, making resource availability the most important factor in its ability to increase production. Continued infrastructure disruptions and legislative uncertainty are expected to limit production growth in the mid-term to 2.8 percent per year, adding 0.4 million barrels per day between 2010 and 2015. In the longer term, if the country's liquids production capability is stabilized as projected in the reference case, investment in oil production could increase by as much as 8.5 percent annually from 2016 to 2020 before settling to a more modest 1.8 percent annually from 2020 to 2030. The fact that Iraq has the resources necessary to support such growth in the long run, even though production was limited to 2.0 million barrels per day in 2006, shows the importance of political developments in shaping the future of Iraq's oil sector.

Qatar is projected to have the second-highest average annual growth in total liquids production from 2006 to 2030, at 3.3 percent, with total volumes increasing from 1.1 million barrels per day in 2006 to 2.5 million barrels per day in 2030. Only one-half of the increase is expected to come from production of crude oil and lease condensate, with NGPL production contributing 0.5 million barrels per day and GTL projects another 0.2 million barrels per day. Despite the current negative outlook for many previously announced GTL projects around the world, a return to, and persistence of, historically high oil prices in the reference case is expected to facilitate the delayed start of Qatar's Pearl facility (0.1 million barrels per day) and expansion of the Oryx facility (adding another 0.1 million barrels per day).

**Figure 31. OPEC Conventional Liquids Production by Region, 2006 and 2030**




Sources: **2006:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **2030:** Energy Information Administration, Generate World Oil Balance Model (2009).

Angola, despite receiving a production target of 1.9 million barrels per day from OPEC in December 2007, is projected to have the third-largest average annual increase in total liquids production from 2006 to 2030, at 2.7 percent, almost entirely attributable to increasing production of crude oil and condensate from offshore projects [7]. Production targets established by OPEC are not expected to impede the development of projects in Angola, where total liquids production increases to 2.7 million barrels per day in 2030 in the reference case. Essentially the same assumptions apply to Nigeria, where a higher level of known resources enables production to grow by an average of 1.4 percent per year, to 3.4 million barrels per day in 2030. For both Angola and Nigeria, the projections for total liquids production in 2030 vary by approximately 2.0 million barrels per day between the low price and high oil price cases.

Total liquids production in Iran is expected to be restricted in the mid-term by political factors, which are not limited to international relations but encompass a variety of factors, including the effectiveness of the national oil company's operations and the ability of the government and foreign investors to agree on contract terms. In the reference case, Iran's oil production declines through 2020 because of both financial and political constraints on the development of new oil and natural gas prospects. In addition, it is assumed that Iran's domestic use of natural gas for electricity generation and for heating in residential and commercial buildings will limit the amount available for improving oil recovery through natural gas reinjection. In the long term, however, liquids production in Iran is projected to return to 2006 levels by 2030 in the reference case. In the alternative oil price cases, production in 2030 varies by 3.0 million barrels per day, from 2.6 million barrels per day in the high price case to 5.6 million barrels per day in the low price case.

Recent history suggests that Venezuela's national government reacts to high oil prices by tightening investment terms for foreign direct investment and limiting access to its reserves. As a result, in the reference case, with prices rebounding after 2012 and remaining at

historically high levels through 2030, further mandated changes in contractual terms along with threats of energy sector nationalization are likely to hinder production potential in the near term and discourage investment in and development of additional projects in the long term. In the reference case, Venezuela's production growth is projected to come mainly from extra-heavy oil production in the Orinoco belt and is limited to about 0.6 million barrels per day from 2006 to 2030.

### Unconventional Production

Unconventional liquids play an increasingly important role in meeting demand for liquid fuels over the course of the *IEO2009* projections. In the reference case, 12.6 percent of world liquids supply in 2030 comes from unconventional sources, including 1.5 million barrels per day from OPEC and 11.9 million from non-OPEC sources. Although the volume and composition of unconventional production vary between the *IEO2009* oil price cases (from 17.8 million barrels per day in the high price case to 12.4 million barrels per day in the low price case), the geographic origin of each type of unconventional liquid does not vary by much, because their production usually is limited to countries where projects already have been announced or are under way.

OPEC's unconventional production consists predominantly of extra-heavy oil from Venezuela's Orinoco belt and GTL production from Qatar. In the reference case, Venezuela's extra-heavy oil production increases from 0.6 million barrels per day in 2006 to 1.2 million barrels per day in 2030, and Qatar's GTL production increases from a negligible amount in 2006 to 0.2 million barrels per day in 2030. Although resources to support those production levels abound in the two countries, large investments will be needed to bring them to market, and the timing of such investment is uncertain.

Outside OPEC, unconventional liquids production comes from a diverse group of countries and resource types. As a whole, non-OPEC unconventional liquids production is projected to increase by 9.6 million barrels per day from 2006 to 2030, with 65 percent coming from OECD countries. The countries that make the largest contributions to the increase in non-OPEC production of unconventional liquids from 2006 to 2030 are Canada (an increase of 3.1 million barrels per day), the United States (2.2 million barrels per day), China (1.0 million barrels per day), and Brazil (0.7 million barrels per day).

Canada's production of bitumen from oil sands makes up more than 35 percent of total non-OPEC unconventional production in 2030 in the reference, low oil price, and high oil price cases, ranging from 3.7 million barrels per day in the low price case to 6.5 million barrels per day in the high price case. The differences in production volumes across the price cases is determined mostly by limitations on economic access to both conventional and unconventional resources and the actions taken by individual consuming countries to lower dependence on foreign energy sources. Although price levels in the high and low price cases are each approximately 50 percent different from the reference case, the distribution of projections of unconventional liquids production does not necessarily vary by a proportionate degree. With world oil prices in the low price case still high enough to support Canada's bitumen production, 2030 production levels are only 0.5 million barrels per day lower in the low price case and 2.3 million barrels per day higher in the high price case than projected in the reference case.

The world's total production of biofuels increases by 5.0 million barrels per day from 2006 to 2030 in the reference case, to 5.9 million barrels per day, for an average annual growth rate of 8.6 percent. The countries expected to provide the largest increases in biofuels production from 2006 to 2030 are the United States (1.5 million barrels per day) and Brazil (0.74 million barrels per day). In addition, production increases of 440 thousand barrels per day in China and 457 thousand barrels per day in South America (excluding Brazil) also are projected in the reference case. As is true for most renewable energy sources, government policies are the most important factor influencing biofuel production. In order to achieve national goals of reducing greenhouse gas emissions and bolstering energy security, many countries have mandated targets for biofuel use and provided tax credits to biofuel producers that are designed to be phased out over time as the cost of biofuel production falls and oil prices rise.

Biofuels also become more economically competitive with conventional oil products in the high and low oil price cases, depending on the oil price assumed. In the low price case, only the least expensive and most cost-effective feedstocks and production technologies are competitive. In the high price case, prototype production processes are used more widely. Thus, world biofuels production in 2030 totals 4.8 million barrels per day in the low price case and 7.2 million barrels in the high price case. The growth of biofuel production slows in all the cases in the near term as current-generation crops reach their economic potential but picks up again around 2012 with the advent of new technologies using cellulosic feedstocks.

China is the largest CTL producer in all the oil price cases, with 2030 production levels ranging from 0.1 million barrels per day (48 percent of the world total) in the low price case to 1.2 million barrels per day (63 percent of the world total) in the high price case. Other major producers include the United States and South Africa, both producing about 0.3 million barrels per day in 2030 in the reference and high price cases and less than 0.1 million barrels per day in the low price case.

GTL makes the smallest contribution to total unconventional liquids production in all the *IEO2009* cases. In the reference and low oil price cases, GTL production is limited primarily to Qatar, although South Africa and Nigeria also produce small volumes in the reference case. In the high oil price case, the United States rapidly becomes the world's largest producer of GTL, accounting for 0.4 million barrels per day to the world total of 0.7 million barrels per day in 2030.

Tables G1-G9 in Appendix G show the ranges of production potential for both OPEC and non-OPEC producers of unconventional liquids. As discussed in detail above, geopolitical issues in a number of the OPEC countries, including Iraq, Iran, Venezuela, and Nigeria, make it difficult to estimate future production levels. As a result, there is a high level of uncertainty associated with the reference case assumptions and projections for OPEC production through 2030.

## Oil Reserves and Resources

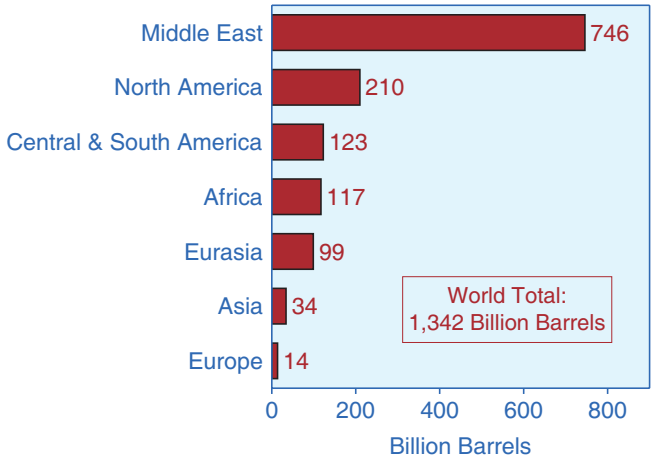
As of January 1, 2009, proved world oil reserves, as reported by the *Oil & Gas Journal*, were estimated at 1,342 billion barrels—10 billion barrels (about 1 percent) higher than the estimate for 2008 [*8*]. According to the *Oil & Gas Journal*, 56 percent of the world's proved oil reserves are in the Middle East (Figure 32). Just under 80 percent of the world's proved reserves are concentrated in eight countries, of which only Canada (with oil sands included) and Russia are not OPEC members (Table 4).

Proved reserves of crude oil are the estimated quantities that geological and engineering data indicate can be recovered in future years from known reservoirs, assuming existing technology and current economic and operating conditions. Companies whose stocks are publicly traded on U.S. stock markets are required by the U.S. Securities and Exchange Commission (SEC) to report their holdings of domestic and international proved reserves, following specific guidelines. In 2008, the SEC revised some of its rules for reporting reserves (see box on page 32). Country-level estimates of proved reserves are developed from the data reported to the SEC, from foreign government reports, and from international geologic assessments. The estimates are not always updated annually.

Whereas proved reserves include only those estimated quantities of crude oil from known reservoirs, they are just a subset of the entire potential oil resource base. Resource base estimates include estimated quantities of both discovered and undiscovered liquids that have the potential to be classified as reserves at some time in the future. The resource base may include oil that currently is not technically recoverable but could become recoverable in the future as technologies advance.

Readers may notice that, in some cases in the *IEO2009* projections, country-level volumes for cumulative production through 2030 exceed the estimates of proved

**Figure 32. World Proved Oil Reserves by Geographic Region as of January 1, 2009**




Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 23-24.

**Table 4. World Oil Reserves by Country as of January 1, 2009**
(Billion Barrels)

| Country | Oil Reserves |
|---|---|
| Saudi Arabia | 266.7 |
| Canada[a] | 178.1 |
| Iran | 136.2 |
| Iraq | 115.0 |
| Kuwait | 104.0 |
| Venezuela | 99.4 |
| United Arab Emirates | 97.8 |
| Russia | 60.0 |
| Libya | 43.7 |
| Nigeria | 36.2 |
| Kazakhstan | 30.0 |
| United States | 21.3 |
| China | 16.0 |
| Qatar | 15.2 |
| Brazil | 12.6 |
| Algeria | 12.2 |
| Mexico | 10.5 |
| Angola | 9.0 |
| Azerbaijan | 7.0 |
| Norway | 6.7 |
| Rest of World | 64.6 |
| **World Total** | **1,342.2** |

[a]Includes 5.4 billion barrels of conventional crude oil and condensate.

Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 23-24.

### Recent Changes in SEC Regulations

In December 2008, the U.S. Securities and Exchange Commission (SEC) approved a new set of regulations to govern company reporting of oil and natural gas reserves and production. The new regulations are expected to become effective as of January 1, 2010. They are intended to bring company reporting to the SEC in line with current industry realities by expanding: the range of technologies recognized for proving reserves, to include seismic and other "reliable" modern technologies; the types of production reported, to include unconventional liquids, such as bitumen and shale oil; and the levels of certainty about reserve estimates, to include "probable" and "possible" as well as "proven."

In addition, the new regulations require companies to use average of start-of-month prices for each month of the year in calculating year-end reserves, rather than the previous practice of using price only as of December 31—which did not account for volatility in oil and natural gas prices or potential differences between the yearly average price and the price on a single day (December 31). The new pricing methodology is important for reserve reporting, because reserves, by definition, must be economical to produce. The previous practice of using one day's price to estimate company reserves had the undesirable effect of transforming the volatility of oil and natural gas prices into volatility of reserve estimates.

reserves. This does not imply that resources and the physical limits of production have not been considered in the development of the projections or that they assume rapid declines in production immediately after the end of the projection period as reserves are depleted. EIA carefully considers resource availability in all long-term country-level projections, the aggregation of which gives the total world production projection; however, proved reserves are not an appropriate measure for judging total resource availability in the long run.

In order to construct realistic and plausible projections for liquids production, and especially for petroleum liquids production, underlying analysis must both consider production beyond the intended end of the projection period and base production projections on the physical realities and limitations of production. The importance of approaching an assessment of liquids production in this way is illustrated by the recent history of U.S. reserve estimates. Whereas the United States reported 22.5 billion barrels of proved reserves in 1998, proved reserves of 21.3 billion barrels were reported in 2008—a decrease of only 1.2 billion barrels despite the cumulative 22.2 billion barrels of liquids supplied from U.S. reserves between 1998 and 2008.

Proved reserves cannot provide an accurate assessment of the physical limits on future production but rather are intended to provide insight as to company- or country-level development plans in the very near term. In fact, because of the particularly rigid requirements for the classification of resources as proved reserves, particularly by the U.S. SEC,[14] even the cumulative production levels from individual development projects may exceed the initial estimates of proved reserves.

EIA attempts to address the lack of applicability of proved reserves estimates to long-term production projections by developing a production methodology based on the true physical limits of production, initially-in-place (IIP) volumes and technologically limited recovery factors (RF). By basing long-term production assessments on resources rather than reserves, EIA is able to present projections that are physically achievable and can be supported beyond the 2030 projection horizon. The realization of such production levels depends on future growth in world demand, taking into consideration such above-ground limitations on production as profitability and specific national regulations, among others.

## References


1. "Oil Price 'May Hit $200 a Barrel,'" *BBC News* (May 7, 2008), web site http://news.bbc.co.uk/2/hi/business/7387203.stm.
2. Energy Information Administration, "Declines in U.S. Petroleum Consumption Expected To Continue," *This Week in Petroleum* (Washington, DC, August 13, 2008), web site http://tonto.eia.doe.gov/oog/info/twip/twiparch/080813/twipprint.html.
3. Energy Information Administration, *Short-Term Energy Outlook* (Washington, DC, August 2008), web site www.eia.doe.gov/pub/forecasting/steo/oldsteos/aug08.pdf.
4. M. Georgy and P. Mackey, "OPEC Agrees Sharp Output Cut, Oil Slide Goes On," *Reuters News Service* (October 24, 2008), web site www.reuters.com/article/newsOne/idUSTRE49L50I20081024.


[14] The U.S. SEC guidelines are seen as particularly rigid because of the limited extraction technologies they recognize and because they base the economic viability of reserves on oil prices for the last day of trading in a year rather than an annual average. Under current rules, a company can generally meet the "reasonable certainty" standard necessary to establish proved reserves only by using actual production or flow tests. In June 2008, the SEC formally proposed changes to the guidelines that would not only expand the extraction technologies recognized and the price used to determine economic viability but also expand the resources eligible to be classified as oil reserves by including oil sands and other unconventional oil deposits.

5. Energy Information Administration, *Short-Term Energy Outlook* (Washington, DC, April 2009), Table 9a, web site www.eia.doe.gov/pub/forecasting/steo/oldsteos/apr08.pdf.
6. Energy Information Administration, *Country Analysis Briefs*, "Kazakhstan" (Washington, DC, February 2008), web site www.eia.doe.gov/emeu/cabs/Kazakhstan/Background.html.
7. Energy Information Administration, *Country Analysis Briefs*, "Angola" (Washington, DC, March 2008), web site www.eia.doe.gov/emeu/cabs/Angola/Background.html.
8. "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 23-24, web site www.ogj.com (subscription site).

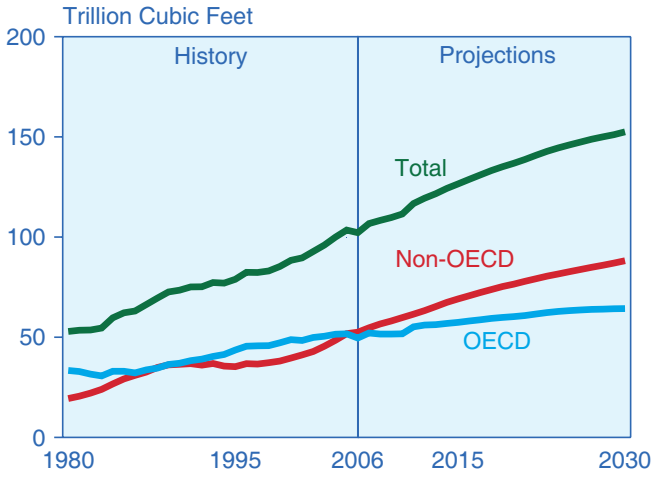
# Chapter 3
# Natural Gas

***In the IEO2009 reference case, natural gas consumption in the non-OECD countries grows more than twice as fast as in the OECD countries. Production increases in the non-OECD region account for more than 80 percent of the growth in world production from 2006 to 2030.***

Worldwide, total natural gas consumption increases by an average of 1.6 percent per year in the *IEO2009* reference case, from 104 trillion cubic feet in 2006 to 153 trillion cubic feet in 2030 (Figure 33). With world oil prices assumed to return to previous high levels after 2012 and remain high through the end of the projection, consumers opt for the comparatively less expensive natural gas for their energy needs whenever possible. In addition, because natural gas produces less carbon dioxide when it is burned than does either coal or petroleum, governments implementing national or regional plans to reduce greenhouse gas emissions may encourage its use to displace other fossil fuels.

Natural gas remains a key energy source for industrial sector uses and electricity generation throughout the projection. The industrial sector currently consumes more natural gas than any other end-use sector and is expected to continue that trend through 2030, when 40 percent of world natural gas consumption is projected to be used for industrial purposes. In particular, new petrochemical plants are expected to rely increasingly on natural gas as a feedstock—particularly in the Middle East, where major oil producers, working to maximize revenues from oil exports, turn to natural gas for domestic uses.

**Figure 33. World Natural Gas Consumption, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

In the electric power sector, natural gas is an attractive choice for new generating plants because of its relative fuel efficiency and low carbon dioxide intensity. Electricity generation accounts for 35 percent of the world's total natural gas consumption in 2030, up from 32 percent in 2006.

In 2006, OECD member countries consumed 52 trillion cubic feet of natural gas and non-OECD countries consumed 53 trillion cubic feet, surpassing OECD gas consumption for the first time since the fall of the Soviet Union in 1991. In the *IEO2009* reference case, natural gas consumption in the non-OECD countries grows more than twice as fast as consumption in the OECD countries, with 2.2 percent average annual growth from 2006 to 2030 for non-OECD countries, compared with an average of 0.9 percent for the OECD countries. The non-OECD countries account for 74 percent of the total world increment in natural gas consumption over the projection period, and the non-OECD share of total world natural gas consumption increases from 50 percent in 2006 to 58 percent in 2030.

The OECD countries accounted for 38 percent of the world's total natural gas production and 50 percent of natural gas consumption in 2006, making them dependent on imports from non-OECD sources for 25 percent of their total consumption. In 2030, the OECD countries account for 31 percent of production and 42 percent of consumption, with their dependence on non-OECD natural gas only slightly higher than in 2006, at 27 percent. In the non-OECD regions, net exports grow more slowly than total production. In 2030, 17 percent of non-OECD production is consumed in OECD countries, down from 19 percent in 2006.

## World Natural Gas Demand

### OECD Countries

In the *IEO2009* reference case, natural gas consumption in North America increases by an average of 0.8 percent per year from 2006 to 2030 (Figure 34). In the United States—the world's largest natural gas consumer—consumption in most of the end-use sectors increases slowly through 2030. Natural gas consumption in the U.S. electric power sector, however, increases rapidly from 2006 through 2025 in response to generators' concerns about the potential for new legislation limiting greenhouse gas

emissions. Those concerns are addressed in the reference case by the addition of a risk premium on new carbon-intensive coal-fired generating capacity, which stimulates investment in less carbon-intensive natural-gas-fired capacity. In addition, the capital costs for new natural gas power plants are lower than those for nuclear and renewable alternatives.

After 2025, the growth in U.S. natural gas consumption for electricity generation is slowed by rising natural gas prices, growing generation from renewables, and the introduction of clean coal-fired capacity. As a result, natural-gas-fired electricity generation in 2030 is 94 percent of the 2025 peak level. With the other end-use sectors showing slow but steady growth in consumption, total U.S. demand for natural gas in 2030 is 2.7 trillion cubic feet above the 2006 total of 21.7 trillion cubic feet.[15]

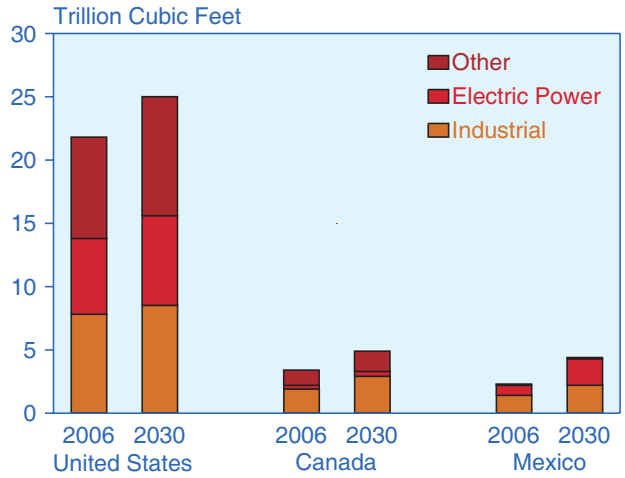
Canada's total natural gas consumption increases steadily, by 1.5 percent per year, in the reference case, from 3.3 trillion cubic feet in 2006 to 4.7 trillion cubic feet in 2030. The strongest growth is in the industrial sector, averaging 1.8 percent per year, and in the electric power sector, averaging 1.3 percent per year. The rapid growth projected for Canada's industrial natural gas consumption is based in large part on the expectation that purchased natural gas will be consumed in increasing quantities for mining of the country's oil sands deposits. In 2006, an estimated 12 percent of Canada's total natural gas consumption was used for oil sands production; in 2030, that share could reach 22 percent of the country's total gas use.[16]

In Mexico, more than 90 percent of natural gas consumption occurs in the industrial and electricity generation sectors combined. Although growth is projected in all sectors, the share of total consumption accounted for by the country's industrial and electric power sectors continues to increase through 2030. The strongest growth is projected for the electricity generation sector, at an average annual rate of 4.1 percent, with consumption increasing almost threefold from 2006 to 2030, while natural gas use in the industrial sector grows by 1.8 percent per year. In 2006, the amount of natural gas consumed for electricity generation in Mexico was about one-half the amount consumed in the industrial sector; in 2030, it is expected to be nearly equal to consumption in the industrial sector.

Natural gas consumption in OECD Europe grows by a modest 1.0 percent per year on average, from 19.2 trillion cubic feet in 2006 to 21.5 trillion cubic feet in 2015 and 24.1 trillion cubic feet in 2030—mostly as a result of increasing use for electricity generation. Many nations in OECD Europe have made commitments to reduce carbon dioxide emissions, bolstering the incentive for governments to encourage natural gas use in place of other fossil fuels. In addition, given the long lead times and high costs associated with constructing new nuclear capacity, as well as the expected retirement of some existing nuclear facilities, natural gas and renewable energy sources become the fuels of choice for new generating capacity. In the *IEO2009* reference case, natural gas is the second fastest-growing source of energy for electricity generation in the region, at 2.0 percent per year, as compared with renewables at 3.2 percent per year . Natural gas use in the region's electric power sector increases from 5.8 trillion cubic feet in 2006 to 7.7 trillion cubic feet in 2015 and 9.3 trillion cubic feet in 2030.

Natural gas consumption in OECD Asia grows on average by 1.0 percent per year from 2006 to 2030. Japan,

**Figure 34. Natural Gas Consumption in North America by Country and Sector, 2006 and 2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[15] Cumulative U.S. natural gas consumption from 2006 to 2030 is reduced by 6 percent in the *updated AEO2009* reference case (April 2009) relative to the *published AEO2009* reference case (March 2009). About 70 percent of the reduction is attributable to reduced use of natural gas for electricity generation, largely as a result of incentives for increased use of renewable fuels in ARRA2009. The difference between the cases narrows somewhat toward the end of the projection period, as natural gas displaces some of the later increase in coal use in the *published AEO2009* reference case, due to somewhat more favorable prices. In the *updated* reference case, total U.S. natural gas consumption increases by 1.8 trillion cubic feet, to 23.5 trillion cubic feet in 2030.

[16] Total projected oil sands production in the *IEO2009* reference case in 2030 is 4.2 million barrels per day. The natural gas efficiency of oil sands production is assumed to improve to around 0.66 million cubic feet of purchased natural gas consumed per barrel of oil sands produced, and the amount of purchased natural gas used for oil sands production is just over 1 trillion cubic feet in 2030. There is considerable room for variation, however, because several factors can influence future rates of natural gas use in oil sands production, including the quality of reservoirs, degree of upgrading, and development and penetration of technologies that would replace natural gas with coke or bitumen in the production process.

South Korea, and Australia/New Zealand are projected to add less than 1 trillion cubic feet of natural gas demand each between 2006 and 2030 (Figure 35). Total natural gas consumption for the region as a whole increases from 5.5 trillion cubic feet in 2006 to 7.0 trillion cubic feet in 2030.

In Japan, the electric power sector is projected to remain the main consumer of natural gas, accounting for 64 percent of the country's total natural gas consumption in 2030, up from 59 percent in 2006. In Australia/New Zealand, the industrial sector accounted for the largest share of natural gas use in 2006, at 56 percent of the total; in 2030, its share falls to 50 percent. Over the same period, the electric power sector share increases from 28 percent to 35 percent. South Korea's natural gas use is concentrated in the electric power and residential sectors, with each accounting for approximately one-third of the country's total natural gas consumption in 2006; however, the electric power sector share is projected to grow to 47 percent in 2030.

### Non-OECD Countries

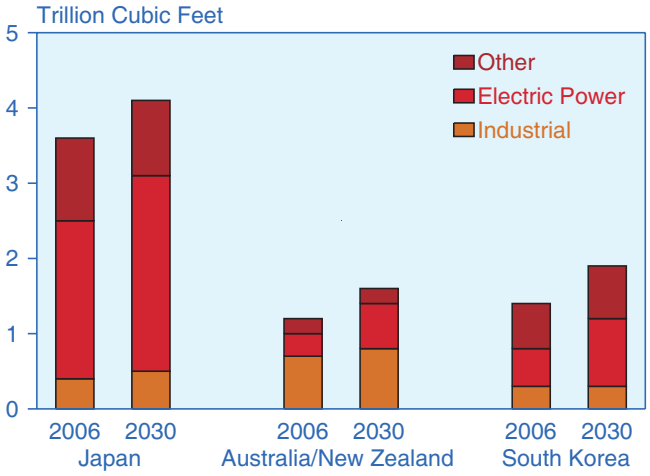
Russia is second only to the United States in total natural gas consumption, with demand totaling 16.6 trillion cubic feet in 2006 and representing 55 percent of Russia's total energy consumption. In the *IEO2009* reference case, natural gas consumption in Russia grows by 0.9 percent per year on average, and its share of total energy consumption increases to 56 percent in 2030, outpacing growth in liquid fuels and coal consumption. Throughout the projection, the industrial and electric power sectors each account for around one-third of total natural gas consumption in Russia, about the same as in 2006.

Natural gas consumption in the other countries of non-OECD Europe and Eurasia grows at an average annual rate of 1.3 percent, from 8.8 trillion cubic feet in 2006 to 12.0 trillion cubic feet in 2030 (Figure 36). In Turkmenistan, domestic consumers have received natural gas for free since 1993. Not surprisingly, then, Turkmenistan has had the fastest consumption growth in the region, averaging 16.1 percent annually from 2000 to 2006, as compared with 6.3 percent per year for the rest of Central Asia and Azerbaijan over the same period, and 0.1 percent per year for the rest of non-OECD Europe and Eurasia, excluding Russia. Outside Central Asia and Azerbaijan, most of the rest of the region relies on imports of natural gas from Russia to meet significant portions of their demand, and they have seen natural gas prices rise as Russia has endeavored to bring most of its export prices up to the levels paid by importing countries in OECD Europe.

Non-OECD Asia, which accounted for 9 percent of the world's total consumption of natural gas in 2006, shows the most rapid growth in natural gas use in the reference case and accounts for 31 percent of the total increase in world natural gas consumption from 2006 to 2030. Natural gas consumption in non-OECD Asia increases from 9.4 trillion cubic feet in 2006 to 24.5 trillion cubic feet in 2030, expanding by 4.1 percent per year on average over the projection period (Figure 37).

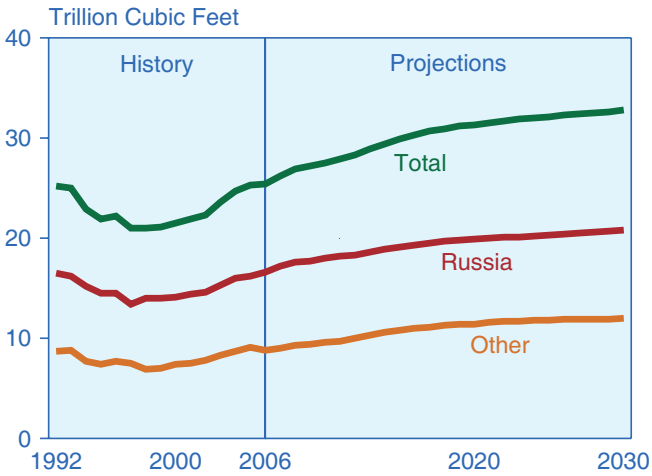
In both China and India, natural gas currently is a minor fuel in the overall energy mix, representing only 3 percent and 8 percent, respectively, of total primary energy consumption in 2006. In the *IEO2009* reference case, natural gas consumption rises rapidly in both countries,

**Figure 35. Natural Gas Consumption in OECD Asia by Country and Sector, 2006 and 2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 36. Natural Gas Consumption in Non-OECD Europe and Eurasia, 1992-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

growing by 5.2 percent per year in China and 4.2 percent per year in India, on average from 2006 to 2030.

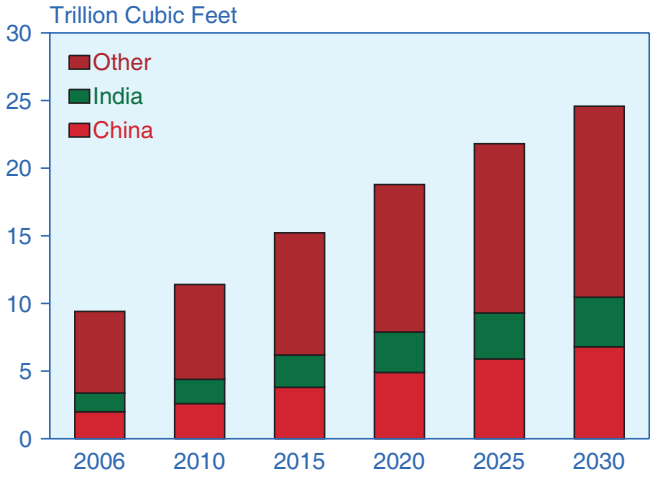
In the rest of the non-OECD Asia countries, natural gas already is a prominent fuel in the energy mix, representing 23 percent of total primary energy consumption in 2006. Their combined annual consumption of natural gas increases more slowly than in either China or India, averaging 3.6-percent growth per year. With consumption starting from a much larger base, however, the rest of non-OECD Asia adds more natural gas consumption over the projection period than do China and India combined. Together, China and India are projected to consume 7.1 trillion cubic feet more natural gas in 2030 than in 2006, as compared with an increase of 8.1 trillion cubic feet for the rest of non-OECD Asia.

Natural gas consumption grows at average annual rates of 2.0 percent in the Middle East and 3.2 percent in Africa from 2006 to 2030. There is very little infrastructure on the continent for intraregional trade of natural gas, and Algeria, Nigeria, Egypt, and Libya—the major African producers—also are the major consumers. The four countries plus South Africa and Tunisia, accounted for 94 percent of Africa's natural gas consumption in 2006. Intraregional infrastructure also is limited in the Middle East, although both Dubai (in the United Arab Emirates) and Kuwait have plans to begin importing LNG to meet peak summer demands for natural gas [*1*].

In Central and South America, natural gas is the fastest-growing energy source in the reference case, with demand increasing on average by 2.4 percent per year, from 4.5 trillion cubic feet in 2006 to 8.1 trillion cubic feet in 2030. For Brazil, the region's largest economy, natural gas consumption more than doubles—from 0.7 trillion cubic feet in 2006 to 1.8 trillion cubic feet in 2030. Several countries in the region are particularly intent on increasing the penetration of natural gas for power generation, in order to diversify electricity fuel mixes that currently are heavily reliant on hydropower (and thus vulnerable to drought) and reduce the use of more expensive oil-fired generation often used to supplement electricity supply.

Although pipeline infrastructure is in place to move natural gas from Argentina to Brazil, Chile, and Uruguay and from Bolivia to Argentina and Brazil, recent concerns about the security of supply have spurred development of LNG regasification terminals in the importing nations. Specifically, Argentina became the region's first LNG importer in May 2008; Chile has plans to add two LNG regasification plants by 2010; a single terminal has been proposed for Uruguay; and Brazil plans to open three LNG terminals in the next several years [*2*].

**Figure 37. Natural Gas Consumption in Non-OECD Asia, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

## World Natural Gas Production

In order to meet the demand growth projected in the *IEO2009* reference case, the world's natural gas producers will need to increase supplies by 48 trillion cubic feet between 2006 and 2030. Much of the increase in supply is expected to come from non-OECD countries, which in the reference case account for 84 percent of the total increase in world natural gas production from 2006 to 2030. Non-OECD natural gas production grows by an average 2.1 percent per year in the reference case, from 65 trillion cubic feet in 2006 to 106 trillion cubic feet in 2030 (Table 5), while OECD production grows by only 0.8 percent per year, from 40 trillion cubic feet to 47 trillion cubic feet.

With more than 40 percent of the world's proved natural gas reserves, the Middle East accounts for the largest increase in regional natural gas production from 2006 to 2030 in the reference case and more than one-fifth of the total increment in world natural gas production. Currently, there are four major natural gas producers in the Middle East: Iran, Saudi Arabia, Qatar, and the United Arab Emirates, which together accounted for 83 percent of the natural gas produced in the Middle East in 2006. Each of the four countries has announced plans to expand natural gas production in order to meet the expected increase in regional demand and/or to supply markets outside the region.

In Saudi Arabia there has been a concerted effort to increase natural gas production specifically for domestic consumption. At present, Saudi Arabia produces most of its natural gas from associated oil and natural gas fields; however, there may be fluctuations in oil production when Saudi Arabia balances global supply and demand, which also will affect the production of natural gas.

To reduce the dependence of its natural gas production on oil production, Saudi Arabia has begun efforts to increase production from nonassociated natural gas fields. To that end, in 2003 private investment for natural gas exploration projects was invited at four sites in the Rub al-Khali desert [*3*]. Although 27 exploration wells are to be drilled at the sites by the end of 2009, results have not been encouraging thus far, and relatively low fixed prices set by Saudi Arabia for the natural gas have made the projects less attractive to foreign participants [*4*]. The Saudi national oil company, Saudi Aramco, on the other hand, has made several nonassociated natural gas finds near existing oil fields, some of which are expected to begin producing in the near term, including the Karan natural gas project, scheduled to begin producing 1.8 billion cubic feet per day in 2012.

Iran has the world's second-largest reserves of natural gas, after Russia, and currently is the Middle East's largest natural gas producer. Political barriers—including U.S. sanctions and international concerns about the country's nuclear power ambitions—have lowered interest in foreign direct investment in the country's natural gas sector. The largest natural gas development project in Iran is the offshore South Pars field, discovered in 1990, which is estimated to contain between 350 and 490 trillion cubic feet of natural gas reserves [*5*]. Located 62 miles offshore, South Pars has a 28-phase development plan spanning 20 years, with each phase set to produce more than 1 billion cubic feet per day. Iran has set a goal to raise marketed natural gas production to between 9 and 10 trillion cubic feet per year by 2010, more than double its 2006 marketed production of

**Table 5. World Natural Gas Production by Region and Country, 2006-2030**
(Trillion Cubic Feet)

| Region/Country | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD North America** | **26.6** | **27.7** | **27.9** | **29.0** | **31.1** | **31.9** | **0.8** |
| United States[a] | 18.3 | 20.1 | 20.5 | 21.5 | 23.3 | 23.6 | 1.1 |
| Canada | 6.5 | 5.5 | 5.4 | 5.4 | 5.6 | 5.7 | -0.6 |
| Mexico | 1.7 | 2.1 | 2.1 | 2.1 | 2.3 | 2.5 | 1.6 |
| **OECD Europe** | **10.7** | **10.9** | **11.0** | **10.9** | **10.7** | **10.4** | **-0.1** |
| **OECD Asia** | **1.8** | **2.3** | **2.8** | **3.6** | **4.0** | **4.6** | **3.9** |
| Japan | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Australia/New Zealand | 1.7 | 2.1 | 2.6 | 3.4 | 3.8 | 4.4 | 4.2 |
| **Total OECD** | **39.1** | **40.9** | **41.7** | **43.4** | **45.8** | **46.9** | **0.8** |
| **Non-OECD Europe and Eurasia** | **30.0** | **31.8** | **35.0** | **36.8** | **38.2** | **40.3** | **1.2** |
| Russia | 23.2 | 24.3 | 26.7 | 28.0 | 29.2 | 31.3 | 1.3 |
| Other Non-OECD Europe and Eurasia | 6.8 | 7.6 | 8.3 | 8.9 | 9.0 | 9.1 | 1.2 |
| **Non-OECD Asia** | **11.1** | **13.0** | **15.6** | **17.3** | **18.7** | **19.8** | **2.5** |
| China | 2.1 | 2.5 | 3.4 | 3.8 | 4.2 | 4.3 | 3.1 |
| India | 1.1 | 1.6 | 2.0 | 2.3 | 2.4 | 2.4 | 3.3 |
| Other Non-OECD Asia | 7.9 | 8.9 | 10.3 | 11.2 | 12.1 | 13.2 | 2.2 |
| **Middle East** | **12.0** | **14.8** | **17.8** | **19.9** | **22.0** | **22.6** | **2.7** |
| **Africa** | **6.6** | **7.9** | **9.6** | **11.6** | **12.8** | **13.9** | **3.2** |
| **Central and South America** | **5.1** | **6.2** | **7.0** | **7.8** | **8.6** | **9.1** | **2.5** |
| Brazil | 0.3 | 0.6 | 1.0 | 1.2 | 1.5 | 1.6 | 6.6 |
| Other Central and South America | 4.7 | 5.5 | 6.0 | 6.5 | 7.1 | 7.5 | 1.9 |
| **Total Non-OECD** | **64.6** | **73.6** | **85.0** | **93.4** | **100.3** | **105.8** | **2.1** |
| **Total World** | **103.8** | **114.5** | **126.7** | **136.8** | **146.1** | **152.7** | **1.6** |

[a]Includes supplemental production or forecast discrepancy. For details, see Energy Information Administration (EIA), *Annual Energy Outlook 2009*, p. 135, Table A13, "Natural Gas Supply, Disposition, and Prices."

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** EIA, *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections: United States:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, June 2009), web site www.eia.doe.gov/oiaf/aeo. **Others:** EIA, World Energy Projections Plus (2009).

4.4 trillion cubic feet. That goal may be difficult to achieve, however, without attracting substantial foreign investment in the near term.

The world's second-largest regional increase in natural gas production is expected in non-OECD Europe and Eurasia, which includes Russia. In the reference case, natural gas production in non-OECD Europe and Eurasia increases from 30.0 trillion cubic feet in 2006 to 40.3 trillion cubic feet in 2030. Russia remains the region's most important natural gas producer, providing the single largest increment in production, from 23.2 trillion cubic feet in 2006 to 31.3 trillion cubic feet in 2030.

Russia's Yamal Peninsula in northwestern Siberia has ample natural gas resources and should provide a major increase in Russian production over the long term. In 2008, state-owned Gazprom began construction of a trunk pipeline to connect Bovanenkovo field, the largest on the Yamal peninsula, to existing pipeline infrastructure. Also in 2008, Gazprom drilled the first production well in the Bovanenkovo field [***6***]. Gazprom intends to increase production from the Yamal peninsula to 12.7 trillion cubic feet by 2030, both to meet domestic demand for natural gas and to double the size of its exports from current levels.

Developing new sources of natural gas is a priority for Gazprom, given that production at its three largest fields (Yamburg, Urengoy, and Medvezh'ye) is in decline [***7***]. There is concern that the global economic recession may reduce both domestic and export demand for natural gas in the short run and dampen investment in Russia's natural gas sector. In the *IEO2009* reference case, however, investment delays are not expected to hinder the growth of Russian supplies.

Two other major natural gas projects also are underway in Russia: one to develop the resources around Sakhalin Island on the country's east coast and another to develop the Shtokman field, off its western Arctic coast. The Sakhalin-1 project began supplying modest amounts of natural gas to domestic consumers in 2007. Production volumes from the first development phase are limited, however, until all the parties involved can agree on how the natural gas should be exported. Production from the second development phase will be exported as LNG, beginning in the first half of 2009, with supplies from the Sakhalin-2 LNG facility expected to reach its total capacity of 9.6 million metric tons in 2010 [***8***]. The Shtokman natural gas and condensate field in the Barents Sea is officially scheduled to begin producing 840 billion cubic feet of natural gas in 2013 (shipped via pipeline), with additional supplies for LNG anticipated beginning in 2014 [***9***]. That schedule may, however, prove to be overly ambitious.

Substantial growth in natural gas production also is projected for Africa, increasing from 6.6 trillion cubic feet in 2006 to 9.6 trillion cubic feet in 2015 and 13.9 trillion cubic feet in 2030. Currently, more than 85 percent of Africa's natural gas is produced in Algeria, Egypt, and Nigeria, which together accounted for 81 percent of Africa's proved natural gas reserves as of January 1, 2009, with a combined total of 402 trillion cubic feet [***10***].

Nigeria has the most attractive geology for natural gas exploration and development and, in terms of reserves, the greatest potential to increase production. With a slightly larger quantity of proved reserves than Algeria, Nigeria produced only about one-third the amount of natural gas produced by Algeria in 20006. Security concerns and uncertainty over access terms are expected to inhibit resource development in Nigeria, however, and its contribution to the expected increase in Africa's natural gas production is more modest than its reserves and geology would imply. The rest of the production increase is spread over a number of countries, including Algeria, Egypt, Libya and Angola.

In the *IEO2009* reference case, non-OECD Asia's natural gas production increases by 8.8 trillion cubic feet from 2006 to 2030, with 2.2 trillion cubic feet of the increment coming from China, 1.3 trillion cubic feet from India, and 5.3 trillion cubic feet from the rest of non-OECD Asia. The strongest growth in natural gas production in recent years has come from China, with increases averaging 13.6 percent per year from 2000 to 2006. China is poised to become the region's largest natural gas producer, as production has declined in recent years in Indonesia and the increases in China's production have outpaced those from the region's other major producers, Malaysia, Pakistan, and India.

Natural gas production from the OECD nations increases by 7.8 trillion cubic feet from 2006 to 2030 in the reference case. The largest regional increases are projected for the United States, at 5.3 trillion cubic feet, and Australia/New Zealand, at 2.8 trillion cubic feet. The projected production increases for the two regions are offset in part by production declines in Canada and OECD Europe, where existing conventional natural gas fields are in decline.

From 2006 to 2030, total U.S. natural gas production per year increases by more than 5 trillion cubic feet, even as onshore lower 48 conventional production (from smaller and deeper deposits) continues to taper off. Unconventional natural gas is the largest contributor to the growth in U.S. production, as rising prices and improvements in drilling technology provide the economic incentives necessary for exploitation of more costly resources. Unconventional natural gas production increases from 47 percent of the U.S. total in 2006 to 56 percent in 2030.

Natural gas in tight sand formations is the largest source of unconventional production, accounting for 30 percent

of total U.S. production in 2030, and production from shale formations is the fastest-growing source, with an assumed 267 trillion cubic feet of undiscovered technically recoverable resources. Production of natural gas from shales increases from 1.1 trillion cubic feet in 2006 to 4.2 trillion cubic feet, or 18 percent of total U.S. production, in 2030. The expected growth in natural gas production from shales is far from certain, however, and continued exploration is needed to provide additional information on the resource potential.

Natural gas production in Australia/New Zealand grows from 1.7 trillion cubic feet in 2006 to 4.4 trillion cubic feet in 2030 in the reference case, at an average rate of 4.2 percent per year—the strongest growth in natural gas production among the OECD countries. In 2006, Australia's production was far larger than New Zealand's, at 1.5 trillion cubic feet and 0.1 trillion cubic feet, respectively. Australia continues to dominate production in the region throughout the projection, given its large resource base and plans for expanding production of natural gas both for domestic use and for export.

The Carnarvon Basin—located off the Northwest shelf in Western Australia—is one of the country's most important natural gas producing areas, holding an estimated 62 trillion cubic feet of probable reserves. In addition, new development in the deepwater Timor Sea at Browse Basin is expected to bring even more natural gas to market in the future [***11***]. There also has been considerable interest in developing Australia's coalbed methane resources, especially as a fuel for LNG production. Five projects to produce coalbed methane for conversion to LNG currently are planned or under development in Australia, with LNG production from the first project (the 1.5 million metric ton Fisherman's Landing project in Queensland) scheduled to begin in late 2012 [***12***].

## Natural Gas Import Dependence

### OECD Countries

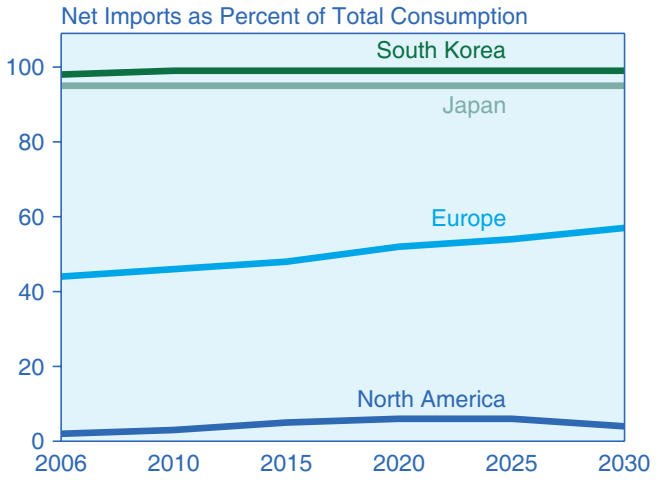
OECD North America is largely a self-contained market for natural gas. Although North America imported 631 billion cubic feet of natural gas from other regions in 2006 through six LNG regasification terminals, including one in Mexico and five in the United States, those imports accounted for only 2 percent of its total natural gas consumption. Three new regasification terminals became operational during 2007 and 2008, including the first on North America's Pacific Coast; and six more were being commissioned or were under construction at the beginning of 2009, including the first regasification terminal in Canada.

With North America's reliance on imports of natural gas projected to grow somewhat in the short to mid-term (Figure 38), imports rise to 6 percent as a share of total natural gas consumption in the region before falling back to 4 percent in 2030. An expected decline in U.S. demand for imports in the later years of the projection is the result of an increase in domestic production from unconventional sources and improvements in clean coal technology that allow for increased generation from coal-fired power plants, reducing demand for natural gas in the power sector. Consequently, U.S. dependence on natural gas imports declines from 17 percent in 2006 to 3 percent in 2030, as Canada's production and exports decline, and as domestic production from shale and other unconventional sources increases. Mexico, on the other hand, becomes more dependent on imports through most of the projection period, as production and investment in its natural gas sector fail to keep up with consumption growth. The shortfall in Mexico's domestic natural gas supply is expected to be balanced by pipeline imports from the United States and imports of LNG.

The dependence of OECD Europe on imported natural gas continues to increase in the reference case, as demand grows modestly and indigenous natural gas production declines. In 2006, 44 percent of OECD Europe's total natural gas demand was met with imports from outside the region. Imports from two countries, Russia and Algeria, accounted for more than 30 percent of the region's total consumption. In 2030, net imports make up 57 percent of total natural gas consumption. OECD Europe's import dependence is an area of concern, particularly because natural gas exporters have signed several cooperation agreements (see box on page 42), and parts of the region have experienced supply disruptions during three of the past four winters.

In January 2006, Russia's Gazprom cut natural gas supplies to Ukraine. Natural gas prices, pipeline transit fees,

**Figure 38. Imports as Share of OECD Natural Gas Consumption by Market, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

## Gas Exporting Countries Forum: What Is GECF and What Is Its Objective?

The Gas Exporting Countries Forum (GECF) was established in 2001, with the objective of generating "tangible cooperation among gas producing and exporting countries."[a] In May 2001, 10 countries attended the first Ministerial Meeting of the GECF in Tehran, Iran,[b]and since then it has held ministerial-level meetings almost every year. The membership has fluctuated from year to year, because the forum has had no formal structure, no membership requirements, and no dues.[c] Topics discussed under the auspices of the GECF have included the structure of the organization, new regulatory policies in consuming countries, development of a natural gas supply and demand model, and various studies to be conducted for the benefit of the membership.[d]

At the Sixth Ministerial Meeting of GECF, Russia agreed to conduct a study of current and possible future pricing regimes for natural gas, fueling fears in consuming countries that the organization could become a producers' cartel similar to OPEC. Indeed, since its creation, concerns have been raised in the natural gas importing countries that GECF could become a "Gas OPEC" that would restrict natural gas production in order to increase prices; however, representatives of many of GECF's most important members in terms of their current involvement in the global natural gas trade have stated publicly that they do not think the GECF should be anything like OPEC, nor do they believe that OPEC-style controls are even possible in the natural gas market. Iran and Venezuela, on the other hand, have repeatedly made comparisons between the GECF and OPEC.[e] The importance of statements from those two countries on the subject of GECF's role is not clear, however, in that neither country is a major exporter of natural gas. In fact, Iran currently imports almost as much natural gas as it exports (although it is a major holder of natural gas reserves). Venezuela exports no natural gas but does import small volumes from Colombia.

The most significant development for GECF in 2008 was its adoption of a formal charter at its Seventh Ministerial Meeting in Russia in December. Representatives from 17 countries attended the meeting.[f] The Forum agreed to establish permanent headquarters in Doha, Qatar, and adopted a charter formalizing its goals: "to foster mutual interests by favouring dialogue between producers, consumers, government and industry, and to promote a stable and transparent energy market."[g] According to the Islamic Republic of Iran News Network (IRINN), the newly formed Executive Committee of the GECF is to hold its first meeting in Doha, Qatar, in March 2009, at which it will discuss candidates to serve as GECF Secretary General, approve a budget for the organization, and discuss "membership fees, the establishment of the secretariat, and financial issues."[h]

Another significant development in 2008 was a cooperation agreement formed between Russia, Iran, and Qatar in October in Tehran, Iran. The Oil Minister of Iran, Gholamhossein Nozari, subsequently announced that the three countries had agreed to establish a "Gas OPEC"; however, the chief executive of Russia's

*(continued on page 43)*

[a]H. Hallouche, "The Gas Exporting Countries Forum: Is It *Really* a Gas OPEC in the Making?" (Oxford, UK: Oxford, Institute for Energy Studies, June 2006), p. 12, web site www.oxfordenergy.org/pdfs/NG13.pdf.

[b]H. Hallouche, "The Gas Exporting Countries Forum: Is It *Really* a Gas OPEC in the Making?", p. 17. The 10 countries included Algeria, Brunei, Indonesia, Iran, Malaysia, Nigeria, Oman, Qatar, Russia, and Turkmenistan. Norway also attended as an observer.

[c]According to the GECF web site (www.gecforum.org), in 2009 there were 14 members of GECF: Algeria, Bolivia, Brunei, Egypt, Indonesia, Iran, Libya, Malaysia, Nigeria, Qatar, Russia, Trinidad and Tobago, the United Arab Emirates, and Venezuela. Equatorial Guinea and Norway are listed as observers.

[d]See the GECF website (www.gecforum.org) for official statements released after the third, fourth, and fifth Ministerial Meetings.

[e]Deputy head of Gazprom, Alexander Medvedev; Russian Energy Minister, Sergei Shmatko; Qatari Oil Minister, Abdullah al-Attiyah; Algerian Oil Minister, Chakib Khelil; President of Indonesia's Pertamina, Ari Soemarno; and Chairman of Libya's National Oil Company, Shokri Ghanem all have been quoted in recent publications, speaking against the prospect of a gas OPEC. See A. Glazov and C. Tellinghuisen, "World's Top Gas Holders Launch 'Gas OPEC,'" *Oil Daily*, Vol. 58, No. 205 (October 22, 2008), pp. 1-2, web site www.energyintel.com (subscription site); "Gas Troika Talks, But Gas Forum Stumbles," *World Gas Intelligence*, Vol. 19, No. 44 (October 29, 2008), pp. 1-2, web site www.energyintel.com (subscription site); "Russia, Iran and Qatar Form Gas OPEC's Core," *International Gas Report*, No. 610 (November 3, 2008), pp. 7-8, web site www.platts.com (subscription site); "Gas Exporters Agree Charter" and "Gas Exporters 'Pose No Threat,'" *International Gas Report*, No. 612 (December 1, 2008), pp. 31-32; and L. Palti, "Gas Exporters Set Up Formal Organization," *Oil Daily*, Vol. 58, No. 248 (December 24, 2008), pp. 1-2.

[f]Algeria, Bolivia, Brunei, Egypt, Indonesia, Iran, Libya, Malaysia, Nigeria, Qatar, Russia, Trinidad and Tobago, the United Arab Emirates, and Venezuela attended as member countries. Norway and Equatorial Guinea attended as observer countries (during the meeting, Equatorial Guinea applied for membership). Kazakhstan attended as a guest and was granted observer status.

[g]"GECF Signs Charter; Formalises Association," *IHS Global Insight* (December 24, 2008), web site www.globalinsight.com/SDA/SDADetail15418.htm.

[h]"'Gas OPEC' To Hold Landmark Meeting in Doha," *The Tehran Times* (March 7, 2009), web site www.tehrantimes.com/index_View.asp?code=190541.

### Gas Exporting Countries Forum: What Is GECF and What Is Its Objective? (continued)

Gazprom, Alexei Miller, referred to the agreement as a "Gas Troika,"[i] which is how the group generally has been characterized since its initial meeting. The purposes of the Gas Troika are unclear. One that has been stated is to examine possible joint projects for natural gas development among the three nations. Another seems to be to push the GECF forward. For example, Alexei Miller has been quoted as saying that he expected the Gas Troika to be a "locomotive" for the GECF.[j]

[i]A. Glazov and C. Tellinghuisen, "World's Top Gas Holders Launch 'Gas OPEC,'" *Oil Daily*, Vol. 58, No. 205 (October 22, 2008), pp. 1-2, web site www.energyintel.com (subscription site).
[j]"Gas Troika Ambitions," *World Gas Intelligence*, Vol. 19, No. 44 (October 29, 2008), pp. 1-2, web site www.energyintel.com (subscription site).

and debts owed by Ukraine all were at issue. The conflict was resolved three days later [***13***]. In January 2008, Turkmenistan cut natural gas exports to Iran, and Iran reacted by cutting exports to Turkey to make up for the lost imports from Turkmenistan. In turn, Turkey cut its exports of natural gas (originally imported from Azerbaijan) to Greece to make up for the lost imports from Iran. Subsequently, Gazprom increased its exports of natural gas to Turkey.

More recently, in January 2009, another dispute with Ukraine again led Russia to curtail natural gas exports to Ukraine [***14***]. The basic issues were the same as in 2006: natural gas prices, pipeline transit fees, and debts owed by Ukraine. In this instance, however, rather than lasting three days, the dispute lasted almost three weeks. On January 1, Russia reduced natural gas deliveries to the Ukrainian border, but some gas continued to flow across Ukraine to downstream customers. On January 7, all natural gas exports via Ukraine stopped, as Russia and Ukraine blamed each other for shutting down the pipelines. Natural gas flows were not resumed until January 20, when Russia and Ukraine finally reached an agreement on prices and pipeline transit fees [***15***].

In OECD Asia, Japan and South Korea continue to be almost entirely dependent on LNG imports for natural gas supplies. The two countries continue to be major players in LNG markets (with Japan representing 41 percent of global LNG imports in 2006 and South Korea 15 percent) despite consuming relatively small amounts of natural gas on a global scale (representing 3 and 1 percent, respectively, of world consumption in 2006). South Korea could begin receiving natural gas supplies by pipeline from Russia sometime after 2015, but Japan and South Korea are expected to remain influential in LNG markets even as growth in global production of LNG outpaces their import demand.

Much of the growth in Australia's natural gas production is expected to support planned or proposed LNG export projects, although it is possible that some projects and the related production increases could be delayed. Pluto LNG, currently under construction in Australia, is one of the few natural gas liquefaction projects for which a final investment decision has been made in the past few years [***16***]. Rising costs for liquefaction projects have led many companies around the world to delay project commitments, and decisions on other projects could be delayed as a result of the current global financial crisis and the impending global oversupply of LNG. Projects in Australia face additional hurdles, including a Western Australia policy that requires new export projects to reserve 15 percent of production for domestic use. Also, LNG liquefaction plants are significant contributors to Australia's carbon dioxide emissions, and new obligations under Australia's Carbon Pollution Reduction Scheme, enacted in December 2008 (and to commence in 2010), may make some liquefaction projects uneconomical [***17***].

### Non-OECD Countries

In the near term, Russia's net exports of natural gas as a percentage of production are projected to decline, as the global economic slowdown affects demand in Europe and, in turn, Russia's pipeline exports to European countries. In the longer-term, the reference case assumes that the necessary investments will be made to develop Russia's vast natural gas resources, allowing it to continue supplying increasing volumes of natural gas to its neighbors. Exports, which represented 28 percent of Russia's natural gas production in 2006, are projected to fall to 26 percent in 2010 before growing to more than 30 percent in 2030. Production of natural gas in Russia grows by 1.3 percent per year on average in the *IEO2009* reference case, from 23 trillion cubic feet in 2006 to 31 trillion cubic feet in 2030.

Natural gas production in the Middle East and in Africa is expected to become oriented more toward exports as the Medgaz pipeline from Algeria to Spain comes on line and new liquefaction capacity comes on line in Qatar, Algeria, Yemen, and Angola. Both the Middle East and Africa are projected to increase production by more than 40 percent from 2006 to 2015. In the Middle East, net exports as a share of total natural gas production grow from 14 percent in 2006 to 24 percent in 2015. In Africa, exports grow from 55 percent of production in 2006 to 57 percent in 2010, before falling back to 56 percent in 2015. After 2015, the pace of export developments in the two regions slows, and with their domestic demand

continuing to grow, the rate of increase in the export share of production in the Middle East slows, while the export share of Africa's natural gas production declines.

India's dependence on imported LNG is projected to be reduced in the short term, when new natural gas production from the Krishna Godavari Basin comes on line. Accordingly, the import share of India's natural gas consumption falls from 20 percent in 2006 to 13 percent in 2010 (Figure 39). Much of India's current production, however, comes from more mature natural gas fields that are beginning to decline, and in 2030 India is projected to be dependent on imports for more than 30 percent of its total natural gas consumption. Pipelines to bring natural gas from Iran, Central Asia, or Myanmar have been discussed in the past, but to date no firm agreements have been reached.

China's dependence on natural gas imports grows throughout the projection period. Although new supplies from Sichuan province are expected to come on line in the short term, and the country's total domestic production of natural gas increases by 3.1 percent per year on average from 2006 to 2030 in the reference case, production growth cannot keep up with demand growth. In 2030, China could be dependent on imports for more than one-third of its total natural gas consumption. To help meet its growing need for imports, China opened its first LNG regasification facility in 2006 at Guangdong [***18***]. Shanghai LNG was to be the second regasification terminal in China, with startup in early 2009; however, a fatal accident at the facility during pipeline testing has delayed its startup. Instead, Fujian LNG, which is expected to begin operation in mid-2009, will be China's second LNG receiving terminal [***19***]. Additionally, the first imports of natural gas into China by pipeline are expected by 2011, when a new pipeline from Turkmenistan via Kazakhstan is to be inaugurated [***20***].

In 2006, the rest of non-OECD Asia (excluding China and India) was a net exporter of natural gas. Three countries—Indonesia, Malaysia, and Brunei—currently have LNG export facilities. There also have been several proposals made to build LNG liquefaction facilities in Papua New Guinea. Although Indonesia's LNG exports peaked in 1999 at about 30 million metric tons (1.4 trillion cubic feet of natural gas) and had declined to about 23 million metric tons (1.1 trillion cubic feet of natural gas) in 2006, a new liquefaction facility, Tangguh LNG, is scheduled to come on line in 2009, temporarily reversing the decline in the country's total LNG exports. Production from the two LNG facilities currently in operation in Indonesia is expected to continue declining [***21***].

In this grouping (non-OECD Asia excluding China and India), only one country, Taiwan, currently has an LNG import terminal, although there have been proposals to build regasification terminals in Singapore, Pakistan, Thailand, the Philippines, and Indonesia. In 2006, net exports equaled 24 percent of total production in the group of countries, but with domestic demand continuing to grow, imports are projected to account for 6 percent of their total natural gas consumption in 2030 in the *IEO2009* reference case.

On a percentage basis, Brazil's natural gas production shows the most rapid growth in the reference case. Starting from 0.3 trillion cubic feet in 2006, Brazil's production is projected to grow by an average of 6.6 percent per year to 2030. In 2006, Brazil depended on imports from Bolivia for nearly one-half of its natural gas consumption; in 2030, its import dependence is less than 10 percent of total consumption. In the short to mid-term, however, Brazil is planning to increase imports. Two LNG import terminals are expected to start up in 2009, and there are plans to build at least one more regasification terminal in the country [***22***]. At the same time, Brazil is also discussing the possibility of building an LNG liquefaction facility that would allow it to supply its own regasification terminals throughout the country or to export small volumes to neighboring countries.

## World Natural Gas Reserves

Historically, world natural gas reserves have generally trended upward (Figure 40). As of January 1, 2009, proved world natural gas reserves, as reported by *Oil & Gas Journal*,[17] were estimated at 6,254 trillion cubic feet—69 trillion cubic feet higher than the estimate of 6,186 trillion cubic feet for 2008 [***23***]. Reserves have remained relatively flat since 2004, despite growing demand for natural gas, implying that, thus far, producers have been able to continue replenishing reserves successfully with new resources over time.

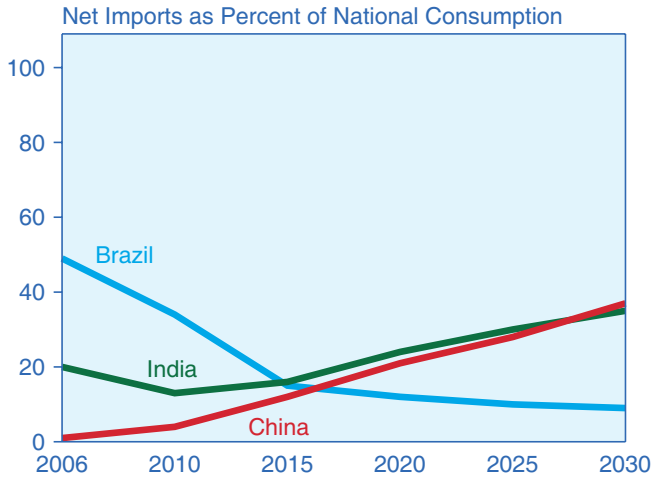
The largest increases in reported natural gas reserves in 2009 were for Iran and the United States. Iran added an estimated 43 trillion cubic feet (a 5-percent increase over 2008 proved reserves) and the United States added 27 trillion cubic feet (a 13-percent increase). There were smaller, but still substantial, reported increases in reserves in Indonesia, Kuwait, Venezuela, and Libya. Reserves in Indonesia and Kuwait both rose by 13 percent—with Indonesia's reserves increasing by 12 trillion

[17] Proved reserves, as reported by the *Oil & Gas Journal*, are estimated quantities that can be recovered under present technology and prices. Natural gas reserves reported by *Oil & Gas Journal* are compiled from voluntary survey responses and do not always reflect the most recent changes. U.S. proved reserves of natural gas are reported by the Energy Information Administration and are defined as the estimated quantities of natural gas reserves as of December 31, 2008, which analysis of geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions. Significant natural gas discoveries made in 2008 are not likely to be reflected in the reported reserves.

cubic feet and Kuwait's by 7 trillion cubic feet. Venezuela added nearly 5 trillion cubic feet of reserves (a 3-percent increase), and Libya added 4 trillion cubic feet (a 9-percent increase).

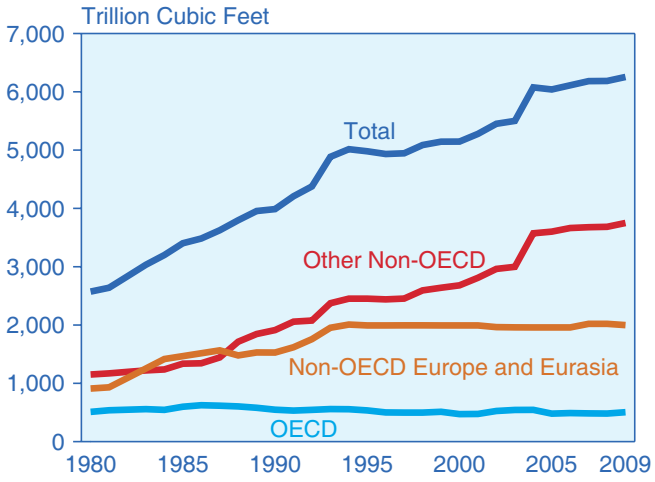
Much of the increase in U.S. natural gas reserves results from expanded knowledge and exploration of shale resources. Outside the United States there has been almost no exploration of shale resources, and correspondingly little is known about the resource potential in other countries. Technologies that have greatly improved the economics of U.S. shale plays, including horizontal drilling and hydraulic fracturing, probably can be adapted to resource plays in other parts of the world. These technologies may, for instance, be applied in Europe before too long. A few North American energy companies have begun to explore potential shale plays in Central and Western Europe. At the same time, a few European energy companies have invested in North American shale plays. As the technologies are applied in other regions, economically recoverable natural gas reserves in the rest of the world are likely to increase, as they have in the United States.

**Figure 39. Imports as Share of Non-OECD Natural Gas Consumption by Country, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 40. World Natural Gas Reserves by Country Grouping, 1980-2008**

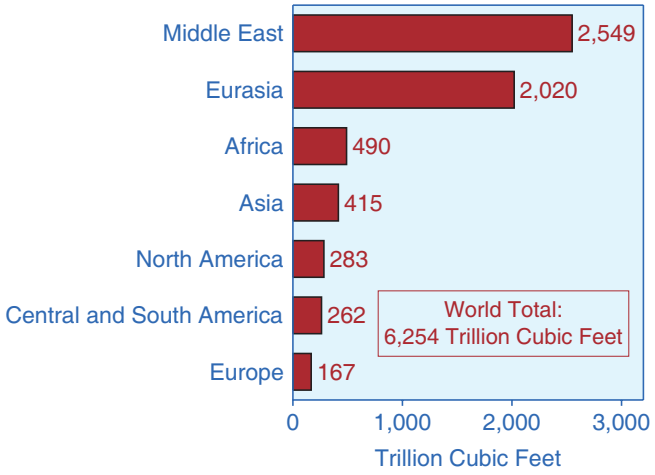



Sources: **1980-1993:** "Worldwide Oil and Gas at a Glance," *International Petroleum Encyclopedia* (Tulsa, OK: PennWell Publishing, various issues). **1994-2009:** *Oil & Gas Journal* (various issues).

The largest reported declines in natural gas reserves in 2009 were in Kazakhstan (a decrease of 15 trillion cubic feet) and Qatar (13 trillion cubic feet). The Kazakhstan decline represents a 15-percent drop, although at 85 trillion cubic feet, the country still holds significant proved reserves. Given the vast resources in Qatar (now about 892 trillion cubic feet), the 2009 decrease amounts to only a 1-percent decline in the country's total proved reserves. Turkmenistan also reported a fairly substantial decrease in reserves of 6 trillion cubic feet (6 percent). Germany and the United Kingdom reported smaller decreases, but they represent more significant shares of the two countries' total reserves. For Germany, the reported decrease of 3 trillion cubic feet amounts to a 31-percent reduction in proved reserves. For the United Kingdom, the decrease of 2 trillion cubic feet amounts to a 17-percent reduction.

Almost three-quarters of the world's natural gas reserves are located in the Middle East and Eurasia (Figure 41). Russia, Iran, and Qatar together accounted for about 57 percent of the world's natural gas reserves as of January 1, 2009 (Table 6).

**Figure 41. World Natural Gas Reserves by Geographic Region as of January 1, 2009**




Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 22-23.

Despite high rates of increase in natural gas consumption, particularly over the past decade, reserves-to-production ratios for most regions are substantial. Worldwide, the reserves-to-production ratio is estimated at 63 years [*24*]. By region, the highest ratios are about 48 years for Central and South America, 78 years for Russia, 79 years for Africa, and more than 100 years for the Middle East.

**Table 6. World Natural Gas Reserves by Country as of January 1, 2009**

| Country | Reserves (Trillion Cubic Feet) | Percent of World Total |
|---|---|---|
| **World** | **6,254** | **100.0** |
| **Top 20 Countries** | **5,674** | **90.7** |
| Russia | 1,680 | 26.9 |
| Iran | 992 | 15.9 |
| Qatar | 892 | 14.3 |
| Saudi Arabia | 258 | 4.1 |
| United States | 238 | 3.8 |
| United Arab Emirates | 214 | 3.4 |
| Nigeria | 184 | 2.9 |
| Venezuela | 171 | 2.7 |
| Algeria | 159 | 2.5 |
| Iraq | 112 | 1.8 |
| Indonesia | 106 | 1.7 |
| Turkmenistan | 94 | 1.5 |
| Kazakhstan | 85 | 1.4 |
| Malaysia | 83 | 1.3 |
| Norway | 82 | 1.3 |
| China | 80 | 1.3 |
| Uzbekistan | 65 | 1.0 |
| Kuwait | 63 | 1.0 |
| Egypt | 59 | 0.9 |
| Canada | 58 | 0.9 |
| **Rest of World** | **581** | **9.3** |

Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 22-23.

## References


1. FACTS Global Energy, *Asia-Pacific LNG Monthly* (May 2008), p. 3.
2. "LNG Project Inventory: South America," *Zeus Liquefied Natural Gas Report*, Vol. 19, No. 6 (March 25, 2009), pp. 24-25; and "Uruguay To Play Local Hub Role," *Platts International Gas Report*, No. 620 (March 30, 2009), pp. 24-25.
3. S. Ciszuk, "Saudi Arabia: Country Reports: Oil & Gas: Upstream," *IHS Global Insight, Inc.* (February 10, 2009), web site www.globalinsight.com (subscription site).
4. A. Schindelar, "Saudi Aramco Beleaguered by Project Delays," *The Oil Daily*, Vol. 58, No. 115 (June 16, 2008), pp. 1 and 2.
5. S. Ciszuk, "Iran: Country Reports: Oil & Gas: Upstream," *IHS Global Insight, Inc.* (September 19, 2008), web site www.globalinsight.com (subscription site).
6. GAZPROM News Release, "Gazprom Launches Yamal Megaproject" (December 3, 2008), web site www.gazprom.com/eng/news/2008/12/32740.shtml.
7. IHS Global Insight, Inc., *European Natural Gas Supply and Demand Report* (Lexington, MA, January 2009), p. 35.
8. IHS Global Insight, Inc., *European Natural Gas Supply and Demand Report* (Lexington, MA, January 2009), p. 35; and GAZPROM News Release, "First Russian LNG Plant Launched in Sakhalin" (February 18, 2009), web site www.gazprom.com/eng/news/2009/02/34304.sthml.
9. GAZPROM Corporate Web Site, "About/Major Projects/Shtokman Project" (undated), web site www.gazprom.com/eng/articles/article21712.shtml.
10. "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 22-23, web site www.ogj.com (subscription site).
11. T. Grieder, "Australia: Country Reports: Oil & Gas: Upstream," *IHS Global Insight, Inc.* (November 6, 2007), web site www.globalinsight.com (subscription site).
12. R. Al-Rikabi, "Global Recession Complicates Australian, PNG LNG Projects," *World Gas Intelligence*, Vol. 20, No. 8 (February 25, 2009), p. 8.
13. S. Blakely and T. Gustafson, "Russian-Ukrainian Gas: Why It's Different This Time." *Cambridge Energy Research Associates Decision Brief* (January 2009), web site www.cera.com (subscription site).
14. S. Blakely and T. Gustafson, "It's Not Over Till It's Over: The Russian Ukrainian Gas Crisis in Perspective," *Cambridge Energy Research Associates Decision Brief* (January 19, 2009), web site www.cera.com (subscription site).
15. "Crux of Gazprom, Ukraine Deals," *World Gas Intelligence,* Vol. 20, No. 3 (January 21, 2009), p. 3.
16. R. Al-Rikabi, "Global Recession Complicates Australian, PNG LNG Projects," *World Gas Intelligence*, Vol. 20, No. 8 (February 25, 2009), p. 8.
17. "Official News—December 2008," Australian Embassy and Mission to the European Communities Belgium-Luxembourg (December 2008), web site www.eu.mission.gov.au/bsls/offnews_dec08.html.

18. Luo Weizhong, "China LNG Spot Trading Practices," U.S.–China Oil & Gas Industry Forum, Forum 8 (September 10, 2007), web site www.uschinaogf.org.
19. "CNOOC begins Fujian LNG storage expansion," *LNGpedia* (January 4, 2009), web site www.lngpedia.com/cnooc-begins-fujian-lng-storage-expansion-report.
20. Yen Ling Song, "Soaring Usage, Imports Push China Toward Gas Price Reform," *World Gas Intelligence*, Vol. 20, No. 3 (January 21, 2009), p. 8.
21. "Indonesia's Inward Looking LNG Strategy, *World Gas Intelligence,* Vol. 20, No. 8 (February 25, 2009), p. 3.
22. "Petrobras into LNG, Slowly But Surely," *World Gas Intelligence*, Vol. 20, No. 5 (February 11, 2009), pp. 4-5.
23. "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 22-23, web site www.ogj.com (subscription site).
24. *BP Statistical Review of World Energy 2008* (London, UK, June 2008), p. 22, web site www.bp.com.

# Chapter 4
# Coal

***In the IEO2009 reference case, world coal consumption increases by 49 percent from 2006 to 2030, and coal's share of world energy consumption increases from 27 percent in 2006 to 28 percent in 2030.***

In the *IEO2009* reference case, world coal consumption increases by 49 percent over the projection period, from 127.5 quadrillion Btu in 2006 to 190.2 quadrillion Btu in 2030 (Figure 42). The growth rate for coal consumption is fairly even over the period, averaging 1.9 percent per year from 2006 to 2015 and 1.6 percent per year from 2015 to 2030—generally reflecting the growth trends for both world GDP and world primary energy consumption. Regionally, increased use of coal in non-OECD countries accounts for 94 percent of the total growth in world coal consumption over the entire period.

In 2006, coal accounted for 27 percent of world energy consumption (Figure 43). Of the coal produced worldwide in 2006, 62 percent was shipped to electricity producers, 34 percent to industrial consumers, and most of the remaining 4 percent to coal consumers in the residential and commercial sectors. Coal's share of total world energy consumption increases to 28 percent in 2030 in the *IEO2009* reference case. In the electric power sector its share declines slightly, from 42 percent in 2006 to 41 percent in 2020, and then increases to 42 percent in 2030.

International coal trade grows by 40 percent in the reference case, from 19.7 quadrillion Btu in 2006 to 27.6 quadrillion Btu in 2030. The share of total world coal consumption accounted for by internationally traded coal remains near the 2006 level of 15 percent throughout the projection period.

## World Coal Consumption

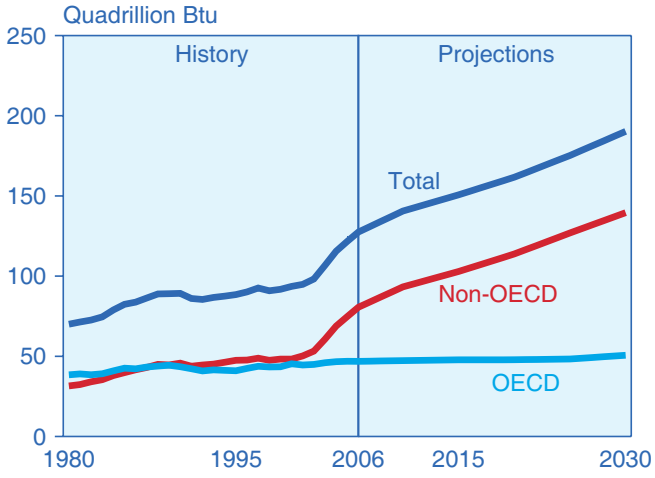
### OECD Countries

Coal consumption in the OECD countries increases in the reference case from 46.9 quadrillion Btu in 2006 to 47.8 quadrillion Btu in 2015 and 50.7 quadrillion Btu in 2030 (Figure 44). The increase represents average growth of 0.3 percent per year over the entire period and 0.4 percent per year from 2015 to 2030. Despite increases in North America and OECD Asia, coal consumption in the OECD countries, which represented 37 percent of the world total in 2006, declines to 27 percent of the total in 2030.

#### *North America*

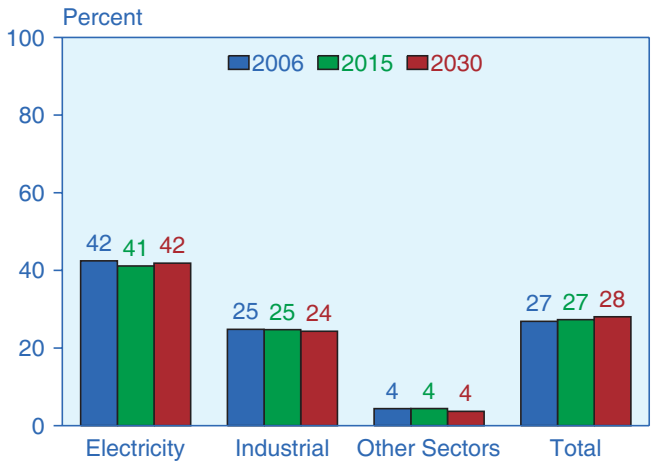
Coal use in the United States totaled 22.5 quadrillion Btu in 2006—92 percent of total coal use in North America and 48 percent of the OECD total. U.S. coal demand rises to 26.6 quadrillion Btu in 2030 in the *IEO2009* reference

**Figure 42. World Coal Consumption by Country Grouping, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 43. Coal Share of World Energy Consumption by Sector, 2006, 2015, and 2030**



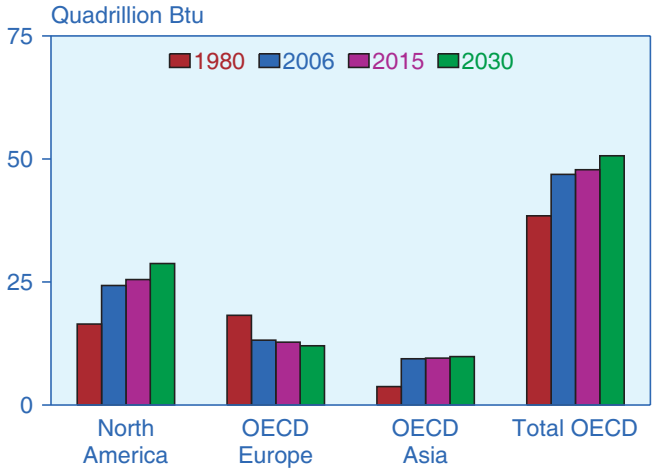

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2015 and 2030:** EIA, World Energy Projections Plus (2009).

case. The United States has substantial coal reserves and relies heavily on coal for electricity generation, a position that continues in the projections. Coal's share of total U.S. electricity generation (including electricity produced at combined heat and power plants in the industrial and commercial sectors) declines from 49 percent in 2006 to 47 percent in 2030.[18]

Increasing coal use for electricity generation at new and existing plants, combined with the startup of several coal-to-liquids (CTL) plants, leads to modest growth in U.S. coal consumption, averaging 0.7 percent per year from 2006 to 2030. Although an assumed risk premium for carbon-intensive technologies dampens investment in new coal-fired power plants in the United States, the projected increase in coal-fired electricity generation still is larger than for any other fuel. Increased generation from coal-fired power plants accounts for 39 percent of the growth in total U.S. electricity generation from 2006 to 2030.

Generation from renewables (including conventional hydroelectric resources) also increases substantially in the forecast, accounting for 32 percent of the growth in total electricity generation, followed by natural gas at 18 percent. Production of coal-based synthetic liquids increases to 257,000 barrels per day in 2030. The projections for both coal-fired electricity generation and coal-based synthetic liquids could change significantly, however, if changes are made in U.S. laws and policies, particularly those regarding greenhouse gas emissions.

**Figure 44. OECD Coal Consumption by Region, 1980, 2006, 2015, and 2030**




Sources: **1980 and 2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2015 and 2030:** EIA, World Energy Projections Plus (2009).

In Canada and Mexico, small increases in coal consumption (0.2 quadrillion Btu for each country) are expected over the period. As a result, the two countries essentially maintain their combined 8-percent share of North America's total coal consumption through 2030. In Mexico, 0.7 gigawatts of coal-fired generating capacity is currently under construction at Lazaro Cardenas on the Pacific coast. In addition, Mexico's Energy Ministry has indicated the potential for additional coal-fired generating projects in the next decade, to be supplied by coal produced locally [*1*]; however, development of the new coal-fired power plants and associated mines is contingent on minability and coal quality assessments of some recently identified resources in the Coahuila coal basin in northeast Mexico.

### OECD Europe

Total coal consumption in the countries of OECD Europe declines slightly in the reference case, from 13.2 quadrillion Btu in 2006 (28 percent of the OECD total) to 12.0 quadrillion Btu in 2030 (24 percent of the OECD total). In 2006, the major coal-consuming countries of OECD Europe included Germany, Poland, the United Kingdom, Spain, Italy, Turkey, and the Czech Republic. Low-Btu coal is an important domestic source of energy for OECD Europe, which also relies heavily on imports of hard coal.[19] In 2006, lignite accounted for 47 percent of total coal consumption in OECD Europe on a tonnage basis and 24 percent on a Btu basis [*2*]. Plans to replace or refurbish existing coal-fired capacity in a number of the countries of OECD Europe are an indication that coal will continue to play an important role in the overall energy mix [*3*].

Coal consumption in OECD Europe remains relatively flat throughout 2030, as governments enact policies to discourage its use, largely in response to environmental concerns, and growth in overall energy consumption is modest, averaging 0.5 percent per year. Other factors that are likely to restrain overall growth in coal consumption in the region include continuing penetration of natural gas in both the electricity and industrial sectors, growing use of renewable fuels, and continuing pressure on member countries of the European Union to reduce subsidies that support domestic production of hard coal.

### OECD Asia

In addition to being major consumers of coal, the nations of OECD Asia play an important role in international coal trade. In 2006 they used 9.4 quadrillion Btu of coal, representing 20 percent of total OECD coal consumption. OECD Asia's coal demand increases by 0.4

[18] Primarily as the result of additional incentives for renewable fuels in ARRA2009, U.S. coal-fired generation in 2030 is slightly lower in the updated *AEO2009* reference case (April 2009) than in the *published AEO2009* reference case projection (March 2009) discussed in this report. As a result, the projection for coal's share of total U.S. electricity generation in 2030 also is slightly lower, at 46 percent.

[19] Internationally, the term "hard coal" is used to describe anthracite and bituminous coal. In data published by the International Energy Agency, coal of subbituminous rank is classified as hard coal for some countries and as brown coal (with lignite) for others.

quadrillion Btu over the projection period, to 9.8 quadrillion Btu in 2030 (19 percent of the OECD total). In 2006, Australia was the world's leading coal exporter, supplying 6.2 quadrillion Btu of coal to the international market. Japan and South Korea were the leading importers, receiving 4.5 and 2.0 quadrillion Btu of coal, respectively [**4**]. With Japan's coal use decreasing in the long term, Australia, New Zealand, and South Korea account for nearly all the projected growth in OECD Asia's demand for coal.

Coal consumption in Australia/New Zealand increases by an average of 0.5 percent per year, from 2.6 quadrillion Btu in 2006 to 2.9 quadrillion Btu in 2030. Of the two countries, Australia is by far the larger coal consumer, at 97 percent of the regional total in 2006. With substantial coal reserves (primarily in Australia), the region continues to rely heavily on coal for electricity generation; however, coal's share of total generation declines gradually. Compared with coal, generation from both renewables and natural gas increases at a more rapid pace, with the result that those fuels capture an increasing share of Australia/New Zealand's total generation. Coal-fired power plants supplied 70 percent of the region's total electricity generation in 2006, as compared with a projected 58-percent share in 2030 in the reference case.

South Korea's total coal consumption increases by 0.7 quadrillion Btu from 2006 to 2030, primarily to fuel existing and planned electric power plants. South Korea's generating companies have announced plans to construct more than 6 gigawatts of new coal-fired capacity at existing sites over the next few years, including three 500-megawatt units that began operation at Korea East-West Power Company's Dangjin plant in 2006 and 2007 [**5**].

## Non-OECD Countries

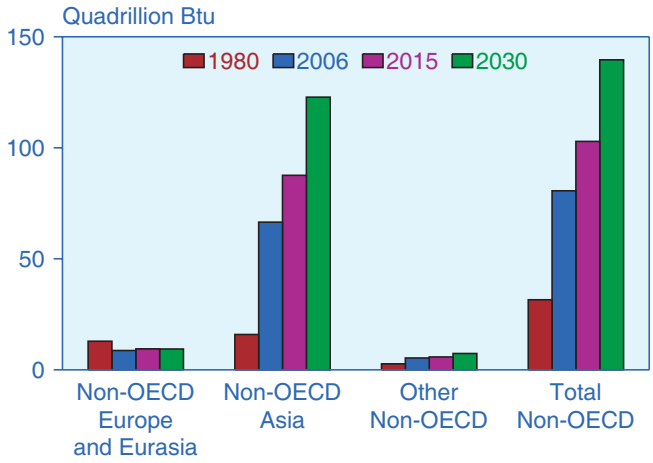
Led by strong economic growth and rising energy demand in non-OECD Asia, total coal consumption in the non-OECD countries increases to 139.6 quadrillion Btu in 2030, an increase of 73 percent over the 2006 total (Figure 45). The increase of 59.0 quadrillion Btu, which represents 94 percent of the projected increase in total world coal consumption, underscores the continuing importance of coal in meeting overall energy demand in the non-OECD nations. Over the entire *IEO2009* reference case horizon, coal accounts for about one-third of total non-OECD energy consumption.

### *Non-OECD Asia*

The countries of non-OECD Asia account for 90 percent of the projected increase in world coal consumption from 2006 to 2030. Strong economic growth is expected for non-OECD Asia, averaging 5.7 percent per year from 2006 to 2030, with China's economy averaging 6.4 percent per year and India's by 5.6 percent per year. Much of the increase in demand for energy in non-OECD Asia, particularly in the electric power and industrial sectors, is expected to be met by coal.

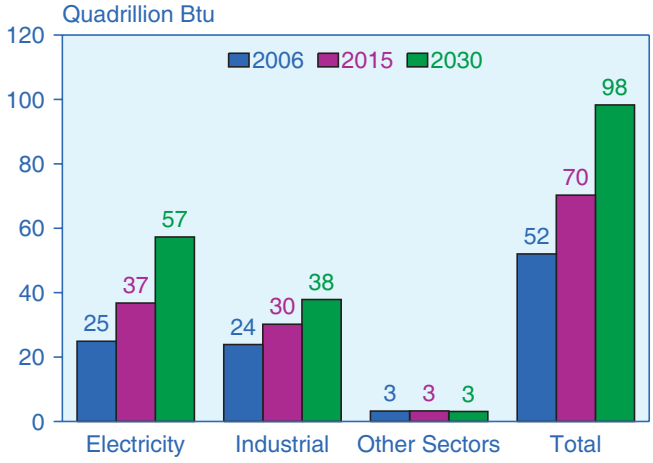
Coal use in China's electricity sector increases from 24.9 quadrillion Btu in 2006 to 57.3 quadrillion Btu in 2030, at an average rate of 3.5 percent per year (Figure 46). In comparison, coal consumption in the U.S. electric power sector is projected to grow by 0.7 percent annually, from 20.7 quadrillion Btu in 2006 to 24.3 quadrillion Btu in 2030. At the beginning of 2006, China had an estimated 350 gigawatts of coal-fired capacity in operation. To

**Figure 45. Non-OECD Coal Consumption by Region, 1980, 2006, 2015, and 2030**




Sources: **1980 and 2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2015 and 2030:** EIA, World Energy Projections Plus (2009).

**Figure 46. Coal Consumption in China by Sector, 2006, 2015, and 2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2015 and 2030:** EIA, World Energy Projections Plus (2009).

meet the demand for electricity that is expected to accompany its rapid economic growth, an additional 600 gigawatts of coal-fired capacity (net of retirements) is projected to be brought on line in China by 2030, requiring large financial investments in new coal-fired power plants and associated electricity transmission and distribution systems. In the near term, the *IEO2009* projections show a substantial amount of new coal builds, with 192 gigawatts of capacity additions between 2006 and 2010.

In addition to required investments in China's electric power industry, the large increase in Chinese coal demand projected in the *IEO2009* reference case indicates a continuing need for substantial investments in both coal mining and coal transportation infrastructure. Examples of some recent and forthcoming investments in China's rail transportation system include major capacity expansions for some of the country's existing coal railways, the planned construction of several new coal railways, the scheduled delivery of 300 modern General Electric locomotives to the Chinese Railways Ministry by 2010, and an estimated $100 billion of investment in rail services included in China's recently approved stimulus package [***6***].

More than one-half (52 percent) of China's coal use in 2006 was in the non-electricity sectors, primarily in the industrial sector. China was the world's leading producer of both steel and pig iron in 2006 [7]. Over the projection period, coal demand in China's non-electricity sectors is expected to increase by 13.9 quadrillion Btu, to 51 percent above the 2006 level.

Because China has limited reserves of oil and natural gas, coal remains the leading source of energy in its industrial sector. In large part, coal's declining share of industrial energy consumption in China is the result of increasing use of electricity in the sector; however, that increase also can be viewed indirectly as an increase in coal consumption, given that coal-fired power plants are projected to satisfy approximately three-fourths of China's total power generation requirements throughout the period from 2006 to 2030. Electricity's share of total industrial energy use rises from 18 percent in 2006 to 28 percent in 2030, while coal's share drops from 61 percent to 51 percent.

Another potential source of future coal demand in China is the production of coal-based synthetic liquids. Rapid development of a CTL industry in China was strongly anticipated several years ago, but the government's concerns about a number of factors, such as potential strains on water resources and shortages of coal supply, led to increased oversight of the emerging industry. As a result, many proposed CTL projects lack official government approval and are now on hold.

One plant that has been approved is the Shenhua Group's direct coal liquefaction facility located in China's Inner Mongolia Autonomous Region. Construction of the plant's first phase was completed in late 2008, but initial production runs revealed a number of problems in the production process [***8***]. Following some corrective modifications, new production trials are expected later in 2009, with commercial production now scheduled to commence sometime in 2010. The plant has an initial design capacity of about 20,000 barrels per day [***9***]. Depending on the successful startup and commercial operation of its first phase, Shenhua plans an eventual expansion of the plant's capacity to 100,000 barrels per day. In the *IEO2009* reference case, China's CTL production increases to about 537,000 barrels per day in 2030, corresponding to a little less than 4 percent of the country's total liquids consumption.

In India, more than 71 percent of the growth in coal consumption is expected to be in the electric power sector and most of the remainder in the industrial sector. In 2006, India's coal-fired power plants consumed 5.9 quadrillion Btu of coal, representing 63 percent of the country's total coal demand. Coal use for electricity generation in India is projected to grow by 1.9 percent per year, to 9.3 quadrillion Btu in 2030, as an additional 65 gigawatts of coal-fired capacity (net of retirements) is brought on line. As a result, India's coal-fired generating capacity increases from 78 gigawatts in 2006 to 142 gigawatts in 2030.

Currently, India's government has tentative plans to add more than 50 gigawatts of new coal-fired generating capacity during the period covered by its eleventh power plan (a 5-year period ending in March 2012) [***10***]. During India's most recent 5-year power plan period, which ended in March 2007, only about 12 gigawatts of the 20 gigawatts of new coal-fired generating capacity that had been planned was actually completed. In addition to the coal projects listed in the preliminary documents for the eleventh power plan, including one "ultra mega" coal-fired plant with a capacity of 4 gigawatts, the Indian government is pursuing the development of eight more "ultra mega" projects with a total combined coal-fired generating capability of 32 gigawatts [***11***].

In the other nations of non-OECD Asia, coal consumption grows by an average of 3.0 percent per year, from 5.1 quadrillion Btu in 2006 to 10.4 quadrillion Btu in 2030, with increases in both the electric power and industrial sectors. In the electric power sector, significant growth in coal consumption is expected in Indonesia and Vietnam, where considerable amounts of new coal-fired generating capacity are expected to come on line before 2030.

### Non-OECD Europe and Eurasia

Coal consumption in non-OECD Europe and Eurasia increases in the *IEO2009* reference case by an average of 0.3 percent per year, from 8.7 quadrillion Btu in 2006 to 9.4 quadrillion Btu in 2030. Russia alone has an estimated 173 billion tons of recoverable reserves (19 percent of the world total), and the other countries of non-OECD Europe and Eurasia have an additional 95 billion tons (10 percent of the world total).[20]

Russia is the largest coal consumer among the nations of non-OECD Europe and Eurasia, at 4.6 quadrillion Btu in 2006, or 52 percent of the total for non-OECD Europe and Eurasia. Coal supplied 15 percent of Russia's total energy requirements in 2006, and coal-fired power plants provided 23 percent of its electricity. In the reference case, coal consumption in Russia in 2030 totals 5.2 quadrillion Btu, its share of Russia's total energy consumption drops slightly to 14 percent, and its share of electricity generation declines to 20 percent. Nearly one-half of the projected growth in electricity demand from 2006 to 2030 is met by natural-gas-fired power plants, with coal and nuclear plants accounting for most of the remainder. The natural gas share of Russia's total electricity generation increases from 39 percent in 2006 to 43 percent in 2030.

In March 2008, the Russian government approved a new long-range plan for the country's electric power sector through 2020 [***12***]. In general, the plan lays out a detailed roadmap of capacity additions and retirements and new transmission infrastructure. In terms of capacity additions, one of the key objectives of the plan is to curb growth in natural-gas-fired generation in order to free up natural gas for export. The plan anticipates some additional growth in natural gas consumption in the power sector through 2020, as does the *IEO2009* reference case, but it differs from the *IEO2009* projection in that it anticipates more generation from coal-fired and nuclear power plants and more rapid growth in total electricity generation.

One of the key uncertainties in Russia's new long-range power plan is the extent to which the new owners of Russia's various regional and wholesale generating companies will adhere to the specific planned additions and retirements outlined in the government plan. In mid-2008, Russia's former power monopoly, Unified Energy System (UES), completed the process of selling all but one of the regional and wholesale generating companies it once controlled. Ownership of those entities is now in the hands of various domestic and international energy companies. Thus far, the new owners have shown some reluctance to add the 36 gigawatts of new coal-fired capacity specified in Russia's long-range power plan by 2015, with their expansion plans in mid-2008 indicating a total of about 20 gigawatts of new coal builds for the period [***13***].

Coal consumption in Other Non-OECD Europe and Eurasia remain near the 2006 level of 4.2 quadrillion Btu through 2030, although the reference case does show some increase in consumption for electricity generation. From 2006 to 2030, coal, natural gas, and nuclear power are projected to satisfy nearly all the region's additional electricity requirements, with increased output from coal-fired plants meeting 19 percent of the growth, natural-gas-fired plants 57 percent, and nuclear plants 23 percent. Coal's share of total electricity generation declines only slightly, from 27 percent in 2006 to 25 percent in 2030. Currently in the region, a number of new coal-fired power projects are in the planning stages [***14***]. Lignite mined locally is the proposed fuel for most of those plants, although imported coal is the likely fuel source for several plants that may be constructed in coastal areas.

### Africa

Africa's coal consumption increases by 1.1 quadrillion Btu from 2006 to 2030 in the reference case. South Africa currently accounts for 92 percent of the coal consumed on the continent and is expected to continue to account for much of Africa's total coal consumption over the projection period.

In South Africa, increasing demand for electricity in recent years has led to a decision by Eskom, the country's state-owned electricity supplier, to restart three large coal-fired plants (Camden, Grootvlei, and Komati) that have been closed for more than a decade [***15***]. The individual units at those plants, with a combined generating capacity of 3.8 gigawatts, are scheduled to return to service between 2006 and 2011. In addition, Eskom is proceeding with the construction of two new coal-fired power plants, Medupi and Kusile, with a combined generating capacity of 9.6 gigawatts. The 12 individual units at the Medupi and Kusile plants are scheduled to be fully operational by the end of 2016.

Recent power shortages and a general lack of spare generating capacity in southern Africa also have led to increased interest in new coal-fired power projects in countries other than South Africa. Of particular significance are major investments being made by several international energy companies to develop coal reserves in Mozambique and Botswana for the purpose of supplying both international markets and domestic coal-fired generating plants [***16***].

In the industrial sector, increasing use of coal in Africa is expected for several purposes, including the production of steam and process heat for industrial applications, production of coke for the steel industry, and

[20] Throughout this chapter, tons refer to short tons (2,000 pounds).

production of coal-based synthetic liquids. Currently, two large-scale CTL plants in South Africa (Sasol II and Sasol III) supply slightly more than 20 percent of the country's total liquid fuel requirements [*17*]. The two plants together are capable of producing 150,000 barrels of synthetic liquids per day.

### *Central and South America*

Central and South America consumed 0.8 quadrillion Btu of coal in 2006. Brazil, with the world's tenth-largest steel industry in 2006, accounted for 54 percent of the region's coal demand; Chile, Colombia, Puerto Rico, Peru, and Argentina accounted for most of the remainder [*18*]. In the projections, coal consumption in Central and South America increases by 0.8 quadrillion Btu from 2006 to 2030, with 75 percent of the increase in Brazil, primarily for coke manufacture and electricity generation. Brazil's steel companies currently plan to expand production capacity by a substantial amount over the mid-term to meet increasing domestic and international demand for steel [*19*].

### *Middle East*

Countries in the Middle East consumed 0.4 quadrillion Btu of coal in 2006. Israel accounted for 85 percent of the total and Iran most of the remainder. The region's coal use increases only slightly in the reference case, to 0.5 quadrillion Btu in 2030.

## World Coal Production

From 2006 to 2030, coal production in China, the United States, and India increases by 43.5 quadrillion Btu, 3.2 quadrillion Btu, and 1.8 quadrillion Btu, respectively, in the *IEO2009* reference case (Table 7), which assumes that most of the demand for coal in the three countries will

**Table 7. World Coal Production by Region, 2006-2030**
(Quadrillion Btu)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD North America** | **25.5** | **26.0** | **26.8** | **26.8** | **27.5** | **29.5** | **0.6** |
| United States | 23.8 | 24.0 | 24.5 | 24.5 | 25.1 | 27.0 | 0.5 |
| Canada | 1.5 | 1.8 | 2.1 | 2.1 | 2.1 | 2.2 | 1.5 |
| Mexico | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 1.0 |
| **OECD Europe** | **7.5** | **7.1** | **6.7** | **6.7** | **6.5** | **6.5** | **-0.6** |
| **OECD Asia** | **8.8** | **9.7** | **10.6** | **11.3** | **12.3** | **13.4** | **1.8** |
| Japan | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| South Korea | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | -0.6 |
| Australia/New Zealand | 8.7 | 9.6 | 10.6 | 11.2 | 12.2 | 13.3 | 1.8 |
| **Total OECD** | **41.8** | **42.9** | **44.1** | **44.7** | **46.3** | **49.4** | **0.7** |
| **Non-OECD Europe and Eurasia** | **10.4** | **10.9** | **11.5** | **11.4** | **11.3** | **11.6** | **0.4** |
| Russia | 6.1 | 6.8 | 7.4 | 7.4 | 7.3 | 7.6 | 0.9 |
| Other | 4.3 | 4.1 | 4.1 | 4.0 | 4.0 | 4.0 | -0.3 |
| **Non-OECD Asia** | **68.3** | **78.4** | **85.7** | **95.5** | **107.0** | **117.6** | **2.3** |
| China | 52.8 | 62.2 | 69.4 | 78.3 | 88.4 | 96.3 | 2.5 |
| India | 8.2 | 8.7 | 8.8 | 9.2 | 9.4 | 10.0 | 0.8 |
| Other | 7.3 | 7.5 | 7.5 | 8.0 | 9.2 | 11.3 | 1.8 |
| **Middle East** | **0.0** | **0.0** | **0.1** | **0.1** | **0.1** | **0.1** | **1.3** |
| **Africa** | **5.9** | **6.2** | **6.6** | **6.7** | **7.3** | **7.8** | **1.2** |
| **Central and South America** | **2.0** | **2.3** | **2.9** | **3.6** | **3.6** | **4.3** | **3.1** |
| Brazil | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.3 |
| Other | 2.0 | 2.2 | 2.9 | 3.5 | 3.5 | 4.1 | 3.2 |
| **Total Non-OECD** | **86.7** | **97.8** | **106.8** | **117.2** | **129.3** | **141.3** | **2.1** |
| **Total World** | **128.5** | **140.7** | **150.9** | **161.9** | **175.6** | **190.7** | **1.7** |

Note: The projections of regional coal production represent the sum of consumption and exports by region, less imports. With the exception of the United States, Canada, and Mexico, the projected levels of coal trade in the *IEO2009* forecast represent seaborne shipments of coal, excluding generally small quantities of non-seaborne or overland coal trade.

Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009); and National Energy Modeling System, run IEO2009.D040709E.

continue to be met by domestic production. Coal production in Australia/New Zealand and Other non-OECD Asia also is projected to rise substantially. The increase in coal production for Australia/New Zealand (4.6 quadrillion Btu) is expected to be used primarily for exports from Australia. Production growth in Other non-OECD Asia (4.0 quadrillion Btu) is attributable to both rising levels of coal consumption and exports. The projected increases in coal production for these five regions dominate the overall trends for the OECD and non-OECD, accounting for virtually all the increase in net production for OECD countries and 90 percent of the increase for non-OECD countries. Rising international trade also is expected to support production increases in Russia, Africa, and Central and South America (excluding Brazil).

## World Coal Trade

At the end of 2008, in response to the global economic crisis, worldwide demand for coal imports fell precipitously, and the ensuing coal supply glut prompted many mines in coal exporting countries to lower their production levels. Although the break from intense global coal demand could provide an opportunity for coal trade infrastructure—including mine, rail, and port capacity—an opportunity to catch up with the previous years' fast-paced growth, many infrastructure projects in the early stages are likely to be deferred. Projects that are in progress, however, are assumed to continue. Despite the global economic crisis, the duration of which is uncertain, over the long run the volumes of total coal traded internationally increase steadily through 2030 (Table 8). The increase in coal trade through 2030 reflects the projected worldwide growth in coal consumption for the same period, particularly in non-OECD Asia.

Trade in coking coal—an essential input for the production of iron used to make steel—has been subject to recent cutbacks, with some companies reducing steel output by as much as 30 percent; however, many countries are adopting economic stimulus packages to support infrastructure investments, which presumably will require steel. The impact of the stimulus packages on coal markets is uncertain and is not explicitly represented in the *IEO2009* projections. In the long run, when the current glut of steel in the market has been worked through and economic growth resumes, demand for imports of coking coal is expected to begin rising again.

Although both steam coal and coking coal are traded internationally, most of the trade is in steam coal, which represents 72 percent of world coal trade in 2030, similar to current levels. In 2007, 58 percent of the world's exported steam coal was imported by Asian countries, and their share of the total in 2030 is projected to be 65 percent. The share of coking coal imports destined for Asian countries increases from 61 percent in 2007 to 67 percent in 2030.

International coal trade accounted for about 16 percent of total world coal consumption in 2007, and in the *IEO2009* reference case it is projected to grow at an average annual rate of 1.2 percent, from about 20.8 quadrillion Btu in 2007 to 27.6 quadrillion Btu in 2030. Because the largest increases in coal consumption through 2030 are projected for non-OECD Asia—particularly China, which is expected to meet most of the increase in its coal demand with domestic supply rather than seaborne imports—the share of coal trade as a percentage of global coal consumption falls to 14 percent in 2030. Australia and Indonesia are well situated geographically to continue as the leading suppliers of internationally traded coal, especially to Asia, over the period. South America is projected to expand its role as an international supplier of coal, primarily as a result of increasing coal production in Colombia.

### Coal Exports

The top four exporters of steam coal in 2007 were Indonesia, Australia, South America (Colombia and Venezuela), and southern Africa (South Africa, Mozambique, and Botswana). Although Indonesia currently is the world's largest exporter of steam coal, Australia is expected to be the leader in most years of the projection, after many of its capacity investments are in place. China is projected to be only the sixth-largest exporter of steam coal in 2030. Australia, Canada, and the United States rank as the three top exporters of coking coal over the projection period. Among the regions expected to expand their international coal trade by 2030 are Australia, South America, southern Africa, and Eurasia (primarily Russia). In Vietnam and China, increases in domestic demand for coal are expected to constrain coal exports.

Already the world's leading exporter of coal, Australia dominates future international coal trade in the reference case as it continues to improve its inland transportation and port infrastructure to expedite coal shipments to international markets. A new coal terminal at Kooragang Island, in New South Wales, will add about 1.5 quadrillion Btu of capacity, about half of which is expected to be operational by 2011 [***20***]. Expansion of Queensland's Dalrymple Bay port in 2009 is expected to increase its annual export capacity from about 1.8 quadrillion Btu to 2.2 quadrillion Btu [***21***]. Australia remains the primary exporter of metallurgical coal to Asian markets, supplying about 76 percent of Asia's import demand for coking coal in 2030, compared with about 70 percent in 2007.

Russia is among the coal-exporting countries that have shown some indication of pulling back in the short term

## Table 8. World Coal Flows by Importing and Exporting Regions, Reference Case, 2007, 2015, and 2030
(Quadrillion Btu)

| Exporters | Importers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Steam | | | | Coking | | | | Total | | | |
| | Europe[a] | Asia | Americas | Total[b] | Europe[a] | Asia[c] | Americas | Total[b] | Europe[a] | Asia | Americas | Total[b] |
| | 2007 | | | | | | | | | | | |
| Australia | 0.11 | 2.64 | 0.13 | **2.88** | 0.85 | 2.62 | 0.22 | **3.68** | 0.96 | 5.25 | 0.34 | **6.56** |
| United States | 0.24 | 0.00 | 0.33 | **0.57** | 0.56 | 0.03 | 0.29 | **0.88** | 0.80 | 0.03 | 0.62 | **1.45** |
| Southern Africa[d] | 1.30 | 0.30 | 0.03 | **1.66** | 0.02 | 0.00 | 0.00 | **0.02** | 1.32 | 0.30 | 0.03 | **1.68** |
| Eurasia | 1.14 | 0.36 | 0.01 | **1.51** | 0.08 | 0.11 | 0.00 | **0.18** | 1.22 | 0.46 | 0.01 | **1.69** |
| Poland | 0.16 | 0.00 | 0.00 | **0.16** | 0.01 | 0.00 | 0.00 | **0.01** | 0.17 | 0.00 | 0.00 | **0.17** |
| Canada | 0.01 | 0.08 | 0.02 | **0.11** | 0.22 | 0.40 | 0.10 | **0.73** | 0.23 | 0.48 | 0.12 | **0.83** |
| China | 0.07 | 1.22 | 0.01 | **1.29** | 0.00 | 0.07 | 0.00 | **0.07** | 0.07 | 1.29 | 0.01 | **1.36** |
| South America[e] | 1.00 | 0.00 | 0.89 | **1.90** | 0.00 | 0.00 | 0.00 | **0.00** | 1.00 | 0.00 | 0.89 | **1.90** |
| Vietnam | 0.00 | 0.62 | 0.00 | **0.62** | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.62 | 0.00 | **0.62** |
| Indonesia[f] | 0.43 | 3.34 | 0.16 | **3.99** | 0.00 | 0.52 | 0.00 | **0.52** | 0.43 | 3.86 | 0.16 | **4.52** |
| **Total** | **4.46** | **8.56** | **1.57** | **14.69** | **1.73** | **3.74** | **0.61** | **6.08** | **6.19** | **12.30** | **2.18** | **20.77** |
| | 2015 | | | | | | | | | | | |
| Australia | 0.03 | 4.10 | 0.01 | **4.14** | 0.38 | 3.19 | 0.24 | **3.80** | 0.41 | 7.28 | 0.25 | **7.95** |
| United States | 0.37 | 0.02 | 0.21 | **0.60** | 0.52 | 0.03 | 0.37 | **0.93** | 0.90 | 0.05 | 0.58 | **1.53** |
| Southern Africa[d] | 1.64 | 0.50 | 0.14 | **2.27** | 0.05 | 0.08 | 0.02 | **0.15** | 1.68 | 0.58 | 0.15 | **2.42** |
| Eurasia | 1.42 | 0.49 | 0.00 | **1.90** | 0.07 | 0.21 | 0.00 | **0.28** | 1.49 | 0.69 | 0.00 | **2.18** |
| Poland | 0.13 | 0.00 | 0.01 | **0.14** | 0.03 | 0.00 | 0.00 | **0.03** | 0.15 | 0.00 | 0.01 | **0.16** |
| Canada | 0.03 | 0.00 | 0.07 | **0.11** | 0.48 | 0.32 | 0.07 | **0.87** | 0.51 | 0.32 | 0.14 | **0.97** |
| China | 0.00 | 0.97 | 0.00 | **0.97** | 0.00 | 0.02 | 0.00 | **0.02** | 0.00 | 0.99 | 0.00 | **0.99** |
| South America[e] | 1.79 | 0.00 | 0.97 | **2.76** | 0.00 | 0.00 | 0.00 | **0.00** | 1.79 | 0.00 | 0.97 | **2.76** |
| Vietnam | 0.00 | 0.24 | 0.00 | **0.24** | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.24 | 0.00 | **0.24** |
| Indonesia[f] | 0.00 | 3.73 | 0.08 | **3.81** | 0.01 | 0.49 | 0.00 | **0.50** | 0.01 | 4.22 | 0.08 | **4.31** |
| **Total** | **5.41** | **10.03** | **1.49** | **16.94** | **1.53** | **4.35** | **0.70** | **6.58** | **6.94** | **14.38** | **2.19** | **23.51** |
| | 2030 | | | | | | | | | | | |
| Australia | 0.00 | 5.51 | 0.00 | **5.51** | 0.64 | 3.92 | 0.41 | **4.97** | 0.64 | 9.43 | 0.41 | **10.48** |
| United States | 0.25 | 0.01 | 0.31 | **0.57** | 0.31 | 0.00 | 0.31 | **0.62** | 0.56 | 0.01 | 0.62 | **1.19** |
| Southern Africa[d] | 0.99 | 1.29 | 0.20 | **2.47** | 0.05 | 0.17 | 0.03 | **0.24** | 1.04 | 1.46 | 0.22 | **2.72** |
| Eurasia | 1.41 | 0.59 | 0.00 | **2.00** | 0.14 | 0.24 | 0.00 | **0.39** | 1.56 | 0.83 | 0.00 | **2.39** |
| Poland | 0.07 | 0.00 | 0.02 | **0.09** | 0.01 | 0.00 | 0.00 | **0.01** | 0.08 | 0.00 | 0.02 | **0.10** |
| Canada | 0.00 | 0.00 | 0.00 | **0.00** | 0.39 | 0.30 | 0.25 | **0.94** | 0.39 | 0.30 | 0.25 | **0.94** |
| China | 0.00 | 0.97 | 0.00 | **0.97** | 0.00 | 0.02 | 0.00 | **0.02** | 0.00 | 0.99 | 0.00 | **0.99** |
| South America[e] | 2.15 | 0.38 | 1.43 | **3.95** | 0.00 | 0.00 | 0.00 | **0.00** | 2.15 | 0.38 | 1.43 | **3.95** |
| Vietnam | 0.00 | 0.24 | 0.00 | **0.24** | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.24 | 0.00 | **0.24** |
| Indonesia[f] | 0.00 | 3.91 | 0.17 | **4.08** | 0.00 | 0.50 | 0.00 | **0.50** | 0.00 | 4.41 | 0.17 | **4.58** |
| **Total** | **4.87** | **12.90** | **2.12** | **19.88** | **1.54** | **5.16** | **1.00** | **7.70** | **6.41** | **18.06** | **3.12** | **27.58** |

[a]Europe/Mediterranean, including coal shipments to the Middle East and Africa.
[b]In 2007, total world coal flows include a balancing item used to reconcile discrepancies between reported exports and imports. The 2007 balancing items by coal type were 0.098 quadrillion Btu (steam coal), 0.002 quadrillion Btu (coking coal), and 0.102 quadrillion Btu (total).
[c]Includes 0.50 quadrillion Btu of coal for pulverized coal injection at blast furnaces shipped to Japanese steelmakers in 2007.
[d]Southern Africa includes South Africa, Mozambique, and Botswana.
[e]Coal exports from South America are projected to originate from mines in Colombia and Venezuela.
[f]Includes shipments from other countries not modeled for the projection period. The 2007 exports from other countries by coal type were 0.10 quadrillion Btu (steam coal), 0.02 quadrillion Btu (coking coal), and 0.12 quadrillion Btu (total).
Notes: Data exclude non-seaborne shipments of coal to Europe and Asia. Totals may not equal sum of components due to independent rounding.
Sources: **2007:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 17, No. 1 (London, UK, July 2008); and Energy Information Administration, *Quarterly Coal Report*, October-December 2007, DOE/EIA-0121(2007/4Q) (Washington, DC, March 2008). **2015 and 2030:** Energy Information Administration, National Energy Modeling System, run IEO2009.D040709E.

in the wake of softening global demand for coal. For example, Mechel, a Russian producer of metallurgical coal, plans to reduce capital expenditures over the next 5 years in response to the global economic slowdown [*22*]; and Evraz, another Russian coal producer, has given up a license to develop a coking coal resource in the Mezhegey coal deposit [*23*].

Hurt by weak cash flows, some coal producers are hoping to benefit from a portion of Russia's multibillion-dollar stimulus package [*24*]. Some planned infrastructure improvements may be delayed in the short term as rail tariffs, which are needed to support some of the investments, are reduced and some coal mines close or reduce production [*25*]; however, as demand growth resumes, Russia is expected to expand its coal supply capability. For example, coal exports to Asia will be facilitated by capacity expansion at the new port of Muchka, where SUEK (Siberian Coal Energy Company) has built about 0.3 quadrillion Btu of an annual export capacity, and Mechel has plans for about 0.7 quadrillion Btu of export capacity at the new Muchka Bay Terminal 2 [*26*]. From an 8-percent share in 2007, Eurasia (primarily Russia) is expected to supply 9 percent of the coal traded internationally in 2030.

South America is projected to remain the third-largest exporter of coal worldwide in 2030, primarily as a result of continued increases in exports from Colombia. The expansion will require investments in mine capacity, rail infrastructure, and port capacity, such as the current proposal to build a tunnel that would expedite coal transportation via truck to Colombia's Pacific Ocean port of Buenaventura when it is completed in 2013. Expansion projects on Colombia's Caribbean coast include a coal terminal at the port of Cienaga and an expanded river-to-port terminal at Barranquilla, each with an annual capacity of about 0.9 quadrillion Btu [*27*].

Indonesia also has demonstrated its potential for significant growth in coal exports, with an increase of about 3.7 quadrillion Btu in annual exports over the past decade. From 2007 to 2030, Indonesia's annual coal exports are projected to average about 4.5 quadrillion Btu; however, continued strength in Indonesia's coal exports depends on investment in resource exploration, the development of new mines, and the ability to attract foreign investment. In late 2008, despite global financial uncertainty, Coal India announced plans to acquire Indonesian coal reserves. The Indonesian company PT Adaro Energy Tbk also reiterated plans to expand its export capacity from about 1.0 quadrillion Btu to 1.8 quadrillion Btu by 2013 and pursue other investments that would lower internal transportation costs [*28*]. Over the long term, areas of uncertainty for Indonesian exports include the rate of growth in its domestic coal consumption, the adequacy of its internal transportation infrastructure, and environmental concerns. Through 2030, Indonesia is expected to continue to be an important source of coal supply coal to other nations.

Despite strong growth in coal exports from Vietnam between 2003 and 2007, the government plans to restrict exports in the future. State-owned Vinacomin, the largest coal producer in Vietnam, has announced plans to begin importing coal from Indonesia [*29*]. In the *IEO2009* reference case, Vietnam's coal exports decline slightly in the short term as a result of softening global demand (rather than burgeoning domestic coal consumption). In later years, however, Vietnam's domestic coal demand is expected to compete more strongly for the country's limited domestic coal production.

The African countries of Mozambique and Botswana are expected to play an emerging role in world coal trade, as importing countries seek to secure additional sources of supply. For example, India's Tata Steel, Brazil's Companhia Vale do Rio Doce (CVRD), and Australia's Riversdale all have financial stakes in mine operations in the Moatize basin of Mozambique [*30*]. An expansion of the port of Beira in Mozambique to handle an annual capacity of about 0.5 quadrillion Btu is also planned [*31*], and the rail link between Moatize coal basin and Beira (Sena Railway) is being updated. Interest in Botswana includes plans to expand mining and to construct a railroad that will connect inland coal mines to a port on the Namibian coast.

South Africa's coal exports have remained flat over the past few years, with a permanent solution for domestic infrastructure and energy supply problems yet to be found; however, coal mining is expected to continue playing an important role in South Africa's economy. A scheduled expansion of the Richards Bay Coal Terminal to about 2.2 quadrillion Btu of annual capacity in 2009 will support South Africa's continued role as an international coal supplier [*32*].

## Coal Imports

### *Asia*

Asia poses a large area of uncertainty for world coal trade projections. In particular, China has the potential to influence the market both as an importer and as an exporter. For example, a significant increase in China's coal imports could put upward pressure on world coal prices. In the *IEO2009* reference case, China's coal imports total 3.3 quadrillion Btu and its exports total 1.0 quadrillion Btu in 2030. Even with a substantial increase in imports, however, most of the coal consumed in China will continue to be supplied by its own coal mines.

India's coal imports in 2030 are projected to be three times the 2007 level, spurred by rising imports of both

coking and steam coal. India's large electricity plants planned for coastal areas are to be fueled by imported steam coal. In light of current limits on available global investment capital and the size and associated risk of the projects, however, it is uncertain whether India's mega-size coal plants will meet their original timelines. The Indian government is trying to accelerate investment in generation and infrastructure, but recent solicitations have resulted in fewer bids than expected [*33*]. Planned investments in India also include port expansions at Paradip and Goa [*34*].

India has domestic resources of coking coal, but their quality is poor in comparison with foreign-sourced coking coal. India's long-term plans include expansion of its steel industry to between 165 and 198 million tons of crude steel output by 2020, up from about 59 million tons in 2007 [*35*], with increased imports of coking coal supporting the expansion. Growth in steel production is necessary for India to expand and improve infrastructure essential for economic development.

Although 2001 marked the final year of significant Japanese coal production [*36*], Japan has continued to rely on coal and is expected to remain the world's largest coal importer in most years of the projection. Australia provides for about 60 percent of Japan's coal supply (both steam and metallurgical coal), and China supplies about 20 percent of its steam coal imports. Japan's purchases of coal from Indonesia increased by 157 percent between 2000 and 2007. Japanese companies also have pursued investments in coal production in other countries, including Russia and Canada [*37*].

Because Japan lacks significant resources of its own, it is likely to continue seeking diverse sources of long-term supply even during the global economic recession. In the short term, however, Japan (along with other countries that import coking coal) reportedly is trying to cut back on contracted imports of coking coal. Japan is a leader in steel production, ranking second only to China among world steel producers [*38*], and is projected to continue to import coking coal for use in its steelmaking plants in 2030.

South Korea also is expected to continue importing most of the coal it consumes. With planned increases in coal-fired generating capacity, South Korea and Taiwan together are projected to maintain a share of world imports at about 16 percent in 2030 despite sizable increases in coal imports by other countries.

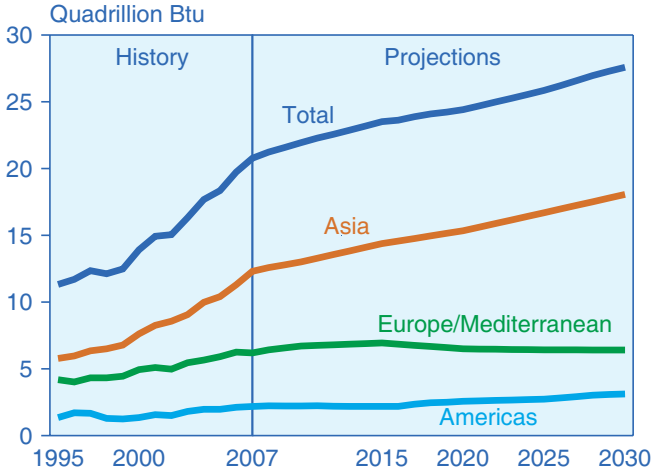
### *Europe, Middle East, and Africa*

In the *IEO2009* reference case, total coal imports to the Europe/Mediterranean market (including the Middle East and Africa) in 2030 are slightly above 2007 levels (Figure 47). With most European countries placing greater emphasis on natural gas in their power sectors, coal becomes a less significant component of the fuel mix for electricity generation. In Turkey, however, electricity demand and steel industry growth are projected to offset some of the decline in Europe's coal imports. Italy's conversion of power plants from oil to coal also is projected to increase its coal imports, and Germany's planned closure of its remaining hard coal mines by 2018 is expected to result in increasing imports of coal for electricity generation [*39*]. Europe's demand for lower sulfur coal (from South America and Eurasia, for example) will be tempered over time by the gradual addition of flue gas desulfurization equipment at existing coal-fired power plants. In the Middle East, Israel accounts for the largest portion of the increase in coal imports over the projection period as it expands its use of coal-fired generation.

### *The Americas*

In the mid- to long term, port expansions are expected to facilitate U.S. coal imports, which increase by about 1.1 quadrillion Btu from 2007 to 2030. In 2008, Kinder Morgan Energy Partners LP completed an expansion of annual capacity at its import terminal in Newport News, Virginia, by 6 million tons (about 0.4 quadrillion Btu); and in late 2009, it received an air permit enabling it to expand its coal terminal in Jacksonville, Florida [*40*]. Although imports remain a relatively small share of U.S. coal consumption in 2030 (4 percent), the increase represents a shift for the United States from a net exporter of

**Figure 47. Coal Imports by Major Importing Region, 1995-2030**




Sources: **History:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 17, No. 1 (London, UK, July 2008); International Energy Agency, *Coal Information 2008* (Paris, France, August 2008), and previous issues; and Energy Information Administration (EIA), *Quarterly Coal Report*, October-December 2007, DOE/EIA-0121(2007/4Q) (Washington, DC, March 2008), and previous issues; Btu conversions from short tons are estimates by EIA's Office of Integrated Analysis and Forecasting. **Projections:** EIA, National Energy Modeling System run IEO2009.D040709E.

coal to a net importer. With declining productivity and mining difficulties in Central Appalachia and rising domestic demand for coal, imports are expected to become increasingly competitive for coastal States in the East and Southeast. South America (Colombia, in particular) is expected to be an important source of U.S. coal imports.

Canada has been the largest importer of U.S. coal in recent years, but exports of U.S. steam coal to Canada in 2030 are projected to fall below their 2007 level. A portion of Ontario's coal-fired generating capacity is expected to be shut down over the projection period for environmental reasons, as legislated by the Provincial government.

Brazil's steelmaking capacity is projected to more than double by 2018, to 88 million tons from 37 million tons in 2007 [*41*]. With rich reserves of iron ore but no coking-grade coal, Brazil's steel industry will need more imports of coking coal from Australia, Canada, the United States, and southern Africa. Overall, South America's imports of coking coal—driven primarily by demand in Brazil—are projected to grow from about 0.4 quadrillion Btu in 2007 to 0.9 quadrillion Btu in 2030.

## World Coal Reserves

Total recoverable reserves of coal around the world are estimated at 929 billion tons—reflecting a current reserves-to-production ratio of 137 (Table 9).[21] Historically, estimates of world recoverable coal reserves, although relatively stable, have declined gradually from 1,145 billion tons in 1991 to 1,083 billion tons in 2000 and 929 billion tons in 2006 [*42*]. The most recent assessment of world coal reserves includes a substantial downward adjustment for India, from 102 billion tons in 2003 to 62 billion tons in 2006—reportedly attributable to better data, which permitted the estimation of recoverable coal reserves as compared with previous estimates of in-place coal reserves. Estimated reserves for OECD Europe of 32 billion tons in the most recent assessment also are substantially lower than the 2003 assessment of 43 billion tons. Much of the downward adjustment for OECD Europe is a result of lower estimates for Poland, Turkey, and the Czech Republic. Poland's reassessment of estimated recoverable coal reserves from 15 billion tons in 2003 to 8 billion tons in 2006 reflects the use of more restrictive criteria for geologic reliability [*43*].

**Table 9. World Recoverable Coal Reserves as of January 1, 2006**
(Billion Short Tons)

| Region/Country | Recoverable Reserves by Coal Rank | | | | 2006 Production | Reserves-to-Production Ratio (Years) |
|---|---|---|---|---|---|---|
| | Bituminous and Anthracite | Subbituminous | Lignite | Total | | |
| **World Total** | **471.3** | **293.1** | **164.9** | **929.3** | **6.8** | **137** |
| United States[a] | 120.1 | 109.3 | 33.3 | **262.7** | 1.2 | 226 |
| Russia | 54.1 | 107.4 | 11.5 | **173.1** | 0.3 | 536 |
| China | 68.6 | 37.1 | 20.5 | **126.2** | 2.6 | 48 |
| Other Non-OECD Europe and Eurasia | 49.1 | 19.0 | 27.3 | **95.3** | 0.3 | 293 |
| Australia and New Zealand | 40.9 | 2.5 | 41.6 | **85.1** | 0.4 | 200 |
| India | 57.6 | 0.0 | 4.7 | **62.3** | 0.5 | 125 |
| Africa | 54.5 | 0.2 | 0.0 | **54.7** | 0.3 | 199 |
| OECD Europe | 9.3 | 3.4 | 19.0 | **31.7** | 0.7 | 48 |
| Other Central and South America | 8.0 | 2.2 | 0.0 | **10.2** | 0.1 | 129 |
| Other Non-OECD Asia | 2.5 | 2.7 | 4.5 | **9.7** | 0.3 | 29 |
| Brazil | 0.0 | 7.8 | 0.0 | **7.8** | 0.0 | 1,109 |
| Canada | 3.8 | 1.0 | 2.5 | **7.3** | 0.1 | 100 |
| Other[b] | 2.9 | 0.5 | 0.1 | **3.4** | 0.0 | 195 |

[a]Data for the United States represent recoverable coal estimates as of January 1, 2008.
[b]Includes Mexico, Middle East, Japan, and South Korea.
Sources: **United States:** Energy Information Administration (EIA), unpublished data from the Coal Reserves Database (March 2009). **All Other Countries:** World Energy Council, *2007 Survey of Energy Sources*, 21st Edition (London, UK: Elsevier, September 2007), and EIA, *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea.

[21] Recoverable reserves are those quantities of coal which geological and engineering information indicates with reasonable certainty can be extracted in the future under existing economic and operating conditions. Because recoverable reserves are a subset of total coal resources, recoverable reserve estimates for a number of countries, including China and the United States, could increase substantially as coal mining technology improves and as additional geological assessments of the coal resource base are completed. The reserves-to-production ratio is based on the reserves estimates and data on world coal production for 2006 shown in Table 9.

Although coal deposits are widely distributed, 80 percent of the world's recoverable reserves are located in five regions: the United States (28 percent), Russia (19 percent), China (14 percent), Other Non-OECD Europe and Eurasia (10 percent), and Australia/New Zealand (9 percent). In 2006 those five regions, taken together, produced 4.9 billion tons (95.8 quadrillion Btu) of coal, representing 71 percent (75 percent on a Btu basis) of total world coal production [***44***]. By rank, anthracite and bituminous coal account for 51 percent of the world's estimated recoverable coal reserves on a tonnage basis, subbituminous coal accounts for 32 percent, and lignite accounts for 18 percent.

Quality and geological characteristics of coal deposits are important parameters for coal reserves. Coal is a heterogeneous source of energy, with quality (for example, characteristics such as heat, sulfur, and ash content) varying significantly by region and even within individual coal seams. At the top end of the quality spectrum are premium-grade bituminous coals, or coking coals, used to manufacture coke for the steelmaking process. Coking coals produced in the United States have an estimated heat content of 26.3 million Btu per ton and relatively low sulfur content of approximately 0.8 percent by weight [***45***]. At the other end of the spectrum are reserves of low-Btu lignite. On a Btu basis, lignite reserves show considerable variation. Estimates published by the International Energy Agency for 2006 indicate that the average heat content of lignite in major producing countries varies from a low of 4.5 million Btu per ton in Greece to a high of 12.4 million Btu per ton in Canada [***46***].

## References


1. "Mexico Adding Coal Generation As Natural Gas Reserves Dwindle," *Platts Coal Outlook*, Vol. 32, No. 2 (January 14, 2008), p. 5.
2. Energy Information Administration, *International Energy Annual 2006* (June-December 2008), Table 5.4, web site www.eia.doe.gov/iea; and International Energy Agency, Databases for *Coal Information: 2006 Edition*: Coal Production, Trade, Demand (II.3, II.8), web site www.iea.org.
3. "PiE's New Plant Tracker—January 2009," *Power in Europe*, No. 542 (January 12, 2009).
4. International Energy Agency, *Coal Information 2008* (Paris, France, August 2008), pp. III.195 and III.203.
5. Korea Electric Power Corporation, web site www.kepco.co.kr; Korea East-West Power Co., Ltd., web site www.ewp.co.kr; Korea South-East Power Co., Ltd., web site www.kosep.co.kr; Korea Midland Power Co., Ltd., web site www.komipo.co.kr; Korea Western Power Co., Ltd, web site www.westernpower.co.kr; and Korea Southern Power Co., Ltd., web site www.kospo.co.kr.
6. A. Sagawa and K. Koizumi, "Present State and Outlook of China's Coal Industry" (December 2007: The Institute of Energy Economics, Japan), web site http://eneken.ieej.or.jp/data/en/data/pdf/410.pdf; D. Miller, "7 China Stocks To Turn Crisis Into Opportunity," (January 7, 2009), web site http://seekingalpha.com/article/113583-7-china-stocks-to-turn-crisis-into-opportunity; M. Hutchinson, "Five Ways To Profit From China's Stimulus Plan" (November 11, 2008), web site http://seekingalpha.com/article/105309-five-ways-to-profit-from-china-s-stimulus-plan; China Mining Association, "China To Invest 150 Bln Yuan in Railways in Coal-Rich Shanxi Province" (December 8, 2008), web site www.chinamining.org/Investment/2008-12-08/1228698848d19914.html; China Mining Association, "Shenhua Group Corp Coal Miner Starts Mongol Railway" (January 9, 2009), web site www.chinamining.org/Investment/2009-01-21/1232500635d21200.html; and Wang Xiaolin, "Shenhua Group—Present and Future" (Beijing, China, April 23, 2004), web site www.iea.org/Textbase/work/2004/coal/ShenhuaEng.pdf.
7. International Iron and Steel Institute, web site www.worldsteel.org.
8. "Shenua CTL Project Delayed; To Come Online Next Year," *Dow Jones International News* (February 26, 2009).
9. R.L. Hershey, *Coal-to-Liquids Production in China: Final Report*, prepared by Z, Inc., for the Energy Information Administration, Contract No. DE-AT01-07EI40197 (February 20, 2008), pp. 6-8.
10. Central Electricity Authority & Confederation of Indian Industry, *White Paper on Strategy for 11th Plan* (August 2007), web site http://cea.nic.in/planning/white%20paper.pdf; and Government of India, Central Electricity Authority, *Power Scenario at a Glance* (January 2009), web site www.cea.nic.in.
11. Government of India, *Outcome Budget of Ministry of Power 2007-2008* (April 2007), pp. 92-93, web site www.powermin.nic.in/reports/pdf/Outcome_Budget_2007-08.pdf; and Government of India, Ministry of Power, *Development of Ultra Mega Power Projects* (October 2007), web site http://powermin.nic.in/whats_new/pdf/development_of_project.pdf.
12. S. Mahnovski and T. Gustafson, *The Russian Long-Range Power Plan: An Uneasy Marriage of Central Planning and Markets* (Cambridge Energy Research Associates, June 11, 2008), web site www.cera.com/aspx/cda/client/report/reportpreview.aspx?CID=9549&KID= (subscription site).
13. S. Shuster and J. Cowhig, "Russia Power Firms Turn Away From Coal As Cost Surges" (Reuters

UK, July 7, 2008), web site http://uk.reuters.com/article/oilRpt/idUKL0749460320080707.

14. "New Power Generation Project Tracker January 2009," *Platts Energy in East Europe*, No. 137 (January 30, 2009), web site www.platts.com (subscription site).
15. Eskom, *Annual Report 2008* (July 2008), web site www.eskom.co.za/annreport08; and Eskom, *New Build News*, Issue 6 (January 2009)," web site www.eskom.co.za/content/New%20Build%20News%20%20(Issue%206%20Jan%202009).pdf.
16. Platts, "Analysis: Africa Coal," *Energy Economist*, Issue 328 (February 1, 2009), web site www.platts.com/Electric%20Power/Newsletters%20&%20Reports/Energy%20Economist (subscription site); allAfrica.com, "Mozambique: Riversdale Hopes To Export Tete Coal by Late 2010" (February 10, 2009), web site http://allafrica.com/stories/200902100592.html; Global Insight, Inc., "Chinese Firm To Invest US$970 mil. In New Coal-Fired Power Plant in Botswana" (December 3, 2008), web site www.globalinsight.com (subscription site); and Global Insight, Inc., "Botswana's Mmamabula Coal Project on Track for Start-Up in Late 2012" (December 5, 2008); web site www.globalinsight.com (subscription site).
17. Sasol, *Sasol Facts 08: A Blueprint to the World of Sasol Edition* (May 2008), web site http://sasol.investoreports.com/sasol_sf_2008/index.php; Eric van de Venter, "Update on the Sasol-Lurgi Technology Company Business Activities and the Application of the S-L FBDB Gasification Technology (Including an Overview of Sasol's CTL Business Activities)," presentation at the 2007 Gasification Technologies Council Conference (San Francisco, CA, October 15-17, 2007), web site http://www.gasification.org/Docs/Conferences/2007/10VAND.pdf; and Energy Information Administration, *International Energy Annual 2006* (June- December 2008), Table 1.2, web site www.eia.doe.gov/iea.
18. International Iron and Steel Institute, Steel in Figure: Search statistics archive, Steel production, web site www.worldsteel.org; and Energy Information Administration, *International Energy Annual 2006* (June-December 2008), Table E.4, web site www.eia.doe.gov/iea.
19. R. Pregnaca, "Can Brazil Live Up to Its Steel Powerhouse Billing?," *American Metal Market* (August 21, 2008), web site amm.com/2008-08-21_16-39-54.html (subscription site); and "Brazil Steel Sector Sees Output Up 135 pct by 2018," *Reuters* (January 29, 2008), web site www.reuters.com/article/companyNews/idUSN2941534820080129.
20. I. Kirkwood, "Deciphering the Coal Industry," *The Newcastle Herald* (January 3, 2009), web site www.nswtrains.com.au/nsw-trains-articles/2009/1/3/deciphering-the-coal-industry.
21. T. Grant-Taylor, "Australia's Dalrymple Bay Coal Terminal Expansion Delayed," *Herald Sun* (May 29, 2008), web site www.news.com.au/heraldsun/story/0,21985,23774661-664,00.html.
22. P. Devitt, R. Paxton, and A. Barker, "RPT—Russia's Mechel To Scale Back $5.5 bln Capex Plan," *Reuters* (October 30, 2008), web site www.reuters.com/article/companyNewsAndPR/idUSLU23894120081030.
23. "Evraz Abandons Right To Develop Russian Coal Reserve," *Business News Europe, Investor Weekly* (January 26, 2009), web site www.businessneweurope.eu/dispatch7350 (subscription site).
24. A. Kueppers and P. Blackburn, "Russia Coking Coal Firms Seek State Relief Package," *Reuters* (November 27, 2008), web site www.reuters.com/article/companyNewsAndPR/idUSLR54777620081127.
25. "Russian Rail Bottlenecks Trim Shipments," *Argus Coal Transportation Report*, Vol. 28, No. 4 (January 27, 2009 ), p. 8.
26. "SUEK of Russia Started Coal Shipments to Japan Through Muchka; Two Cargoes of 20,000 MT Each After Turn of the Year," *Tex Energy Report* (February 3, 2009), web site www.texreport.co.jp/xenglish (subscription site); I. Zhitomirsky, Mechel, News, "Mechel OAO Commences Construction of Coal Transshipment Complex at Vanino Port" (September 9, 2008), web site www.mechel.com/news/article.wbp?article-id=96E8D4FA-6F89-42F6-A6ED-E0664ABC37CD.
27. "Colombia Moves Ahead on Port Expansions," *Argus Coal Transportation Report*, Vol. 28, No. 4 (January 29, 2009), pp. 6-7.
28. B. Cassell, "Adaro Takes Hard Look at Budget But Still Plans Big Coal Expansion," *SNL Interactive* (February 4, 2009), web site www.snl.com (subscription site).
29. B. Thomas and W. Zhu, "Vietnam To Cut Coal Exports, May Phase Out Shipments (Update 2)," *Bloomberg* (February 15, 2008), web site www.bloomberg.com/apps/news?pid=newsarchive&sid=axT.gsmXorfw.
30. "Moatize Basin Shaping Up As a Coal Province—Riversdale," *Steel Guru* (September 11, 2008), web site http://steelguru.com/news/index/2008/09/11/NjI2NDA%3D/Moatize_Basin_shaping_up_as_a_coal_province_-_Riversdale. html.
31. C. Mangwiro, "Mozambique in Talks To Fund $180 Mln Coal Terminal," *Reuters* (September 29, 2007),

web site www.reuters.com/article/bondsNews/idUSL2920474220070929.

32. Richards Bay Coal Terminal Company Limited, "Phase V Expansion," web site www.rbct.co.za/default.asp?id=1087 (not dated).
33. S. Saraf, "India Responds to Global Crisis," *Platt's Power in Asia*, No. 520 (January 22, 2009), p. 11.
34. "Paradip Port Invites Financial Bids for 2 Deep-Draught Berths," *Business Line* (January 6, 2009), web site www.mjunction.in/market_news/logistics_1/paradip_port_invites_financial.php; "Govt Clears Three Port Projects Worth Rs 2,000 cr," *The Economic Times* (January 9, 2009), web site www.mjunction.in/market_news/logistics_1/govt_clears_three_port_project.php.
35. B. Mukherji, "Reforms Seen Failing To Remove Indian Mine Shackles," *Reuters* (October 7, 2007), web site www.reuters.com/article/companyNewsAndPR/idUSSP7159720071009; and World Steel Organization, Media Centre, News Releases, "World Crude Steel Production Decreases by 1.2% in 2008," web site www.worldsteel.org/?action=newsdetail&id=257.
36. Energy Information Administration, *International Energy Annual 2006* (June-December 2008), Table 2.5, web site www.eia.doe.gov/iea.
37. Y. Inoue and H. Lawson, "Japan's Sumitomo Corp Eyes Russia's Elga Coal Mine," *Reuters* (November 21, 2007), web site http://uk.reuters.com/article/oilRpt/idUKT26814420071121; and B. Cassell, "Japan's Mitsui Takes Bigger Stake in Canada's Cline Mining," *SNL Interactive* (July, 9, 2008), web site www.snl.com (subscription site).
38. World Steel Organization, Media Centre, News Releases, "World Crude Steel Production Decreases by 1.2% in 2008," web site www.worldsteel.org/?action=newsdetail&id=257.
39. C. Dougherty, "Germany Finds Solution to Its Withering Coal Mines," *International Herald Tribune* (June 14, 2007), web site www.iht.com.
40. W. Browning and K. Morgan "Coal Markets in 2009: Let the Games Begin Anew," Presentation to the 7th Annual Coal Trading Conference, December 11-12, New York, NY, World Coal Trading Association, Events, web site www.coaltrade.org/events/documents/Browning.pdf.
41. "Jim Walters Links Mine and Port Expansions," *Argus Coal Transportation Report,* Vol. 26, No. 23 (November 6, 2007), p. 5.
42. Energy Information Administration, *International Energy Annual 1991*, DOE/EIA-0219(91) (Washington, DC, December 1992), Table 33; and *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, March 2003), Table 8.2.
43. World Energy Council, *2007 Survey of Energy Sources*, 21st Edition (London, UK, September 2007), pp. 25-26.
44. Energy Information Administration, *International Energy Annual 2006* (June-December 2008), Table 2.5, web site www.eia.doe.gov/iea.
45. Energy Information Administration, Form EIA-5, "Quarterly Coal Consumption and Quality Report, Coke Plants."
46. International Energy Agency, *Coal Information 2008* (Paris, France, August 2008), p. xxxv.

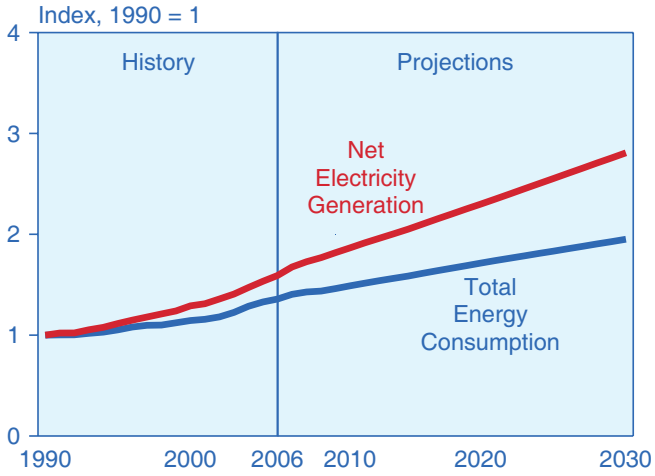
# Chapter 5
# Electricity

***World electricity generation increases by 77 percent from 2006 to 2030 in the IEO2009 reference case. The non-OECD countries are projected to account for 58 percent of world electricity use in 2030.***

World net electricity generation increases by an average of 2.4 percent per year from 2006 to 2030 in the *IEO2009* reference case. Electricity is projected to supply an increasing share of the world's total energy demand and is the fastest-growing form of end-use energy worldwide in the mid-term. Since 1990, growth in net electricity generation has outpaced the growth in total energy consumption (2.9 percent per year and 1.9 percent per year, respectively), and the growth in demand for electricity continues to outpace growth in total energy use throughout the projection (Figure 48).

World net electricity generation increases by 77 percent in the reference case, from 18.0 trillion kilowatthours in 2006 to 23.2 trillion kilowatthours in 2015 and 31.8 trillion kilowatthours in 2030 (Table 10). Although the current recession is expected to dampen electricity demand in the near term, the reference case projection does not anticipate that the recession will be prolonged and expects growth in electricity demand to return to trend after 2010. The impact of the recession on electricity consumption is likely to be felt most strongly in the industrial sector, as manufacturing slows as a result of lower demand for manufactured products. Demand in the building sector is less sensitive to changing economic conditions than the industrial sector, because people generally continue to consume electricity for space heating and cooling, cooking, refrigeration, and hot water heating even in a recession.

**Figure 48. Growth in World Electric Power Generation and Total Energy Consumption, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

In general, growth in the OECD countries, where electricity markets are well established and consuming patterns are mature, is slower than in the non-OECD countries, where a large amount of demand goes unmet at present. The International Energy Agency estimates that nearly 32 percent of the population in the developing non-OECD countries (excluding non-OECD Europe and Eurasia) did not have access to electricity in 2005—a total of about 1.6 billion people [*1*]. Regionally, sub-Saharan Africa fares the worst: more than 75 percent of the population remains without access to power. High projected economic growth rates support strong increases in demand for electricity among the developing regions of the world through the end of the projection period.

The non-OECD nations consumed 45 percent of the world's total electricity supply in 2006, and their share of world consumption is poised to increase over the projection period. In 2030, non-OECD nations account for 58 percent of world electricity use, and the OECD share declines to 42 percent (Figure 49). In the developing countries, strong economic growth translates to growing demand for electricity. Increases in income per capita lead to improved standards of living, rising consumer demand for lighting and appliances, and growing requirements for electricity in the industrial sector. As a result, total net electricity generation in the non-OECD countries increases by an average of 3.5 percent per year in the reference case, led by non-OECD Asia (including China and India), with annual increases averaging 4.4 percent from 2006 to 2030 (Figure 50). In contrast, net generation among the OECD nations grows by an average of 1.2 percent per year from 2006 to 2030.

## Electricity Supply by Energy Source

The mix of primary fuels used to generate electricity has changed a great deal over the past four decades on a worldwide basis. Coal continues to be the fuel most widely used for electricity generation, although generation from nuclear power increased rapidly from the 1970s through the 1980s, and natural-gas-fired generation grew rapidly in the 1980s and 1990s. The use of oil

for electricity generation has been declining since the mid-1970s, when the oil embargo by Arab producers in 1973-1974 and the Iranian Revolution in 1979 caused oil prices to increase to levels much higher than those for other fuels.

Although world oil prices contracted strongly at the end of 2008 and into 2009, the high prices recorded between 2003 and 2008, combined with concerns about the environmental consequences of greenhouse gas emissions, renewed interest in the development of alternatives to fossil fuels—specifically, nuclear power and renewable energy sources. The *IEO2009* reference case does not expect oil prices to remain at current levels. As economies begin to recover from the global recession, so too does the demand for liquids and other energy. As a result, long-term prospects continue to improve for generation from both nuclear and renewable energy sources—supported by government incentives and by high fossil fuel prices. Natural gas and coal are the second- and third fastest-growing sources of energy for electricity generation in the projection, although the outlook for coal, in particular, could be altered substantially by any future legislation that aims to reduce or limit the growth of greenhouse gas emissions.

## Coal

In the *IEO2009* reference case, coal continues to fuel the largest share of worldwide electric power production, by a wide margin (Figure 51). In 2006, coal-fired generation accounted for 41 percent of world electricity supply; in 2030, its share is projected to be 43 percent. Sustained high prices for oil and natural gas make coal-fired generation more attractive economically, particularly in nations that are rich in coal resources, which include China, India, and the United States. World net coal-fired generation nearly doubles over the projection period, from 7.4 trillion kilowatthours in 2006 to 9.5 trillion kilowatthours in 2015 and 13.6 trillion kilowatthours in 2030.

The outlook for coal-fired generation could be altered substantially by international agreements to reduce greenhouse gas emissions. The electric power sector offers some of the most cost-effective opportunities for reducing carbon dioxide emissions in many countries. Coal is both the world's most widely used source of energy for power generation and also the most carbon-intensive energy source. If a cost, either implicit or explicit, were applied to carbon dioxide emissions, there are several alternative no- or low-emission

**Table 10. OECD and Non-OECD Net Electricty Generation by Energy Source, 2006-2030**
(Trillion Kilowatthours)

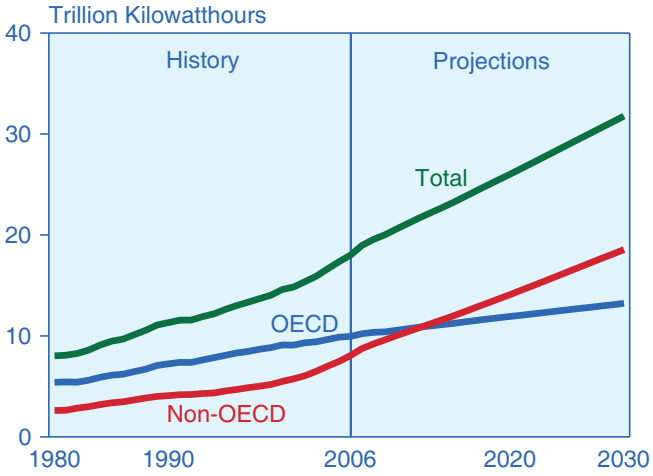
| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | | | | | | | |
| Liquids | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | -0.4 |
| Natural Gas | 2.0 | 2.2 | 2.4 | 2.7 | 3.0 | 3.1 | 1.8 |
| Coal | 3.7 | 3.9 | 4.0 | 4.0 | 4.0 | 4.3 | 0.6 |
| Nuclear | 2.2 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 0.6 |
| Renewables | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 2.9 | 2.5 |
| **Total OECD** | **9.9** | **10.6** | **11.3** | **11.9** | **12.6** | **13.2** | **1.2** |
| **Non-OECD** | | | | | | | |
| Liquids | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.1 |
| Natural Gas | 1.6 | 2.0 | 2.5 | 3.0 | 3.4 | 3.7 | 3.6 |
| Coal | 3.7 | 4.8 | 5.5 | 6.4 | 7.8 | 9.2 | 3.9 |
| Nuclear | 0.4 | 0.5 | 0.7 | 0.9 | 1.2 | 1.3 | 4.8 |
| Renewables | 1.8 | 2.2 | 2.7 | 3.2 | 3.4 | 3.8 | 3.2 |
| **Total Non-OECD** | **8.0** | **10.0** | **12.0** | **14.1** | **16.3** | **18.6** | **3.5** |
| **World** | | | | | | | |
| Liquids | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | -0.1 |
| Natural Gas | 3.6 | 4.2 | 4.9 | 5.7 | 6.4 | 6.8 | 2.7 |
| Coal | 7.4 | 8.7 | 9.5 | 10.4 | 11.8 | 13.6 | 2.5 |
| Nuclear | 2.7 | 2.8 | 3.0 | 3.4 | 3.6 | 3.8 | 1.5 |
| Renewables | 3.4 | 4.1 | 4.9 | 5.7 | 6.1 | 6.7 | 2.9 |
| **Total World** | **18.0** | **20.6** | **23.2** | **26.0** | **28.9** | **31.8** | **2.4** |

Note: Totals may not equal sum of components due to independent rounding.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

technologies that currently are commercially proven or under development, which could be used to replace some coal-fired generation. Implementing the technologies would not require expensive, large-scale changes in the power distribution infrastructure or in electricity-using equipment.

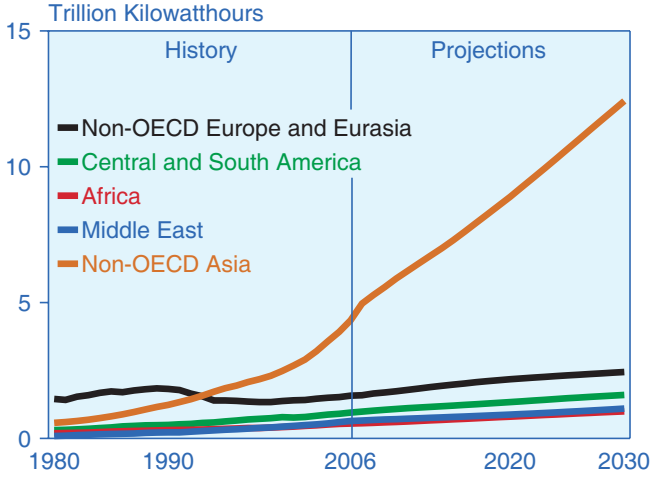
It could be more difficult, however, to achieve similar results in other end-use sectors. In the transportation sector, for instance, large-scale reduction of carbon dioxide emissions probably would require extensive changes in the motor vehicle fleet, fueling stations, and fuel distribution systems, at tremendous expense. In contrast, substitution of nuclear power and renewables for fossil fuels in the electric power sector would be a comparatively inexpensive way to reduce emissions, as would improving the efficiency of electric appliances.

**Figure 49. World Net Electric Power Generation, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 50. Non-OECD Net Electricity Generation by Region, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

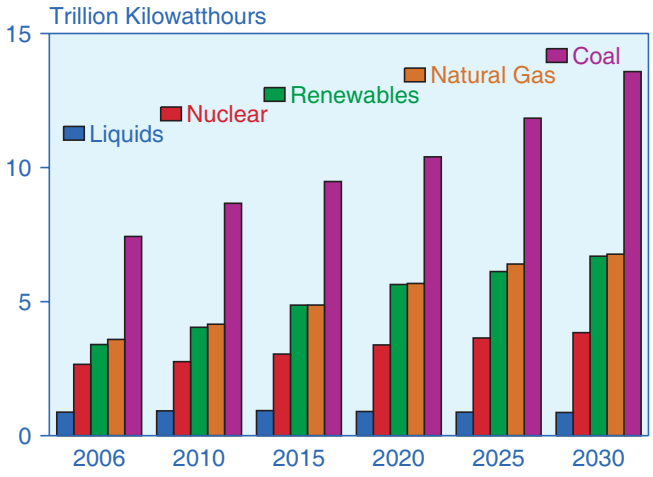
## Natural Gas

Over the 2006 to 2030 projection period, natural-gas-fired electricity generation increases by 2.7 percent per year, making gas the fastest-growing power source after renewables in the *IEO2009* reference case. Generation from natural gas worldwide increases from 3.6 trillion kilowatthours in 2006 to 6.8 trillion kilowatthours in 2030, but the total amount of electricity generated from natural gas continues to be only about one-half the total for coal, even in 2030. Natural-gas-fired combined-cycle capacity is an attractive choice for new power plants because of its fuel efficiency, operating flexibility (it can be brought online in minutes rather than the hours it takes for coal-fired and some other generating capacity), relatively short planning and construction times (months instead of the years that nuclear power plants typically require), and capital costs that are lower than those for other technologies.

## Liquid Fuels and Other Petroleum

With world oil prices projected to return to relatively high levels, reaching $130 per barrel (in real 2007 dollars) in 2030, liquids are the only energy source for power generation that does not grow on a worldwide basis. Most nations are expected to respond to high oil prices by reducing or eliminating their use of oil for generation—opting instead for more economical sources of electricity, including coal. Although the recent decline in world oil prices has forestalled the retreat from oil-fired generation in the near term, nations turn to alternative

**Figure 51. World Electricity Generation by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

fuels for their power sources as oil prices rebound. From 2006 to 2015, oil-fired generation grows by 0.7 percent per year; thereafter, with world oil prices above $100 per barrel and rising after 2015, generation from liquids falls by an average of 0.5 percent per year. Modest growth in liquids generation in the later years of the projection, particularly in the Middle East, is more than offset by declines in all other regions.

## Nuclear Power

Electricity generation from nuclear power is projected to increase from about 2.7 trillion kilowatthours in 2006 to 3.8 trillion kilowatthours in 2030, as concerns about rising fossil fuel prices, energy security, and greenhouse gas emissions support the development of new nuclear generation capacity. High prices for fossil fuels allow nuclear power to become economically competitive with generation from coal, natural gas, and liquids despite the relatively high capital and maintenance costs associated with nuclear power plants. Moreover, higher capacity utilization rates have been reported for many existing nuclear facilities, and it is anticipated that most of the older nuclear power plants in the OECD countries and non-OECD Eurasia will be granted extensions to their operating lives.

Around the world, nuclear generation is attracting new interest as countries look to increase the diversity of their energy supplies, improve energy security, and provide a low-carbon alternative to fossil fuels. Still, there is considerable uncertainty associated with nuclear power. Issues that could slow the expansion of nuclear power in the future include plant safety, radioactive waste disposal, and concerns that weapons-grade uranium may be produced from centrifuges installed to enrich uranium for civilian nuclear power programs. Those issues continue to raise public concern in many countries and may hinder the development of new nuclear power reactors. Nevertheless, the *IEO2009* reference case incorporates improved prospects for world nuclear power. The *IEO2009* projection for nuclear electricity generation in 2025 is 25 percent higher than the projection published 5 years ago in *IEO2004*.

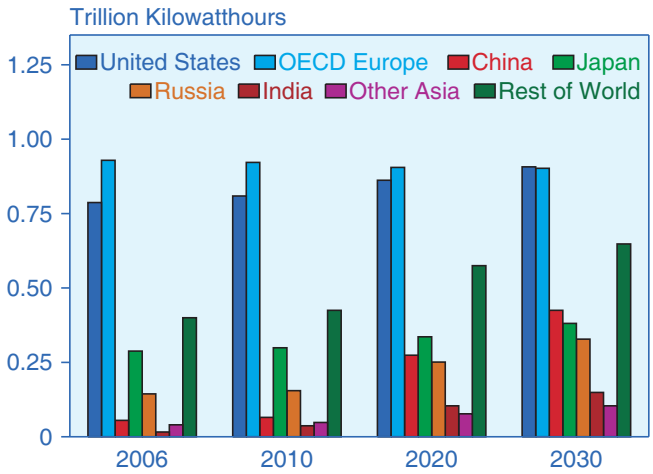
On a regional basis, the *IEO2009* reference case projects the strongest growth in nuclear power for the countries of non-OECD Asia (Figure 52). Non-OECD Asia's nuclear power generation is projected to grow at an average annual rate of 7.8 percent from 2006 to 2030, including projected increases of 8.9 percent per year in China and 9.9 percent per year in India. Outside Asia, the largest increase in installed nuclear capacity among the non-OECD nations is projected for Russia, where nuclear power generation increases by an average of 3.5 percent per year. In contrast, OECD Europe is expected to see a small decline in nuclear power generation, as some national governments (including Germany and Belgium) still have plans in place to phase out nuclear programs entirely.

To address the uncertainty inherent in projections of nuclear power growth in the long term, a two-step approach is used to formulate the outlook for nuclear power. In the near term (through 2015), projections are based primarily on the current activities of the nuclear power industry and national governments. Because of the long permitting and construction lead times associated with nuclear power plants, there is general agreement among analysts on which nuclear projects are likely to become operational in the mid-term. After 2015, the projections are based on a combination of announced plans or goals at the country and regional levels and consideration of other issues facing the development of nuclear power, including economics, geopolitical issues, technology advances, and environmental policies. The availability of potential uranium resources is also considered as part of the *IEO2009* modeling effort. At production costs between $40 and $80 per kilogram of uranium, total uranium reserves in excess of 3.8 billion metric tons will be sufficient to meet the 2.7 billion metric tons that would be needed to support the projected growth in nuclear generation worldwide [2].

## Hydroelectric, Wind, Geothermal, and Other Renewable Generation

Renewable energy is the fastest-growing source of electricity generation in the *IEO2009* reference case. Total generation from renewable resources increases by 2.9 percent annually, and the renewable share of world electricity generation grows from 19 percent in 2006 to 21 percent in 2030. Much of the increase is expected to be in hydroelectric power and wind power. Generation from

**Figure 52. World Net Electricity Generation from Nuclear Power by Region, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

wind energy, in particular, has grown swiftly over the past decade, from 11 gigawatts of net installed capacity at the beginning of 2000 to 121 gigawatts at the end of 2008—a trend that is projected to continue into the future [3]. Of the 3.3 trillion kilowatthours of new renewable generation added over the projection period, 1.8 trillion kilowatthours (54 percent) is attributed to hydroelectric power and 1.1 trillion kilowatthours (33 percent) to wind (Table 11).[22]

Although renewable energy sources have positive environmental and energy security properties, most renewable technologies other than hydroelectricity are not able to compete economically with fossil fuels during the projection period outside a few regions. Solar power, for instance, is currently a "niche" source of renewable energy but can be economical where electricity prices are especially high or government incentives are available (see box on page 68). In fact, government policies or incentives often provide the primary motivation for construction of renewable generation facilities.

Changes in the mix of renewable fuels used for electricity generation are expected to differ between the OECD and non-OECD regions in the *IEO2009* reference case. In the OECD nations, the majority of economically exploitable hydroelectric resources already have been used; and, with the exceptions of Canada and Turkey, there are few large-scale hydroelectric power projects planned for the future. As a result, most renewable energy growth in the OECD countries is expected to come from nonhydroelectric sources, especially wind and biomass. Many OECD countries, particularly those in Europe,

**Table 11. OECD and Non-OECD Renewable Electricty Generation by Energy Source, 2006-2030**
(Billion Kilowatthours)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | | | | | | | |
| Hydropower | 1,274 | 1,321 | 1,396 | 1,447 | 1,496 | 1,530 | 0.8 |
| Wind | 113 | 258 | 418 | 572 | 713 | 842 | 8.7 |
| Geothermal | 35 | 45 | 54 | 57 | 59 | 62 | 2.4 |
| Other | 212 | 263 | 354 | 438 | 487 | 513 | 3.7 |
| **Total OECD** | **1,635** | **1,888** | **2,222** | **2,515** | **2,756** | **2,948** | **2.5** |
| **Non-OECD** | | | | | | | |
| Hydropower | 1,723 | 2,060 | 2,491 | 2,911 | 3,098 | 3,242 | 2.7 |
| Wind | 14 | 53 | 82 | 115 | 150 | 372 | 14.6 |
| Geothermal | 19 | 29 | 40 | 42 | 45 | 47 | 3.8 |
| Other | 33 | 41 | 64 | 83 | 100 | 114 | 5.3 |
| **Total Non-OECD** | **1,790** | **2,184** | **2,676** | **3,151** | **3,393** | **3,776** | **3.2** |
| **World** | | | | | | | |
| Hydropower | 2,997 | 3,381 | 3,887 | 4,359 | 4,594 | 4,773 | 2.0 |
| Wind | 127 | 312 | 500 | 687 | 864 | 1,214 | 9.9 |
| Geothermal | 55 | 75 | 93 | 99 | 104 | 109 | 2.9 |
| Other | 246 | 304 | 418 | 521 | 587 | 628 | 4.0 |
| **Total World** | **3,424** | **4,072** | **4,898** | **5,666** | **6,149** | **6,724** | **2.9** |

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from ARRA2009 that stimulate increased renewable generation, a significant expansion in the use of renewable fuels is projected. As a result, in the projections for 2030, total world electricity generation from hydropower rises to 4,771 billion kilowatthours, total generation from wind rises to 1,291 billion kilowatthours, total generation from geothermal energy rises to 111 billion kilowatthours, and total generation from other renewables rises to 594 billion kilowatthours.

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[22] In the *updated AEO2009* reference case (April 2009), a significant expansion in U.S. use of renewable fuels for electricity generation is projected, particularly in the near term. An extension of key Federal tax credits and a new loan guarantee program in ARRA2009 both stimulate increased renewable generation relative to the projection in the *published AEO2009* reference case (March 2009). U.S. renewable generation in 2030 is 9 percent higher in the *updated* reference case than in the *published* reference case. As a result, incorporating the U.S. projections from the *updated AEO2009* reference case results in an increase in total world renewable generation of 3.4 trillion kilowatthours over the projection period, of which 1.8 trillion kilowatthours (53 percent of the total increase) is hydroelectric power and 1.2 trillion kilowatthours (35 percent) is wind power.

## Solar Photovoltaic and Solar Thermal Electric Technologies

Solar power is one of the fastest-growing sources of renewable energy worldwide. Many nations, concerned about the environmental impacts of electricity generation from fossil fuels or from large-scale hydroelectric plants, have been turning to solar power as an environmentally benign alternative. The solar energy that reaches the earth can be harnessed to generate electric power, and the potential for large-scale applications of solar power has improved markedly in recent years. Two solar power technologies—solar photovoltaic and solar thermal—are widely employed today, and their use is likely to increase in the future.

Solar photovoltaic technologies convert sunlight directly into electricity by using photons from the sun's light to excite electrons into higher states of energy. The resultant voltage differential across cells allows for a flow of electric current. Because individual solar cells are very small and produce a few watts of power at most, they are connected together in solar panels that can be arranged in arrays to increase electricity output. The arrangement of arrays is one major advantage of photovoltaic technologies, because they can be made in virtually any size to fit a specific application.

One popular application of solar photovoltaics is in solar panel installations on residential roofs, which can be scaled to accommodate house size and electricity needs. Although the technology now is used most often in small residential applications, it can be scaled up to create larger power plants, such as the 14-megawatt Nellis solar plant in Nevada with some 70,000 panels and the 11-megawatt solar plant in Serpa, Portugal, with 52,000 panels.

At present, the cost of electricity produced from solar photovolatics generally is too high to compete with wholesale electricity. In sunny locations, however, the cost can be as low as 23 cents per kilowatthour,[a] which may be competitive with the delivered price of electricity to retail customers in areas where electricity prices are high, as they are in California, Southern Spain, and Italy.[b] On the basis of installed cost per megawatt, solar photovoltaic installations are relatively costly, because the panel components are expensive and the conversion of solar energy to electricity in the cells still is inefficient. From conversion efficiencies of 5 to 6 percent for the first solar cells built in the 1950s, there has been an improvement to efficiencies of 12 to 18 percent for modern commercial wafer-silicon cells.[c]

Efficiency gains, coupled with other technological advances, have reduced the cost of solar photovoltaic capacity from approximately $300 per watt in 1956[d] to less than $5 per watt in 2009.[e] EIA's *Annual Energy Outlook 2009* projects that, by 2030, overnight capacity costs for new generating plants using solar photovoltaics will be 37 percent lower than the 2009 costs. In addition, the efficiency of solar photovoltaic applications is expected to improve as the technology continues to be developed. As a result, U.S. solar photovoltaic generating capacity is projected to increase from 30 megawatts in 2006 to 381 megawatts in 2030 (see figures on page 69).

Although prices for electricity from photovoltaics may not become widely competitive with wholesale prices for electricity from conventional generating technologies within the next 25 years, they may be competitive with high retail electricity prices in sunny regions. Already, photovoltaic technology is gaining market share in countries where declining prices and government-backed financial incentives have led to increased usage. In Germany, for example, a feed-in tariff of 27 cents per kilowatthour[f] has produced an explosion in the use of solar photovoltaics, and in Japan the government has set a target for 30 percent of all households to have solar panels installed by 2030.

Solar thermal technologies produce electricity by concentrating the sun's heat to boil a liquid and using the steam to rotate a generator turbine, in much the same way that electricity is produced from steam plants powered by coal or natural gas. There are two main types of solar thermal power plants: towers and parabolic troughs. A solar power tower consists of a large array of sun-tracking mirrors, which are used to reflect the sun's rays onto a central tower. When the rays hit the tower's receiving panel, their heat is transferred to a fluid medium that is boiled to produce steam. Solar power towers have been demonstrated successfully,

*(continued on page 69)*

[a]U.S. Department of Energy, *Solar Energy Technologies Program Multi Year Program Plan 2008-2012* (Washington, DC, April 18, 2008), p. 18, web site www1.eere.energy.gov/solar/pdfs/solar_program_mypp_2008-2012.pdf. In comparison, wholesale electricity prices averaged 5.42 cents per kilowatthour in California in 2009.

[b]Because retail electricity prices in the United States include generation, transmission, and distribution costs, prices paid by consumers are higher than average retail prices per kilowatthour.

[c]U.S. Department of Energy, *Solar Energy Technologies Program Multi Year Program Plan 2008-2012*, p. 119.

[d]Southface Energy Institute, "History of Solar," web site www.southface.org/solar/solar-roadmap/solar_how-to/history-of-solar.htm.

[e]Solarbuzz LLC, "Solar Module Retail Price Environment," web site www.solarbuzz.com/Moduleprices.htm.

[f]Under a feed-in tariff structure, regional or national electric utilities are obligated to purchase renewable electricity at a higher rate than retail, in order to allow renewable energy sources to overcome price disadvantages.

## Solar Photovoltaic and Solar Thermal Electric Technologies (continued)

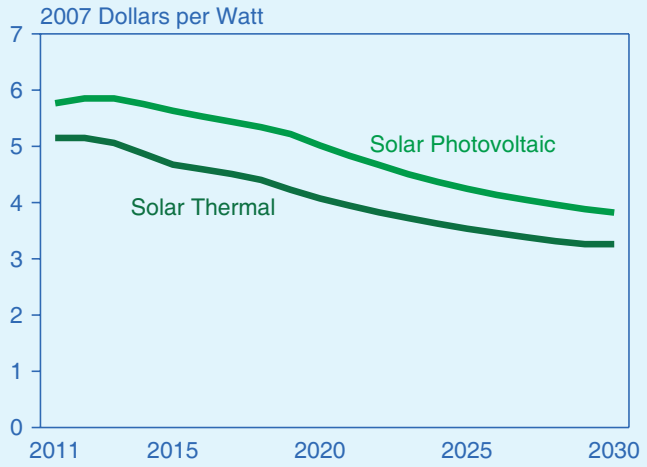
but they still are in the early stages of technology development. The world's largest solar power tower, located in Spain, is the 15-megawatt Solar Tres Power Tower.

The most commonly used solar thermal technology is the parabolic trough, in which a parabolic reflector focuses the sun's rays on a heat pipe that runs the length of the trough and transports heated fluid to a central power station. Most parabolic trough installations consist of a field of reflectors concentrated on a central location, where the working fluid is heated to produce steam. The world's largest parabolic trough installation is the Kramer Junction Solar Electric Generating System in California, which consists of five 30-megawatt parabolic trough arrays. Total U.S. installed solar thermal capacity, currently 400 megawatts, is projected to increase to 859 megawatts in 2030 (see figure below).

Solar thermal power plants are designed to be large-scale grid-connected plants, but at present they generally cannot be used as baseload generators, because they do not produce heat at night or during the day when clouds block the sun. Some advances have been made in storing solar energy by using it to heat liquid sodium, which can be used later to boil water and produce the steam needed to power a generator turbine. The process is time-limited, however, and can extend a plant's operations by only a few hours at best. In some cases, storage times of 4 to 16 hours have been achieved, sufficient to allow electricity from solar thermal generators to be sold when it is more valuable, during the peak demand hours of 7-9 am and 5-7 pm.

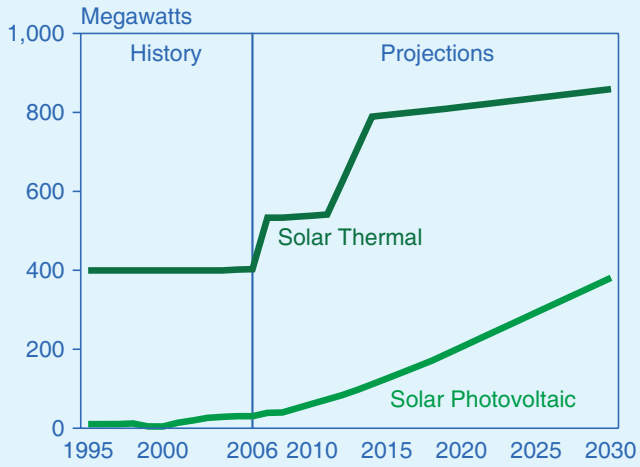
Solar technologies have benefited from much research and development over the past two decades, bringing down the delivered price of solar electricity. Today, electricity from residential photovoltaics is marketed to compete with high-priced retail electricity. In the future, it is possible that utility-scale photovoltaic plants will compete with wholesale electricity generation, provided that further technological advances are achieved. Solar thermal power plants are intended to compete with wholesale generation, especially from peaking plants, and they may become more competitive over time if heat storage technologies improve, costs decrease, and/or policies to mitigate carbon dioxide emissions are adopted.

### Projected U.S. Average Installed Capital Costs for New Solar Electricity Generating Plants, 2011-2030




Source: Energy Information Administration, AEO2009 National Energy Modeling System, run AEO2009.D120908A.

### U.S. Solar Thermal and Solar Photovoltaic Installed Net Summer Generating Capacity, 1995-2030




Source: Energy Information Administration, AEO2009 National Energy Modeling System, run AEO2009.D120908A.

have government policies, including feed-in tariffs,[23] tax incentives, and market share quotas, that encourage the construction of renewable electricity facilities.

In the non-OECD countries, hydroelectric power is expected to be the predominant source of renewable energy growth. Strong growth in hydroelectric generation,

[23] A feed-in tariff is an incentive structure to encourage the adoption of renewable energy through government legislation. Under a feed-in tariff structure, regional or national electricity utilities are obligated to purchase renewable electricity at a higher rate than retail, guaranteeing the renewable generator a positive return on its investment and allowing renewable energy sources to overcome price disadvantages.

primarily from mid- to large-scale power plants, is expected in China, India, Brazil, and a number of nations in Southeast Asia, including Vietnam and Laos. Growth rates for wind-powered generation also are expected to be high in non-OECD countries. The most substantial additions of electricity supply generated from wind power may be centered in China.

The *IEO2009* projections for renewable energy sources include only marketed renewables. Non-marketed (non-commercial) biofuels from plant and animal resources are an important source of energy, however, particularly in the developing non-OECD economies. The International Energy Agency has estimated that approximately 2.5 billion people in developing countries depend on traditional biomass as their main cooking fuel [***4***]. Non-marketed fuels and distributed renewables (renewable energy consumed at the site of production, such as off-grid solar photovoltaic panels) are not included in the projections, however, because comprehensive data on their use are not available. Further, the full impacts of the current global economic downturn and credit crisis on the potential for growth of marketed renewable generation are not known. The reference case assumes that these issues may delay some projects in the short term but will not affect the long-term growth of electricity generation from renewable resources.

## Regional Outlook

In the *IEO2009* reference case, the highest projected growth rates for electricity generation are for the non-OECD nations, where strong economic growth and rising personal incomes drive the projected growth in demand for electric power. In the OECD countries—where electric power infrastructures are relatively mature, national populations generally are expected to grow slowly or decline, and GDP growth is expected to be slower than in the developing nations—demand for electricity is projected to grow much more slowly than in the non-OECD countries. In the reference case, non-OECD electricity generation increases by 3.5 percent per year, as compared with 1.2 percent per year in the OECD nations.

### OECD Economies

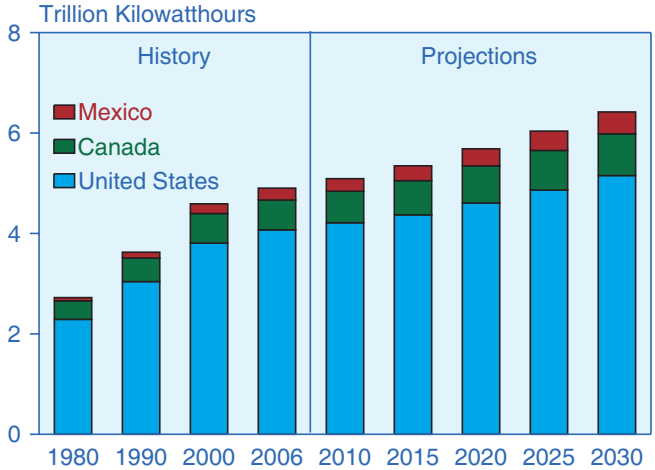
#### *North America*

North America currently accounts for the largest regional share of world electricity generation, at 27 percent of the total in 2006. That share declines over the course of the projection period, as the non-OECD nations experience fast-paced growth in demand for electric power. In 2030, North America accounts for only 20 percent of the world's electric power generation.

The United States is the largest consumer of electricity in North America and is projected to remain in that position through 2030 (Figure 53). U.S. electricity generation—including both generation by electric power producers and on-site generation—increases slowly, at an average annual rate of 1.0 percent.[24] Canada, like the United States, has a mature electricity market, and its generation is projected to increase by 1.4 percent per year from 2006 to 2030. Mexico's electricity generation grows at a faster rate—averaging 2.8 percent per year through 2030—reflecting the underdeveloped state of the country's electric power infrastructure (and thus the greater potential for expansion) relative to Canada and the United States.

There are large differences in the mix of energy sources used to generate electricity in the three countries that make up OECD North America, and those differences are likely to become more pronounced in the future (Figure 54). In the United States, coal is the leading source of energy for power generation, accounting for 49 percent of the 2006 total; but in Canada, hydroelectricity provided 59 percent of the nation's electricity generation in 2006. Most of Mexico's electricity generation currently is fueled by petroleum-based liquids and natural gas, which together accounted for 60 percent of its total electricity generation in 2006. In the reference case, U.S. reliance on coal decreases slightly, to 47 percent in

**Figure 53. Net Electricity Generation in OECD North America, 1980-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[24] Primarily as the result of slower macroeconomic growth, U.S. net electricity generation grows more slowly (averaging 0.9 percent per year) in the *updated AEO2009* reference case (April 2009) than in the *published AEO2009* reference case (March 2009) discussed in this report.

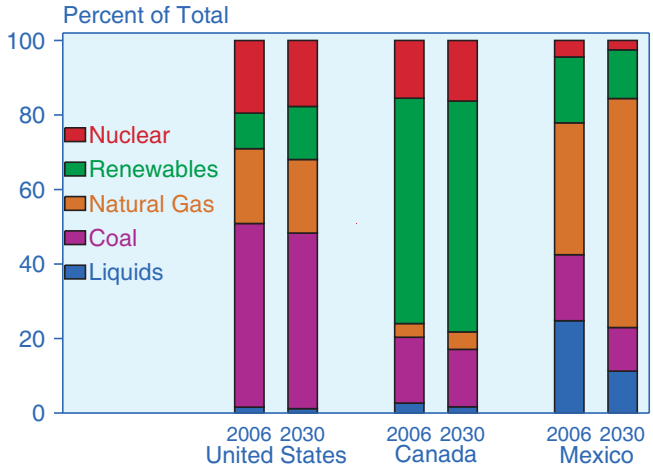
2030;[25] Canada's hydropower continues to be the predominant energy source for electricity generation, although its share of the total falls to 54 percent in 2030; and the natural gas share of Mexico's total electricity generation increases from 35 percent in 2006 to 62 percent in 2030.

Although coal remains the most important fuel for U.S. electricity generation, slower growth in the demand for electricity and increasing concern about greenhouse gas emissions affect the coal markets by slowing the growth in demand for coal-fired generation in this year's outlook relative to the *IEO2008* projection. Even though the mix of investments in new power plants relies less on coal than in recent outlooks, however, coal remains the dominant fuel for generation because of continued reliance on existing coal-fired plants and the addition of some new ones in the absence of an explicit policy to reduce greenhouse gas emissions.

In contrast to coal, natural gas plays a larger role in U.S. generation projections than in recent *IEO*s, because it is less carbon intensive than coal, and because it is much less expensive to build new natural-gas-fired plants than to build either new renewable or new nuclear plants. Electricity generation from natural gas in 2030 is 37 percent higher in the *IEO2009* reference case than was projected in the *IEO2008* reference case.[26] A key factor in the change is slower growth in coal use as a result of environmental concerns and the possible impacts of related future policies that would reduce the number of new coal-fired plants added.

Generation from renewable energy sources in the United States increases in response to requirements in more than one-half of the 50 States for minimum renewable generation or capacity shares. Renewable generation in the *IEO2009* reference case is substantially higher than in last year's projections, with the share of generation coming from renewable energy sources growing from 9.5 percent in 2006 to 14.2 percent in 2030.[27] Federal subsidies for renewable generation are assumed to expire as enacted; however, if those subsidies were extended, a much larger increase in renewable generation would be expected.

**Figure 54. Net Electricity Generation in OECD North America by Fuel, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

Electricity generation from nuclear power plants accounts for 18 percent of total U.S. generation in 2030 in the *IEO2009* reference case.[28] From 2006 to 2030, the United States is expected to add 12.7 gigawatts of capacity at newly built nuclear power plants and 3.7 gigawatts from uprates of existing plants—offset in part by the retirement of 4.4 gigawatts of capacity at older nuclear power plants. The increase in U.S. nuclear capacity is attributed to policies enacted to spur nuclear power growth, as well as concerns about greenhouse gas emissions, which limit additions of coal-fired plants in the projection.

In Canada, generation from natural gas is projected to increase by 2.5 percent per year from 2006 to 2030, while coal-fired generation increases by 0.8 percent per year, nuclear by 1.5 percent per year, hydroelectricity by 1.0 percent per year, wind by 13.1 percent per year, and other renewable energy sources by 3.5 percent per year. Oil-fired generation, on the other hand, declines by 0.6 percent per year.

[25] Primarily as the result of additional incentives for renewable fuels included in ARRA2009, U.S. coal-fired generation in 2030 is slightly lower in the *updated AEO2009* reference case (April 2009) than in the *published* reference case (March 2009). As a result, coal's share of total U.S. electricity generation in 2030 is slightly lower (at 46 percent) in the *updated* reference case.

[26] Primarily as a result of lower assumptions for macroeconomic growth in the *updated AEO2009* reference case (April 2009), U.S. natural-gas-fired generation in 2030 is about 4 percent lower than in the *published* reference case (March 2009).

[27] In the *updated AEO2009* reference case (April 2009), a significant expansion in the use of renewable fuels for U.S. electricity generation is projected, particularly in the near term. An extension of key Federal tax credits and a new loan guarantee program in ARRA2009 both stimulate increased renewable generation relative to the *published* reference case (March 2009). In 2030, U.S. renewable electricity generation is about 9 percent higher in the *updated* reference case and accounts for 15.8 percent of total U.S. net generation.

[28] Additional incentives for renewable energy and improved energy efficiency measures included in ARRA2009 lower the prospects for U.S. nuclear power. In the *updated AEO2009* reference case (April 2009), the projection for U.S. nuclear generating capacity in 2030 is 2.5 gigawatts lower than in the *published* reference case (March 2009), and the net addition to U.S. installed nuclear capacity between 2006 and 2030 is 9.9 gigawatts, bringing the 2030 total to 110.1 gigawatts in the *updated* reference case, as compared with 112.6 gigawatts in the *published* reference case. In both cases, nuclear generation accounts for 18 percent of total U.S. net generation in 2030.

In Ontario—Canada's largest provincial electricity consumer—the government maintains that it will close its four coal-fired plants (Atikokan, Lambton, Nonticoke, and Thunder Bay) by December 31, 2014, citing environmental and health concerns [*5*]. The government plans to replace coal-fired capacity with natural gas, nuclear, hydroelectricity, and wind, along with increased conservation measures. At present, coal provides about 16 percent of Ontario's electric power. In the *IEO2009* reference case, the retirement of Ontario's coal-fired facilities is offset by increases elsewhere in the country—notably, Alberta and Nova Scotia. As a result, Canada's coal-fired generation rises modestly, from about 106 billion kilowatthours in 2006 to 128 billion kilowatthours in 2030.

Hydroelectric power is, and is expected to remain, the primary source of electricity in Canada. In 2006, hydroelectric generation provided 59 percent of the country's total generation. While the hydropower share falls to 54 percent in 2030, wind's share grows from less than 1 percent in 2006 to 6 percent in 2030. As a result, the renewable share of Canada's overall generation remains roughly constant throughout the projection.

As one of the few OECD countries with untapped hydroelectric potential, Canada currently has several large- and small-scale hydroelectric facilities currently either planned or under construction. Hydro-Québec has announced plans to construct a 768-megawatt facility near Eastman and a smaller 125-megawatt facility at Sarcelle in Québec, both of which are expected to be fully commissioned by 2012 [*6*]. Other planned hydroelectric projects include the 2,260-megawatt Lower Churchill River project in Newfoundland and Labrador, the 1,550-megawatt Romaine River project in Québec, and the 200-megawatt Wuskwatim project in Manitoba [*7*]. The *IEO2009* reference case does not anticipate that all planned projects will be constructed, but given Canada's historical experience with hydropower and the commitments for construction, new hydroelectric capacity accounts for 15,610 megawatts of additional renewable capacity projected to be added in Canada between 2006 and 2030.

Canada also has plans to continue expanding its wind power capacity. From 2,246 megawatts of installed capacity at the beginning of 2009 [*8*], the total is projected to increase to nearly 24,000 megawatts in 2030 in the reference case. Almost 3,000 megawatts of wind capacity is currently under construction or under development in Quebec alone. Growth in wind capacity has been so rapid that Canada's federal wind incentive program, "ecoENERGY for Renewable Power," which allows the deployment of 4,000 megawatts of renewable energy by 2011, will use the remainder of its funding by the end of 2009 [*9*].

In addition to the incentive programs of Canada's federal government, several provincial governments have instituted their own incentives to support the construction of new wind capacity. Ontario's Renewable Energy Standard Offer Program has helped support robust growth in wind installations over the past several years, and installed wind capacity in the province has risen from 0.6 megawatts in 1995 to more than 780 megawatts in January 2009 [*10*]. The Standard Offer Program pays all small renewable energy generators (with installed capacity less than 10 megawatts) 11.0 cents (Canadian) per kilowatthour of electricity delivered to local electricity distributors [*11*] and 42.0 cents per kilowatthour for electricity from solar photovoltaic projects. Contracts between Ontario Power Authority and the small renewable generators last for a term of 20 years, and beginning in 2007 a portion of the rate paid to generators was to be indexed annually for inflation. Continued support from Canada's federal and provincial governments—along with the sustained higher world oil prices in the *IEO2009* reference case—is expected to provide momentum for the projected increase in the country's use of wind power for electricity generation.

Mexico's electricity generation increases by an average of 2.8 percent annually from 2006 to 2030—double the rate for Canada and triple the rate for the United States. The Mexican government has recognized the need for the country's electricity infrastructure to keep pace with the fast-paced growth anticipated for electricity demand. In July 2007, the government unveiled its 2007-2012 National Infrastructure Programme, which included plans to invest $25.3 billion to improve and expand electricity infrastructure [*12*]. As part of the program, the government has set a goal to increase installed generating capacity by 8.6 gigawatts from 2006 to 2012. The country is well on its way to meeting the government target. The 1,135-megawatt Tamazunchale combined-cycle plant became operational in June 2007 (and there are plans to expand the generating capacity to 5,000 megawatts eventually), and several other plants under construction will bring on line another 840 megawatts in 2009, 650 megawatts in 2010, and 750 megawatts in 2012 [*13*].

Most of the projected increase in Mexico's electricity generation in the *IEO2009* reference case is fueled by natural gas, as the Mexican government implements plans to reduce the country's use of diesel and fuel oil in the power sector [*14*]. Natural-gas-fired generation is more than triples in the projection, from 80 billion kilowatthours in 2006 to 268 billion kilowatthours in 2030. The resulting growth in Mexico's demand for natural gas strongly outpaces its growth in production, leaving the country dependent on pipeline imports from the United States and LNG from other countries. Currently, Mexico has one LNG import terminal, Altimira,

operating on the Gulf Coast and another, Costa Azul, on the Pacific Coast. A contract tender for a third terminal at Manzanillo, also on the Pacific Coast, was awarded in March 2008, and the project is scheduled for completion by 2011 [***15***]. New coal-fired plants also are planned, to help diversify the fuel mix for power generation. The 651-megawatt Pacifico coal-fired plant currently is under construction, with a scheduled completion date of 2010 [***16***].

Although much of the growth in Mexico's electric power sector is expected to be in the form of natural-gas-fired generation, renewable energy resources are expected to be the second fastest-growing source of generation in the projection. Mexico's renewable generation increases by 1.5 percent per year from 2006 to 2030, compared with a 5.2 percent per year for natural-gas-fired generation. The country's current renewable generation energy mix is split largely between hydroelectricity (76 percent) and geothermal energy (17 percent). Two major hydroelectric projects are under way: the 750-megawatt La Yesca facility, which is scheduled for completion by 2012, and the planned 900-megawatt La Parota project, which is expected to be completed by 2015 [***17***].

Mexico also plans to add substantial wind generation to its power resource mix. During 2006 alone, the country's installed wind capacity increased from 2.2 megawatts to 86.5 megawatts [***18***]. Although no additional wind capacity was installed in Mexico in 2008, there are ambitious plans to add another 700 megawatts of wind capacity by 2010, including 400 megawatts planned by independent power producers and a 100-megawatt expansion of the existing 83-megawatt La Venta wind farm [***19***].

### *OECD Europe*

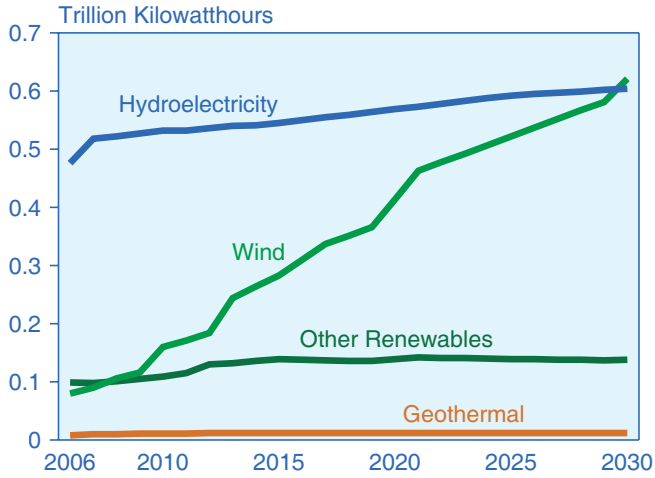
Electricity generation in the nations of OECD Europe increases by an average of 1.3 percent per year in the *IEO2009* reference case, from 3.4 trillion kilowatthours in 2006 to 4.0 trillion kilowatthours in 2015 and 4.6 trillion kilowatthours in 2030. Because most of the countries in OECD Europe have relatively stable populations and mature electricity markets, most growth in electricity demand is expected to come from those nations with more robust population growth (including Turkey, Ireland, and Spain) and from the newest OECD members (including the Czech Republic, Hungary, and Poland), whose economic growth rates exceed the OECD average through the projection period. In addition, as environmental concerns remain prominent in the region, there is a concerted effort to switch from coal and liquids use to electricity in the industrial sector.

Renewable energy is OECD Europe's fastest-growing source of electricity generation in the *IEO2009* reference case. The use of renewables for electricity generation is projected to grow by 3.1 percent per year through 2030, and the increase is almost entirely from nonhydropower sources. Because most of the economically feasible hydroelectric resources in Europe already have been developed, the countries of OECD Europe have switched their focus to alternative renewable energy capacity—consisting mainly of wind turbines—over the past decade. At present, seven of the world's ten largest markets for wind-powered electricity generation are in Europe,[29] and the 27-member European Union accounted for 54 percent of the world's total installed wind capacity at the end of 2008 [***20***].

OECD Europe's leading position worldwide in wind power capacity is projected to be maintained through 2030, with growth in generation from wind sources averaging 8.9 percent per year, even though the reference case assumes no enactment of additional international legislation to limit greenhouse gas emissions during the period. The robust growth in wind power, coupled with a mature hydropower sector, causes electricity generation from wind power to surpass hydroelectric generation by the end of the projection period (Figure 55). A lack of additional land for installation of new wind turbines will force many European countries either to "repower" their existing fleets by replacing old turbines with larger, more effective (higher capacity rated) ones or to build significant portions of future capacity offshore, especially in the North Sea and Baltic Sea.

The growth of nonhydropower renewable energy sources in OECD Europe is encouraged by some of the

**Figure 55. Renewable Electricity Generation in OECD Europe by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[29] According to the Global Wind Energy Council, at the end of 2008 the 10 countries with the largest amounts of installed wind capacity were the United States, Germany, Spain, China, India, Italy, France, the United Kingdom, Denmark, and Portugal.

world's most favorable renewable energy policies. The European Union has set a binding target to produce 21 percent of electricity generation from renewable sources by 2010 [*21*] and has reaffirmed the goal of increasing renewable energy use with its December 2008 "climate and energy policy," which mandates that 20 percent of total energy production must come from renewables by 2020 [*22*]. Approximately 19 percent of the European Union's electricity came from renewable sources in 2006.

The *IEO2009* reference case does not anticipate that all the renewable energy targets in the European Union will be met on time, especially because of the uncertain impact of the current economic and fiscal conditions on the financing of electricity projects and the adherence to stated goals. Nevertheless, current laws are expected to lead to the construction of more renewable capacity than would have occurred in their absence. In addition, some individual countries provide economic incentives to promote the expansion of renewable electricity. Germany, Spain, and Denmark—the leaders in OECD Europe's installed wind capacity—have enacted feed-in tariffs that guarantee above-market rates for electricity generated from renewable sources and, typically, last for 20 years from the completion of a power plant. As long as European governments support such price premiums for renewable electricity, robust growth in renewable generation is likely to continue.

Natural gas is the second fastest-growing source of power generation after renewables in the outlook for OECD Europe, increasing at an average rate of 2.3 percent per year from 2006 to 2030. Although the growth still is quite strong considering that total electricity demand increases by only 1.3 percent per year, it is somewhat slower than the 3.9-percent annual increase projected for natural-gas-fired generation in last year's outlook. The difference results in part from the more robust growth projected for the region's renewable generation and in part from concerns about the security of power supplies. Russia is Europe's major natural gas supplier, and in 2009, for the second time since 2006, it cut off deliveries of natural gas through Ukraine in a dispute with that country over pricing. Although natural gas storage and LNG supplies were sufficient to prevent OECD Europe from being physically affected by the cutoff, the event did underscore Europe's dependence on Russian supplies, particularly as domestic regional production continues to decline. Nearly 65 percent of Russia's exported natural gas is delivered through Ukraine, which is substantially lower than in 1998 (95 percent) but still much higher than Russia's 2015 goal of 40 percent [*23*].

Nuclear power has gained renewed interest in Europe as concerns about greenhouse gas emissions and secure electricity supplies have increased. Although OECD Europe's total nuclear capacity declines from 132 gigawatts in 2006 to 119 gigawatts in 2020 in the reference case, that decrease is followed by a net increase to 121 gigawatts in 2030. Belgium and Germany, with substantial nuclear programs, have policies in effect to reduce their use of nuclear power in the future; however, it is unclear whether their planned closures of nuclear power plants actually will take place, given that nuclear plants provide baseload capacity while producing no carbon dioxide emissions. Further, many European nations previously staunchly against nuclear power have been revisiting their stances. Sweden's government, for instance, announced in February 2009 that it would move to halt its plan to phase out nuclear power by 2010 and reverse its 30-year ban on building new nuclear capacity [*24*]. Italy has also announced its intention to diversify its electric power fuel mix by building nuclear power plants [*25*].

Renewed interest and moves to reverse legislative bans on nuclear power have led to more license extensions and fewer retirements of operating nuclear power plants than were expected in assessments in previous outlooks. In addition, the *IEO2009* reference anticipates some new builds (about 18 gigawatts of new nuclear capacity) in France, Finland, and possibly other countries of OECD Europe. On the other hand, the significant investments being made in renewable energy sources may lessen the opportunities for new nuclear capacity.

Coal accounted for nearly 30 percent of OECD Europe's net electricity generation in 2006, but concerns about carbon dioxide emissions and global warming could reduce that share in the future. On the other hand, in countries that rely heavily on coal for their electricity supplies, it may be difficult to reduce coal use substantially and at the same time carry out plans to dismantle nuclear power programs, in spite of the strong growth projected for renewable generation. In particular, coal provides about 55 percent of total electricity generation in Germany and 95 percent in Poland [*26*]. In the *IEO2009* reference case, electricity from coal remains an important part of supply in OECD Europe, increasing at a relatively slow average rate of 0.1 percent per year from 2006 to 2030.

### OECD Asia

Total electricity generation in OECD Asia increases by an average of 1.2 percent per year in the reference case, from 1.7 trillion kilowatthours in 2006 to 2.2 trillion kilowatthours in 2030. Japan accounts for the largest share of electricity generation in the region today and continues to do so in the mid-term projection, despite having the slowest-growing electricity market in the region and the slowest among all the OECD countries, averaging 0.6-percent per year, as compared with 1.5 percent per year for Australia/New Zealand and 2.3

percent per year for South Korea (Figure 56). Japan's electricity markets are well established, and its aging population and relatively slow projected economic growth in the mid-term translate into slow growth in demand for electric power. In contrast, both Australia/New Zealand and South Korea are expected to have more robust income and population growth, leading to more rapid growth in demand for electricity.

The fuel mix for electricity generation varies widely among the three economies that make up the OECD Asia region. In Japan, natural gas, coal, and nuclear power make up the bulk of the current electric power mix, with natural gas and nuclear accounting for about 53 percent of total generation and coal another 28 percent. The remaining portion is split between renewables and petroleum-based liquids. Japan's reliance on nuclear power and natural gas is projected to increase somewhat over the projection period, to 60 percent of total generation in 2030. Coal's share of generation declines to 22 percent, being displaced by natural gas, nuclear, and—to a much smaller extent—renewable energy sources.

As is true for much of the OECD, wind power is expected to be Japan's fastest-growing source of renewable energy, increasing by 7.4 percent per year in the *IEO2009* reference case. Although wind power development is expected to continue, it has encountered difficulties because of limited government policy support and weather-related technological problems. Japan's current target for electricity from nonhydroelectric renewable sources is 1.63 percent by 2014, a relatively modest goal that is unlikely to encourage as much growth in Japan as in countries with more aggressive policies [**27**]. Inclement weather also has had a negative impact on wind development in Japan, with typhoons and lightning strikes damaging wind turbines and driving up the cost of wind farms in the country. Despite its current strategy of investing in research to develop J-Class wind turbines that can better withstand adverse weather conditions [**28**], wind remains a modest source of electric power for Japan in the *IEO2009* reference case, accounting for less than 1 percent of total electricity generation in 2030, as compared with hydropower's 8-percent share of the total in 2030.

Australia and New Zealand, as a region, rely on coal for about 70 percent of electricity generation, based largely on Australia's rich coal resource base (9 percent of the world's total coal reserves). The remaining regional generation is supplied by natural gas and renewable energy sources—mostly hydropower, wind, and, in New Zealand, geothermal. The Australia/New Zealand region uses negligible amounts of oil for electricity generation and no nuclear power, and that is not expected to change over the projection period. Natural-gas-fired generation is expected to grow strongly in the region, at 2.9 percent per year from 2006 to 2030, reducing the coal share to 58 percent at the end of the projection.

In South Korea, coal and nuclear power currently provide 41 percent and 38 percent of total electricity generation, respectively. Natural-gas-fired generation grows quickly in the reference case projection, but despite a doubling of electricity generation from natural gas, its share of total generation increases only from 16 percent in 2006 to 19 percent in 2030. Coal and nuclear power continue to provide most of the South Korea's electricity generation, with a combined 77 percent of total electricity in 2030.

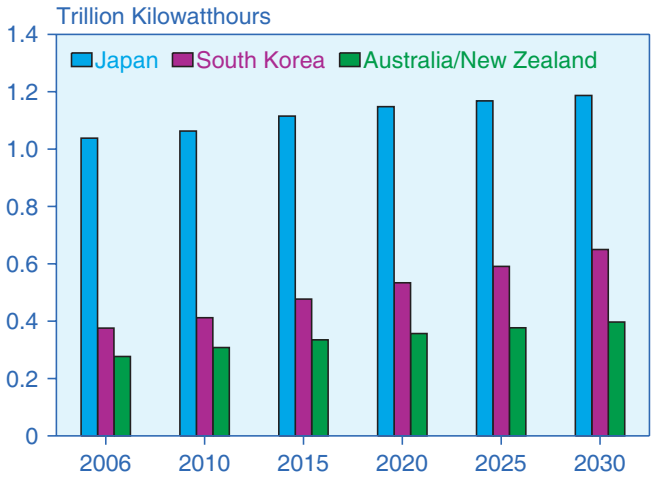
## Non-OECD Economies

### *Non-OECD Europe and Eurasia*

Total electricity generation in non-OECD Europe and Eurasia grows at an average rate of 2.0 percent per year in the *IEO2009* reference case, from 1.5 trillion kilowatthours in 2006 to 2.0 trillion kilowatthours in 2015 and 2.4 trillion kilowatthours in 2030. Russia, with the largest economy in non-OECD Europe and Eurasia, accounted for around 60 percent of the region's total generation in 2006 and is expected to retain approximately that share throughout the projection (Figure 57).

Natural gas and nuclear power are expected to supply much of the growth in electricity generation in the region. As a whole, non-OECD Europe and Eurasia has ample resources of natural gas, equal to nearly one-third of the world's total proved natural gas reserves. As a result, natural-gas-fired generation grows robustly in the outlook, by an average annual rate of 2.7 percent from 2006 to 2030.

**Figure 56. Net Electricity Generation in OECD Asia, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

Generation from nuclear power also grows strongly in the region, averaging 2.8 percent per year. Much of the increase is expected in Russia. In 2006, the Russian government released Resolution 605, which set a federal target program for nuclear power development. The section of the resolution titled "Development of the Nuclear Industry in Russia 2007-2010 and -2015" states that 10 nuclear power reactors are to be completed by 2015: Volgodonsk 2, 3, and 4; Kalinin 4; Novoronezh 2-1 and 2-2; Leningrad 2-1, 2-2, and 2-3; and Beloyarsky 4 [*29*]. In addition, a total of 40 reactors are supposed to be constructed by 2030, raising Russia's nuclear generating capacity by 2 gigawatts per year from 2012 to 2014 and by 3 gigawatts per year from 2014 to 2020, bringing the total to 40 gigawatts [*30*] and increasing the nuclear share of total generation to 23 percent by 2020 [*31*]. The *IEO2009* reference case takes a more conservative view of the rate at which new nuclear power plants will come on line in Russia, and the outlook includes some delay in meeting the current construction schedule. A net total of 5 gigawatts of nuclear generating capacity is added to Russia's existing 23 gigawatts by 2015 and another 16 gigawatts by 2030.

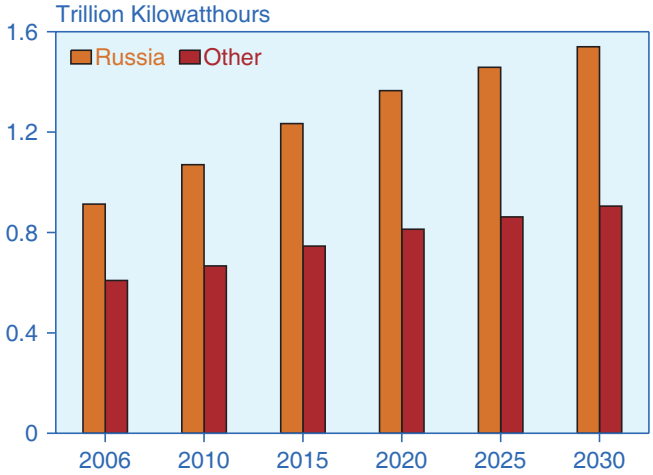
Renewable generation in non-OECD Europe and Eurasia, almost entirely from hydropower facilities, increases relatively slowly, by an average of 0.7 percent per year, largely as a result of repairs and expansions at existing sites. Notable exceptions include the 3,000-megawatt Boguchan Dam in Russia and the 3,600-megawatt Rogun Dam in Tajikistan [*32*]. Construction began on Boguchan in 1980 and on Rogun in 1976, but work ceased when the former Soviet Union experienced economic difficulties in the 1980s. Construction has recently been restarted on the Boguchan Dam, which is expected to be completed by 2012. Work on the Rogun Dam has been suspended but should begin again in the near term. Growth of nonhydropower renewable generation is projected to be negligible.

### *Non-OECD Asia*

Non-OECD Asia—led by China and India—has the fastest projected regional growth in electric power generation worldwide, averaging 4.4 percent per year from 2006 to 2030 in the reference case. Although the global economic recession has an impact on the region's near-term economic growth, in the long term the economies of non-OECD Asia are expected to expand strongly, with corresponding increases in demand for electricity in both the building and industrial sectors. Total electricity generation in non-OECD Asia rises by nearly two-thirds between 2006 and 2015, from 4.4 trillion kilowatthours to 7.3 trillion kilowatthours. After 2015 the growth in electricity demand moderates as infrastructure matures and patterns of energy use in the regional economies begin to resemble those in the more established OECD nations. Still, electricity demand increases by 46 percent between 2015 and 2025, and by another 17 percent between 2025 and 2030. In 2030, net generation in non-OECD Asia totals 12.4 trillion kilowatthours in the reference case.

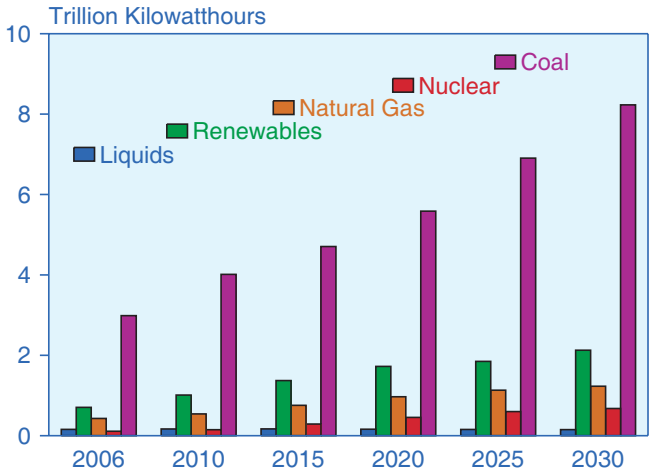
Coal accounts for two-thirds of the electricity generation in non-OECD Asia (Figure 58), dominated by generation in China and India. Both countries already rely heavily on coal to produce electric power. In 2006, coal's share of generation was an estimated 79 percent in China and 71 percent in India. Efforts to diversify the fuel mix away from coal are expected to meet with limited success, and it is likely that coal will remain the dominant source of

**Figure 57. Net Electricity Generation in Non-OECD Europe and Eurasia, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 58. Net Electricity Generation in Non-OECD Asia by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

power generation in both countries. In the *IEO2009* reference case, the coal share of electricity generation declines to 56 percent in India and 75 percent in China in 2030.

Throughout non-OECD Asia, consumption of liquids and other petroleum for electricity generation is projected to decline, as relatively high world oil prices make other fuels more attractive economically. Although the liquids share of electricity generation in non-OECD Asia falls from 4 percent in 2006 to about 1 percent in 2030, some oil-fired generation is expected to continue to be needed. Many rural areas currently do not have access to transmission lines, and until transmission infrastructure can be put in place, noncommercial energy sources are expected to be replaced with electricity from diesel-fired generators.

Non-OECD Asia leads the world in installing new nuclear capacity in the *IEO2009* reference case, accounting for 54 percent of the projected net increment in nuclear capacity worldwide (or 72 gigawatts of the total 132-gigawatt increase). China, in particular, has expansive plans for nuclear power, with a net 47 gigawatts of additional capacity projected to be installed by 2030. Currently, 11 nuclear power plants are under construction in China, including 6 for which construction was started in 2008 [***33***]. With generation from coal, natural gas, and renewable energy sources also expected to continue increasing rapidly, however, the nuclear share of total generation in China increases only from 2 percent in 2006 to 5 percent in 2030.

India also has plans to boost its nuclear power generation. From 3 gigawatts of installed nuclear power capacity in operation today, India has set an ambitious goal of increasing its nuclear generating capacity to 20 gigawatts by 2020 and 40 gigawatts by 2030 [***34***]. Six nuclear generating stations are under construction now, four of which are scheduled for completion by the end of 2009. There is considerable optimism for the future development of India's nuclear program, in part because of the "123 Agreement" signed by the United States and India in October 2008.[30] The agreement allows India—despite the fact it has not joined the Nuclear Non-Proliferation Treaty—to import nuclear materials, nuclear technology, and fuel [***35***]. The projected increase in nuclear capacity in the *IEO2009* reference case is somewhat slower than anticipated by India's government, with 17 gigawatts of net installed capacity becoming operational by 2030.

In addition to China and India, several other countries in non-OECD Asia are expected to begin or expand nuclear power programs. In the reference case, new nuclear power capacity is installed in Vietnam, Indonesia, and Pakistan by 2030. The impact of high fossil fuel prices, combined with concerns about security of energy supplies, leads many nations in the region to consider diversifying the fuel mix for their power generation by adding a nuclear component.

Electricity generation from renewable energy sources in non-OECD Asia is projected to grow at an average annual rate of 4.7 percent, increasing the renewable share of the region's total generation from 16 percent in 2006 to 17 percent in 2030. Mid- to large-scale hydroelectric facilities provide much of the increment. Several countries have hydropower facilities either planned or under construction, including Vietnam, Malaysia, Pakistan, and Myanmar (the former Burma). Almost 50 hydropower facilities, with a combined 3,398 megawatts of capacity, are under construction in Vietnam's Son La province, including the 2,400-megawatt Son La and 520-megawatt Houi Quang projects, both of which are scheduled for completion before 2015 [***36***]. Malaysia expects to complete its 2,400-megawatt Bakun Dam by 2011, although the project has experienced a number of delays and setbacks in the past [***37***]. Pakistan and Myanmar also have substantial hydropower development plans, but those plans have been discounted in the *IEO2009* reference case to reflect the two countries' historical difficulties in acquiring foreign direct investment for infrastructure projects.

India has plans to more than double its installed hydropower capacity by 2030. In its Eleventh and Twelfth Five-Year Plans, which span 2007 through 2017, India's Central Electricity Authority has identified 40,943 megawatts of hydroelectric capacity that it intends to build. Although the *IEO2009* reference case does not assume that all the planned capacity will be completed, more than one-third of the announced projects are under construction already and are expected to be completed by 2020 [***38***].

India's federal government is attempting to incentivize the development of hydropower across the nation. Legislation has been proposed to allow private hydroelectric power developers to be eligible over a 5-year period for a tariff that would guarantee a fixed return on investment and allow generators to improve their returns by selling up to 40 percent of their electricity on the spot market. In addition, India's federal hydropower intentions are being supported by state authorities. The state government in Himachal Pradesh has plans to commercialize a substantial portion of the state's reported 21,000 megawatts of hydroelectric power potential, adding 5,744 megawatts of hydroelectric capacity before 2015, which would nearly double the existing capacity [***39***]. Also, the 2,000-megawatt lower Subansiri facility under construction in Arunachal Pradesh is expected to be completed by 2012 [***40***].

[30] The United States has negotiated 123 agreements with several countries. The agreements are part of the U.S. Atomic Energy Act of 1954, which promotes the peaceful pursuit of nuclear power among nations.

Similar to India, China also has a number of large-scale hydroelectric projects under construction. The 18,200-megawatt Three Gorges Dam project's final generator went on line in October 2008, and the Three Gorges Project Development Corporation plans to further increase the project's total installed capacity to 22,400 megawatts by 2012 [***41***]. In addition, work continues on the 12,600-megawatt Xiluodu project on the Jisha River (scheduled for completion in 2020 as part of a 14-facility hydropower development plan). The country's third-largest hydroelectric facility, the 6,300-megawatt Longtan project on the Hongshui River, is scheduled for completion before the end of 2009 [***42***]. China also has the world's tallest dam (at nearly 985 feet) currently under construction, as part of the 3,600-megawatt Jinping I project on the Yalong River, which is scheduled for completion in 2014 as part of a plan by the Ertan Hydropower Development Company to construct 21 facilities with 34,620 megawatts of hydroelectric capacity on the Yalong [***43***].

The China Power Investment Corporation began construction on the first of a proposed 13-dam hydroelectric power system on the Yellow River in 2007, with plans for an ultimate total installed capacity of 8,000 megawatts. The first part of the system, the 360-megawatt Banduo project, is scheduled to become operational by 2011 [***44***]. The Chinese government has set a 300-gigawatt target for hydroelectric capacity in 2020. Including those mentioned above, the country has a sufficient number of projects under construction or in development to meet the target. China's aggressive hydropower development plan is expected to increase hydroelectricity generation by 4.0 percent per year, more than doubling the country's total hydroelectricity generation by 2030.

Although hydroelectric projects dominate the renewable energy mix in non-OECD Asia, generation from nonhydroelectric renewable energy sources, especially wind, also is expected to grow significantly. At the end of 2008, China completed installation of its 10,000th megawatt of wind capacity, achieving its 2010 target a full year ahead of the schedule set out by the National Development and Reform Commission [***45***]. The Chinese government has established a 30,000-megawatt target for installed wind capacity by 2020; however, at the current installation rate of at least 3,000 megawatts of wind capacity a year, China is projected to have 40,000 megawatts of wind capacity installed by 2020. The *IEO2009* reference case anticipates that electricity from wind plants in China will grow by 23.2 percent per year, from 2 billion kilowatthours in 2006 to 315 billion kilowatthours in 2030.

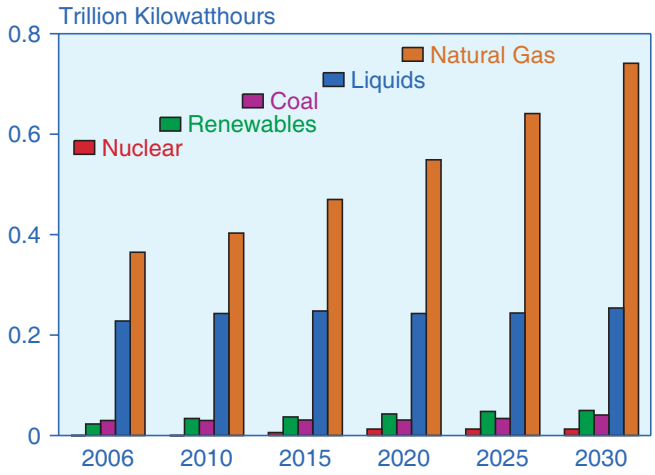
Geothermal energy, while a small contributor to non-OECD Asia's total electricity generation, plays an important role in the Philippines and Indonesia. With the second-largest amount of installed geothermal capacity in the world, the Philippines generated more than 17 percent of its total electricity from geothermal sources in 2007 [***46***]. Indonesia, with the fifth-largest installed geothermal capacity, generated just over 5 percent of its electricity from geothermal energy in 2005, the last year for which reliable data are available [***47***]. Although the Indonesian geothermal industry suffered setbacks from the country's 1997 financial crisis, there is strong potential for future geothermal development, with more than 20 gigawatts of geothermal potential available [***48***]. Both the Philippines and Indonesia have announced plans to increase their installed geothermal capacities in the coming years.

### *Middle East*

Electricity generation in the Middle East region grows by 2.2 percent per year in the reference case, from 0.6 trillion kilowatthours in 2006 to 1.1 trillion kilowatthours in 2030. The region's young and rapidly growing population and an expected strong increase in national income are expected to result in rapid growth in demand for electric power. Iran, Saudi Arabia, and the United Arab Emirates (UAE) account for two-thirds of the regional demand for electricity, and demand has increased sharply over the past several years in each of the countries. From 2000 to 2006, Iran's net generation increased by an average of 9.1 percent per year; Saudi Arabia's by 6.1 percent per year; and the UAE's by 8.9 percent per year.

The Middle East depends on natural gas and petroleum liquids to generate most of its electricity and is projected to continue that reliance through 2030 (Figure 59). In

**Figure 59. Net Electricity Generation in the Middle East by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

2006, natural gas supplied 56 percent of electricity generation in the Middle East and liquids 35 percent. In 2030, the natural gas share is projected to be 67 percent and the liquids share 23 percent. There has been a concerted effort by many of the petroleum exporters in the region to develop their natural gas resources for use in domestic power generation. Petroleum is a valuable export commodity for many nations in the Middle East, and there is increasing interest in the use of domestic natural gas for electricity generation in order to make more oil assets available for export.

Given the collapse of world oil prices at the end of 2008, oil-fired generation in the Middle East is likely to increase in the short-run, particularly in major oil-exporting nations that rely on associated natural gas production to fulfill growing demand for natural gas in the power sector. In Saudi Arabia, for instance, associated natural gas from oil production accounts for 60 percent of total natural gas supply [***49***]. As Saudi oil production has been reduced both as a reaction to the lowered worldwide demand for liquids and in an attempt to stabilize oil prices, the associated natural gas production has slowed as well. Until world oil prices and demand recover from current lows and production of both oil and natural gas begins to rise, petroleum is likely to continue being used to supplement natural gas in the power sector. In the *IEO2009* reference case, liquids-fired generation in the Middle East grows from 228 billion kilowatthours in 2006 to 248 billion kilowatthours in 2015 and 254 billion kilowatthours in 2030.

Other energy sources make only minor contributions to electricity supply in the Middle East. Israel is the only country in the region that uses significant amounts of coal to generate electric power [***50***], and Iran, with the completion of its Bushehr 1 reactor expected in 2011, is the only one projected to add nuclear capacity. Other Middle Eastern countries recently have expressed some interest in increasing both coal-fired and nuclear generation, however, in response to concerns about diversifying the electricity fuel mix and meeting the region's fast-paced growth in electricity demand. For example, Oman announced in 2008 that it would construct the Persian Gulf's first coal-fired power plant at Duqm [***51***]. Although details have not been released, it is expected that the plant—if constructed—would have a capacity between 1,000 and 2,000 megawatts and could be completed as early as 2012. The UAE, Saudi Arabia, and Bahrain also have considered adding coal-fired capacity [***52***].

In addition to Iran, several other Middle Eastern nations have announced intentions to pursue nuclear power programs in recent years. In 2007, the six-nation Gulf Cooperation Council[31] completed a feasibility study, in cooperation with the International Atomic Energy Association, of the potential for a regional nuclear power and desalinization program, while also announcing their intention to pursue a peaceful nuclear program [***53***]. The UAE government in 2008 announced plans to have three 1,500-megawatt nuclear power plants completed by 2020 and has since signed nuclear cooperative agreements with France, Japan, the United Kingdom, and the United States [***54***]. Jordan also has announced its intention to add nuclear capacity [***55***], and in 2009 the Kuwaiti cabinet announced that it would form a national committee on nuclear energy use for peaceful purposes [***56***]. Even given the considerable interest in nuclear power that has arisen in the region, however, *IEO2009* expects that economic and political issues, in concert with the long lead times usually associated with beginning a nuclear program, will mean that beyond Iran's Bushehr 1 reactor, only the UAE will add one additional nuclear power plant in the Middle East over the course of the projection.

Although there is little incentive for countries in the Middle East to increase their use of renewable energy sources (the renewable share of the region's total electricity generation increases only from 4 percent in 2006 to 5 percent in 2030 in the reference case), there have been some recent developments in renewable energy use in the region. Iran, which generated 9 percent of its electricity from hydropower in 2006, is developing 94 new hydroelectric power plants, 5 of which are expected to come on line before March 2010 [***57***]. Construction also continues on Masdar City in Abu Dhabi, a "zero carbon" city that will be powered by 190 megawatts of solar photovoltaic cells and 20 megawatts of wind power [***58***]. The first phase of construction is expected to be completed by the end of 2009.

### *Africa*

Demand for electricity in Africa grows at an average annual rate of 2.6 percent in the *IEO2009* reference case. Fossil-fuel-fired generation supplied 81 percent of the region's total electricity in 2006, and reliance on fossil fuels is expected to continue through 2030. Coal-fired power plants, which were the region's largest source of electricity in 2006, accounting for 46 percent of total generation, are projected to provide a 37-percent share in 2030, and natural-gas-fired generation is projected to expand strongly, from 25 percent of the total in 2006 to 39 percent in 2030 (Figure 60).

At present, South Africa's two nuclear reactors are the only ones operating in the region, accounting for about 2 percent of Africa's total electricity generation. Reports suggest that construction of a new Pebble Bed Modular Reactor could begin in South Africa in 2010, with an anticipated completion date of 2014; however, the

[31] Gulf Cooperation Council members are Saudi Arabia, Kuwait, Bahrain, the United Arab Emirates, Qatar, and Oman.

project has had various setbacks since it was originally initiated in 1993, and it is uncertain whether the current schedule will be met [***59***]. In addition, Egypt's government has moved forward with its plans to construct a nuclear power project, signing a nuclear power cooperation agreement with Russia in 2008 and awarding a contract to U.S.-based Bechtel to design the new power plant, tentatively to be located at Dabaa, about 100 miles west of Alexandria [***60***]. In the reference case, 1,100 megawatts of net nuclear capacity is projected to become operational in Africa over the 2006-2030 period, and the nuclear share of the region's total generation remains at 2 percent through the end of the period.

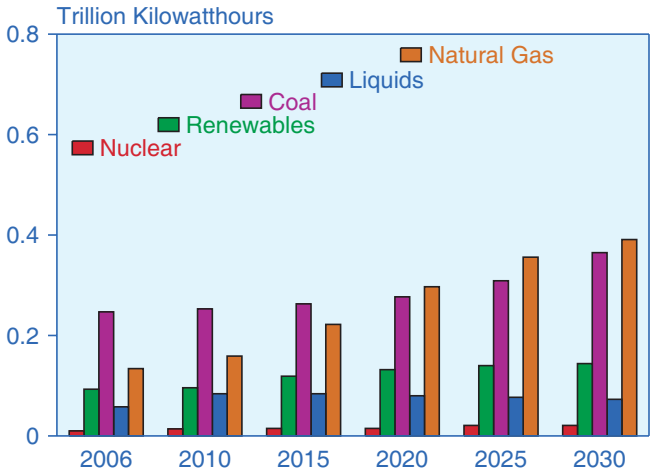
Generation from hydropower and other marketed renewable energy sources is expected to grow slowly in Africa. As they have in the past, nonmarketed renewables are expected to continue providing energy to Africa's rural areas; however, it is often difficult for African nations to find funding or international support for larger commercial projects. Plans for several hydroelectric projects in the region have been advanced recently, however, and they may help boost supplies of marketed renewable energy in the mid-term. Several (although not all) of the announced projects are expected to be completed by 2030, allowing the region's consumption of marketed renewable energy to grow by 1.8 percent per year from 2006 to 2030. For example, Ethiopia is finishing work on three hydroelectric facilities: the 300-megawatt Takeze power station, the 460-megawatt Anabeles, and the 420-megawatt Gilgel Gibe II, all of which are scheduled for completion at the end of 2009 [***61***].

### *Central and South America*

Electricity generation in Central and South America increases by 2.2 percent per year in the *IEO2009* reference case, from 0.9 trillion kilowatthours in 2006 to 1.2 trillion kilowatthours in 2015 and 1.6 trillion kilowatthours in 2030. The present global economic crisis is affecting the region's economies and thus their electricity markets, lowering demand for electricity, especially in the industrial sector. In the longer term, however, the region's electricity markets are expected to return to trend growth as the economic difficulties recede.

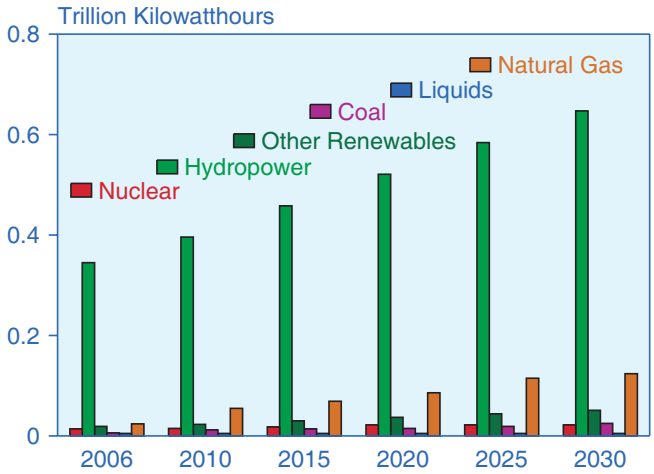
The fuel mix for electricity generation in Central and South America is dominated by hydroelectric power, which accounted for two-thirds of the region's total net electricity generation in 2006. Of the top seven electricity generating countries in the region, six generate more than 55 percent of their total electricity from hydropower—Brazil, Venezuela, Paraguay, Colombia, Chile, and Peru.[32] In Brazil, the region's largest economy, hydropower provided almost 84 percent of electricity generation in 2006 (Figure 61). The country has been trying to diversify its electricity supply fuel mix away from hydroelectric power because of the risk of power shortages during times of severe drought. In the Brazilian National Energy Plan for 2008-2017, the government has set a goal to reduce reliance on hydropower to 78 percent [***62***]. To achieve that target, the government has announced plans to increase nuclear power capacity, beginning with the completion of the long-idled 1,000-megawatt Angra-3 project [***63***]. Construction is set to begin in April 2009, and the reactor is scheduled to begin coming on line in 2014. Brazil also has plans to

**Figure 60. Net Electricity Generation in Africa by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 61. Net Electricity Generation in Brazil by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[32] Argentina is the region's second-largest electricity generator but derives only about one-third of its electricity from hydropower.

construct four additional 1,000-megawatt nuclear plants beginning in 2015. In the *IEO2009* reference case, only the Anagra-3 project is projected to be completed by 2015, and none of the other planned nuclear projects in Brazil is expected to be completed before 2030.

In the past, the Brazilian government has tried relatively unsuccessfully to attract substantial investment in natural-gas-fired power plants, mostly because of the higher costs of natural-gas-fired generation relative to hydroelectric power and because of concerns about the security of natural gas supplies. Brazil has relied on imported Bolivian natural gas for much of its supply, but concerns about the impact of Bolivia's nationalization of its energy sector on foreign investment in the country's natural gas production has led Brazil to look toward LNG imports for secure supplies. Brazil has invested strongly in its LNG infrastructure, and its third LNG regasification plant is scheduled for completion in 2013 [***64***]. With Brazil diversifying its natural gas supplies, substantially increasing domestic production, and resolving to reduce the hydroelectric share of generation, natural gas is projected to be its fastest-growing source of electricity, increasing by 7.1 percent per year on average from 2006 to 2030.

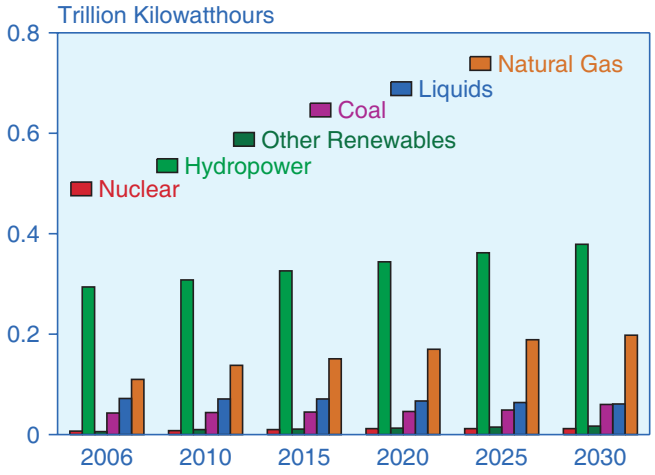
Several other nations in Central and South America have been trying to increase the amounts of natural gas used in their generation fuel mixes by increasing both pipeline and LNG supplies. Chile, for instance, relies on Argentina for its natural gas supplies, but beginning in 2004, Argentina began to restrict its exports after it was unable to meet its own domestic supply. As a result, Chile has been forced to use diesel-fueled electric generating capacity periodically to avoid power outages during the winter months [***65***]. In response to the lack of a secure source of natural gas from Argentina, Chile has begun construction on two LNG regasification projects. The Quintero facility is expected to become operational in June 2009, and the second Mejillones facility scheduled for completion by the end of 2010. In the *IEO2009* reference case, natural-gas-fired generation in Central and South America (excluding Brazil) increases by an average 2.5 percent per year, and the natural gas share of total electricity generation rises from 21 percent in 2006 to 27 percent in 2030 (Figure 62).

Brazil still has plans to continue expanding its hydroelectric generation over the projection period, including the construction of two plants on the Rio Madeira in Rondonia—the 3,150-megawatt Santo Antonio and the 3,326-megawatt Jirau hydroelectric facilities. The two plants, with completion dates scheduled for 2012-2015, are expected to help Brazil meet electricity demand in the mid-term [***66***]. In the long term, electricity demand could be met in part by the 11,181-megawatt Belo Monte dam, which is scheduled to receive bids for construction in 2009; however, each of the three projects could be subject to delay as a result of legal challenges. An injunction to stop the construction of the Jirau power plant, for example, was overturned in 2008 after the plaintiff's second appeal [***67***].

Brazil also is interested in increasing the use of other, nonhydroelectric renewable resources in the future—notably, wind. Wind power generation in Brazil grows by 14.8 percent per year in the *IEO2009* reference case, from 250 million kilowatthours in 2006 to 6,890 million kilowatthours in 2030. Despite that robust growth projection, however, wind remains a modest component of Brazil's renewable energy mix in the reference case, as compared with the projected growth in hydroelectric generation to 646,600 million kilowatthours in 2030.

Increases in Brazil's electricity generation from nonhydropower renewable energy sources have been supported primarily by the federal Program of Incentives for Alternative Electricity Sources (PROINFA). Phase I of the program guaranteed power purchase agreements for 3,300 megawatts of biomass, wind, and small hydroelectric capacity through 2008. A second phase of PROINFA was intended to increase nonhydroelectric generation to 10 percent of total electricity generation by 2027, but insufficient utilization of Phase I has reduced the likelihood that Phase II will be implemented [***68***]. Until a replacement policy is enacted, growth in Brazil's nonhydroelectric renewable generation is expected to be relatively slow in comparison with the growth in other sources of electricity generation.

**Figure 62. Net Electricity Generation in Other Central and South America by Fuel, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

## References


1. International Energy Agency, *World Energy Outlook 2006* (Paris, France, November 2006), p. 567.
2. Energy Information Administration, *International Energy Outlook 2008*, DOE/EIA-0484(2008) (Washington, DC, September 2008), p. 67.
3. World Wind Energy Association, *World Wind Energy Report 2008* (February 2009), p. 4, web site www.wwindea.org.
4. International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), p. 177.
5. Ontario Ministry of Energy and Infrastructure, "Frequently Asked Questions" (as of February 23, 2009), web site www.mei.gov.on.ca/english/energy/electricity.
6. Hydro Québec, "Eastmain-1-A/Sarcelle/Rupert Project," web site www.hydroquebec.com/rupert/en/index.htm.
7. Natural Energy Board Canada, *Canada's Energy Future: Reference Case and Scenarios to 2030* (Ottawa, Ontario, Canada, November 2007), p. 31; and Hydro Québec Production, *Complexe de La Romaine: Etude d'impact sur l'environnment* (December 2007), p. iii.
8. Canadian Wind Energy Association, "Canada Becomes 12th Country in the World To Surpass 2,000 MW of Installed Wind Energy Capacity" (press release, December 10, 2008), web site www.canwea.ca/media/release/release_e.php?newsId=51.
9. Canadian Wind Energy Association, "Federal/Provincial Incentives on Wind Energy" (May 2008), web site www.canwea.ca/images/uploads/File/Fed_and_provincial_initiatives_may_2008.pdf.
10. Canadian Wind Energy Association, "Canadian Wind Farms" (January 2009), web site www.canwea.ca/farms/index_e.php.
11. Ontario Power Authority, *Standard Offer Program—Renewable Energy for Small Electricity Generators: An Introductory Guide* (Toronto, Ontario, Canada), web site http://powerauthority.on.ca/SOP/Storage/ 44/3985_SOPInformationBrochure.pdf.
12. IHS Global Insight, Inc., "Mexico: Country Reports: Utilities: Electricity and Gas" (January 27, 2009), web site www.globalinsight.com (subscription site).
13. "Tamazunchale I CCGT Plant, Mexico," *power-technology.com web site: Industry Projects* (undated) web site www.power-technology.com/projects/tamazunchale.
14. J. Roeder, "Natural Gas Replacing Fuel Oil and Diesel in Mexico's Power Plants," *The Oil Daily*, Vol. 59, No. 19 (January 29, 2009), p. 5.
15. IHS Global Insight, Inc., "Mexico: Country Reports, Oil & Gas Downstream" (December 18, 2008), web site www.globalinsight.com (subscription site).
16. IHS Global Insight, Inc., "Mexico: Country Reports: Utilities: Electricity and Gas" (January 27, 2009), web site www.globalinsight.com (subscription site).
17. S. Frias, "In-Depth Look at the National Infrastructure Program for CFE," Railroad Commission of Texas, *Texas Trade Mission to Mexico 2008* (August 27-29,2008), web site www.rrc.state.tx.us/commissioners/carrillo/mexico/2008.
18. World Wind Energy Association, *World Wind Energy Report 2008* (Bonn/Toronto, February 2009), p. 12, web site www.wwindea.org.
19. International Energy Agency, *IEA Wind Energy Annual 2007* (Boulder, CO, July 2008), p. 181.
20. Global Wind Energy Council, "US and China in Race to the Top of Global Wind Industry" (press release, February 2, 2009), web site www.gwec.net.
21. European Parliament, Directive 2001/77/EC, "Renewable Energy: The Promotion of Electricity From Renewable Energy Sources" (2001), web site http://europa.eu/scadplus/leg/en/lvb/l27035.htm.
22. European Parliament, "EU Climate and Energy Policy" (December 2008), web site http://ec.europa.eu/climateaction/docs/climate-energy_summary_en.pdf.
23. Cambridge Energy Research Associates, "It's Not Over Till It's Over: The Russian-Ukrainian Gas Crisis in Perspective," *CERA Decision Brief* (Cambridge, MA, January 2009), p. 4.
24. "Recalled to Half-Life," *The Economist*, Vol. 390, No. 8618 (February 14-20, 2009), pp. 60-61.
25. "Nuclear the 'only solution' to Italy's energy imports," *World Nuclear News* (January 9, 2009), web site www.world-nuclear-news.org.
26. "German Utilities Fear Gas, German Public Fears Coal," *World Gas Intelligence,* Vol. 19, No. 9 (February 27, 2008), p. 7; and "Carbon Emissions Price Could Test Polish Devotion to Coal," *World Gas Intelligence,* Vol. 19, No. 13 (March 26, 2008), p. 7.
27. REN21, Renewables 2007 Global Status Report (Paris, France, 2008), p.41, web site www.ren21.net/pdf/RE2007_Global_Status_Report.pdf.
28. International Energy Agency, *IEA Wind Energy Annual Report 2007* (Paris, France, July 2008), p. 163.
29. S.I. Antipov, "Nuclear Industry of Russia Today and Tomorrow," *Papers from the PBNC 2006 Conference of the Pacific Nuclear Society* (October 15-20, 2006), web site www.pacificnuclear.org/pnc/publications.html.

30. "Nuclear Power Engineering in Russia," Rosenergoatom Concern OJSC, Virtual Museum (copyright 2000-2009), web site http://museum.rosenergoatom.ru/eng/modern/russia/index.wbp.
31. "Nuclear Power in Russia," *World Nuclear Association: Information Papers: Country Briefings* (February 25, 2009), web site www.world-nuclear.org.
32. World Energy Council, *2007 Survey of Energy Resources* (London, United Kingdom, 2007), p. 310; and International Water and Power, "Power Machines Wins Brazil Order, Sends Unit to Boguchanskaya" (August 20, 2008), web site www.waterpowermagazine.com/story.asp?sectioncod=130&storyCode=2050664.
33. International Atomic Energy Association, Power Reactor Information System (as of March 2, 2009), web site www.iaea.org/programmes/a2/index.html.
34. M. Schneider, "2008 World Nuclear Industry Status Report: Asia," *Bulletin of the Atomic Scientists* (September 18, 2008), web site www.thebulletin.org/web-edition/reports/2008-world-nuclear-industry-status-report/2008-world-nuclear-industry-status-re-0; and Indian National Congress web site, "India's Nuclear Energy Programme and the 123 Agreement with United States" (undated), web site www.aicc.org.in/documents-detail.php?id=29.
35. B. Pradhan and A. Chaudhary, "Singh, Bush Affirm U.S.-India Nuclear Deal Commitment," Bloomberg News Service (July 9, 2008), web site www.bloomberg.com; and "USIBC Concludes Successful Commercial Nuclear Trade Mission to India," India Post News Service (January 23, 2009), web site http://indiapost.com/article/techbiz/5269/1/print.
36. "Son La Pushes Hydro Program," *Power in Asia*, No. 509 (August 14, 2008), p. 17.
37. A. Netto, "New Doubts Over Malaysia's Bakun Dam," *Asia Times Online* (July 10, 2007), web site www.atimes.com.
38. Central Energy Authority, *Hydro Development Plan for 12th Five Year Plan (2012-2017)* (New Delhi, India, September 2008), pp. i and iv, web site www.cea.nic.in/hydro/Hydro%20Development%20Plan%20for%2012th%20Five%20Year%20Plan.pdf.
39. "Himachal Pradesh Pushes Hydro Generation Projects," *Power in Asia*, No. 488 (October 11, 2007), p. 14.
40. "Private Players for Developing Hydro Projects in Arunachal," *The Economic Times of India* (December 19, 2007), web site www.economictimes.indiatimes.com.
41. Probe International Editorial, "Probe International Asks Canadian Government Provide Legal Aid Three Gorges Dam Victims" (January 23, 2008), web site www.probeinternational.org.
42. "Longtan Enters Operation," *Power in Asia*, No. 494 (January 3, 2008), p. 23.
43. "Asian Experiences," *International Water Power Magazine* (October 1, 2007), web site www.waterpowermagazine.com.
44. "Banduo Project Starts Construction," *Power in Asia*, No. 488 (October 11, 2007), p. 19.
45. United Press International, "China Increases Its Wind Power" (Beijing, January 19, 2009), web site www.upi.com/Energy_Resources/2009/01/19/China_increases_its_wind_power/UPI-58981232388248.
46. Philippine Department of Energy, *Power Statistics*, "Power Sector Situationer, 2007," p. 2, web site www.doe.gov.ph/EP/Powerstat.htm.
47. World Energy Council, *2007 Survey of Energy Resources* (London, United Kingdom, October 2007), p. 440.
48. World Energy Council, *2007 Survey of Energy Resources* (London, United Kingdom, October 2007), p. 458.
49. "OPEC Cut Poses Gas Problem for Saudi Arabia,"' *The Oil Daily*, Vol. 50, No. 40 (March 2, 2009), p. 7.
50. International Energy Agency, *Energy Balances of Non-OECD Countries, 2004-2006*, 2007 Edition (Paris, France, 2007), web site www.iea.org/w/bookshop/add.aspx?id=31.
51. K. Maree, "Gulf's First Coal-Fired Power Plant To Be Built at Duqm: Muscat Approves Project As Concerns Grow Over Future Energy Sources," *MEED Middle East Economic Digest* (April 25, 2008), web site www.meed.com/power (subscription site).
52. D. Candappa and T. Austin, "Oman Eyes Gulf's First Coal Power Plant—Report," *Reuters UK News Release* (January 26, 2008), web site http://uk.reuters.com.
53. "Keeping Up With the (Nuclear) Joneses" (March 26, 2008), web site www.forbes.com.
54. "Nuclear Power in the United Arab Emirates," World Nuclear Association Information Papers (January 2009), web site www.world-nuclear.org; E. Lake, "U.S.-UAE Nuclear Deal To Test Obama," *Washington Times* (January 6, 2009), web site www.washingtontimes.com; and "Resources on the United Arab Emirates Nuclear Energy Program and 123 Agreement," web site www.usuae123.com.
55. "Keeping Up With the (Nuclear) Joneses" (March 26, 2008), web site forbes.com.

56. "Kuwait To Form Nuclear Energy Commission," *World Nuclear News: Nuclear Policies* (March 3, 2009), web site www.world-nuclear-news.org.
57. Global Insight, Inc., "Iran: Investment in Hydropower to Continue as Iran Pushes 94 Dam Projects Forward" (January 13, 2009), web site www.globalinsight.com.
58. D. Dilworth, "Zero Carbon; Zero Waste in Abu Dhabi," *Business Week* (August 1, 2007), web site www.businessweek.com/innovate/content/aug2007/id2007081_901739.htm.
59. World Nuclear Association, "Nuclear Power in South Africa" (February 2009), web site www.world-nuclear.org/info/inf88.html.
60. T. Carlisle, "Egypt Awards Nuclear Power Contract," *The National Newspaper* (December 22, 2008), web site www.thenational.ae.
61. Global Insight, Inc., "Ethiopia-Kenya: Ethiopia To Export Electricity to Kenya from Gilgel Gibe 2 Hydropower Plant" (August 19, 2008), web site www.globalinsight.com.
62. N. Viana, "Brazil Energy Proposal Said To Contradict Poznan Promises," *Climate Media Partnership* (January 15, 2009), web site www.climatemediapartnership.org.
63. "Nuclear Power in Brazil," World Nuclear Association, Information Papers, Country Briefings (December 2008), web site www.world-nuclear.org.
64. L. Viscidi, "Brazil Plans To Have Third LNG Terminal Up and Running by 2013," *The Oil Daily*, Vol. 59, No. 30 (February 13, 2009), p. 2.
65. L. Viscidi, "Argentina Ups Gas Exports to Chile, Region Appears Well Supplied," *The Oil Daily*, Vol. 59, No. 41 (March 3, 2009), p. 5.
66. Global Insight, Inc., "Brazil: Date Set for Brazilian Hydroelectric Power Plant Tender" (January 28, 2008), web site www.globalinsight.com.
67. Global Insight, Inc., "Brazil: Environmental Agency Wins Second Appeal Overturning Brazilian Court Injunction Against Power Plant" (December 8, 2008), web site www.globalinsight.com.
68. Global Wind Energy Council, "The PROINFA Program," *Global Wind 2007 Report* (May 2008), p. 22, web site www.gwec.net/fileadmin/documents/test2/gwec-08-update_FINAL.pdf.

## Chapter 6

# Industrial Sector Energy Consumption

***Worldwide industrial energy consumption increases by an average of 1.4 percent per year from 2006 to 2030 in the IEO2009 reference case. Much of the growth is expected to occur in the developing non-OECD nations.***

The world's industries make up a diverse sector that includes manufacturing, agriculture, mining, and construction. Industrial energy demand varies across regions and countries, depending on the level and mix of economic activity and technological development, among other factors. Energy is consumed in the industrial sector for a wide range of activities, such as processing and assembly, space conditioning, and lighting. Industrial energy use also includes natural gas and petroleum products used as feedstocks to produce nonenergy products, such as plastics. In aggregate, the industrial sector uses more energy than any other end-use sector, consuming about one-half of the world's total delivered energy.

Over the next 25 years, worldwide industrial energy consumption is projected to grow from 175.0 quadrillion Btu in 2006 to 245.6 quadrillion Btu in 2030 (Table 12). In the *IEO2009* reference case, world industrial energy demand increases at an average annual rate of 1.4 percent to 2030. National economic growth rates return to historical trends when the current economic downturn ends, with much of the subsequent growth in industrial sector energy demand expected to occur in the developing non-OECD nations.

Currently, non-OECD economies consume 58 percent of global delivered energy in the industrial sector. In the period through 2030, industrial energy use in the

**Table 12. OECD and Non-OECD Industrial Energy Consumption by Source, 2006-2030**
(Quadrillion Btu)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | | | | | | | |
| Liquids | 31.3 | 27.8 | 28.2 | 28.2 | 28.2 | 28.4 | -0.4 |
| Natural Gas | 19.1 | 19.5 | 20.5 | 21.0 | 21.7 | 22.4 | 0.7 |
| Coal | 9.2 | 8.6 | 8.5 | 8.4 | 8.4 | 8.5 | -0.3 |
| Electricity | 11.2 | 11.5 | 12.3 | 12.8 | 13.2 | 13.7 | 0.8 |
| Renewables | 2.4 | 2.7 | 2.9 | 3.3 | 3.8 | 4.1 | 2.2 |
| **Total OECD** | **73.1** | **70.0** | **72.3** | **73.7** | **75.5** | **77.1** | **0.2** |
| **Non-OECD** | | | | | | | |
| Liquids | 29.2 | 31.4 | 33.6 | 36.7 | 39.4 | 41.8 | 1.5 |
| Natural Gas | 23.2 | 26.9 | 31.8 | 35.2 | 38.0 | 40.5 | 2.3 |
| Coal | 34.2 | 37.8 | 41.8 | 46.2 | 49.3 | 51.2 | 1.7 |
| Electricity | 14.9 | 19.6 | 23.4 | 27.4 | 31.3 | 34.6 | 3.6 |
| Renewables | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Total Non-OECD** | **101.9** | **115.9** | **131.0** | **145.7** | **158.2** | **168.5** | **2.1** |
| **World** | | | | | | | |
| Liquids | 60.5 | 59.2 | 61.8 | 64.9 | 67.6 | 70.3 | 0.6 |
| Natural Gas | 42.3 | 46.4 | 52.3 | 56.1 | 59.8 | 62.9 | 1.7 |
| Coal | 43.4 | 46.4 | 50.3 | 54.7 | 57.8 | 59.7 | 1.3 |
| Electricity | 26.2 | 31.0 | 35.7 | 40.1 | 44.5 | 48.4 | 2.6 |
| Renewables | 2.7 | 2.9 | 3.2 | 3.6 | 4.1 | 4.3 | 2.0 |
| **Total World** | **175.0** | **185.9** | **203.3** | **219.4** | **233.7** | **245.6** | **1.4** |

Note: Totals may not equal sum of components due to independent rounding.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

non-OECD countries is expected to grow at a rate of 2.1 percent per year, compared with 0.2 percent per year in the OECD countries (Figure 63). Thus, 94 percent of the growth in industrial energy use from 2006 to 2030 is projected to take place in non-OECD countries. In 2030, non-OECD nations are expected to consume 69 percent of total delivered energy in the world's industrial sector.

Fuel prices shape the mix of fuel consumption in the industrial sector, as industrial enterprises are assumed to choose the cheapest fuels available to them, whenever possible. Because liquids are more expensive than other fuels, world industrial sector liquids use increases at an average annual rate of only 0.6 percent in the projection (Figure 64), and the share of liquid fuels in the industrial fuel mix declines. The liquids share is displaced primarily by electricity use, which grows by an average of 2.6 percent per year from 2006 to 2030.

At present, the overall industrial fuel mixes in the OECD and non-OECD countries differ, especially for liquids and coal. In 2006, liquids made up 43 percent of industrial energy use in the OECD countries, compared with 29 percent in the non-OECD countries; however, OECD industrial liquids use declines at a rate of 0.4 percent per year between 2006 and 2030, while non-OECD liquids use increases at a rate of 1.5 percent per year. In 2030, the non-OECD industrial sector consumes 41.8 quadrillion Btu of energy from liquids, compared with 28.4 quadrillion Btu for the OECD industrial sector.

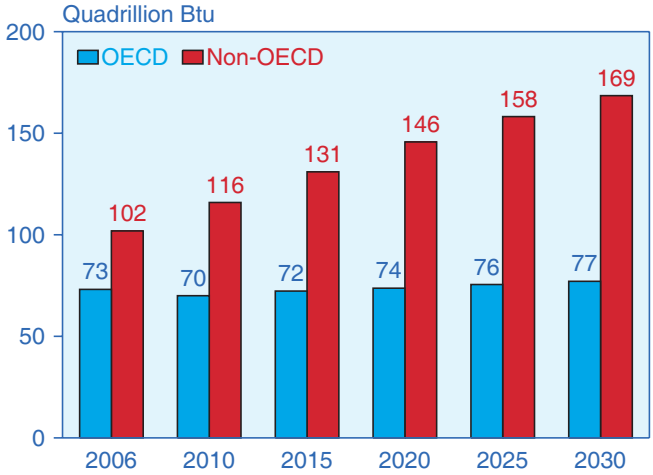
Coal use in the industrial sector also is considerably more prominent in non-OECD nations than in the OECD nations, especially in China and India, which have abundant domestic coal reserves and less stringent environmental regulations. Coal represented 13 percent of OECD industrial energy use in 2006 and is projected to decline by an average of 0.3 percent per year over the projection period. In non-OECD nations, coal represented 34 percent of industrial energy us in 2006 and increases by an average of 1.7 percent per year.

Total industrial energy consumption in each region is a product of the energy intensity of industrial output—as measured by the energy consumed per unit of output—and the level of industrial output. To capture the dynamics of industrial energy consumption, those two elements must be examined in concert. This chapter focuses on the policy and economic trends that drive both the changes in the energy intensity of production in key industries and the trade and development patterns that affect the levels of industrial output in different areas.

Energy-intensive industries, which consume most of the energy in the industrial sector, have focused on reducing their energy consumption for years, because energy represents a large portion of their costs [*1*]. Enterprises can reduce energy use in numerous ways. Industrial processes can be improved to reduce energy waste and recover energy, often process heat, which would otherwise be lost. Recycling material and fuel inputs also improves efficiency. Public policies aimed at reducing greenhouse gas emissions often include mandates for heavy industry to lower the energy intensity of production, especially in OECD countries.

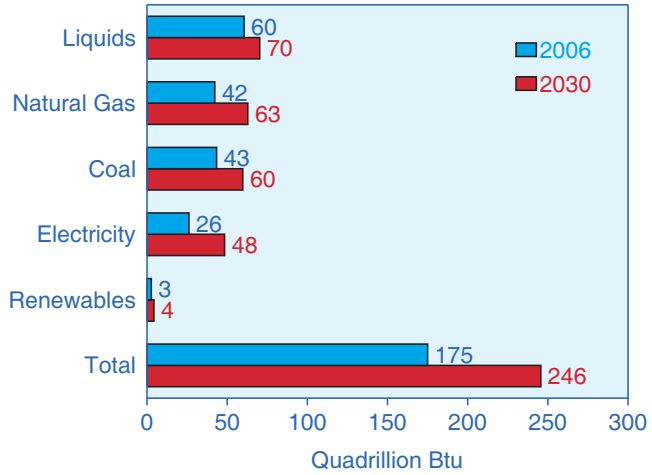
Policies governing greenhouse gas emissions also can influence the location of new energy-intensive industrial enterprises. The phenomenon of industries relocating

**Figure 63. OECD and Non-OECD Industrial Sector Energy Consumption, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 64. World Industrial Sector Energy Consumption by Fuel, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

their emissions-intensive facilities to less restrictive operating environments, know as "carbon leakage," is only one of many factors influencing global patterns of industrial output [2]. Countries' development trajectories also play a major role. When economies initially begin to develop, industrial energy use rises as manufacturing output begins to take up a larger portion of GDP, as has taken place already in many non-OECD economies (most clearly in China). When the developing economies attain higher levels of economic development, they begin to transition to service-oriented economies, and their industrial energy use begins to level off as can be seen currently in OECD countries.

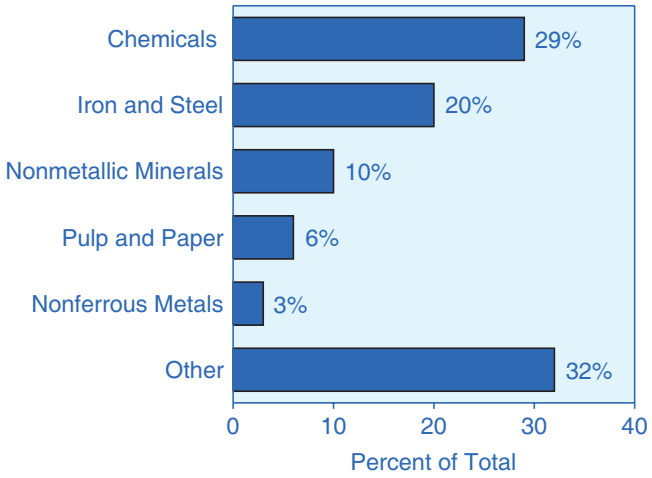
The following section describes patterns of energy use in the world's most energy-intensive industries. Subsequent sections examine specific patterns of industrial energy use in the major OECD and non-OECD regions.

## Energy-Intensive Industries

Five industries account for 68 percent of all energy used in the industrial sector (Figure 65): chemicals (29 percent), iron and steel (20 percent), nonmetallic minerals (10 percent), pulp and paper (6 percent), and nonferrous metals (3 percent) [3]. The quantity and fuel mix of future industrial energy consumption will be determined largely by energy use in those five industries. In addition, the same industries emit large quantities of carbon dioxide, related to both their energy use and their production processes (see box on page 88).

The largest industrial consumer of energy is the chemical sector, which made up 29 percent of total world industrial energy consumption in 2006. Energy represents 60 percent of the industry's cost structure and an even higher percentage in the petrochemical subsector, which uses energy products as feedstocks. Petrochemical feedstocks account for 60 percent of the energy used in the chemicals sector. Intermediate petrochemical products, or "building blocks," which go into products such as plastics, require a fixed amount of hydrocarbon feedstock input. In other words, for any given amount of chemical output a fixed amount of feedstock is required, depending on the fundamental chemical process of production, which greatly reduces opportunities for reducing fuel use [4].

**Figure 65. World Industrial Sector Energy Consumption by Major Energy-Intensive Industry Shares, 2005**




Source: International Energy Agency Data Services, *World Energy Balances* (2007), web site http://data.iea.org (subscription site).

By volume, the largest "building block" in the petrochemical sector is ethylene, which can be produced by various chemical processes. In Europe and Asia, ethylene is produced primarily from naphtha, which is refined from crude oil. In North America and the Middle East, where domestic supplies of natural gas are more abundant, ethylene is produced from ethane, which typically is obtained from natural gas. Because petrochemical feedstocks represent such a large share of industrial energy use, patterns of feedstock use play a substantial role in determining each region's fuel mix.

In recent years, most of the expansion of petrochemical production and consumption has taken place in non-OECD Asia. Although the global recession will slow demand growth for a time, continued aggressive expansion of petrochemical manufacturing capacity in Asia and the Middle East points toward further growth of the petrochemical industry over the projection period. Since 2004, capital expenditures in the chemical sector of the Asia-Pacific region have outpaced those in North America and Europe combined. That trend is likely to continue through 2013 [5]. The chemical sector also is likely to continue using hydrocarbon feedstocks throughout the projection period, although the high oil prices of recent years have sparked interest in the use of alternative renewable feedstocks, such as agricultural ("chemurgy") products, which could gain some market share[33] during the forecast period [6].

The next-largest industrial user of energy is iron and steel, which accounts for about 20 percent of industrial energy consumption. Across the iron and steel sector as a whole, energy represents roughly 15 percent of production costs [7]. The amount of energy used in the production of steel varies greatly, however, depending on the process used. In the blast furnace process, superheated oxygen is blown into a furnace containing iron ore and coke. The iron ore is reduced (meaning that oxygen molecules in the ore bond with the carbon), leaving molten iron and carbon dioxide [8]. Coal use and heat

[33] Analysts estimate that world oil prices must be sustained at $50 to $60 per barrel in order for this technology to be economically feasible.

generation make this process tremendously energy-intensive, and in addition it requires metallurgical coal, or coking coal, which is more costly than steam coal because of its lower ash and sulfur content.

Electric arc furnaces, the other major type of steel production facility, produce steel by using an electric current to melt scrap metal. The process is more energy-efficient and produces less carbon dioxide than the blast

### Process-Related Emissions in the Industrial Sector

Carbon dioxide emissions in the industrial sector result from both energy use and production processes. Together, energy- and process-related emissions in the industrial sector account for about one-fourth of global carbon dioxide emissions.[a] Process-related emissions are a direct byproduct of production. Because releases of carbon dioxide are inherent in the production of iron and steel, cement, and aluminum, the potential for reducing process-related emissions is limited. As a result, carbon abatement will face significant technological challenges in the industrial sector. In addition, there are no economical substitutes for these materials or their production processes, and none is likely be available in the near term.

The largest carbon dioxide emitter in the industrial sector is the iron and steel industry. In addition to being tremendously energy-intensive, the blast furnace process for steel production generates carbon dioxide directly. When super-heated oxygen (O) is blown into a blast furnace containing coal coke and iron oxide ($FE_2O_3$), the oxygen fuses with carbon in the coke to produce carbon monoxide (CO) which, at high temperatures, reduces iron oxide by removing the oxygen to produce pure molten iron (Fe) and carbon dioxide. The primary chemical reaction involved in the process is:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \quad .$$

Two-thirds of the world's steel production uses blast furnaces, including 90 percent of the steel made in China, which is the world's fastest-growing steel producer.[b]

The situation is similar in the cement industry. The primary ingredient in marketed cement is cement clinker, composed largely of calcium oxide (CaO). Clinker is produced by superheating quarried and ground raw materials in a massive kiln. The most abundant material in the process is limestone ($CaCO_3$). The chemical reaction involved in heating limestone is:

$$CaCO_3 \rightarrow CaO + CO_2 \quad .$$

Although there are many possible ways to improve energy efficiency in the cement production process, the fundamental chemistry of producing cement clinker will always result in direct emissions of carbon dioxide. Cement industry groups point out that cement and concrete are important components of environmentally friendly development because of their durability and energy performance.[c] To the extent that that is true, demand for cement is likely to remain strong even in the most carbon-constrained future scenario, and direct emissions from cement production will remain an issue.

The basic process involved in producing aluminum also emits carbon dioxide directly. Aluminum is produced by running an electrical current through a molten mixture of electrolyte and refined alumina ($Al_2O_3$). In the process, carbon (C) from a graphite anode fuses with and removes oxygen from the alumina to produce molten aluminum metal. A simplified version of the reaction is:

$$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2 \quad .$$

Just as cement will continue to be a component of energy efficiency improvements in the buildings sector, aluminum will play a role in reducing fuel use in the transportation sector. Specifically, fuel economy is substantially improved when aluminum is used to reduce the weight of vehicles. Although aluminum production from recycled scrap metal would avoid most of the process-related emissions, most of the aluminum sold in world markets probably will come from primary production for the foreseeable future.

The inability of major energy users (and carbon dioxide emitters) in the industrial sector—including the iron and steel, cement, and aluminum industries—to remove carbon dioxide from their production processes limits their ability to respond to climate change initiatives. The situation is further complicated in that demand for their products is unlikely to subside in the near future. As a result, policy regimes insituted by OECD nations to address carbon dioxide emissions already have begun to afford those industries special treatment.

[a]International Energy Agency, *Energy Technology Perspectives: Scenarios and Strategies to 2050* (Paris, France, June 2008), p. 471.
[b]World Steel Association, "World Steel in Figures 2008" (2008), web site www.worldsteel.org/pictures/publicationfiles/WSIF%202008%202nd%20edition.pdf.
[c]Portland Cement Association, "Sustainable Development" (2008), web site www.cement.org/newsroom/newsroom_reference_sustain.asp.

furnace process, but it depends on a reliable supply of discarded steel. Currently, two-thirds of global steel production uses the blast furnace process. The only major steel producers that make a majority of their steel using the electric arc furnace process are the United States (59 percent) and India (58 percent) [*9*].

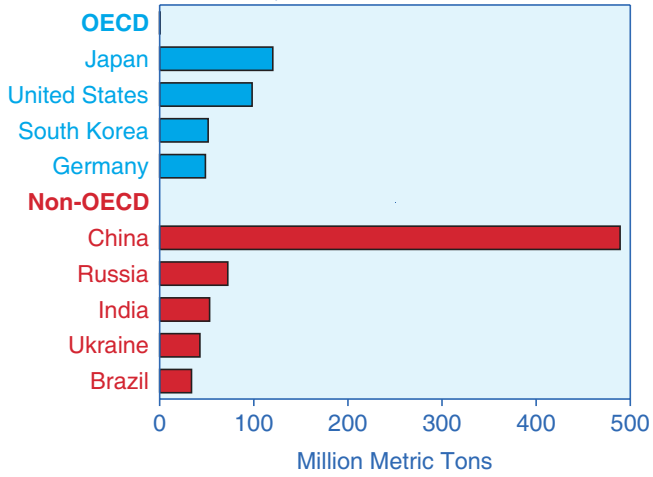
Earlier this decade, non-OECD economies witnessed a (now-subsiding) boom in steel production and consumption that drove up global production and prices. Fueled by demand from the construction and manufacturing sectors, China has become the world's largest steel manufacturer, producing more steel than the seven next-largest producers combined (Figure 66). Ninety percent of China's production employs the blast-furnace method [*10*]. A major effect of increased steel production has been a sharp rise in the price of scrap metal, which has made the blast furnace method of production more cost-effective, especially in non-OECD countries that do not have large inventories of scrap metal. When scrap steel becomes available and cheap enough to have a clear cost advantage over iron ore, use of electric arc furnaces in non-OECD countries will increase, reducing coal use and increasing electricity use.

After iron and steel, the next largest energy-consuming industry is nonmetallic minerals, which includes cement, glass, brick, and ceramics. Production of those materials requires a substantial amount of heat and accounts for 10 percent of global industrial energy use. The most significant nonmetallic minerals industry is cement production, which accounts for 83 percent of energy use in the nonmetallic minerals sector [*11*]. Although the cement industry in OECD countries has improved energy efficiency over the years by switching from the "wet kiln" production process to the "dry kiln" process, which requires less heat [*12*], energy costs still constitute 40 percent of the total cost of cement production [*13*].

Although OECD countries are beginning to add some additional cement production capacity, the primary growth in cement production over the next few years is expected to be in non-OECD countries. As is the case for steel, the growth in cement production is fueled by growing demand in the construction sector [*14*]. In the coming years, the energy efficiency of cement production is likely to increase as a result of continued improvements in kiln technology, the use of recycled material (such as used tires) as fuel, and increased use of additives to reduce the amount of clinker (the primary ingredient in marketed cement) needed to produce a given amount of cement [*15*].

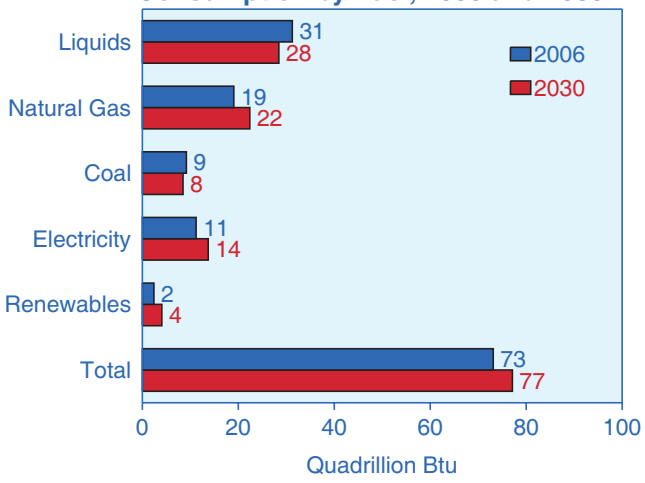
Pulp and paper production accounts for 6 percent of global industrial energy use. Paper manufacturing is an energy-intensive process, but paper mills typically generate about one-half of the energy they use through cogeneration with biomass from wood waste. In some cases, paper mills generate more electricity than they need and are able to sell their excess power back to the grid [*16*]. Because of the widespread use of biomass and the high efficiency of the cogeneration process, a dramatic reduction in the energy intensity of paper output is unlikely in the near future. In addition, total output of the paper industry has declined in recent years as technological substitutes for paper—notably, electronic record keeping and the dissemination of information via the Internet. Although the world's total paper output is unlikely to grow over the projection period, increases in non-OECD demand should slow the decline in the

**Figure 66. OECD and Non-OECD Major Steel Producers, 2007**




Source: World Steel Association, "World Steel in Figures 2008" (October 2008), web site www.worldsteel.org/pictures/publicationfiles/WSIF%202008%202nd%20edition.pdf.

**Figure 67. OECD Industrial Sector Energy Consumption by Fuel, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

global paper industry. For example, China recently made the transition from a net exporter to a net importer of paper [*17*].

Production of nonferrous metals, which include aluminum, copper, lead, and zinc, consumed 3 percent of industrial delivered energy in 2006, mostly for aluminum production. Although aluminum is one of the most widely recycled materials on the planet, 70 percent of aluminum still comes from primary production [*18*]. Energy accounts for about 30 percent of the total production cost of primary aluminum manufacturing and is the second most expensive input after alumina ore [*19*]. Lower electricity costs and increased demand have led to substantial growth in aluminum production in non-OECD countries. To guard against electricity outages and fluctuations in electric power prices, many aluminum producers have turned to hydropower, going so far as to locate plants in areas where they can operate captive hydroelectric facilities. For example, Norway, which possesses considerable hydroelectric resources, hosts seven aluminum smelters. Today, more than half of the electricity used to make primary aluminum comes from hydropower [*20*].

Aluminum production from recycled materials uses only one-twentieth of the energy of primary production [*21*]. Although both the aluminum industry and many governments encourage aluminum recycling, it is unlikely that the share of aluminum made from recycled product will increase much in the future, because most aluminum (which is consumed in the construction and manufacturing sectors) is used for long periods of time. Indeed, with three-fourths of the aluminum ever produced still in use [*22*], it is likely that the aluminum industry will continue to consume large amounts of electricity.

## Regional Outlook

### OECD Countries

In recent decades, OECD countries have been in transition from manufacturing economies to service economies. As a result, in the *IEO2009* reference case, industrial energy use in the OECD countries grow at an average annual rate of only 0.2 percent from 2006 to 2030, as compared with a rate of 1.0 percent per year in the commercial sector, reflecting the shift from industrial interests to service economies. In addition to the shift away from industry, slow growth in OECD industrial energy consumption can be attributed to slow growth in economic output. OECD economies are projected to grow by 2.2 percent per year in the *IEO2009* reference case, compared with 2.8 percent per year projected in the *IEO2008* reference case. Although OECD economies currently account for 59 percent of global economic output (as measured in purchasing power parity terms), their share falls to about 43 percent in 2030.

Higher oil prices in the *IEO2009* reference case lead to changes in the industrial fuel mix of OECD nations (Figure 67). OECD liquids use in the industrial sector is projected to contract by 0.4 percent per year, reducing the share of liquids in industrial energy use from 43 percent in 2006 to 37 percent in 2030. Coal use in the industrial sector also declines, and coal's share of OECD delivered industrial energy use falls from 13 percent to 11 percent, as industrial uses of natural gas, electricity, and renewables expand. Industrial consumption of renewables in the OECD countries grows faster than the use of any other fuel, nearly doubling from 2006 to 2030, but still represents just 5 percent of total OECD industrial energy use in 2030. In the coming decades, industrial fuel use patterns and energy intensity trends in the OECD countries are expected to be determined as much by policies regulating energy use as by economic and technological fundamentals.

Currently, more energy is consumed in the industrial sector in the United States than in any other OECD country, and that continues to be true throughout the *IEO2009* reference case projection. Minimal growth in U.S. industrial energy use is projected, however, averaging 0.2 percent per year and rising from 25.3 quadrillion Btu in 2006 to 26.3 quadrillion Btu in 2030,[34] with the industrial share of total U.S. energy consumption remaining at approximately one-third in 2030. In contrast, U.S. commercial energy use increases at more than five times that rate, reflecting the continued U.S. transition to a service economy. With oil prices rising steadily in the reference case, liquids consumption in the U.S. industrial sector contracts on average by 0.8 percent per year,[35] which is the steepest decline in the OECD. Increasing use of natural-gas-based feedstocks in the U.S. petrochemical sector causes demand for liquids in the industrial sector to be more elastic than it is in OECD Asia or OECD Europe.

The use of renewable fuels in the U.S. industrial sector grows faster than the use of any other energy source in the reference case, increasing its share of the fuel mix from 8 percent in 2006 to 14 percent in 2030.[36] Most of the growth can be attributed to an increase in recycling of

[34] In the *updated AEO2009* reference case (April 2009), the total contracts to 24.9 quadrillion Btu in 2030, largely as a result of slower macroeconomic growth than projected in the *published AEO2009* reference case (March 2009).

[35] In the *updated AEO2009* reference case (April 2009), the rate of contraction is 1.0 percent per year, largely as a result of slower macroeconomic growth than projected in the *published AEO2009* reference case.

[36] In the *updated AEO2009* reference case (April 2009), the share grows to 16 percent in 2030, based on renewable energy measures included in ARRA2009.

waste energy and waste products and to legislation leading to further reductions in the energy intensity of industrial processes. For example, the U.S. Department of Energy supports reductions in energy use through its Industrial Technologies Program, guided by the Energy Policy Act of 2005, which is working toward a 25-percent reduction in the energy intensity of U.S. industrial production by 2017 [***23***]. The Energy Independence and Security Act of 2007 (EISA2007) also addresses energy-intensive industries, providing incentive programs for industries to recover additional waste heat and supporting research, development, and demonstration for efficiency-increasing technologies [***24***].

Industrial energy use in Canada grows at an average rate of 1.1 percent per year in the *IEO2009* reference case, continuing to constitute just under one-half of Canada's total delivered energy use. With world oil prices projected to return to and remain at sustained high levels, liquids use in the industrial sector does not increase from current levels, while natural gas use increases by 1.8 percent per year. As a result, the share of liquids in the industrial fuel mix falls from 37 percent in 2006 to 28 percent in 2030, while the natural gas share increases from 41 percent to 48 percent. As in the United States, Canada's petrochemical sector uses a substantial amount of natural-gas-based feedstocks. In addition, increased production of unconventional liquids (oil sands) in western Canada, which requires a large amount of natural gas, contributes to the projected increase in industrial natural gas use.

Industrial energy efficiency in Canada has been increasing at an average rate of about 1.5 percent per year in recent decades, largely reflecting provisions in Canada's Energy Efficiency Act of 1992 [***25***]. The government recently increased those efforts, releasing the Regulatory Framework for Industrial Greenhouse Gas Emissions in 2007, which calls for a 20-percent reduction in greenhouse gas emissions by 2020. The plan stipulates that industrial enterprises must reduce the emissions intensity of production by 18 percent between 2006 and 2010 and by 2 percent per year thereafter. The proposal exempts "fixed process emissions," from industrial processes in which carbon dioxide is a basic chemical byproduct of production. Therefore, most of the abatement will have to come from increased energy efficiency and fuel switching [***26***].

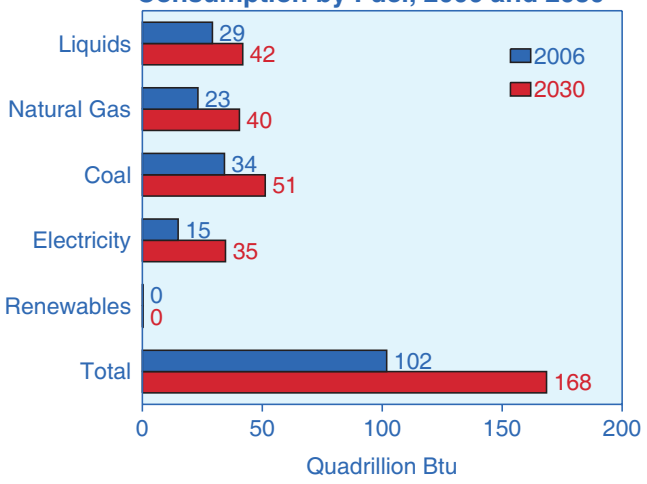
Mexico's GDP grows by 3.4 percent year from 2006 to 2030 in the reference case, which is the highest economic growth rate among all the OECD nations. Mexico also is projected to have the highest average annual rate of growth in industrial energy use, at 1.8 percent per year, with industrial energy use growing to 4.1 quadrillion Btu in 2030 from 2.7 quadrillion Btu in 2006. The country's industrial sector continues to use oil and natural gas for most of its energy needs, and the combined share of liquids and natural gas in the industrial fuel mix remains above 80 percent throughout the projection.

In OECD Europe, GDP grows by 2.0 percent per year and population by 0.2 percent per year from 2006 to 2030 in the *IEO2009* reference case, while industrial energy use increases by 0.1 percent per year. The continuing transition of Europe to a service economy is reflected in the projection for growth in commercial sector energy use, which is nine times the projected growth in industrial energy use.

Energy and environmental policies are a significant factor behind the trends in industrial energy use in OECD Europe. In December 2008, the European Parliament passed the "20-20-20" plan, which stipulated a 20-percent reduction in greenhouse gas emissions, a 20-percent improvement in energy efficiency, and a 20-percent share for renewables in the fuel mix of European Union member countries by 2020 [***27***]. In debates on the plan, representatives of energy-intensive industries voiced concern about the price of carbon allocations. They argued that fully auctioning carbon dioxide permits to heavy industrial enterprises exposed to global competition would simply drive industrial production from Europe and slow carbon abatement efforts at the global level [***28***]. The resulting compromise was an agreement that 100 percent of carbon allowances would be given to heavy industry free of charge, provided that they adhered to efficiency benchmarks [***29***].

The 20-20-20 policy also is expected to affect the mix of fuels consumed in OECD Europe's industrial sector. Industrial coal use contracts at a rate of 1.1 percent per year over the projection period, while both natural gas use and renewables use increase. Industrial sector use of

**Figure 68. Non-OECD Industrial Sector Energy Consumption by Fuel, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

electric power, increasingly generated from low-carbon sources in OECD Europe, also rises. Liquids use in the industrial sector decreases only slightly, by 0.2 percent per year, because the vast majority of feedstocks in OECD Europe's petrochemical sector are oil-based.

Japan has the slowest projected GDP growth among the OECD regions, at 0.8 percent per year in the *IEO2009* reference case. Consequently, industrial consumption of delivered energy falls by 0.4 percent per year—the only projected decline among the OECD nations. Along with slow economic growth, a major factor behind Japan's slowing industrial energy use is efficiency. Because Japan possesses virtually no domestic energy supplies, it maintained a strategic focus on reducing energy use long before high prices brought energy security to the forefront of global issues. As a result, the energy intensity of Japan's industrial production is among the lowest in the world. Since 1970, Japan has reduced the energy intensity of its manufacturing sector by 50 percent, mostly through efficiency improvements, along with a structural shift toward lighter manufacturing. In 2006, Japan approved a "frontrunner" plan, aimed at improving its national energy efficiency by another 30 percent by 2030 [***30***].

South Korea, which experienced rapid industrial development during the later years of the 20th century, is beginning to make a transition to a service-oriented economy. In the *IEO2009* reference case, South Korea's GDP grows at an average annual rate of 3.3 percent from 2006 to 2030, much faster than the OECD average of 2.2 percent per year. Its industrial energy use grows by just 0.2 percent per year, however, while its commercial energy use grows by nearly 2 percent per year. Accordingly, the industrial share of delivered energy use in South Korea falls from 58 percent in 2006 to 53 percent in 2030.

South Korea currently is the sixth-largest steel producer in the world. A large portion of its steel production already is from electric arc furnaces [***31***], and that portion is projected to grow as inventories of discarded steel build up. As a result, coal consumption in South Korea's industrial sector decreases in the reference case, and electricity is the fastest-growing source of energy for industrial uses.

In Australia and New Zealand, industrial delivered energy consumption grows by 0.8 percent per year in the reference case, from 1.9 quadrillion Btu in 2006 to 2.4 quadrillion Btu in 2030. Industry's share of delivered energy consumption in the region remains steady at slightly less than 50 percent. The implementation of an Australian emissions trading scheme in 2009 is expected to reduce the region's energy use somewhat in the coming decades [***32***]. Liquids consumption in the industrial sector remains flat in the projection as a result of high world oil prices, while the share of coal in the industrial fuel mix increases from 11 percent of delivered energy use in 2006 to 17 percent in 2030, exploiting Australia's abundant coal reserves.

### Non-OECD Countries

Non-OECD industrial energy consumption grow at an average annual rate of 2.1 percent in the *IEO2009* reference case—10 times the average for the OECD countries as a whole (Figure 68). The industrial sector accounted for about 60 percent of total non-OECD delivered energy use in 2006 and is expected to continue consuming approximately that share of the total through 2030. With the non-OECD economies projected to expand at an average annual rate of 4.9 percent, their share of global output increases from 41 percent in 2006 to 57 percent in 2030.

The key engines of non-OECD growth in the *IEO2009* projections are the BRIC countries (Brazil, Russia, India, and China), which are expected to account for more than two-thirds of the growth in non-OECD industrial energy use through 2030. China's growth rate in industrial energy consumption, averaging 2.7 percent per year over the period, is higher than projected for any other major economy, and its industrial energy use nearly doubles from 2006 to 2030.

The industrial sector accounted for 76 percent of China's total delivered energy consumption in 2006 and is projected to remain above 70 percent through 2030. Since the beginning of economic reform in 1979, China's GDP has grown by 9.8 percent per year through 2007 [***33***]. The *IEO2009* reference case projects a slower but substantial average growth rate of 6.4 percent per year for China's GDP through 2030, despite a reduction in the 2006-2010 growth projection relative to the *IEO2008* reference case because of the global economic slowdown. With a return to strong growth between 2011 and 2015, China still is expected to account for more than one-fourth of total global GDP growth from 2006 to 2030.

In addition to the impact of strong economic growth on industrial energy demand in China, continued rapid increases in industrial demand can be explained in part by the structure of the Chinese economy. Although the energy intensity of production in individual industries has improved over time, heavy industry accounts for more than 70 percent of China's total output [***34***]. Energy-intensive industries, including steel, cement, and chemicals, provide inputs to China's massive export and construction sectors, which continue to flourish in the *IEO2009* projection. China is expected to construct an additional 65 billion square feet of building space by 2020—equal to Europe's current total building stock [***35***]—contributing to demand for basic materials and increased energy use in the industrial sector.

Government policy contributes as much as to the energy-intensive structure of the Chinese economy as does demand growth. A considerable share of heavy industrial production in China is carried out by large State-Owned Enterprises (SOEs), which are favored by Chinese economic policy. SOEs enjoy relatively easy access to capital through state-owned banks and other forms of government support, such as subsidized energy supplies [***36***]. In some of the first policy initiatives to address the recent economic downturn, China's government extended export tax support, financing, and some direct funding to the steel industry [***37***]. Taken together, those measures and existing government policies support continued expansion of China's industrial energy use in the reference case.

China's industrial fuel mix is projected to change somewhat over the projection period. Despite its abundant coal reserves, direct use of coal in China's industrial sector is grows by an average of only 1.9 percent per year in the reference case, while industrial use of electricity (most of which is coal-fired) grows by 4.6 percent per year. As a result, coal's share in the industrial fuel mix falls from 61 percent in 2006 to 51 percent in 2030, while electricity's share increases from 18 percent to 28 percent.

The vast majority of steel production in China, which accounts for one-third of the country's industrial energy use, employs the coal-intensive blast furnace process. As China's economy matures, however, and a more reliable inventory of scrap steel is developed, much of the steel manufacturing capacity added over the projection period uses the electricity-intensive electric arc furnace process. Additionally, as China continues to expand manufacturing in areas with higher added value, such as consumer electronics and computer components, the share of industries that use electricity instead of primary fuels increases.

Despite focusing primarily on economic development, the Chinese government also has introduced policy initiatives focused on improving industrial energy efficiency. In 2005, China released its 11th Five Year Economic Plan, which included the goal of reducing energy intensity by 20 percent between 2005 and 2010. In support of that goal, China introduced a "Top-1000 Energy-Consuming Enterprises" program, designed to improve the efficiency of the country's 1,000 largest energy consumers, which account one-third of China's total energy use. The program focuses on assisting major energy consumers through benchmarking, energy audits, technological assistance, and stricter reporting [***38***]. In the *IEO2009* reference case, China is projected to achieve a 16-percent reduction in the energy intensity of its GDP between 2005 and 2010, which falls short of the government's goal but still constitutes a substantial improvement. From 2006 to 2030, China's total energy intensity is projected to decline at a rate of 3 percent per year.

In the *IEO2009* reference case, India is projected to sustain the world's second-highest rate of GDP growth, averaging 5.6 percent per year from 2006 to 2030. This translates into a 2.3-percent average annual increase in delivered energy to the industrial sector. Although India is likely to achieve an economic growth rate similar to China's between 2006 and 2030, its levels of GDP and energy consumption continue to be dwarfed by those in China throughout the projection period. India's economic growth over the next 25 years is expected to derive more from light manufacturing and services than from heavy industry, so that the industrial share of total energy consumption falls from 72 percent in 2006 to 64 percent in 2030, and its commercial energy use grows nearly twice as fast as its industrial energy use. The changes are accompanied by shifts in India's industrial fuel mix, with electricity use growing more rapidly than coal use in the industrial sector.

India has been successful in reducing the energy intensity of its industrial production over the past 20 years. A majority of its steel production is from electric arc furnaces, and most of its cement production uses dry kiln technology [***39***]. A major reason is the Indian government's public policy, which provides subsidized fuel to citizens and farmers but requires industry to pay higher prices for fuel. Because the market interventions have spurred industry to reduce energy costs, India is now one of the world's lowest cost producers of both aluminum and steel [***40***]. The quality of India's indigenous coal supplies also has contributed to the steel industry's efforts to reduce its energy use. India's metallurgical coal (which is needed for steel production in blast furnaces) is low in quality, forcing steel producers to import more expensive metallurgical coal from abroad [***41***]. As a result, producers have invested heavily in improving the efficiency of their capital stock to lower the amount of relatively expensive imported coal used in the production process.

The Indian government has facilitated further reductions in industrial energy use over the past decade by mandating industrial energy audits in the Energy Conservation Act of 2001 and mandating specific consumption decreases for heavy industry as part of the 2008 National Action Plan on Climate Change. The new plan also calls for fiscal and tax incentives for efficiency, an energy-efficiency financing platform, and a trading market for energy savings certificates, wherein firms that exceed their required savings level will be able to sell the certificates to firms that have not [***42***]. Those measures contribute to a reduction in the energy intensity of India's GDP, which declines by an average of 2.9 percent per year from 2006 to 2030 in the *IEO2009* reference case.

In Russia, industrial energy consumption patterns are shaped largely by its role as a major energy producer. Russia's economy is projected to grow at a rate of 3.6 percent per year, with industrial energy demand growing by 0.9 percent per year and accounting for about 54 percent of the nation's total energy use throughout the reference case projection. The energy intensity of Russia's GDP is the highest in the world, and although its energy intensity declines in the reference case projection, Russia remains among the least energy-efficient economies in the world through 2030. The relative inefficiency of Russian industry can be attributed to Soviet-era capital stock and abundant and inexpensive domestic energy supplies. In the reference case, the share of natural gas, Russia's most abundant domestic fuel, in the country's industrial fuel mix increases, as does the share of electricity, most of which is provided by natural-gas-fired generation.

Brazil's industrial energy use grow at an average rate of 2.1 percent per year in the *IEO2009* reference case, as its GDP expands by 3.8 percent per year. Although continued growth in industrial output is expected through 2030, the Brazilian economy begins to move toward a service-based economy. The share of industry in total delivered energy use is projected to fall from 49 percent in 2006 to 45 percent in 2030, while the rate of growth for energy use in the commercial sector is projected double the rate in the industrial sector. Unlike most countries and regions, coal use in Brazil's industrial sector is projected to expand more rapidly than the use of any other fuel, primarily because of its burgeoning steel industry, which has become a significant global producer in recent years, based on plentiful domestic supplies of iron ore and increasing global demand for steel [***43***].

Industrial energy use in the Middle East grows on average by 2.1 percent per year from 2006 to 2030 in the *IEO2009* reference case. In terms of energy consumption, the largest industry in the Middle East is the chemical sector. Higher world prices for oil and natural gas have spurred new investment in the petrochemical sector, where companies can rely on low-cost feedstocks. Numerous "mega" petrochemical projects currently are under construction in Saudi Arabia, Qatar, Kuwait, the UAE, and Iran [***44***]. The Middle East is becoming a major manufacturer of the olefin building blocks that constitute a large share of global petrochemical output, and the region's ethylene production capacity is expected to double between 2008 and 2012 [***45***]. Liquids and natural gas are projected to maintain a combined 95-percent share of the Middle East's industrial fuel mix through 2030 in the reference case.

## References


1. International Energy Agency, *Energy Technology Perspectives: Scenarios and Strategies to 2050* (Paris, France, June 2008), pp. 471-473.
2. International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), p. 429.
3. International Energy Agency Data Services, *Energy Balances of Non-OECD Countries* (2007), web site http://data.iea.org (subscription site).
4. International Energy Agency, *Tracking Industrial Energy Efficiency and $CO_2$ Emissions* (Paris, France, June 2007), pp. 59-75.
5. Global Insight, Inc., "IHS Global Insight Report: Chemicals (World Industry)" (December 12, 2008), web site www.globalinsight.com (subscription site).
6. "Better Living Through Chemurgy," *The Economist* (June 26, 2008), web site www.economist.com (subscription site).
7. Global Insight, Inc., "IHS Global Insight Report: Steel (World Industry)" (March 13, 2008), web site www.globalinsight.com (subscription site).
8. American Iron and Steel Institute, "How a Blast Furnace Works," web site www.steel.org/AM/Template.cfm?Section=Articles3&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=25317.
9. World Steel Association, "World Steel in Figures 2008" (October 2008), web site www.worldsteel.org/pictures/publicationfiles/WSIF%202008%202nd%20edition.pdf.
10. World Steel Association, "World Steel in Figures 2008" (October 2008), web site www.worldsteel.org/pictures/publicationfiles/WSIF%202008%202nd%20edition.pdf.
11. International Energy Agency, *Energy Technology Perspectives: Scenarios and Strategies to 2050* (Paris, France, June 2008), p. 490.
12. Portland Cement Association, "Economics of the U.S. Cement Industry" (May 2008), web site www.cement.org/econ/industry.asp.
13. Cembureau (The European Cement Association), "Key Facts: Energy Is a Sensitive Factor in Cement Manufacturing" (2000-2009), web site www.cembureau.be.
14. Global Insight, Inc., "IHS Global Insight Report: Cement (U.S.) (World Industry)" (September 15, 2008), web site www.globalinsight.com (subscription site).

15. "Concrete Proposals Needed," *The Economist* (December 19, 2007), web site www.economist.com (subscription site).
16. American Forest and Paper Association, "Policy Issues: Energy" (2008), web site www.afandpa.org/Template.cfm?Section=Energy1&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=6&ContentID=3687.
17. "Flat Prospects," *The Economist* (March 15, 2007), web site www.economist.com (subscription site).
18. International Aluminum Institute, "Aluminum for Future Generations/2007 Update" (2007), web site www.world-aluminium.org/UserFiles/File/fl0000189.pdf.
19. Global Insight, Inc., "IHS Global Insight Report: Nonferrous Metals (World Industry)" (September 26, 2008), web site www.globalinsight.com (subscription site).
20. A. Simon, "Aluminum East of Suez: The Search for Cheap Electricity Supplies," *Power in Asia*, No. 516 (November 20, 2008), pp. 4-8.
21. The Aluminum Association, "Industry Overview" (2008), web site www.aluminum.org/AM/Template.cfm?Section=Overview&Template=/CM/HTMLDisplay.cfm&ContentID=27135.
22. International Aluminum Institute, "Aluminum for Future Generations/2007 Update" (2007), web site www.world-aluminium.org/UserFiles/File/fl0000189.pdf.
23. U.S. Department of Energy, "Industrial Technologies Program Fact Sheet," web site http://www1.eere.energy.gov/industry/about/pdfs/itp_program_fact_sheet.pdf.
24. 110th Congress, "Energy Independence and Security Act of 2007," Public Law 110-140, web site http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ140.110.
25. National Energy Board of Canada, "Energy Briefing Note: Codes, Standards, and Regulations Influencing Energy Demand" (Calgary, Alberta, November 2008), p. 13, web site www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgdmnd/cdstndrdrgltn2008/cdstndrdrgltn-eng.pdf.
26. Government of Canada, *Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions* (Ottawa, Ontario, March 2008), pp. 7-9, web site www.ec.gc.ca/doc/virage-corner/2008-03/pdf/COM-541_Framework.pdf.
27. European Commission, "Climate Change: Commission Welcomes Final Adoption of Europe's Climate and Energy Package" (Press Release, December 17, 2008), web site http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/1998&format=HTML&aged=0&language=EN&guiLanguage=en.
28. International Federation of Industrial Energy Consumers, "IFIEC Europe's Initial Response to the EU Climate Package: Challenging Climate Change Targets Require Cost Efficient Solutions" (Press Release, January 29, 2008), web site www.ifieceurope.org/docs/climate%20package%20resp%20press%20rel%2029%2001%2008.pdf.
29. "Keeping It Clean," *The Economist* (December 12, 2008), web site www.economist.com (subscription site).
30. Kensuke Kanekiyo, "Japanese Experience Toward Energy Efficient Economy," presentation at The China International Energy Forum (Beijing, November 1-2, 2007), web site http://eneken.ieej.or.jp/en/data/pdf/408.pdf.
31. World Steel Association, "World Steel in Figures 2008" (October 2008), web site www.worldsteel.org/pictures/publicationfiles/WSIF%202008%202nd%20edition.pdf.
32. K. Rudd, "Large Issues and Medium Powers," in *The World in 2009* (November 19, 2008), web site www.economist.com/theworldin (subscription site).
33. W.M. Morrison, *CRS Report for Congress: China's Economic Conditions* (Washington, DC: Congressional Research Service, November 20, 2009), p. 1, web site http://opencrs.com/document/RL33534/2008-11-20.
34. M. Herberg, "China's Energy and Environmental Crisis," presentation at The National Bureau of Asian Research Energy Panel Meeting (Naperville, IL, July 23, 2008).
35. The Climate Group, *China's Clean Revolution* (London, UK, 2008), pp. 15-17, web site www.theclimategroup.org/assets/resources/Chinas_Clean_Revolution.pdf.
36. J.L. Yifu, speech at "China and the Faltering Global Economy: A Brookings-Caijing Symposium," (Washington, DC, January 13, 2009), web site www.brookings.edu/~/media/Files/events/2009/0113_caijing/20090113_caijing.pdf.
37. Global Insight, Inc., "China To Accelerate Capacity Expansion of Steel, Petrochemical and Agrochemicals As Industrial Growth Slows" (November 20, 2008), web site www.globalinsight.com (subscription site).
38. L. Price and W. Xuejun, *Constraining Energy Consumption of China's Largest Industrial Enterprises Through the Top-1000 Energy-Consuming Enterprise Program*, LBNL-00000 (Berkeley, CA: Lawrence Berkeley National Laboratory, June 2007), p. 1, web site http://ies.lbl.gov/iespubs/2007aceee.pdf.

39. J.A. Sathaye, "India: Energy Demand and Supply and Climate Opportunities," presentation at the Workshop on Asia-Pacific Partnership on Clean Development and Climate Opportunities in China and India (Washington, DC, March 22, 2006), web site. http://ies.lbl.gov/ppt/indiasupplydemand.pdf.
40. "Melting Asia," *The Economist* (June 5, 2008), web site www.economist.com (subscription site).
41. Energy Information Administration, *International Energy Outlook 2008*, DOE/EIA-0484(2008) (Washington, DC, September 2008), web site www.eia.doe.gov/oiaf/ieo/index.html.
42. Government of India—Prime Minister's Council on Climate Change, *National Action Plan on Climate Change* (June 2008), pp. 22-24, web site www.pmindia.nic.in/Pg01-52.pdf.
43. "ArcelorMittal Hopes Brazil Model Will Give India Plans a Boost," *Hellenic Shipping News* (February 9, 2008), web site www.hellenicshippingnews.com/index.php?mod=article&cat=commoditynews&article=8720.
44. FACTS Global Energy, *Energy Advisory: Middle East Olefin Production Prospects: Oversupply in the Market?*, No. 342 (December 2008), pp. 2-3.
45. "SPECIAL REPORT: CMAI: Wave of New Mideast Olefins Capacity Coming On Line," *Oil and Gas Journal*, Vol. 106, No. 32 (August 25, 2008), web site www.ogj.com (subscription site).

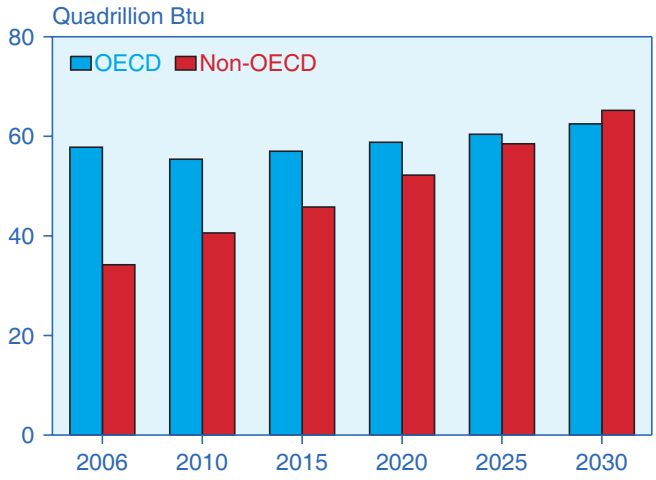
# Chapter 7
# Transportation Sector Energy Consumption

***In the IEO2009 reference case, transportation energy use in the non-OECD countries increases by an average of 2.7 percent per year from 2006 to 2030, as compared with an average of 0.3 percent per year for the OECD countries.***

Over the next 25 years, world demand for liquids fuels is projected to increase more rapidly in the transportation sector than in any other end-use sector. In the *IEO2009* reference case, the transportation share of total liquids consumption increases from 51 percent in 2006 to 56 percent in 2030. Over the 2006-2030 period, transportation accounts for nearly 80 percent of the total increase in world liquids consumption. Much of the growth in transportation energy use is projected for the non-OECD nations. Many rapidly expanding non-OECD economies are expected to see strong growth in energy consumption as transportation systems are modernized and income per capita increases the demand for personal motor vehicle ownership. Non-OECD transportation energy use increases by an average of 2.7 percent per year from 2006 to 2030, as compared with an average of 0.3 percent per year for transportation energy consumption in the OECD countries, where transportation systems are generally well established (Figure 69 and Table 13).

In the transportation sector, energy provides mobility for people and goods. For people, mobility provides access to employment opportunities, friends and family, grocery and clothing stores, entertainment and leisure activities, and medical and financial services, to name a few. For businesses, mobility provides access to the means of production (raw materials, human resources, and the output of other businesses), as well as access to markets for their products. Understanding patterns in

**Figure 69. OECD and Non-OECD Transportation Sector Liquids Consumption, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table 13. World Energy Consumption for Transportation by Country Grouping, 2006-2030**
(Quadrillion Btu)

| Region | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| **OECD** | **57.8** | **55.4** | **57.0** | **58.8** | **60.4** | **62.5** | **0.3** |
| North America | 32.6 | 31.8 | 32.8 | 33.6 | 35.0 | 36.9 | 0.5 |
| Europe | 17.8 | 16.5 | 16.7 | 17.4 | 17.5 | 17.6 | 0.0 |
| Asia | 7.4 | 7.1 | 7.5 | 7.8 | 7.9 | 8.0 | 0.3 |
| **Non-OECD** | **34.2** | **40.6** | **45.8** | **52.2** | **58.5** | **65.2** | **2.7** |
| Europe and Eurasia | 6.8 | 7.7 | 8.1 | 8.5 | 8.7 | 9.0 | 1.2 |
| Asia | 13.0 | 15.8 | 19.6 | 24.4 | 28.8 | 33.2 | 4.0 |
| Middle East | 5.0 | 6.0 | 6.6 | 7.2 | 7.9 | 8.9 | 2.4 |
| Africa | 3.3 | 3.8 | 4.0 | 4.2 | 4.5 | 4.7 | 1.5 |
| Central and South America | 6.0 | 7.3 | 7.5 | 7.9 | 8.6 | 9.4 | 1.9 |
| **Total World** | **91.9** | **96.0** | **102.8** | **111.0** | **118.9** | **127.7** | **1.4** |

Note: Totals may not equal sum of components due to independent rounding.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

transportation energy demand is important, because distances traveled and modes used to attain access in the future may differ from historical trends.

Because access to people, goods, and services (rather than mobility *per se*) is the prime consideration for assessing demand growth in the transportation sector, factors that have nothing to do with transportation equipment can have profound effects on the amount of energy consumed. For example, advances in communication technologies have made it possible for consumers to have a high degree of access to financial services without traveling to a financial institution. Similarly, high-speed Internet communication has increased the productivity of telecommuters, reducing traffic congestion, air pollution, and transportation energy demand.[37]

The difference between mobility and access is particularly important for the analysis of transportation systems in today's rapidly developing and urbanizing economies. Transportation equipment provides no services without roads, rail lines, ports, and airports. Such infrastructure is expensive to build and maintain, and infrastructure decisions made in the near term affect energy use (and greenhouse gas emissions) in the future. Where urban rail systems are built, they affect modes of travel to and from workplaces for many years to come.

Development that proceeds without a plan may result in the need to construct infrastructure in "catch-up mode," with developers continually addressing existing congestion problems rather than shaping transportation demand patterns. Suburban sprawl in one generation limits economical transportation choices in the future. In particular, in the developing non-OECD regions where urbanization is still in early stages and much of the urban transportation infrastructure has not yet been built, transportation energy needs over the long-term future will be affected substantially by policy decisions made in the coming decades.

In many non-OECD countries, walking and bicycling play important roles in personal transport, and handcarts and draft animals are widely used in commerce. Given its large base level in those countries, small declines in the nonmotorized share of the transportation activity translate into very large growth rates for motorized travel. Uncertainty about the future role of nonmotorized transport in the world's emerging economies introduces additional uncertainty to the *IEO2009* projections, as does uncertainty about the form and pace of urbanization. For example, will rapid urbanization in developing Asia follow the U.S. pattern of ring roads surrounding central cities, or will mixed land-use patterns and more compact cities be emphasized as a matter of policy?

Another uncertainty in non-OECD nations, where buses now account for a major share of motorized passenger transport, is whether attractive and affordable bus systems will be developed to maintain heavy ridership or personal automobiles will replace buses for most trips. The answers to such questions will shape future transportation energy consumption, and the answers are highly uncertain. Further, the outlook does not incorporate any changes in transportation energy use that might occur as a result of future legislation or policies aimed at reducing greenhouse gas emissions, which could also substantially alter the projections.

The *IEO2009* reference case assumes that, as personal income grows in the developing non-OECD nations, demand for personal motor vehicles will grow, and major urban areas will address the accompanying congestion and strains on infrastructure with a variety of solutions, including development of mass transit (bus and/or rail) and urban design that reduces vehicle miles traveled, among other improvements to transportation networks. In non-OECD Asia, for example, the reference case projects that energy use for personal motor vehicles (light-duty cars and trucks, as well as two- and three-wheel vehicles) will increase by 3.6 percent per year from 2006 to 2030, while energy use for public passenger travel (rail and bus) also increases by a robust 2.8 percent per year.

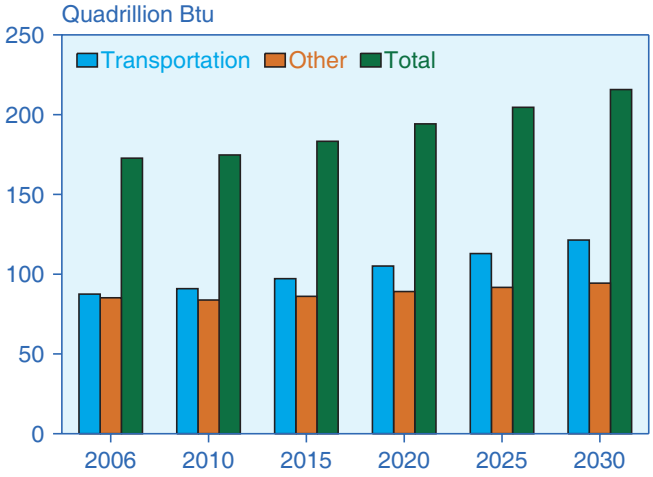
Projected world oil prices in the *IEO2009* reference case are significantly higher than projected in last year's outlook. In *IEO2009*, oil prices are 80 percent higher in 2030 than projected in *IEO2008*. As a result, consumers in end-use sectors other than transportation (notably, the electric power and industrial sectors) are expected to switch to other fuels where possible. In the transportation sector, however, liquid fuels remain the most widely used energy source, and the impact of high prices on demand for liquid fuels is comparatively modest. World demand for liquid fuels in the transportation sector increases by 1.4 percent per year on average from 2006 to 2030—only 0.2 percentage points below the average increase in the *IEO2008* reference case.

In the *IEO2009* projections, the transportation sector continues to rely heavily on liquid fuels to meet demand for travel. Total world liquids consumption increases by 25 percent from 2006 to 2030 (Figure 70). Given the world oil price environment projected in the reference case, economic incentives will prompt consumers to find substitutes for liquid fuels. In the OECD nations, liquids

[37] Commerce conducted via the Internet ("e-commerce") may also reduce the number of consumer shopping trips; however, because getting the product to individual consumers' residences quickly via delivery vans is a fuel-intensive process, it is unclear whether consumption of transportation fuels would decline as a result.

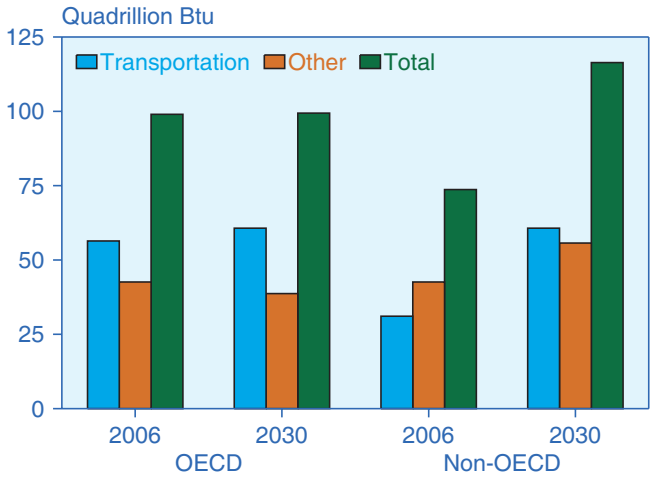
consumption outside the transportation sector is projected to decline (Figure 71), especially in the electric power sector, where the use of petroleum products declines by 1.3 percent per year from 2006 to 2030. In the non-OECD nations, the transportation sector accounts for 69 percent of the projected increase in liquids consumption, with liquids used for feedstock in the chemical industry accounting for most of the rest. Worldwide, the non-OECD nations are expected to account for 87 percent of the total increase in transportation energy use.

**Figure 70. World Liquids Consumption by End-Use Sector, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 71. OECD and Non-OECD Liquids Consumption by End-Use Sector, 2006 and 2030**



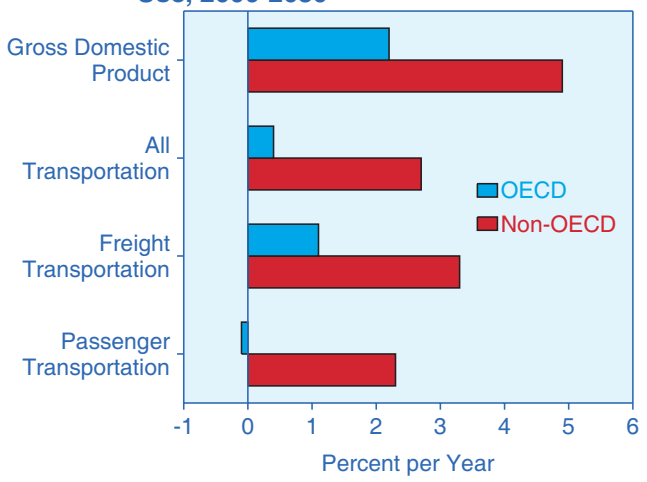

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

Growing demand for transportation services in the non-OECD countries is the most important factor affecting the projections for world liquids consumption. In 2006, the OECD nations consumed 81 percent more liquid fuels for transportation than the non-OECD nations. In 2030, however, the totals for OECD and non-OECD liquids consumption for transportation are approximately equal at 61 quadrillion Btu. For the OECD countries, the transportation share of total liquids consumption increases from 57 percent in 2006 to 61 percent in 2030. For the non-OECD countries, the transportation share of total liquids consumption increases from 42 percent in 2006 to 52 percent in 2030.

Growth in fuel consumption to move both freight and people is correlated with economic growth (as measured by GDP) in both the OECD and non-OECD countries. In the more service-oriented OECD economies, the link between economic growth and transportation energy use is weaker than in the developing non-OECD economies. From 2006 to 2030, the rate of increase in total transportation energy consumption is 15 percent of the projected GDP growth rate in the OECD countries, compared with 55 percent in the non-OECD countries (Figure 72).

In the non-OECD nations, transportation energy services need to be considered within the broader context of economic and social development. Sustained high rates of economic growth probably would be impossible without rapid modernization of national transportation systems to move raw materials and finished products. For much of the developing world, animal power still is

**Figure 72. Average Annual Growth in OECD and Non-OECD Gross Domestic Product and Transportation Sector Delivered Energy Use, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

a prime means of freight transport, and walking is a prime means of personal transport. As a result, particularly in rural developing regions, growth in transportation services and energy use does not follow economic growth but, rather, enables it. Products and services are not produced if they cannot reach consumers, and without modern transportation systems economic growth may be severely limited.

Freight transportation energy use includes fuels used by large trucks, freight trains, and both domestic and international marine vessels.[38] Passenger transportation energy use includes fuels used in light-duty vehicles, buses, aircraft, and passenger trains. In 2006, about two-thirds of transportation energy use in the OECD countries was for passenger travel; that share declines slightly from 2006 to 2030. For the non-OECD nations, passenger travel accounted for 56 percent of total transportation energy use in 2006, and the share falls to 51 percent in 2030. Although energy consumption for passenger transportation grows by 2.4 percent per year in the non-OECD countries and declines by 0.1 percent per year in the OECD countries, passenger-related energy use in the developing world remains far below levels in the OECD on a per capita basis.

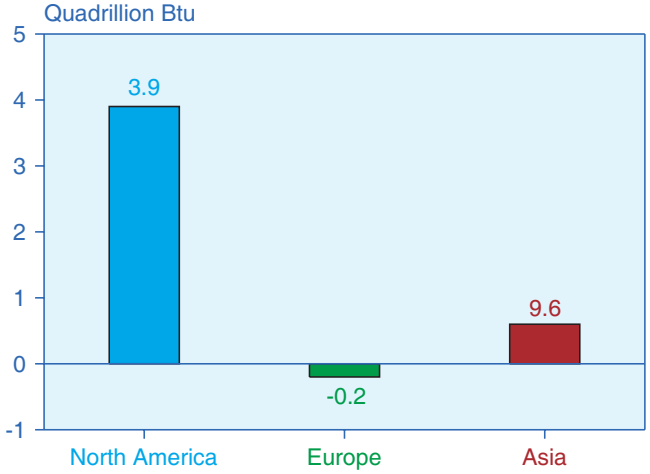
## OECD Countries

Transportation infrastructure in the OECD countries generally is well established. Roads and highways connect most population centers, and motorization levels (vehicles per 1,000 people), which already are high, probably will reach saturation over the course of the projection period. As the OECD economies have become more service-oriented, the link between income and the transportation of goods has weakened. The established transportation sectors and relatively slow rates of GDP growth and population growth among the OECD economies lead to the expectation that transportation energy demand will increase only modestly from 2006 to 2030. It is projected to grow at an average annual rate of 0.3 percent in the *IEO2009* reference case, from 57.8 quadrillion Btu in 2006 to 62.5 quadrillion Btu in 2030 (see Figure 71). The projection assumes that infrastructure developments in the OECD nations represent incremental changes to existing transport systems.

North America accounts for 92 percent of the increase in OECD liquids consumption for transportation in the reference case (Figure 73), and the United States accounts for 79 percent of that increase (even though the rate of increase in U.S. transportation liquids use is less than one-half the corresponding rate for Mexico). U.S. delivered energy consumption in the transportation sector grows from 28.6 quadrillion Btu in 2006 to 31.9 quadrillion Btu in 2030. In 2030, U.S. transportation energy demand is about 1.1 quadrillion Btu lower than the amount projected in last year's outlook,[39] largely because of higher energy prices and a revision in the way the Energy Independence and Security Act 2007 (EISA2007) corporate average fuel economy (CAFE) standards are handled. EISA2007 includes provisions for improving the CAFE standards applicable to new light-duty vehicles (both cars and light trucks). To meet the mandated fuel economy levels, sales of unconventional vehicle technologies[40]—such as flex-fuel, hybrid, and diesel vehicles—increase over the projection period, and the growth of new light truck sales slows.

In 2008, U.S. Public Law 110-343, the Energy Improvement and Extension Act of 2008 (EIEA2008) was enacted. EIEA2008 Title II, Section 205, provides a tax credit for the purchase of new, qualified plug-in electric drive motor vehicles.[41] According to the legislation,

**Figure 73. Change in OECD Transportation Sector Liquids Consumption by Region, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[38] In the *IEO2009* projections, fuel use in dedicated freight aircraft is included with fuel use in passenger aircraft.

[39] Primarily as a result of lower projected industrial output, U.S. energy demand for freight transportation is 0.8 quadrillion Btu lower in the *updated AEO2009* reference case (April 2009) than in the *published AEO2009* reference case projection (March 2009) discussed in this report.

[40] Vehicles that use alternative fuels, electric motors and advanced electricity storage, advanced engine controls, or other new technologies.

[41] The *updated AEO2009* reference case (April 2009) incorporates ARRA2009 modifications to the plug-in hybrid electric vehicle tax credits that increase the number of vehicles covered to 200,000 per manufacturer and also eliminate the tax credit's expiration on December 31, 2014. In addition, the *updated* reference case includes the ARRA tax credit of 10 percent against the cost of a qualified plug-in all-electric vehicle.

beginning two calendar quarters after the first quarter in which the cumulative number of qualified plug-in electric vehicles sold reaches 250,000, the credit will be reduced by 50 percent in the first two calendar quarters of the phaseout period and by another 25 percent in the third and fourth calendar quarters. The credit is scheduled to be eliminated after December 31, 2014, regardless of how many qualifying vehicles have been sold. In the *IEO2009* reference case, plug-in hybrid electric vehicle sales grow quickly as a result of the tax credits, rising to 90,000 annually in 2014. In 2030, plug-in hybrid electric vehicles account for 2 percent of all sales of new light-duty vehicles in the United States [***1***]. Overall, hybrid vehicle sales increase from 2 percent of new light-duty vehicles in 2007 to 38 percent in 2030.

The *updated AEO2009* reference case (April 2009), incorporates ARRA2009 modifications to the U.S. tax credits for plug-in hybrid electric vehicles, which increase the number of vehicles covered to 200,000 per manufacturer and eliminate the tax credit's expiration on December 31, 2014. In addition, the *updated* reference case includes the ARRA2009 tax credit of 10 percent against the cost of a qualified plug-in all-electric vehicle. ARRA2009 also contains several changes to the plug-in hybrid electric vehicle tax credit originally included in EIEA2008, and those changes also are included in the *updated AEO2009* reference case.

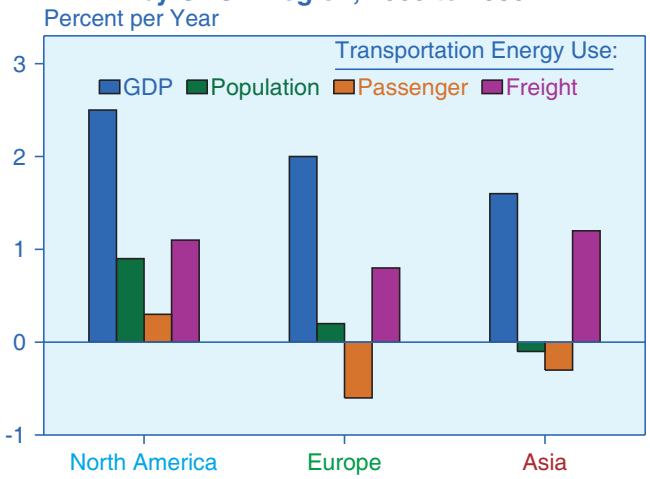
For plug-in hybrid electric vehicles, ARRA2009 allows a $2,500 tax credit for the purchase of qualified vehicles with a battery capacity of at least 4 kilowatthours. Starting at a battery capacity of 5 kilowatthours, plug-in hybrids earn an additional battery credit of $417 per kilowatthour, up to a maximum of $5,000. The maximum total hybrid vehicle credit that can be earned is capped at $7,500 per vehicle. Tax credit eligibility and phaseout are specific to the individual vehicle manufacturers. The credits are phased out when cumulative sales of qualified vehicles reach 200,000 vehicles. The phaseout period begins two calendar quarters after the first date later than December 31, 2009, on which a manufacturer's sales reach the cumulative sales maximum. The credit is reduced to 50 percent of the total value for the first two calendar quarters of the phaseout period and then to 25 percent for the third and forth calendar quarters, before being eliminated entirely thereafter. The credit applies to plug-in hybrid vehicles with gross vehicle weight rating less than 14,000 pounds. The ARRA2009 tax credit for qualified plug-in all-electric vehicles with a battery capacity of at least 4 kilowatthours is subject to the same phaseout schedule as the credits for plug-in hybrid electric vehicles.

Canada's current mix of transportation energy use is similar to that in the United States (personal motor vehicles are fueled largely by motor gasoline rather than diesel or alternative fuels), and it is projected to remain so in the *IEO2009* reference case. The markets of the two countries are largely interconnected, not only because of their proximity but also because of similar geography and demographics. As in the United States, the fastest growth in Canada's transportation fuel use is expected to be in the form of jet fuel and distillate fuel. For both countries, growth in total demand for transportation fuels averages less than 1.0 percent per year in the reference case from 2006 to 2030 [***2***].

In Mexico, relatively strong GDP growth (3.4 percent per year) is projected to increase energy consumption in the transportation sector at an average rate of 1.0 percent per year, from 1.5 quadrillion Btu in 2006 to 2.0 quadrillion Btu in 2030. The projected increase in transportation fuel use is based on expected growth in trade with the United States and overall improvement in the country's standard of living.

In OECD Europe, slow population growth, high transportation fuel costs, and environmental policies contribute to slow growth in transportation energy use in the *IEO2009* reference case. OECD Europe's population increases by 0.2 percent per year; the countries of the region already have mature transportation systems; and improvements in energy efficiency over the course of the projection result in passenger transportation energy use that declines by an average of 0.6 percent per year from 2006 to 2030 (Figure 74). Despite the slow growth projected for OECD Europe's population, economic growth continues at an average rate of 2.0 percent per year, and energy use for freight transportation grows by an average of 0.8 percent per year. The growth in fuel use

**Figure 74. Average Annual Change in Gross Domestic Product, Population, and Energy Consumption for Transportation by OECD Region, 2006 to 2030**



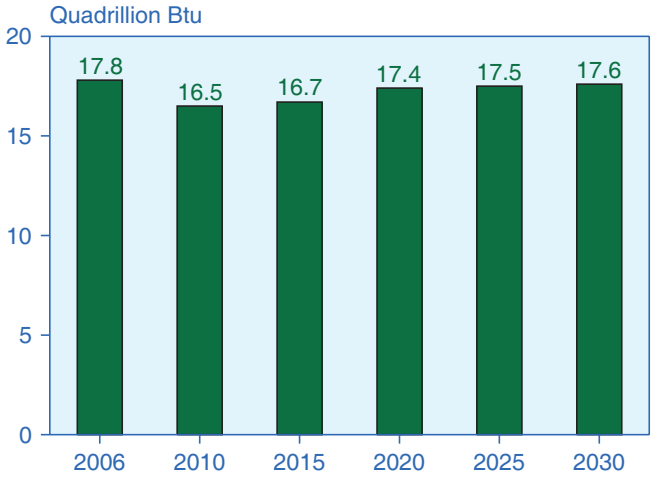

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

to move freight outweighs the decline in fuel use for passenger transport over the projection period.

OECD Europe's transportation energy consumption contracts strongly in the short term, as a result of the runup in world oil prices from 2004 to mid-2008 and the present global recession. In the reference case, OECD Europe's transportation energy use falls from 17.8 quadrillion Btu in 2006 to 16.5 quadrillion Btu in 2010, then rises slowly to 17.6 quadrillion Btu in 2030, as the region's economies recover in the long term (Figure 75). The transportation share of total delivered energy use in OECD Europe falls slightly, from 29 percent in 2006 to 28 percent in 2010, and remains at that level for the rest of the projection.

With increasing concerns about the impacts of freight road transport on pollution and congestion, the European Union (EU) has introduced a program to shift the modal shares of freight transport. The EU's Marco Polo program provides funding to commercial projects that result in a reduction in freight road transport by shifting it to "rail, sea, and inland waterways."[42] As part of the program, a subsidy of 2 euros per metric ton-kilometer is offered for freight shifted from road to one of the alternative transportation modes. The stated goal of the program is to reduce congestion and pollution and to allow for the "more reliable and efficient transport of goods." Marco Polo began in 2007, and 450 million Euros have been committed for the period through 2013 to fund mode-switching projects.

**Figure 75. Energy Consumption for Transportation in OECD Europe, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

OECD Asia, like OECD Europe, generally has well-established transportation infrastructures; however, with population in the region as a whole projected to contract (averaging -0.1 percent per year from 2006 to 2030), a decline in passenger transport demand is expected. The region's passenger transportation energy use declines by about 0.3 percent per year from 2006 to 2030 in the *IEO2009* reference case (see Figure 74). In the near term, the global economic recession has a strong dampening affect on transportation sector energy use, as manufacturing and consumer demand for goods and services slows substantially. Total demand for transportation fuels in OECD Asia declines from 7.4 quadrillion Btu in 2006 to 7.1 quadrillion Btu in 2010, then increases slowly to 8.0 quadrillion Btu in 2030. The largest increases are expected in South Korea, Australia, and New Zealand.

In Japan, transportation energy use declines by 0.3 percent per year on average, as the population declines by a total of 7.5 percent (10 million people) from 2006 to 2030. As a result, energy use in the country's passenger transportation sector in 2030 is projected to be 9 percent below the 2006 level. Although Japan's GDP growth averages 0.8 percent per year, its energy use for freight transportation increases on average by only 0.4 percent per year.

In South Korea, transportation energy use is projected to grow by 0.7 percent per year in the *IEO2009* reference case. The country has the region's strongest projected GDP growth, averaging 3.3 percent per year from 2006 to 2030, and its transportation infrastructure is still relatively young compared with those in Japan and Australia/New Zealand. South Korea accounts for about one-fourth of OECD Asia's total population, and its share of OECD Asia's transportation energy use is projected to increase from 26 percent in 2006 to 29 percent in 2030. Energy use for freight transportation in South Korea is projected to increase by an average of 1.7 percent per year, and its share of OECD Asia's total energy use for freight movement increases from 29 percent in 2006 to 34 percent in 2030, reflecting an increase in its share of OECD Asia's total GDP from 16 percent to 23 percent.

In Australia/New Zealand, transportation energy use is projected to grow by average of 1.2 percent per year, based on modest population growth and average annual GDP growth of 3.0 percent. As in South Korea, freight transportation is the key factor behind the projected increase in transportation fuel demand for Australia/New Zealand in the *IEO2009* reference case, rising from 0.5 quadrillion Btu in 2006 to 0.8 quadrillion Btu in 2030, at an average annual rate of 2.3 percent. Air travel

[42] Under the Director General for Energy and Transport of the European Commission, 450 million euros has been committed to the Marco Polo project for 2007-2013.

also is expected to count for a substantial part of the growth in Australia/New Zealand's transportation fuel demand, as income growth raises standards of living and demand for business and vacation travel. Passenger air travel in Australia/New Zealand increases by 3.5 percent per year over the projection period, from 79 billion passenger miles traveled in 2006 to 181 billion passenger miles traveled in 2030.

## Non-OECD Countries

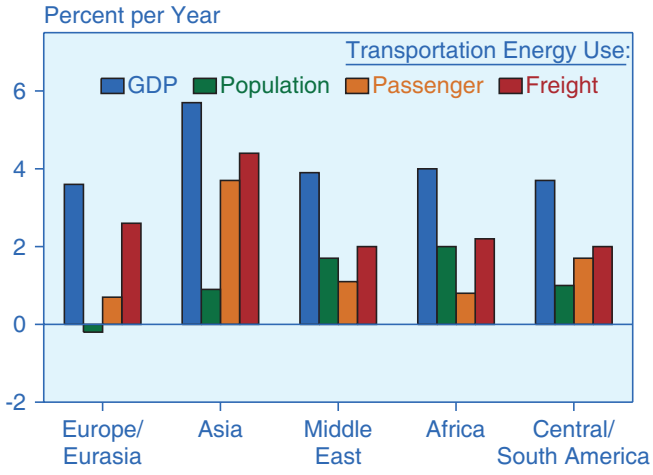
The projected average growth rate for transportation energy use in the non-OECD countries from 2006 to 2030, at 2.7 percent per year, is 8 times higher than the projected rate for OECD countries, and the use of liquids in the non-OECD transportation sector as a whole nearly doubles over the period. In non-OECD Asia, transportation energy consumption for both passenger and freight transportation increases more rapidly than in the other non-OECD countries (Figure 76). In total, China, India, and the other developing countries of non-OECD Asia are expected to sustain high rates of economic growth over the forecast, accounting for almost one-half of the increase in world GDP from 2006 to 2030. In 2030 they represent 37 percent of the world economy, up from 22 percent in 2006. Over the same period, non-OECD Asia's share of world transportation liquids consumption increases from 14 percent to 27 percent (Figure 77).

China has been, and is projected to continue to be, the fastest-growing economy among non-OECD countries. From 2006 to 2030, China's GDP increases by an average of 6.4 percent per year in the reference case projection, and its use of transportation fuels increases by 4.8 percent per year for passenger and 5.2 percent per year for freight transportation. From 1996 to 2006, growth in the combined length of China's highways averaged 11.3 percent per year, and GDP expanded by an annual average of 9.3 percent [*3*]. Over the same period, passenger miles traveled and ton-miles of highway freight travel increased at annual rates of 7.5 and 6.9 percent, respectively. India, similarly, has been expanding its road infrastructure to keep pace with economic growth.

China's passenger transportation energy use per capita is projected to triple over the projection period, and India's is projected to double. Nevertheless, China's energy consumption per capita for passenger transportation in 2030 still is only about one-fourth of South Korea's, and India's is less than one-tenth of South Korea's (Figure 78). In part, this is because of the importance of nonmotorized transport—including handcarts and bicycles—in China and India. It is also explained in part by the differences between rural and urban population shares in China and India and in South Korea.

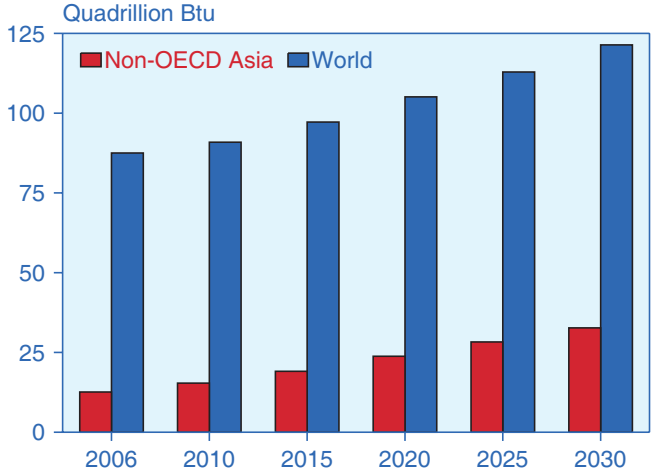
In 2007, according to the United Nations, 42 percent of China's population and only 29 percent of India's population were considered urban [*4*]. In contrast, 81 percent of South Korea's total population is urban. The urban share of total population is expected to increase in both China and India, but even in 2025 the United Nations expects China's urban share of population to be only 57 percent and India's only 37 percent. As a result, even with the fast-paced economic growth projected for China and India in the *IEO2009* reference case, their levels of transportation energy use per capita in 2030 do not reach the corresponding level in substantially more urban South Korea.

**Figure 76. Average Annual Change in Gross Domestic Product, Population, and Energy Consumption for Transportation by Non-OECD Region, 2006 to 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 77. Non-OECD Asia and World Transportation Sector Liquids Consumption, 2006-2030**



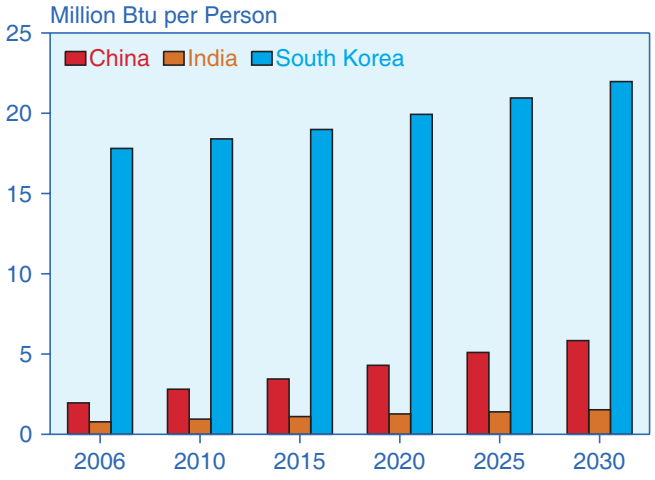

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

Both China and India have become major vehicle markets. In fact, China became the world's second-largest vehicle market after the United States in 2006, when sales exceeded those in Japan [*5*]. In 2007, China produced nearly 8.9 million motor vehicles, an increase of 22 percent over production in 2006. The country became the third-largest vehicle producer in the world after Japan and the United States and accounted for more than one-tenth of the world's total motor vehicle production [*6*]. The recent economic downturn reduced the growth in China's vehicle sales to less than 7 percent in 2008, the first time since 1999 that annual growth in sales had fallen below 10 percent [*7*].

A further reduction in vehicle sales growth is expected for China in 2009. The Chinese government is trying to shore up sales, however, with a 50-percent cut, as of January 20, 2009, in the car purchase tax on low-emission vehicles with engines under 1.6 liters—from 10 percent to 5 percent of the vehicle purchase price [*8*]. Several domestic manufacturers of eligible cars, including Chery, Geely, and BYD, posted record high sales in the month after the incentive was announced; however, it is unclear how long the trend will last, given the country's slowing economic growth. The sales incentive is scheduled to end on December 31, 2009.

In addition, China's government announced plans for an economic stimulus package valued at 4 trillion Yuan (about $585 billion U.S. dollars), as the global economic situation worsened. Of the total package, 1.8 trillion Yuan is expected to be used for infrastructure improvements in the electric power and transportation sectors, including construction of new railways, subways, and airports in the southwestern part of the country, where an earthquake caused extensive damage in May 2008 [*9*].

**Figure 78. Energy Consumption for Passenger Transportation per Capita in China, India, and South Korea, 2006-2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

India's motor vehicle sales also have been affected by the global economic difficulties. In 2008, car sales through October were only 5.6 percent higher than in 2007—the slowest monthly growth since July 2005 [*10*]. Difficulties for consumers trying to obtain financing—because of both high borrowing costs and more difficult loan conditions stemming from the global economic crisis—make the growth in India's car sales will remain relatively weak in the near term. As in China, concerns about the drop in Indian car sales have prompted the national government to offer incentives to support sales by reducing the value-added tax on vehicle purchases and reducing motor fuel costs by 10 percent in December [*11*].

India's automobile producers manufactured 2.3 million vehicles in 2007, making it the world's tenth-largest motor vehicle producer [*12*]. The Indian automotive industry is a fairly important component of the country's economy, accounting for about 5 percent of its total GDP. India's motor vehicle manufacturers aspire to improve their penetration of the world's automotive sector. India's government has estimated that the country's production of passenger cars—largely supported by anticipated robust economic growth—will increase from 1.7 million vehicles in 2007 to 3.0 million vehicles in 2015, although clearly the worsening economic climate may delay the achievement of such a target [*13*].

The *IEO2009* reference case projection assumes robust growth in travel for both personal (cars and 2- and 3-wheel vehicles) and public (bus and rail) land transport modes in non-OECD Asia. In China, for instance, while passenger travel (annual passenger miles) in personal vehicles grows at an average of 5.0 percent from 2006 to 2030, public vehicle travel also increases by 3.3 percent per year. Total passenger travel using public vehicles more than doubles over the projection period. The personal transportation service provided by motor vehicles, along with an expanding road infrastructure, greatly increases the mobility of the labor force and helps support continued high rates of economic growth. Although new vehicles are expected to achieve high levels of fuel efficiency per mile, the growing fleet of automobiles will replace even more fuel-efficient motorcycles, and motorcycles will continue to replace bicycles.

Figure 79 compares travel shares of personal and public vehicles for passenger land travel in non-OECD Asia (China, India, and other non-OECD Asia) and OECD Asia (Japan, South Korea, and Australia/New Zealand). The public vehicle share of passenger land travel declines modestly in both OECD Asia and non-OECD Asia in the *IEO2009* reference case. In OECD Asia, the decline is from 32 percent to 28 percent and in non-OECD Asia the decline is from 66 percent to 59 percent between 2006

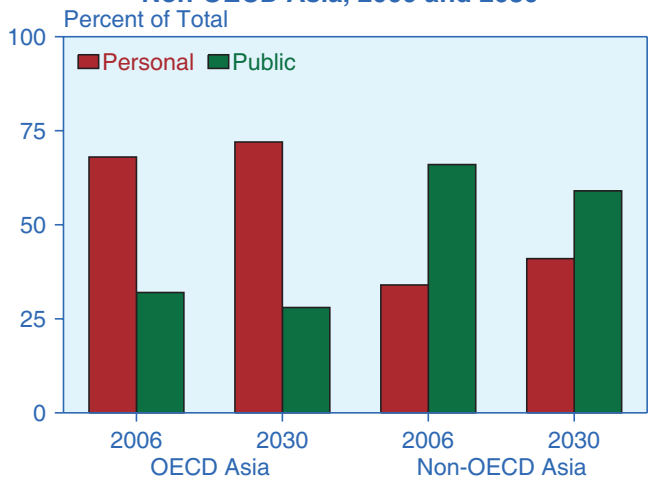
and 2030. Thus, reliance on public transport in 2030 in non-OECD Asia is still twice the level in OECD Asia.

Differences in the way in which passenger services are provided help explain the large disparity in passenger transportation energy use per capita shown in Figure 78. The reference case projects substantial increases in travel by both public and personal modes over the next two decades; however, small differences from the projected modal shares in 2030 would have large impacts on the projected levels of energy use. If China's transportation system developed in a manner similar to South Korea's, significantly more energy would be required for passenger travel in China in 2030.

Russia is another non-OECD country in which the transportation sector has been growing rapidly over the past several years, as higher energy prices (Russia is a net exporter of oil and natural gas) have bolstered the economy and spurred robust growth in car sales. Motor vehicle sales in Russia increased by 29 percent from 2006 to 2007, and total sales reached 3.2 billion in 2008 [***14***]. Not surprisingly, because of the collapse of commodity prices in late 2008 and the global economic downturn, the outlook for Russia's personal automobile sales in 2009 is fairly pessimistic. Some analysts are projecting a decline in sales by as much as 25 to 50 percent this year.

In the *IEO2009* reference case, Russia's energy consumption for passenger transportation declines at an average rate of 0.8 percent per year from 2006 to 2030, while the Russian population declines by an average of 0.6 percent per year (for a total population reduction of 19 million).

**Figure 79. Personal and Public Transportation Shares of Total Passenger Miles Traveled in OECD Asia and Non-OECD Asia, 2006 and 2030**




Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

Thus, passenger energy use per capita is projected to decrease by an average of 0.2 percent per year.

The population in the rest of non-OECD Europe and Eurasia is expected to be virtually unchanged between 2006 and 2030, while energy consumption for passenger transportation per capita is projected to increase at a yearly rate of 1.1 percent, compared with 3.7-percent annual growth in income per capita. Based on economic growth averaging 3.7 percent per year in non-OECD Europe and Eurasia (excluding Russia), energy use for freight transportation is projected to grow by an average of 2.8 percent per year, reflecting improvements in standards of living among countries that have continued to prosper since the fall of the Soviet Union. Rising standards of living fuel the demand for merchandise and appliances and the need to ship those goods to market.

Energy consumption for transportation in the Middle East grows by an average of 2.4 percent per year from 2006 to 2030 in the reference case, to a total of 8.9 quadrillion Btu in 2030. The Middle East has a relatively small population and is not a major energy-consuming region but rather an exporter; however, rapid population growth in the region is expected to result in increased demand for transportation. Transportation energy use has been expanding quickly in the Middle East, at a rate greatly exceeding the world average. From 2000 to 2006, the Middle East's total transportation energy use increased by an annual average of 5.5 percent, compared with the worldwide increase of 2.4 percent per year [***15***]. The region's oil and natural gas producers had some of the fastest growth in transportation energy demand from 2000 to 2006: 4.7 percent per year in Saudi Arabia; 6.9 percent per year in Iran; 7.7 percent per year in Kuwait; and an impressive 16.4 percent per year in Qatar.

Saudi Arabia, Kuwait, and Iran, among other Middle Eastern nations, have maintained transport subsidies for their citizens despite the persistent high world oil prices of the past few years, which has discouraged conservation or efficiency of use [***16***]. On the other hand, high world oil prices have increased revenues from oil exports in many of the exporting nations, and as a result several transportation infrastructure projects, including those for mass transit, are underway. For instance, the government in Saudi Arabia has launched a $624 billion investment program that will run through 2020, including $140 billion for transportation infrastructure.

There are plans to expand the Saudi rail system by adding 2,400 miles of new rail lines. Similar in geographic size to OECD Europe, Saudi Arabia currently has a rail network consisting of only one 283-mile passenger line between Riyadh and the port of Dammam and one 350-mile freight line between the two cities. One of the three new major railway projects is the East-West

railway project (also known as the "Saudi Land Bridge"), a 600-mile line that will link the capital Riyadh to the Red Sea port of Jeddah, and a 75-mile line from Dammam north along the Gulf coast to Jubail. The second project is the Mecca-Medina Rail Link, which will be a 315-mile high-speed passenger railway connecting Jeddah with the two holy cities [***17***]. A third rail project, the North-South Railway (NSR) already is under construction and should be completed by 2010 [***18***]. The NSR freight project consists of 1,400 miles of rail that will link northern Saudi Arabia with the Gulf coast and Riyadh.

Air travel infrastructure is also being expanded in several Middle Eastern countries. As countries in the region become increasingly prosperous, the demand for business and leisure air travel is expected to rise. In the United Arab Emirates, construction of the Dubai World Central International Airport is currently underway. It is set to become the world's largest airport and should be able to handle between 120 and 150 million passengers and 12 million metric tons of cargo annually. Construction of the first of six runways was completed in 2007, and the entire project is expected to be operational by 2015 [***19***]**.** In Qatar, the new Doha International Airport has been under construction since 2004, with the first phase scheduled for completion by the end of 2009, when it will be able to accommodate 24 million passengers annually [***20***]. Upon completion of the final phase in 2015, its capacity will have been expanded to 50 million passengers per year.

Transportation energy use in Central and South America is projected to increase by 1.9 percent per year from 2006 to 2030. Brazil, the region's largest economy, is experiencing particularly strong growth in its transportation sector following its success in achieving economic stability, which has bolstered consumer confidence and improved consumer access to credit, allowing vehicle sales to increase strongly [***21***]. Total vehicle sales in Brazil (including light-duty vehicles, heavy-duty trucks, and buses) rose by 28 percent in 2007, following a 12-percent increase in 2006. Indications are that robust domestic sales will continue [***22***]. In the *IEO2009* reference case, energy use by light-duty vehicles in Brazil increases by an average of 3.8 percent per year from 2006 to 2015, before slowing to 2.9 percent per year from 2015 to 2030.

In 1975, the Brazilian government launched its National Alcohol Program to increase the use of ethanol in the transportation fuel mix [***23***]. Subsequently, ethanol consumption in Brazil rose from 0.1 billion gallons in 1975 to 4.4 billion gallons in 2007 [***24***]. Its reliance on biofuels (and ethanol in particular) to fuel its transportation sector has focused attention on Brazil, as other nations of the world have begun to increase alternative fuel use in the face of sustained high world oil prices over recent years. Although the global economic downturn may affect the short-term growth potential of Brazilian biofuels, it is expected that, as world economies recover and oil prices again begin to rise, ethanol production will continue to expand, along with the country's biofuels-consuming automobile fleet, which may account for as much as one-half of the total fleet by 2013 [***25***].

Flexible-fuel vehicles (FFVs)[43] have become increasingly popular in Brazil. According to Brazil's vehicle manufacturers' association, Associação Nacional dos Fabricantes de Veículos Automotores (Anfavea), the number of FFVs sold each year in Brazil has increased strongly since their introduction in March 2003, from 49,000 in 2003 to 3 million in 2008 [***26***]. FFVs now account for nearly 86 percent of new automobile sales in Brazil.

## References


1. Energy Information Administration, *Annual Energy Outlook 2009* (Early Release Overview), DOE/EIA-0383(2009) (December 17, 2008), p. 6.
2. National Energy Board of Canada, *Canada's Energy Future: Reference Case and Scenarios to 2030* (Calgary, Alberta, November 2007), pp. 20-21.
3. National Bureau of Statistics of China, *China Statistical Yearbook 2007*, "Transport, Postal and Telecommunication Services," web site www.stats.gov.cn/tjsj/ndsj/2007/indexee.htm.
4. United Nations, Department of Economic and Social Affairs, Population Division, "Urban and Rural Areas 2007," web site www.un.org/esa/population/publications/wup2007/2007_urban_rural_chart.xls.
5. "Auto Sales 'Surpassed US' in Jan," *The China Daily* (February 6, 2009), web site www.chinadaily.com.cn/bizchina/2009-02/06/content_7450489.htm.
6. International Organization of Motor Vehicle Manufacturers, "2007 Production Statistics," web site http://oica.net/2007-production-statistics (2007).
7. P. Jiayi Ho, "China 08 Auto Sales Up 6.7 Percent to 9.38 Million Units—Xinhua," Dow Jones Newswires (January 12, 2009).
8. "Autos: Small Car Sales Boom in Jan on Tax Cut," *The China Daily* (February 6, 2009), web site www.chinadaily.com.cn/bizchina/2009-02/06/content_7452135.htm.
9. Z. Hong, "A 4-trillion Yuan Question," *Caijing Online Magazine* (December 1, 2008), web site http://english.caijing.com.cn/ajax/ensprint.html; and D. Barboza, "China Unveils Sweeping Plan for


[43] Flexible-fuel vehicles can operate using 100 percent ethanol, 100 percent motor gasoline, or any combination of the two fuels.

Economy," *The New York Times* (November 10, 2008), web site www.nytimes.com.

10. "India Car Sales Tumble in October," Agence France-Presse (November 11, 2008), web site www.industryweek.com.
11. V.V. Nair and K. Goyal, "India's Car Sales Plunge Most in Five Years on Loans (Update1)," Bloomberg News Agency (December 10, 2008) web site www.bloomberg.com.
12. International Organization of Motor Vehicle Manufacturers, "Production Statistics" (1998-2007), web site http://oica.net/category/production-statistics.
13. S. Chatterjee, "Honda Bullish on Indian Market, Ramps Up Production, Dealer Network," *International Business Times* (February 26, 2008), web site http://in.ibtimes.com/articles/20080226/honda-motor-jazz-civic-hybrid-accord_2.htm.
14. P. Negyesi, "Moscow Auto Show Raises Its Curtain Against Tense Backdrop," *Auto Observer* (August 22, 2008), web site www.autoobserver.com; and T. Vorobyova, "Russia Jan Car Sales at 100,000—Avtovaz Head," Thomson Reuters News Release (February 4, 2009) web site www.reuters.com.
15. International Energy Agency Data Services, *Energy Balances of Non-OECD Countries* (2008), web site http://data.iea.org (subscription site).
16. M. Markey, "Topic Report: Oil Consumption Growth in the Middle East" (December 17, 2007), Apache Corporation, web site www.apachecorp.com/explore/explore_features/browse_archives/View_Article/?docdoc=662.
17. R. High, "Getting Connected: Investing in the Middle East's Infrastructure," International Construction, KHL Group (December 1, 2007), web site www.khl.com.
18. "MEED Middle East Rail Projects, 2007 Conferences in Dubai, Ameinfo" (November 7, 2007), web site www.ameinfo.com/137462.html.
19. "Dubai World Central Awards Air Traffic Management System" (July 30, 2007), web site www.asiatraveltips.com.
20. B. Bibbo, "Qatar Targets 24m Annual Passengers in New Airport" (February 11, 2008), web site www.gulfnews.com.
21. T. Rideg, "Brazil Auto Boom: Can Supply Keep Pace?" *Latin Business Chronicle* (August 13, 2007), web site www.latinbusinesschronicle.com/app/article.aspx?id=1537.
22. "GM and Renault Doing Well in Brazil: Car Industry Hits Record Sales," *Brazzil Magazine* (February 8, 2008), web site www.brazzilmag.com/content/view/9114/54; and "Brazil's 2006 Vehicle Sales Top 1.9 Million in 2006," *Global Refining & Fuels Report*, Vol. 11, No. 1 (January 3, 2007), web site www.worldfuels.com (subscription site).
23. P. Nastari, "The Brazilian Fuel Ethanol Experience," in *Ethanol in the 21st Century: New Sources, New Uses* (Sacramento, CA, April 1998).
24. I. Riveras, "Brazil Local Demand To Drive Ethanol Production," Reuters News Release (January 14, 2008), web site www.reuters.com.
25. AFX News Limited, "Brazil Registers Over 2 mln Biofuel Cars in 2007, 86.5 pct of Cars Sold" (January 8, 2008), web site www.forbes.com.
26. W. Lemos, "Flex-Fuels Pump Up Ethanol," *ICIS News* (November 12, 2007); and "Brazil Flexible-Fuel Vehicles Surpass 5m Units," *ICIS News* (April 8, 2008), web site www.icis.com (subscription site).

# Chapter 8
# Energy-Related Carbon Dioxide Emissions

***In 2006, non-OECD energy-related emissions of carbon dioxide exceeded OECD emissions by 14 percent. In 2030, energy-related carbon dioxide emissions from the non-OECD countries are projected to exceed those from the OECD countries by 77 percent.***

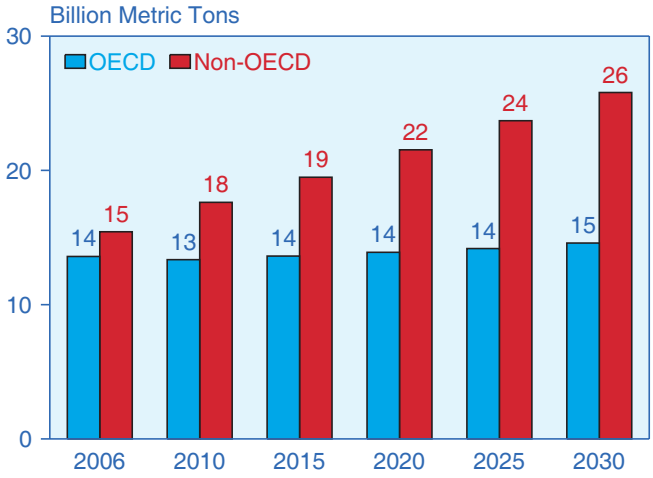
Because anthropogenic emissions of carbon dioxide result primarily from the combustion of fossil fuels, world energy use continues to be at the center of the climate change debate. In the *IEO2009* reference case, world energy-related carbon dioxide emissions grow from 29.0 billion metric tons in 2006 to 33.1 billion metric tons in 2015 and 40.4 billion metric tons in 2030.[44]

From 2005 to 2006, total energy-related carbon dioxide emissions from the non-OECD countries grew by 5.2 percent, while emissions from the OECD countries declined by 0.3 percent. The decline in OECD countries' carbon dioxide emissions is projected to continue through 2010, as fossil fuel demand contracts, in part because of the current global recession. Consequently, annual emissions from the non-OECD countries exceed those from the OECD countries by more than 30 percent in 2010 (Figure 80). Over the 24-year projection period, the average annual increase in non-OECD emissions from 2006 to 2030 (2.2 percent) is seven times the rate projected for the OECD countries (0.3 percent). In 2030, non-OECD emissions (25.8 billion metric tons) exceed OECD emissions (14.6 billion metric tons) by 77 percent.

The *IEO2009* reference case projections are, to the extent possible, based on existing laws and policies. Projections for carbon dioxide emissions may change significantly if existing laws and policies aimed at reducing greenhouse gas emissions are changed or new ones are introduced. In addition, beyond carbon dioxide there are other gases and sources that contribute to greenhouse gas emissions. The other gases and sources may be addressed in existing legislation and international treaties, but their reductions would not be reflected either in EIA's historical data or in the projections in this report.

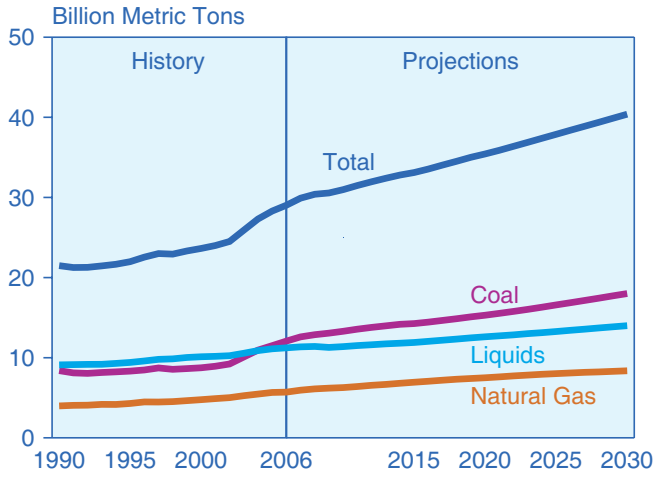
The relative contributions of different fossil fuels to total energy-related carbon dioxide emissions have changed over time. In 1990, emissions from the combustion of liquid fuels made up an estimated 42 percent of the world total; in 2006 their share was 39 percent; and in 2030 it is projected to be 35 percent (Figure 81). Carbon dioxide emissions from natural gas combustion, which accounted for 19 percent of the total in 1990, increased to 20 percent of the 2006 total, and their share is projected to stabilize at between 20 and 21 percent from 2006 to 2030.

**Figure 80. World Energy-Related Carbon Dioxide Emissions, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 81. World Energy-Related Carbon Dioxide Emissions by Fuel Type, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[44] In keeping with current international practice, *IEO2009* presents data on greenhouse gas emissions in billion metric tons carbon dioxide equivalent. The figures can be converted to carbon equivalent units by multiplying by 12/44.

Coal's share of world carbon dioxide emissions grew from 39 percent in 1990 to 42 percent in 2006 and is projected to increase to 45 percent in 2030. Coal is the most carbon-intensive of the fossil fuels, and it is the fastest-growing carbon-emitting energy source in the *IEO2009* reference case projection, reflecting its important role in the energy mix of non-OECD countries—especially, China and India. In 1990, China and India together accounted for 13 percent of world carbon dioxide emissions; in 2006 their combined share had risen to 25 percent, largely because of strong economic growth and increasing use of coal to provide energy for that growth. In 2030, carbon dioxide emissions from China and India combined are projected to account for 34 percent of total world emissions, with China alone responsible for 29 percent of the world total.

The Kyoto Protocol, which requires participating "Annex I" countries to reduce their greenhouse gas emissions collectively to an annual average of about 5 percent below their 1990 level over the 2008-2012 period, entered into force on February 16, 2005. Annex I countries include the 24 original OECD countries, the European Union, and 14 countries that are considered "economies in transition."[45] Although 174 countries and the European Commission have ratified the Kyoto Protocol, only the Annex I countries that have ratified the Protocol are obligated to reduce or limit their carbon dioxide emissions. The United States has not ratified the Protocol, and although both China and India have ratified it, neither of those countries is subject to emissions limits under the terms of the treaty. Table 14 compares carbon dioxide emissions in selected Annex I countries or regions in 1990 and 2006 and their projected reference case values in 2010, 2020, and 2030.

Many of the Kyoto goals are being addressed by "Kyoto mechanisms," such as reforestation, which are not reflected in EIA's projections of energy-related carbon dioxide emissions. Additionally, some greenhouse gases other than carbon dioxide often are the least expensive to reduce (for example, by capturing fugitive emissions of methane). Those reductions may account for a larger proportion of some countries' Kyoto goals than would their carbon dioxide emissions reductions.

There are signs that concerns about global climate change are beginning to affect the world fuel mix. In recent years, many countries have begun to demonstrate an interest in expanding their use of non-carbon-emitting renewable energy and nuclear power, in part to stem the growth of greenhouse gas emissions. The *IEO2009* reference case projection for energy from hydropower and other renewable energy sources in 2030 is 26 percent higher than the projection in *IEO2008*, which in turn was 10 percent higher than the *IEO2007* projection. Similarly, the *IEO2009* projection for world electricity generation from nuclear power is up by 2 percent from the *IEO2008* projection, which was 4 percent higher than the corresponding projection in *IEO2007*.

## Reference Case

### Carbon Dioxide Emissions

In the *IEO2009* reference case, world energy-related carbon dioxide emissions increase by an average of 1.4 percent per year from 2006 to 2030 (Table 15). For the OECD, annual increases in carbon dioxide emissions are projected to average 0.3 percent over the 24-year period. The annual increases are not uniform, however. OECD carbon dioxide emissions in the reference case decline from 13.6 billion metric tons in 2006 to 13.4 billion metric tons in 2010 and return to 13.6 billion metric tons in 2015 (essentially no increase in OECD emissions over the decade), then increase to 14.6 billion metric tons in 2030.

Projected emissions growth for the OECD countries over the 2006-2030 period is much lower than was the case for

**Table 14. World Energy-Related Carbon Dioxide Emissions in Selected Annex I Areas, 1990, 2006, and 2010**
(Billion Metric Tons)

| | Australia/ New Zealand | Canada | United States | Japan | OECD Europe | Total |
|---|---|---|---|---|---|---|
| **History** | | | | | | |
| 1990 . . . . . | 0.3 | 0.5 | 5.0 | 1.1 | 4.1 | **11.0** |
| 2006 . . . . . | 0.5 | 0.6 | 5.9 | 1.2 | 4.4 | **12.6** |
| **Projections** | | | | | | |
| 2010 . . . . . | 0.5 | 0.6 | 5.8 | 1.2 | 4.3 | **12.4** |
| 2020 . . . . . | 0.5 | 0.7 | 6.0 | 1.2 | 4.4 | **12.8** |
| 2030 . . . . . | 0.5 | 0.7 | 6.4 | 1.2 | 4.5 | **13.4** |

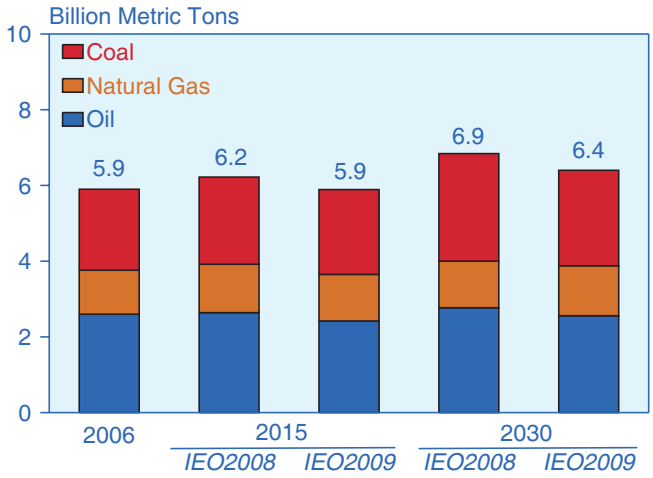
Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[45] Turkey is an Annex I country that has not ratified the Framework Convention on Climate Change and did not commit to quantifiable emissions targets under the Kyoto Protocol.

the 1990-2006 historical period. In addition, although the United States has not yet accepted internationally binding emissions constraints, recent changes in U.S. laws and regulations (as well as broader price and economic developments and observed behavior) have lowered the projections for U.S. carbon dioxide emissions relative to earlier estimates.[46]

In the *IEO2008* reference case, the projection for U.S. emissions growth was 0.5 percent per year from 2005 to 2030. In the *IEO2009* reference case, U.S. energy-related carbon dioxide emissions are projected to grow at an average annual rate of 0.3 percent from 2006 to 2030.[47] As a result, the projection for U.S. emissions in 2030 is 20 percent lower in *IEO2009* than it was in *IEO2007* (Figure 82). Moreover, a recent Presidential Memorandum that directs the U.S. Environmental Protection Agency to reassess California's request for a waiver under the Clean Air Act that would allowing the State to place stricter standards on greenhouse gas emissions from vehicles could have an additional impact on U.S. emissions growth.[48]

**Figure 82. U.S. Energy-Related Carbon Dioxide Emissions by Fuel in *IEO2008* and *IEO2009*, 2006, 2015, and 2030**




Sources: Energy Information Administration, *Annual Energy Outlook 2007*, DOE/EIA-0383(2007) (Washington, DC, February 2007), *Annual Energy Outlook 2008*, DOE/EIA-0383 (2008) (Washington, DC, January 2008), and *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009).

**Table 15. World Energy-Related Carbon Dioxide Emissions by Region, 1990-2030**
(Billion Metric Tons)

| Region | History | | Projections | | | | | Average Annual Percent Change | |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | 1990-2006 | 2006-2030 |
| **OECD** | **11.5** | **13.6** | **13.4** | **13.6** | **13.9** | **14.2** | **14.6** | **1.0%** | **0.3%** |
| North America | 5.8 | 6.9 | 6.8 | 7.0 | 7.1 | 7.3 | 7.7 | 1.2% | 0.4% |
| Europe | 4.1 | 4.4 | 4.3 | 4.4 | 4.5 | 4.5 | 4.5 | 0.4% | 0.1% |
| Asia | 1.6 | 2.2 | 2.2 | 2.3 | 2.3 | 2.3 | 2.4 | 2.1% | 0.3% |
| **Non-OECD** | **10.0** | **15.4** | **17.6** | **19.5** | **21.5** | **23.7** | **25.8** | **2.8%** | **2.2%** |
| Europe and Eurasia | 4.2 | 2.9 | 3.1 | 3.2 | 3.3 | 3.4 | 3.4 | -2.4% | 0.7% |
| Asia | 3.7 | 9.0 | 10.5 | 11.9 | 13.6 | 15.4 | 17.0 | 5.7% | 2.7% |
| Middle East | 0.7 | 1.5 | 1.7 | 1.8 | 1.9 | 2.1 | 2.3 | 4.6% | 1.9% |
| Africa | 0.7 | 1.0 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 | 2.5% | 1.5% |
| Central and South America | 0.7 | 1.1 | 1.3 | 1.4 | 1.4 | 1.5 | 1.7 | 3.0% | 1.6% |
| **Total World** | **21.5** | **29.0** | **31.0** | **33.1** | **35.4** | **37.9** | **40.4** | **1.9%** | **1.4%** |

Sources: **1990 and 2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2010-2030:** EIA, World Energy Projections Plus (2009).

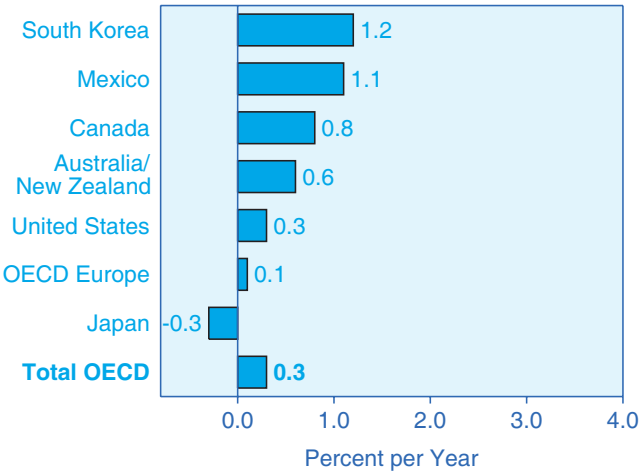
[46] For example, the Energy Independence and Security Act of 2007, which was signed into law in December 2007 (Public Law 110-140), includes a number of provisions aimed at reducing greenhouse gas emissions. Other factors that contribute to the lower projections for carbon dioxide emissions include lower projected economic growth rates in comparison with previous outlooks. In addition, ARRA2009 includes a number of provisions designed to increase energy efficiency and renewable electricity generation, which will also reduce greenhouse gas emissions in the United States, and the impact of these provisions can be seen in the *updated AEO2009* reference case (April 2009).

[47] In the the *updated AEO2009* reference case (April 2009), U.S. carbon dioxide emissions increase by 0.2 percent per year from 2006 to 2030, and the projection for U.S. energy-related carbon dioxide emissions in 2030 is 3.0 percent lower than in the *published AEO2009* reference case (March 2009). The lower projections result largely from the impacts of ARRA2009 on renewable electricity generation and overall energy consumption, including energy efficiency gains and renewable incentives that lead to reduced use of fossil fuels.

[48] The Presidential Memorandum of January 26, 2009, on the State of California Request for Waiver Under 42 U.S.C. 7543(b), the Clean Air Act, and addressed to the Administrator of the U.S. Environmental Protection Agency (EPA) states: "In order to ensure that the EPA carries out its responsibilities for improving air quality, you are hereby requested to assess whether the EPA's decision to deny a waiver based on California's application was appropriate in light of the Clean Air Act. I further request that, based on that assessment, the EPA initiate any appropriate action."

The highest rate of increase in annual emissions of carbon dioxide among the OECD countries is projected for South Korea, at 1.2 percent per year (Figure 83). Mexico (1.1 percent per year), which is also still industrializing, is the only OECD country other than South Korea for which the average growth is projected to exceed 1 percent per year. The GDP growth rates projected for South Korea and Mexico in *IEO2009* are about the same, at 3.3 percent and 3.4 percent, respectively. Japan's emissions are projected to *decrease* by an average of 0.3 percent per year from 2006 to 2030, and OECD Europe's energy-related carbon emissions are projected to grow only slightly (by 0.1 percent per year).

**Figure 83. Average Annual Growth in Energy-Related Carbon Dioxide Emissions in the OECD Economies, 2006-2030**

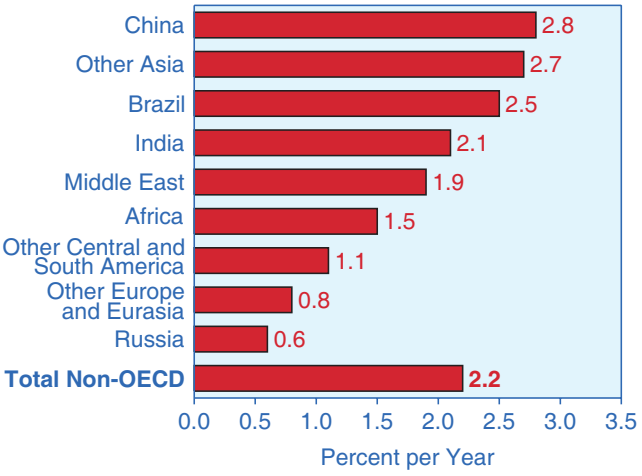



Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

For the non-OECD countries, total energy-related carbon dioxide emissions are projected to average 2.2-percent annual growth (Figure 84). The highest growth rate among the non-OECD countries is projected for China, at 2.8 percent annually from 2006 to 2030, reflecting the country's continued heavy reliance on fossil fuels, especially coal, in the projection. The lowest growth rate among the non-OECD countries is projected for Russia, at 0.6 percent per year. Over the projection period, Russia is expected to expand its reliance on indigenous natural gas resources and nuclear power to fuel electricity generation, and a decline in its population is expected to slow its overall rate of increase in energy demand.

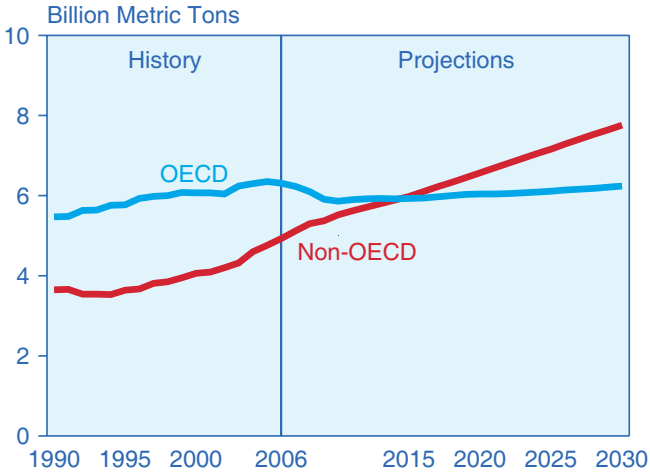
By fuel, world carbon dioxide emissions from the consumption of liquid fuels are projected to grow at an average annual rate of 0.9 percent from 2006 to 2030. All the growth in carbon dioxide emissions is projected to come from non-OECD countries, as total emissions from the OECD countries decline in the early years of the projection period and return only to 2006 levels in 2030 (Figure 85). The highest rate of growth in petroleum-related carbon dioxide emissions is projected for China, at 3.2 percent per year, as its demand for liquid fuels increases to meet growing demand in its transportation and industrial sectors. The United States is expected to remain the largest source of petroleum-related carbon dioxide emissions throughout the period, with projected emissions of 2.6 billion metric tons in 2030.

**Figure 84. Average Annual Growth in Energy-Related Carbon Dioxide Emissions in the Non-OECD Economies, 2006-2030**




Sources: **2006:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** EIA, World Energy Projections Plus (2009).

**Figure 85. World Carbon Dioxide Emissions from Liquids Combustion, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

Carbon dioxide emissions from natural gas combustion worldwide are projected to increase on average by 1.6 percent per year, to 8.4 billion metric tons in 2030, with the OECD countries averaging 0.9 percent per year and the non-OECD countries 2.2 percent per year (Figure 86). Again, China is projected to have the most rapid growth in emissions, averaging 5.2 percent annually; however, China's emissions from natural gas combustion amounted to only 0.1 billion metric tons in 2006, and in 2030 they are projected to total only 0.4 billion metric tons—equivalent to 3 percent of China's total energy-related emissions and less than 5 percent of the world's total emissions from natural gas combustion. The much lower projected growth in U.S. emissions from natural gas use, averaging 0.5 percent per year, still results in 1.3 billion metric tons of emissions in 2030, which is more than triple the projection for China.

Total carbon dioxide emissions from the combustion of coal throughout the world are projected to increase by 1.7 percent per year on average, from 12.1 billion metric tons in 2006 to 18.0 billion metric tons in 2030. Total coal-related emissions from the non-OECD countries were already greater than those from the OECD countries in 1990, and in 2030 they are projected to be more than 2.5 times the OECD total (Figure 87), in large part because of the increase in coal use projected for China and India.

China accounts for 74 percent of the total increase in the world's coal-related carbon dioxide emissions from 2006 to 2030, and India accounts for 8 percent. For China alone, coal-related emissions are projected to grow by an average of 2.7 percent annually, from 4.9 billion metric tons in 2006 to 9.3 billion metric tons (or 52 percent of the world total) in 2030. India's carbon dioxide emissions from coal combustion are projected to total 1.3 billion metric tons in 2030, accounting for more than 7 percent of the world total. In the United States—the world's other major coal consumer—coal-related carbon dioxide emissions rise more slowly, by 0.7 percent per year, to 2.5 billion metric tons (14 percent of the world's total coal-related carbon emissions) in 2030.

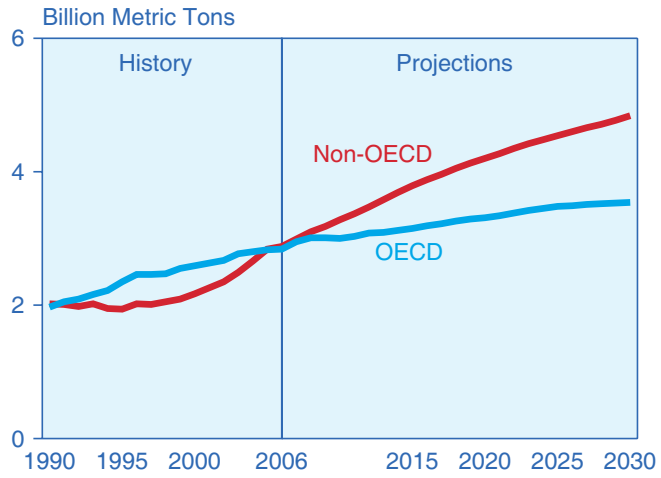
## Carbon Dioxide Intensity Measures

### *Emissions per Dollar of GDP*

In all countries and regions, energy-related carbon dioxide intensities—expressed in emissions per unit of economic output—are projected to improve (decline) over the projection period, as all world economies continue to use energy more efficiently. In 2006, estimated carbon dioxide intensities were 386 metric tons per million dollars of GDP in the OECD countries and 624 metric tons per million dollars of GDP in the non-OECD countries (Table 16).[49]

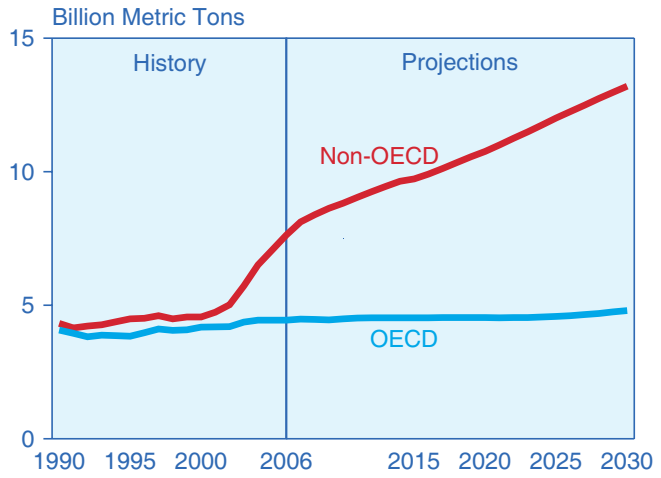
Fossil fuel use in the non-OECD countries increases strongly in the reference case projection, but their economic growth is even stronger. As a result, non-OECD carbon dioxide intensity declines by an average of 2.6 percent per year, from 624 metric tons per million dollars of GDP in 2006 to 330 metric tons per million dollars in 2030. In particular, China, with a relatively high rate of growth in emissions (2.8 percent per year), has an

**Figure 86. World Carbon Dioxide Emissions from Natural Gas Combustion, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 87. World Carbon Dioxide Emissions from Coal Combustion, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

[49] GDP is measured in chain-weighted 2005 dollars, converted to the currency of the relevant country or region, based on purchasing power parity.

even higher GDP growth rate (6.4 percent per year). As a result, its emissions intensity falls from 1,001 metric tons per million dollars in 2006 to 443 metric tons per dollars in 2030.

For all the OECD countries combined, average carbon dioxide intensity in 2030 is projected to be 246 metric tons per million dollars of GDP. Mexico has the lowest carbon dioxide intensity among the OECD economies in 2030 in the reference case, at 184 metric tons per million dollars, followed by OECD Europe at 196 metric tons and Japan at 242 metric tons. (Mexico's relatively low carbon dioxide intensity results in large part from its projected 3.4-percent annual GDP growth rate, the highest among the OECD countries.) Canada has the highest carbon dioxide intensity among the OECD countries in 2030, at 359 metric tons per million dollars of GDP, followed by South Korea at 351 metric tons and Australia/New Zealand at 322 metric tons. U.S. carbon dioxide intensity in 2030 is 282 metric tons per million dollars of GDP. For the entire world, average carbon dioxide intensity falls from 484 metric tons per million dollars of GDP in 2006 to 294 metric tons in 2030.

### *Emissions per Capita*

Another measure of carbon dioxide intensity is emissions per person. Carbon dioxide emissions per capita in the OECD economies are significantly higher (about fourfold higher in 2006) than in the non-OECD economies (Figure 88). Among the non-OECD countries, China has the highest percentage increase in carbon dioxide emissions per capita in the *IEO2009* reference case, from 4.6 metric tons per person in 2006 to 8.0 metric tons per person in 2030 (Table 17 and Figure 89). Russia has the highest absolute increase, from 11.9 metric tons per person in 2006 to 16.0 metric tons per person in 2030. Among the *IEO2009* country groupings, the lowest levels of emissions per capita in the world are in India and Africa. India's emissions per capita increase from 1.1 metric tons per person in 2006 to 1.4 metric tons per person in 2030, and Africa's emissions per capita remain at about 1.0 metric ton per person from 2006 to 2030.

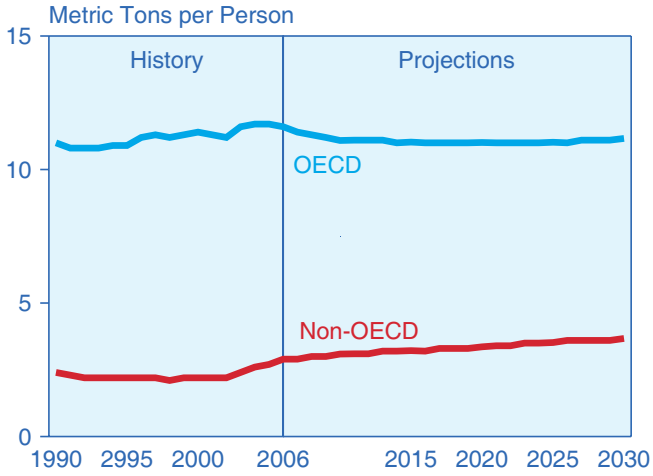
**Table 16. Carbon Dioxide Intensity by Region and Country, 1980-2030**
(Metric Tons per Million 2005 U.S. Dollars of Gross Domestic Product)

| Region | History | | Projections | | | | | Average Annual Percent Change | |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | 1990-2006 | 2006-2030 |
| **OECD** | **491** | **386** | **360** | **321** | **293** | **267** | **246** | **-1.5%** | **-1.9%** |
| North America | 597 | 453 | 423 | 371 | 334 | 302 | 277 | -1.7% | -2.0% |
| United States | 620 | 463 | 436 | 380 | 341 | 308 | 282 | -1.8% | -2.0% |
| Canada | 609 | 507 | 488 | 444 | 414 | 387 | 359 | -1.1% | -1.4% |
| Mexico | 361 | 317 | 250 | 230 | 215 | 198 | 184 | -0.8% | -2.2% |
| Europe | 428 | 311 | 289 | 259 | 237 | 215 | 196 | -2.0% | -1.9% |
| Asia | 391 | 391 | 367 | 338 | 318 | 300 | 283 | 0.0% | -1.3% |
| Japan | 327 | 314 | 285 | 271 | 265 | 254 | 242 | -0.2% | -1.1% |
| South Korea | 651 | 581 | 575 | 480 | 414 | 380 | 351 | -0.7% | -2.1% |
| Australia/New Zealand | 615 | 558 | 505 | 444 | 402 | 357 | 322 | -0.6% | -2.3% |
| **Non-OECD** | **816** | **624** | **555** | **469** | **407** | **364** | **330** | **-1.7%** | **-2.6%** |
| Europe/Eurasia | 1,397 | 913 | 779 | 665 | 580 | 514 | 464 | -2.6% | -2.8% |
| Russia | 1,272 | 932 | 774 | 664 | 584 | 517 | 468 | -1.9% | -2.8% |
| Other | 1,599 | 888 | 785 | 666 | 576 | 510 | 458 | -3.6% | -2.7% |
| Asia | 825 | 670 | 584 | 484 | 415 | 371 | 335 | -1.3% | -2.8% |
| China | 1,812 | 1,001 | 832 | 669 | 558 | 494 | 443 | -3.6% | -3.3% |
| India | 563 | 483 | 391 | 323 | 277 | 240 | 214 | -0.9% | -3.3% |
| Other | 373 | 355 | 326 | 284 | 254 | 234 | 221 | -0.3% | -2.0% |
| Middle East | 657 | 709 | 679 | 604 | 535 | 485 | 447 | 0.5% | -1.9% |
| Africa | 475 | 420 | 378 | 322 | 283 | 256 | 236 | -0.8% | -2.4% |
| Central and South America | 306 | 299 | 292 | 253 | 223 | 203 | 185 | -0.1% | -2.0% |
| Brazil | 225 | 235 | 231 | 212 | 197 | 186 | 174 | 0.3% | -1.2% |
| Other | 375 | 346 | 336 | 282 | 242 | 216 | 194 | -0.5% | -2.4% |
| **Total World** | **603** | **484** | **450** | **394** | **353** | **321** | **294** | **-1.4%** | **-2.1%** |

Note: GDP is expressed in terms of purchasing power parity.

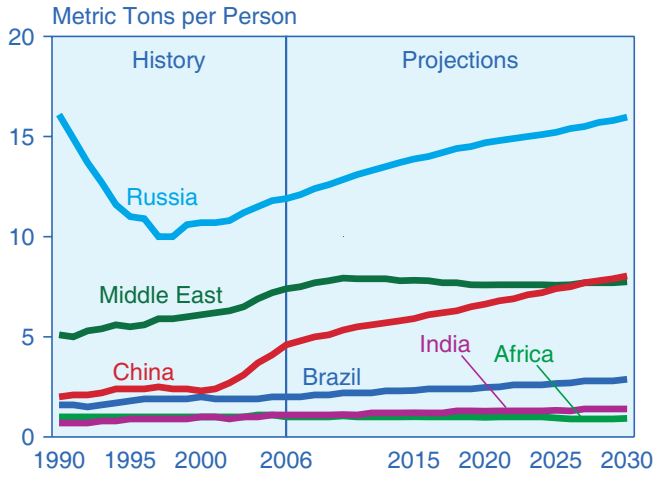
Sources: **1980-2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2010-2030:** IHS Global Insight, *World Economic Outlook 4th Quarter 2008*, and EIA, World Energy Projections Plus (2009).

**Figure 88. World Carbon Dioxide Emissions per Capita, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 89. Non-OECD Carbon Dioxide Emissions per Capita by Country and Region, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table 17. Energy-Related Carbon Dioxide Emissions per Capita by Region and Country, 1990-2030**
(Metric Tons per Person)

| Region | History | | Projections | | | | | Average Annual Percent Change | |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | 1990-2006 | 2006-2030 |
| **OECD** | **11.0** | **11.6** | **11.1** | **11.0** | **11.0** | **11.0** | **11.2** | **0.3%** | **-0.1%** |
| North America | 15.7 | 15.9 | 14.9 | 14.6 | 14.3 | 14.1 | 14.2 | 0.1% | -0.5% |
| United States | 19.6 | 19.7 | 18.6 | 18.1 | 17.5 | 17.1 | 17.1 | 0.0% | -0.6% |
| Canada | 17.0 | 18.7 | 18.4 | 18.3 | 18.4 | 18.6 | 18.7 | 0.6% | 0.0% |
| Mexico | 3.6 | 4.1 | 3.4 | 3.6 | 3.9 | 4.1 | 4.3 | 0.8% | 0.3% |
| Europe | 8.3 | 8.2 | 7.9 | 7.9 | 7.9 | 7.9 | 8.0 | -0.1% | -0.1% |
| Asia | 8.5 | 11.1 | 11.0 | 11.3 | 11.5 | 11.7 | 12.0 | 1.6% | 0.4% |
| Japan | 8.5 | 9.8 | 9.2 | 9.5 | 9.8 | 9.8 | 9.8 | 0.8% | 0.0% |
| South Korea | 5.7 | 10.7 | 12.3 | 12.5 | 12.5 | 13.3 | 14.0 | 4.0% | 1.1% |
| Australia/New Zealand | 14.7 | 18.5 | 17.7 | 17.4 | 17.5 | 17.4 | 17.6 | 1.4% | -0.2% |
| **Non-OECD** | **2.4** | **2.9** | **3.1** | **3.2** | **3.4** | **3.5** | **3.7** | **1.2%** | **1.1%** |
| Europe/Eurasia | 12.2 | 8.4 | 9.0 | 9.6 | 10.0 | 10.2 | 10.6 | -2.3% | 1.0% |
| Russia | 16.1 | 11.9 | 12.8 | 13.9 | 14.7 | 15.2 | 16.0 | -1.9% | 1.2% |
| Other | 9.3 | 6.0 | 6.4 | 6.7 | 6.9 | 7.1 | 7.3 | -2.7% | 0.8% |
| Asia | 1.3 | 2.6 | 2.9 | 3.1 | 3.4 | 3.7 | 4.0 | 4.2% | 1.8% |
| China | 2.0 | 4.6 | 5.3 | 5.9 | 6.6 | 7.4 | 8.0 | 5.3% | 2.4% |
| India | 0.7 | 1.1 | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 3.3% | 0.9% |
| Other | 1.1 | 1.7 | 1.8 | 1.9 | 2.0 | 2.2 | 2.4 | 2.8% | 1.5% |
| Middle East | 5.1 | 7.4 | 7.9 | 7.8 | 7.6 | 7.6 | 7.8 | 2.3% | 0.2% |
| Africa | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.0% | -0.5% |
| Central and South America | 1.9 | 2.4 | 2.7 | 2.7 | 2.7 | 2.7 | 2.8 | 1.5% | 0.6% |
| Brazil | 1.6 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.9 | 1.4% | 1.6% |
| Other | 2.2 | 2.8 | 3.1 | 2.9 | 2.8 | 2.8 | 2.8 | 1.5% | 0.0% |
| **Total World** | **4.1** | **4.4** | **4.5** | **4.5** | **4.6** | **4.7** | **4.9** | **0.5%** | **0.4%** |

Sources: **1980-2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2010-2030:** UN Population Statistics (2006 Revision), and EIA, World Energy Projections Plus (2009).

The OECD countries have higher levels of carbon dioxide emissions per capita, in part because of their higher per-capita levels of income and fossil fuel use. In the reference case U.S. emissions per capita fall from 19.7 metric tons per person in 2006 to 17.1 metric tons per person in 2030 (Figure 90). Canada's emissions remain stable at around 19 metric tons per person over the period. In Mexico, with the lowest level of emissions per capita among the OECD countries in 2006 (approximately 4 metric tons per person) there is essentially no change over the projection period.

Per-capita income is the most important determinant of carbon dioxide emissions per capita, but other factors also affect the calculation. For example, climate is important, because in general more energy is used per capita for heating in colder climates than in warmer climates. Similarly, population density is important, because densely populated countries use less energy for transportation per capita than do more sparsely populated countries. For example, Canada has both a relatively cold climate and low population density, and its carbon dioxide emissions in 2006 are estimated at 18.7 metric tons per capita, whereas Japan has a more temperate climate and a much higher population density, and its emissions in 2006 are estimated at 9.8 metric tons per capita. Income per capita in Japan, by comparison, was only 16 percent lower than Canada's in 2006.

## Alternative Macroeconomic Growth Cases

Economic growth is the most significant factor underlying the projections for growth in energy-related carbon dioxide emissions in the mid-term, as the world continues to rely on fossil fuels for most of its energy use. Accordingly, projections of world carbon dioxide emissions are lower in the *IEO2009* low economic growth case and higher in the high economic growth case.

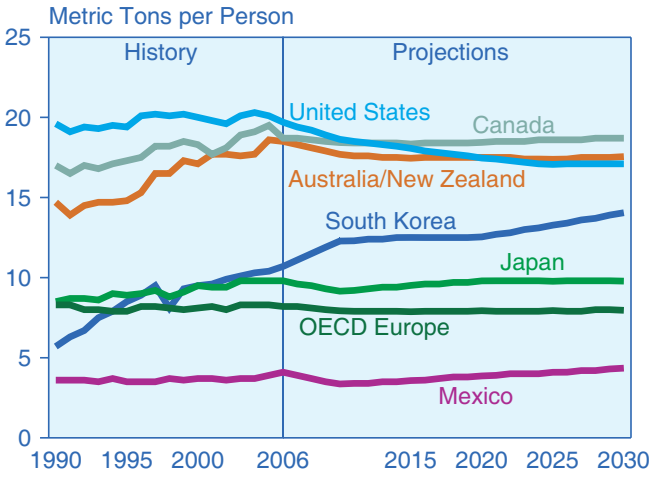
In the high growth case, world carbon dioxide emissions increase at an average rate of 1.8 percent annually from 2006 to 2030, as compared with 1.4 percent in the reference case. For the OECD countries, the projected average increase in the high growth case is 0.6 percent per year; for the non-OECD countries, the average is 2.6 percent per year.

In the low growth case, world carbon dioxide emissions increase by 1.0 percent per year from 2006 to 2030, with averages of -0.1 percent per year for the OECD countries and 1.8 percent per year for the non-OECD countries (compared with 0.3 percent and 2.2 percent, respectively, in the reference case). In 2030, total energy-related carbon dioxide emissions worldwide (Figure 91) range from a projected 37.0 billion metric tons in the low growth case to 44.1 billion metric tons in the high growth case—19 percent higher than projected in the low growth case. The projections for emissions by fuel show similar variations across the cases.

## Alternative Oil Price Cases

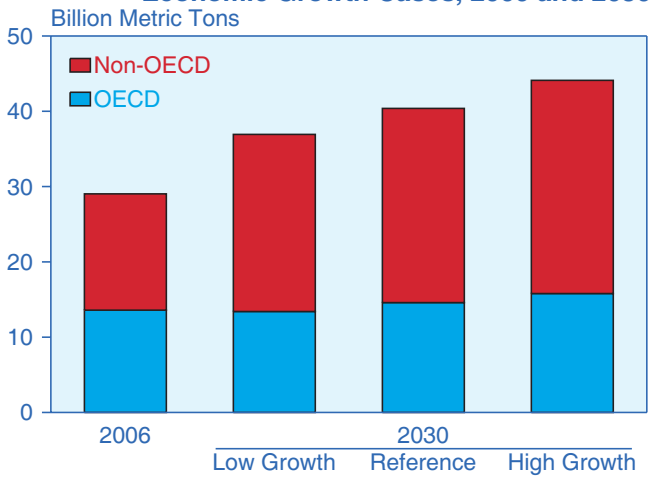
The projections for carbon dioxide emissions in the *IEO2009* low and high oil price cases (Figure 92) show smaller variations from the reference case than do those in the alternative macroeconomic growth cases. In 2030, as compared with the reference case projection (40.4 billion metric tons), total carbon dioxide emissions are higher in the low price case (42.2 billion metric tons) and

**Figure 90. OECD Carbon Dioxide Emissions per Capita by Country and Region, 1990-2030**




Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Figure 91. Carbon Dioxide Emissions in Three Economic Growth Cases, 2006 and 2030**




Sources: **2006:** Energy Information Administration, *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** Energy Information Administration, World Energy Projections Plus (2009).

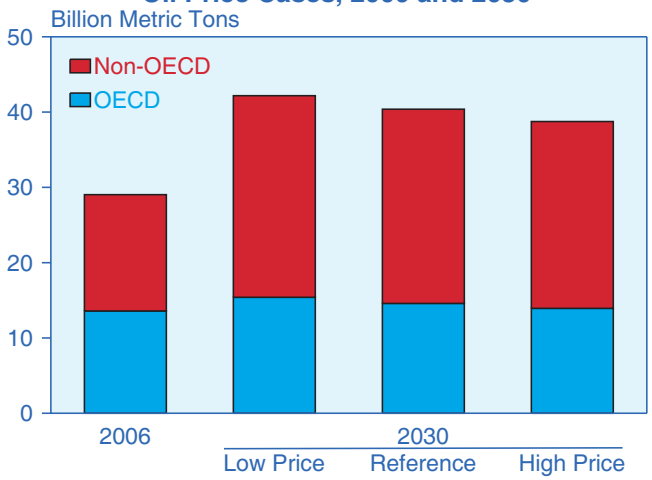
lower in the high price case (38.7 billion metric tons), largely as a result of greater demand for liquids in the low price case and lower demand in the high price case. Thus, there is a 9-percent difference between the projections in the two alternative oil price cases, as compared with a 19-percent difference between the alternative economic growth cases.

In the alternative oil price cases, world carbon dioxide emissions from liquids consumption are affected more strongly than emissions from either coal or natural gas, both of which are higher in the high price case and lower in the low price case. Coal-related emissions in 2030 increase by 1 percent in the high price case relative to the reference case and decline by 0.4 percent relative to the reference case in the low price case.

In the high price case, where world oil prices reach $200 per barrel in real 2007 dollars in 2030 (as compared with $130 per barrel in the reference case), nations choose alternative fuels over liquids wherever possible. Consequently, liquids-related emissions total 11.7 billion metric tons in 2030 in the high price case, down by 16 percent from the total of 14.0 billion metric tons in 2030 in the reference case. In the low price case, where world oil prices decline to $50 per barrel in 2030, there is little economic incentive for nations to turn to other forms of energy. Consequently, liquids-related emissions in 2030 in the low oil price case, at 16.0 billion metric tons, are 2.0 billion metric tons (14 percent) higher than projected in the reference case.

World carbon dioxide emissions from natural gas combustion in 2030 total 8.8 billion metric tons in the high oil price case, 5 percent above the projection of 8.4 billion metric tons in the reference case. In the low price case, with higher levels of liquids consumption, natural-gas-related emissions in 2030 total 8.3 billion metric tons, or 1 percent lower than projected in the reference case.

**Figure 92. Carbon Dioxide Emissions in Three Oil Price Cases, 2006 and 2030**




Sources: **2006:** Energy Information Administration, *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **2030:** Energy Information Administration, World Energy Projections Plus (2009).

Appendix A

# Reference Case Projections:

- World Energy Consumption
- Gross Domestic Product
- Carbon Dioxide Emissions
- World Population

**Table A1. World Total Primary Energy Consumption by Region, Reference Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **100.7** | **121.6** | **121.3** | **121.1** | **125.9** | **130.3** | **135.6** | **141.7** | **0.6** |
| United States[a] | 84.7 | 100.5 | 100.0 | 99.9 | 102.9 | 105.4 | 109.1 | 113.6 | 0.5 |
| Canada | 11.0 | 14.2 | 14.0 | 14.6 | 15.6 | 16.5 | 17.4 | 18.3 | 1.1 |
| Mexico | 5.0 | 6.9 | 7.4 | 6.6 | 7.4 | 8.3 | 9.1 | 9.9 | 1.2 |
| **OECD Europe** | **70.0** | **81.4** | **81.6** | **82.2** | **84.8** | **87.9** | **90.0** | **91.8** | **0.5** |
| **OECD Asia** | **27.0** | **38.4** | **38.7** | **39.5** | **41.8** | **43.1** | **43.9** | **44.6** | **0.6** |
| Japan | 18.7 | 22.7 | 22.8 | 21.9 | 22.9 | 23.4 | 23.2 | 23.0 | 0.0 |
| South Korea | 3.8 | 9.2 | 9.4 | 11.0 | 11.6 | 12.0 | 12.7 | 13.2 | 1.4 |
| Australia/New Zealand | 4.5 | 6.4 | 6.5 | 6.7 | 7.3 | 7.7 | 8.0 | 8.4 | 1.1 |
| **Total OECD** | **197.7** | **241.3** | **241.7** | **242.8** | **252.4** | **261.3** | **269.5** | **278.2** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **67.3** | **50.6** | **50.7** | **54.0** | **57.6** | **60.3** | **62.0** | **63.3** | **0.9** |
| Russia | 39.4 | 30.1 | 30.4 | 32.2 | 34.3 | 36.0 | 36.9 | 37.7 | 0.9 |
| Other | 28.0 | 20.6 | 20.3 | 21.7 | 23.3 | 24.3 | 25.0 | 25.6 | 1.0 |
| **Non-OECD Asia** | **47.4** | **109.4** | **117.6** | **139.2** | **163.2** | **190.3** | **215.4** | **239.6** | **3.0** |
| China | 27.0 | 66.8 | 73.8 | 90.5 | 105.9 | 124.0 | 140.7 | 155.8 | 3.2 |
| India | 7.9 | 16.3 | 17.7 | 19.1 | 22.9 | 26.8 | 29.6 | 32.3 | 2.5 |
| Other Non-OECD Asia | 12.5 | 26.3 | 26.1 | 29.6 | 34.4 | 39.5 | 45.1 | 51.5 | 2.9 |
| **Middle East** | **11.2** | **22.7** | **23.8** | **27.7** | **30.3** | **32.2** | **34.6** | **37.7** | **1.9** |
| **Africa** | **9.5** | **14.5** | **14.5** | **16.2** | **17.7** | **19.1** | **20.6** | **21.8** | **1.7** |
| **Central and South America** | **14.5** | **23.4** | **24.2** | **28.3** | **30.3** | **32.5** | **35.2** | **37.7** | **1.9** |
| Brazil | 5.8 | 9.4 | 9.6 | 11.4 | 12.9 | 14.5 | 16.3 | 18.0 | 2.6 |
| Other Central and South America | 8.8 | 14.0 | 14.6 | 17.0 | 17.5 | 18.0 | 18.9 | 19.7 | 1.3 |
| **Total Non-OECD** | **149.9** | **220.7** | **230.8** | **265.4** | **299.1** | **334.4** | **367.8** | **400.1** | **2.3** |
| **Total World** | **347.7** | **462.1** | **472.4** | **508.3** | **551.5** | **595.7** | **637.3** | **678.3** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A2. World Total Energy Consumption by Region and Fuel, Reference Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | | | | | | | | | |
| Liquids | 40.5 | 49.6 | 49.2 | 45.4 | 46.7 | 47.2 | 48.4 | 50.5 | 0.1 |
| Natural Gas | 23.0 | 28.0 | 28.0 | 29.3 | 30.3 | 31.9 | 33.9 | 34.4 | 0.9 |
| Coal | 20.6 | 24.7 | 24.3 | 24.8 | 25.5 | 26.0 | 26.5 | 28.8 | 0.7 |
| Nuclear | 6.9 | 9.2 | 9.4 | 9.8 | 10.0 | 10.4 | 10.6 | 11.1 | 0.7 |
| Other | 9.7 | 10.3 | 10.5 | 11.8 | 13.3 | 14.8 | 16.1 | 17.0 | 2.0 |
| **Total** | **100.7** | **121.6** | **121.3** | **121.1** | **125.9** | **130.3** | **135.6** | **141.7** | **0.6** |
| **OECD Europe** | | | | | | | | | |
| Liquids | 28.4 | 32.3 | 32.4 | 30.0 | 29.9 | 30.8 | 31.0 | 31.1 | -0.2 |
| Natural Gas | 11.2 | 19.8 | 19.7 | 21.0 | 22.1 | 23.3 | 24.2 | 24.8 | 1.0 |
| Coal | 17.7 | 12.9 | 13.2 | 13.0 | 12.8 | 12.4 | 12.2 | 12.0 | -0.4 |
| Nuclear | 7.9 | 9.7 | 9.6 | 9.7 | 9.7 | 9.6 | 9.5 | 9.5 | -0.1 |
| Other | 4.8 | 6.5 | 6.6 | 8.5 | 10.3 | 11.9 | 13.3 | 14.4 | 3.3 |
| **Total** | **70.0** | **81.4** | **81.6** | **82.2** | **84.8** | **87.9** | **90.0** | **91.8** | **0.5** |
| **OECD Asia** | | | | | | | | | |
| Liquids | 14.7 | 17.5 | 17.2 | 17.0 | 17.4 | 17.8 | 17.8 | 17.7 | 0.1 |
| Natural Gas | 3.1 | 5.8 | 6.1 | 6.5 | 7.1 | 7.5 | 7.6 | 7.7 | 1.0 |
| Coal | 5.2 | 9.3 | 9.4 | 9.5 | 9.5 | 9.5 | 9.6 | 9.8 | 0.2 |
| Nuclear | 2.5 | 4.3 | 4.3 | 4.5 | 5.0 | 5.6 | 6.0 | 6.4 | 1.6 |
| Other | 1.6 | 1.6 | 1.7 | 2.1 | 2.6 | 2.8 | 2.9 | 3.0 | 2.4 |
| **Total** | **27.0** | **38.4** | **38.7** | **39.5** | **41.8** | **43.1** | **43.9** | **44.6** | **0.6** |
| **Total OECD** | | | | | | | | | |
| Liquids | 83.6 | 99.4 | 98.8 | 92.4 | 94.0 | 95.8 | 97.2 | 99.4 | 0.0 |
| Natural Gas | 37.3 | 53.6 | 53.9 | 56.7 | 59.6 | 62.6 | 65.7 | 66.8 | 0.9 |
| Coal | 43.5 | 46.9 | 46.9 | 47.3 | 47.8 | 47.9 | 48.3 | 50.7 | 0.3 |
| Nuclear | 17.3 | 23.2 | 23.3 | 24.0 | 24.7 | 25.6 | 26.0 | 27.0 | 0.6 |
| Other | 16.0 | 18.3 | 18.8 | 22.4 | 26.3 | 29.5 | 32.3 | 34.3 | 2.5 |
| **Total** | **197.7** | **241.3** | **241.7** | **242.8** | **252.4** | **261.3** | **269.5** | **278.2** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | | | | | | | | | |
| Liquids | 19.6 | 10.1 | 10.2 | 10.5 | 10.7 | 11.1 | 11.2 | 11.2 | 0.4 |
| Natural Gas | 27.5 | 25.8 | 25.8 | 28.0 | 30.4 | 31.9 | 32.7 | 33.4 | 1.1 |
| Coal | 15.1 | 8.9 | 8.7 | 9.2 | 9.5 | 9.3 | 9.2 | 9.4 | 0.3 |
| Nuclear | 2.5 | 2.9 | 2.9 | 3.0 | 3.6 | 4.5 | 5.2 | 5.5 | 2.6 |
| Other | 2.8 | 3.1 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 0.9 |
| **Total** | **67.3** | **50.6** | **50.7** | **54.0** | **57.6** | **60.3** | **62.0** | **63.3** | **0.9** |
| **Non-OECD Asia** | | | | | | | | | |
| Liquids | 14.0 | 31.6 | 33.1 | 36.8 | 42.4 | 49.8 | 56.2 | 62.2 | 2.7 |
| Natural Gas | 3.0 | 9.6 | 9.6 | 11.7 | 15.6 | 19.2 | 22.3 | 25.1 | 4.1 |
| Coal | 27.0 | 60.4 | 66.5 | 78.5 | 87.6 | 98.4 | 111.1 | 122.8 | 2.6 |
| Nuclear | 0.4 | 1.1 | 1.1 | 1.6 | 3.0 | 4.7 | 6.2 | 7.0 | 7.9 |
| Other | 3.0 | 6.6 | 7.2 | 10.7 | 14.6 | 18.2 | 19.5 | 22.4 | 4.9 |
| **Total** | **47.4** | **109.4** | **117.6** | **139.2** | **163.2** | **190.3** | **215.4** | **239.6** | **3.0** |

See notes at end of table.

**Table A2. World Total Energy Consumption by Region and Fuel, Reference Case, 1990-2030 (Continued)**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD (Continued)** | | | | | | | | | |
| **Middle East** | | | | | | | | | |
| Liquids | 7.2 | 11.9 | 12.4 | 14.4 | 15.3 | 16.1 | 17.5 | 19.2 | 1.8 |
| Natural Gas | 3.8 | 10.2 | 10.8 | 12.5 | 14.2 | 15.0 | 16.1 | 17.4 | 2.0 |
| Coal | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 1.1 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Other | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 3.4 |
| **Total** | **11.2** | **22.7** | **23.8** | **27.7** | **30.3** | **32.2** | **34.6** | **37.7** | **1.9** |
| **Africa** | | | | | | | | | |
| Liquids | 4.3 | 6.1 | 6.1 | 7.1 | 7.3 | 7.5 | 7.8 | 8.1 | 1.2 |
| Natural Gas | 1.5 | 3.2 | 3.2 | 3.7 | 4.6 | 5.5 | 6.2 | 6.7 | 3.2 |
| Coal | 3.0 | 4.2 | 4.2 | 4.2 | 4.4 | 4.6 | 4.8 | 5.3 | 1.0 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Other | 0.6 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **9.5** | **14.5** | **14.5** | **16.2** | **17.7** | **19.1** | **20.6** | **21.8** | **1.7** |
| **Central and South America** | | | | | | | | | |
| Liquids | 7.8 | 11.3 | 11.7 | 13.5 | 13.6 | 13.9 | 14.7 | 15.7 | 1.2 |
| Natural Gas | 2.2 | 4.7 | 4.8 | 5.8 | 6.7 | 7.4 | 8.2 | 8.6 | 2.4 |
| Coal | 0.6 | 0.9 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.6 | 2.8 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 2.0 |
| Other | 3.9 | 6.4 | 6.6 | 7.8 | 8.7 | 9.7 | 10.6 | 11.5 | 2.3 |
| **Total** | **14.5** | **23.4** | **24.2** | **28.3** | **30.3** | **32.5** | **35.2** | **37.7** | **1.9** |
| **Total Non-OECD** | | | | | | | | | |
| Liquids | 52.9 | 71.0 | 73.6 | 82.3 | 89.3 | 98.4 | 107.4 | 116.4 | 1.9 |
| Natural Gas | 38.0 | 53.5 | 54.2 | 61.7 | 71.4 | 79.1 | 85.5 | 91.2 | 2.2 |
| Coal | 45.7 | 74.8 | 80.6 | 93.3 | 102.9 | 113.8 | 126.9 | 139.6 | 2.3 |
| Nuclear | 3.1 | 4.3 | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.2 | 4.7 |
| Other | 10.3 | 17.2 | 18.0 | 23.1 | 28.4 | 33.2 | 35.8 | 39.8 | 3.4 |
| **Total** | **149.9** | **220.7** | **230.8** | **265.4** | **299.1** | **334.4** | **367.8** | **400.1** | **2.3** |
| **Total World** | | | | | | | | | |
| Liquids | 136.4 | 170.4 | 172.4 | 174.7 | 183.3 | 194.2 | 204.6 | 215.7 | 0.9 |
| Natural Gas | 75.3 | 107.1 | 108.1 | 118.5 | 131.0 | 141.7 | 151.3 | 158.0 | 1.6 |
| Coal | 89.2 | 121.7 | 127.5 | 140.6 | 150.7 | 161.7 | 175.2 | 190.2 | 1.7 |
| Nuclear | 20.4 | 27.5 | 27.8 | 29.0 | 31.9 | 35.4 | 38.1 | 40.2 | 1.6 |
| Other | 26.3 | 35.5 | 36.8 | 45.6 | 54.6 | 62.8 | 68.1 | 74.1 | 3.0 |
| **Total** | **347.7** | **462.1** | **472.4** | **508.3** | **551.5** | **595.7** | **637.3** | **678.3** | **1.5** |

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Reference Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,651** | **14,885** | **15,331** | **16,073** | **18,789** | **21,341** | **24,283** | **27,802** | **2.5** |
| United States[a] | 8,040 | 12,422 | 12,768 | 13,315 | 15,538 | 17,548 | 19,885 | 22,737 | 2.4 |
| Canada | 773 | 1,167 | 1,204 | 1,275 | 1,453 | 1,629 | 1,822 | 2,035 | 2.2 |
| Mexico | 838 | 1,296 | 1,359 | 1,483 | 1,798 | 2,164 | 2,575 | 3,030 | 3.4 |
| **OECD Europe** | **9,703** | **13,756** | **14,224** | **15,015** | **16,839** | **18,811** | **20,894** | **23,105** | **2.0** |
| **OECD Asia** | **4,080** | **5,509** | **5,667** | **6,045** | **6,775** | **7,314** | **7,819** | **8,357** | **1.6** |
| Japan | 3,222 | 3,873 | 3,966 | 4,105 | 4,438 | 4,601 | 4,688 | 4,773 | 0.8 |
| South Korea | 374 | 843 | 886 | 1,040 | 1,281 | 1,492 | 1,713 | 1,939 | 3.3 |
| Australia/New Zealand | 485 | 794 | 815 | 899 | 1,056 | 1,222 | 1,418 | 1,645 | 3.0 |
| **Total OECD** | **23,434** | **34,150** | **35,221** | **37,133** | **42,403** | **47,466** | **52,996** | **59,264** | **2.2** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3,039** | **2,932** | **3,159** | **3,940** | **4,865** | **5,725** | **6,536** | **7,381** | **3.6** |
| Russia | 1,880 | 1,703 | 1,829 | 2,328 | 2,854 | 3,331 | 3,770 | 4,230 | 3.6 |
| Other | 1,159 | 1,229 | 1,330 | 1,612 | 2,011 | 2,393 | 2,766 | 3,151 | 3.7 |
| **Non-OECD Asia** | **4,457** | **12,272** | **13,408** | **17,934** | **24,606** | **32,726** | **41,428** | **50,834** | **5.7** |
| China | 1,265 | 5,389 | 6,014 | 8,686 | 12,263 | 16,888 | 21,664 | 26,501 | 6.4 |
| India | 1,019 | 2,436 | 2,672 | 3,497 | 4,871 | 6,428 | 8,039 | 9,877 | 5.6 |
| Other Non-OECD Asia | 2,173 | 4,448 | 4,723 | 5,751 | 7,472 | 9,410 | 11,725 | 14,456 | 4.8 |
| **Middle East** | **1,072** | **1,919** | **2,053** | **2,484** | **3,030** | **3,621** | **4,300** | **5,102** | **3.9** |
| **Africa** | **1,387** | **2,211** | **2,341** | **2,870** | **3,612** | **4,384** | **5,182** | **5,958** | **4.0** |
| **Central and South America** | **2,270** | **3,555** | **3,757** | **4,495** | **5,415** | **6,450** | **7,615** | **8,945** | **3.7** |
| Brazil | 1,045 | 1,534 | 1,591 | 1,895 | 2,296 | 2,753 | 3,292 | 3,922 | 3.8 |
| Other Central and South America | 1,224 | 2,021 | 2,165 | 2,600 | 3,119 | 3,697 | 4,324 | 5,023 | 3.6 |
| **Total Non-OECD** | **12,225** | **22,888** | **24,717** | **31,723** | **41,529** | **52,907** | **65,062** | **78,220** | **4.9** |
| **Total World** | **35,659** | **57,038** | **59,939** | **68,856** | **83,932** | **100,373** | **118,058** | **137,484** | **3.5** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for Russia and other non-OECD Europe and Eurasia, China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo.

**Table A4. World Gross Domestic Product (GDP) by Region Expressed in Market Exchange Rates, Reference Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,338** | **14,403** | **14,825** | **15,523** | **18,124** | **20,544** | **23,338** | **26,693** | **2.5** |
| United States[a] | 8,040 | 12,422 | 12,768 | 13,315 | 15,538 | 17,548 | 19,885 | 22,737 | 2.4 |
| Canada | 750 | 1,133 | 1,168 | 1,238 | 1,410 | 1,582 | 1,769 | 1,975 | 2.2 |
| Mexico | 548 | 847 | 889 | 969 | 1,176 | 1,415 | 1,684 | 1,981 | 3.5 |
| **OECD Europe** | **10,349** | **14,560** | **15,031** | **15,762** | **17,555** | **19,480** | **21,495** | **23,628** | **2.0** |
| **OECD Asia** | **4,644** | **6,170** | **6,342** | **6,738** | **7,518** | **8,079** | **8,592** | **9,139** | **1.6** |
| Japan | 3,791 | 4,558 | 4,668 | 4,831 | 5,223 | 5,415 | 5,517 | 5,617 | 0.8 |
| South Korea | 351 | 791 | 832 | 977 | 1,203 | 1,401 | 1,609 | 1,821 | 3.4 |
| Australia/New Zealand | 502 | 821 | 843 | 930 | 1,092 | 1,263 | 1,467 | 1,701 | 3.0 |
| **Total OECD** | **24,332** | **35,133** | **36,198** | **38,023** | **43,197** | **48,103** | **53,425** | **59,460** | **2.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,342** | **1,320** | **1,426** | **1,785** | **2,208** | **2,616** | **3,022** | **3,457** | **3.9** |
| Russia | 843 | 764 | 820 | 1,044 | 1,283 | 1,508 | 1,728 | 1,965 | 3.9 |
| Other | 498 | 556 | 606 | 741 | 925 | 1,109 | 1,294 | 1,492 | 4.0 |
| **Non-OECD Asia** | **1,704** | **4,738** | **5,177** | **6,929** | **9,518** | **12,738** | **16,305** | **20,245** | **6.0** |
| China | 525 | 2,236 | 2,496 | 3,604 | 5,106 | 7,118 | 9,324 | 11,675 | 6.8 |
| India | 340 | 812 | 891 | 1,166 | 1,626 | 2,157 | 2,722 | 3,378 | 5.9 |
| Other Non-OECD Asia | 840 | 1,690 | 1,791 | 2,159 | 2,785 | 3,463 | 4,259 | 5,192 | 4.6 |
| **Middle East** | **581** | **1,071** | **1,150** | **1,400** | **1,701** | **2,035** | **2,422** | **2,876** | **4.0** |
| **Africa** | **615** | **965** | **1,021** | **1,244** | **1,576** | **1,962** | **2,416** | **2,908** | **4.5** |
| **Central and South America** | **1,250** | **1,934** | **2,041** | **2,432** | **2,940** | **3,523** | **4,196** | **4,977** | **3.9** |
| Brazil | 601 | 882 | 915 | 1,089 | 1,320 | 1,583 | 1,892 | 2,255 | 3.8 |
| Other Central and South America | 649 | 1,052 | 1,127 | 1,343 | 1,620 | 1,940 | 2,304 | 2,722 | 3.9 |
| **Total Non-OECD** | **5,492** | **10,028** | **10,816** | **13,789** | **17,943** | **22,874** | **28,362** | **34,461** | **5.1** |
| **Total World** | **29,823** | **45,161** | **47,014** | **51,812** | **61,140** | **70,977** | **81,787** | **93,922** | **3.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for Russia and other non-OECD Europe and Eurasia, China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), Table A19.

**Table A5. World Liquids Consumption by Region, Reference Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.5** | **25.2** | **25.1** | **23.5** | **24.1** | **24.4** | **25.2** | **26.2** | **0.2** |
| United States[a] | 17.0 | 20.8 | 20.7 | 19.6 | 20.2 | 20.2 | 20.8 | 21.7 | 0.2 |
| Canada | 1.7 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.4 | 2.5 | 0.3 |
| Mexico | 1.8 | 2.1 | 2.1 | 1.5 | 1.7 | 1.9 | 2.0 | 2.1 | 0.0 |
| **OECD Europe** | **13.7** | **15.7** | **15.7** | **14.5** | **14.5** | **14.9** | **15.0** | **15.0** | **-0.2** |
| **OECD Asia** | **7.2** | **8.6** | **8.5** | **8.4** | **8.6** | **8.8** | **8.8** | **8.7** | **0.1** |
| Japan | 5.3 | 5.3 | 5.2 | 4.6 | 4.8 | 5.0 | 4.8 | 4.7 | -0.4 |
| South Korea | 1.0 | 2.2 | 2.2 | 2.8 | 2.7 | 2.6 | 2.7 | 2.8 | 1.0 |
| Australia/New Zealand | 0.8 | 1.1 | 1.1 | 1.0 | 1.1 | 1.2 | 1.2 | 1.3 | 0.6 |
| **Total OECD** | **41.4** | **49.5** | **49.2** | **46.3** | **47.2** | **48.1** | **48.9** | **50.0** | **0.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **9.4** | **4.9** | **5.0** | **5.1** | **5.2** | **5.4** | **5.4** | **5.5** | **0.4** |
| Russia | 5.4 | 2.8 | 2.8 | 2.7 | 2.8 | 2.9 | 2.8 | 2.7 | -0.1 |
| Other | 3.9 | 2.1 | 2.1 | 2.4 | 2.4 | 2.5 | 2.6 | 2.7 | 1.0 |
| **Non-OECD Asia** | **6.6** | **15.3** | **16.0** | **17.8** | **20.6** | **24.2** | **27.3** | **30.2** | **2.7** |
| China | 2.3 | 6.7 | 7.2 | 8.5 | 10.0 | 12.1 | 13.8 | 15.3 | 3.2 |
| India | 1.2 | 2.5 | 2.7 | 2.4 | 3.1 | 3.9 | 4.3 | 4.7 | 2.4 |
| Other Non-OECD Asia | 3.1 | 6.1 | 6.1 | 6.9 | 7.5 | 8.2 | 9.1 | 10.2 | 2.1 |
| **Middle East** | **3.5** | **5.8** | **6.1** | **7.0** | **7.4** | **7.9** | **8.5** | **9.4** | **1.8** |
| **Africa** | **2.1** | **3.0** | **3.0** | **3.5** | **3.6** | **3.7** | **3.8** | **3.9** | **1.2** |
| **Central and South America** | **3.8** | **5.5** | **5.7** | **6.6** | **6.6** | **6.8** | **7.1** | **7.6** | **1.2** |
| Brazil | 1.5 | 2.2 | 2.3 | 2.5 | 2.8 | 3.0 | 3.4 | 3.7 | 2.1 |
| Other Central and South America | 2.3 | 3.3 | 3.4 | 4.0 | 3.8 | 3.7 | 3.8 | 3.9 | 0.5 |
| **Total Non-OECD** | **25.3** | **34.5** | **35.8** | **40.0** | **43.4** | **47.8** | **52.2** | **56.6** | **1.9** |
| **Total World** | **66.7** | **84.0** | **85.0** | **86.3** | **90.6** | **95.9** | **101.1** | **106.6** | **0.9** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A6. World Natural Gas Consumption by Region, Reference Case, 1990-2030**
(Trillion Cubic Feet)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **22.5** | **27.1** | **27.2** | **28.4** | **29.4** | **30.8** | **32.8** | **33.3** | **0.8** |
| United States[a] | 19.2 | 22.0 | 21.7 | 22.6 | 22.8 | 23.4 | 24.7 | 24.4 | 0.5 |
| Canada | 2.4 | 3.4 | 3.3 | 3.4 | 3.9 | 4.2 | 4.5 | 4.7 | 1.5 |
| Mexico | 0.9 | 1.8 | 2.2 | 2.4 | 2.8 | 3.2 | 3.7 | 4.2 | 2.7 |
| **OECD Europe** | **11.6** | **19.3** | **19.2** | **20.4** | **21.5** | **22.6** | **23.5** | **24.1** | **1.0** |
| **OECD Asia** | **2.9** | **5.2** | **5.5** | **5.9** | **6.5** | **6.8** | **6.9** | **7.0** | **1.0** |
| Japan | 2.0 | 3.1 | 3.2 | 3.3 | 3.6 | 3.7 | 3.7 | 3.7 | 0.5 |
| South Korea | 0.1 | 1.1 | 1.1 | 1.3 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 |
| Australia/New Zealand | 0.8 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.3 |
| **Total OECD** | **37.0** | **51.7** | **51.9** | **54.7** | **57.4** | **60.3** | **63.3** | **64.3** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **26.7** | **25.3** | **25.4** | **27.5** | **29.9** | **31.3** | **32.1** | **32.8** | **1.1** |
| Russia | 17.3 | 16.2 | 16.6 | 18.0 | 19.1 | 19.9 | 20.3 | 20.8 | 0.9 |
| Other | 9.5 | 9.1 | 8.8 | 9.6 | 10.8 | 11.4 | 11.8 | 12.0 | 1.3 |
| **Non-OECD Asia** | **2.9** | **9.3** | **9.4** | **11.4** | **15.2** | **18.7** | **21.8** | **24.5** | **4.1** |
| China | 0.5 | 1.7 | 2.0 | 2.6 | 3.8 | 4.9 | 5.9 | 6.8 | 5.2 |
| India | 0.4 | 1.3 | 1.4 | 1.8 | 2.4 | 3.0 | 3.4 | 3.7 | 4.2 |
| Other Non-OECD Asia | 2.0 | 6.4 | 6.0 | 7.0 | 9.0 | 10.9 | 12.5 | 14.1 | 3.6 |
| **Middle East** | **3.6** | **9.8** | **10.3** | **11.9** | **13.5** | **14.4** | **15.3** | **16.6** | **2.0** |
| **Africa** | **1.4** | **3.0** | **2.9** | **3.4** | **4.3** | **5.1** | **5.8** | **6.2** | **3.2** |
| **Central and South America** | **2.0** | **4.4** | **4.5** | **5.5** | **6.3** | **7.0** | **7.7** | **8.1** | **2.4** |
| Brazil | 0.1 | 0.7 | 0.7 | 1.0 | 1.2 | 1.4 | 1.7 | 1.8 | 4.1 |
| Other Central and South America | 1.9 | 3.7 | 3.8 | 4.5 | 5.1 | 5.6 | 6.0 | 6.3 | 2.1 |
| **Total Non-OECD** | **36.5** | **51.8** | **52.5** | **59.8** | **69.1** | **76.5** | **82.7** | **88.2** | **2.2** |
| **Total World** | **73.5** | **103.4** | **104.4** | **114.4** | **126.5** | **136.8** | **146.0** | **152.5** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A7. World Coal Consumption by Region, Reference Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.6** | **24.7** | **24.3** | **24.8** | **25.5** | **26.0** | **26.5** | **28.8** | **0.7** |
| United States[a] | 19.2 | 22.8 | 22.5 | 22.9 | 23.6 | 24.0 | 24.4 | 26.6 | 0.7 |
| Canada | 1.2 | 1.5 | 1.4 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 0.5 |
| Mexico | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.5 |
| **OECD Europe** | **17.7** | **12.9** | **13.2** | **13.0** | **12.8** | **12.4** | **12.2** | **12.0** | **-0.4** |
| **OECD Asia** | **5.2** | **9.3** | **9.4** | **9.5** | **9.5** | **9.5** | **9.6** | **9.8** | **0.2** |
| Japan | 2.7 | 4.6 | 4.6 | 4.5 | 4.5 | 4.3 | 4.2 | 4.0 | -0.6 |
| South Korea | 1.0 | 2.1 | 2.2 | 2.4 | 2.4 | 2.5 | 2.7 | 2.9 | 1.2 |
| Australia/New Zealand | 1.5 | 2.6 | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.9 | 0.5 |
| **Total OECD** | **43.5** | **46.9** | **46.9** | **47.3** | **47.8** | **47.9** | **48.3** | **50.7** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **15.1** | **8.9** | **8.7** | **9.2** | **9.5** | **9.3** | **9.2** | **9.4** | **0.3** |
| Russia | 7.2 | 4.8 | 4.6 | 5.0 | 5.2 | 5.1 | 5.1 | 5.2 | 0.5 |
| Other | 7.9 | 4.1 | 4.2 | 4.2 | 4.3 | 4.2 | 4.1 | 4.2 | 0.0 |
| **Non-OECD Asia** | **27.0** | **60.4** | **66.5** | **78.5** | **87.6** | **98.4** | **111.1** | **122.8** | **2.6** |
| China | 20.3 | 46.9 | 52.0 | 62.7 | 70.3 | 79.5 | 90.1 | 98.3 | 2.7 |
| India | 4.2 | 8.6 | 9.4 | 10.3 | 11.2 | 12.1 | 12.9 | 14.2 | 1.7 |
| Other Non-OECD Asia | 2.6 | 4.9 | 5.1 | 5.5 | 6.1 | 6.7 | 8.1 | 10.4 | 3.0 |
| **Middle East** | **0.1** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.5** | **1.1** |
| **Africa** | **3.0** | **4.2** | **4.2** | **4.2** | **4.4** | **4.6** | **4.8** | **5.3** | **1.0** |
| **Central and South America** | **0.6** | **0.9** | **0.8** | **0.9** | **1.0** | **1.2** | **1.3** | **1.6** | **2.8** |
| Brazil | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 3.5 |
| Other Central and South America | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.7 |
| **Total Non-OECD** | **45.7** | **74.8** | **80.6** | **93.3** | **102.9** | **113.8** | **126.9** | **139.6** | **2.3** |
| **Total World** | **89.2** | **121.7** | **127.5** | **140.6** | **150.7** | **161.7** | **175.2** | **190.2** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A8. World Nuclear Energy Consumption by Region, Reference Case, 1990-2030**
(Billion Kilowatthours)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **649** | **880** | **891** | **928** | **955** | **992** | **1,004** | **1,053** | **0.7** |
| United States[a] | 577 | 782 | 787 | 809 | 831 | 862 | 867 | 907 | 0.6 |
| Canada | 69 | 87 | 93 | 108 | 113 | 120 | 127 | 135 | 1.5 |
| Mexico | 3 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 0.1 |
| **OECD Europe** | **743** | **932** | **929** | **922** | **915** | **905** | **896** | **902** | **-0.1** |
| **OECD Asia** | **242** | **429** | **430** | **441** | **494** | **546** | **583** | **624** | **1.6** |
| Japan | 192 | 290 | 288 | 299 | 319 | 336 | 358 | 381 | 1.2 |
| South Korea | 50 | 139 | 141 | 142 | 175 | 210 | 225 | 243 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **1,635** | **2,240** | **2,250** | **2,291** | **2,364** | **2,443** | **2,484** | **2,579** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **219** | **264** | **269** | **283** | **342** | **424** | **494** | **519** | **2.8** |
| Russia | 115 | 140 | 144 | 155 | 197 | 251 | 307 | 328 | 3.5 |
| Other | 104 | 124 | 124 | 128 | 145 | 173 | 187 | 191 | 1.8 |
| **Non-OECD Asia** | **38** | **106** | **111** | **151** | **290** | **455** | **600** | **678** | **7.8** |
| China | 0 | 50 | 55 | 65 | 164 | 274 | 366 | 425 | 8.9 |
| India | 6 | 16 | 16 | 37 | 66 | 104 | 134 | 149 | 9.9 |
| Other Non-OECD Asia | 32 | 40 | 40 | 48 | 61 | 77 | 100 | 104 | 4.0 |
| **Middle East** | **0** | **0** | **0** | **0** | **6** | **13** | **13** | **13** | **—** |
| **Africa** | **8** | **12** | **10** | **14** | **15** | **15** | **21** | **21** | **3.2** |
| **Central and South America** | **9** | **16** | **21** | **23** | **28** | **34** | **34** | **34** | **2.1** |
| Brazil | 2 | 10 | 14 | 15 | 18 | 22 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 6 | 7 | 8 | 10 | 12 | 12 | 12 | 2.2 |
| **Total Non-OECD** | **274** | **399** | **411** | **471** | **681** | **941** | **1,162** | **1,266** | **4.8** |
| **Total World** | **1,909** | **2,639** | **2,660** | **2,761** | **3,045** | **3,385** | **3,646** | **3,844** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A9. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Reference Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9.7** | **10.3** | **10.5** | **11.8** | **13.3** | **14.8** | **16.1** | **17.0** | **2.0** |
| United States[a] | 6.2 | 6.1 | 6.5 | 7.4 | 8.3 | 9.5 | 10.4 | 10.9 | 2.2 |
| Canada | 3.1 | 3.7 | 3.6 | 3.9 | 4.4 | 4.7 | 5.1 | 5.4 | 1.7 |
| Mexico | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.9 |
| **OECD Europe** | **4.8** | **6.5** | **6.6** | **8.5** | **10.3** | **11.9** | **13.3** | **14.4** | **3.3** |
| **OECD Asia** | **1.6** | **1.6** | **1.7** | **2.1** | **2.6** | **2.8** | **2.9** | **3.0** | **2.4** |
| Japan | 1.1 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.3 |
| Australia/New Zealand | 0.4 | 0.5 | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.3 | 4.2 |
| **Total OECD** | **16.0** | **18.3** | **18.8** | **22.4** | **26.3** | **29.5** | **32.3** | **34.3** | **2.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **2.8** | **3.1** | **3.0** | **3.2** | **3.4** | **3.5** | **3.7** | **3.8** | **0.9** |
| Russia | 1.8 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| Other | 1.0 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Non-OECD Asia** | **3.0** | **6.6** | **7.2** | **10.7** | **14.6** | **18.2** | **19.5** | **22.4** | **4.9** |
| China | 1.3 | 4.0 | 4.3 | 7.0 | 9.5 | 11.8 | 12.4 | 14.7 | 5.2 |
| India | 0.7 | 1.1 | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| Other Non-OECD Asia | 0.9 | 1.6 | 1.6 | 2.1 | 2.9 | 3.7 | 4.2 | 4.5 | 4.3 |
| **Middle East** | **0.1** | **0.2** | **0.2** | **0.3** | **0.4** | **0.5** | **0.5** | **0.5** | **3.4** |
| **Africa** | **0.6** | **0.9** | **0.9** | **1.0** | **1.3** | **1.4** | **1.5** | **1.5** | **2.1** |
| **Central and South America** | **3.9** | **6.4** | **6.6** | **7.8** | **8.7** | **9.7** | **10.6** | **11.5** | **2.3** |
| Brazil | 2.2 | 3.5 | 3.6 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 3.0 |
| Other Central and South America | 1.7 | 2.9 | 3.0 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 1.4 |
| **Total Non-OECD** | **10.3** | **17.2** | **18.0** | **23.1** | **28.4** | **33.2** | **35.8** | **39.8** | **3.4** |
| **Total World** | **26.3** | **35.5** | **36.8** | **45.6** | **54.6** | **62.8** | **68.1** | **74.1** | **3.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. U.S. consumption of hydroelectricity and other renewable energy is projected to be 9.4 quadrillion Btu in 2015 and 11.8 quadrillion Btu in 2030 in the *updated AEO2009* reference case—13 percent higher in 2015 and 8 percent higher in 2030 than in the earlier projections reported in this table.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A10. World Carbon Dioxide Emissions by Region, Reference Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **5,762** | **7,007** | **6,948** | **6,794** | **6,963** | **7,123** | **7,341** | **7,703** | **0.4** |
| United States[a] | 4,989 | 5,975 | 5,907 | 5,801 | 5,904 | 5,982 | 6,125 | 6,414 | 0.3 |
| Canada | 471 | 629 | 611 | 622 | 645 | 675 | 705 | 731 | 0.8 |
| Mexico | 302 | 403 | 431 | 371 | 414 | 466 | 510 | 557 | 1.1 |
| **OECD Europe** | **4,149** | **4,424** | **4,429** | **4,335** | **4,368** | **4,450** | **4,489** | **4,519** | **0.1** |
| **OECD Asia** | **1,595** | **2,200** | **2,216** | **2,221** | **2,287** | **2,327** | **2,346** | **2,367** | **0.3** |
| Japan | 1,054 | 1,250 | 1,247 | 1,169 | 1,204 | 1,219 | 1,188 | 1,157 | -0.3 |
| South Korea | 243 | 497 | 515 | 598 | 614 | 617 | 651 | 680 | 1.2 |
| Australia/New Zealand | 298 | 454 | 455 | 454 | 469 | 491 | 507 | 530 | 0.6 |
| **Total OECD** | **11,506** | **13,632** | **13,594** | **13,351** | **13,617** | **13,900** | **14,176** | **14,588** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **4,246** | **2,889** | **2,886** | **3,069** | **3,234** | **3,323** | **3,362** | **3,422** | **0.7** |
| Russia | 2,393 | 1,699 | 1,704 | 1,803 | 1,894 | 1,945 | 1,950 | 1,978 | 0.6 |
| Other | 1,853 | 1,190 | 1,182 | 1,266 | 1,339 | 1,378 | 1,412 | 1,443 | 0.8 |
| **Non-OECD Asia** | **3,678** | **8,305** | **8,987** | **10,465** | **11,900** | **13,590** | **15,382** | **17,033** | **2.7** |
| China | 2,293 | 5,429 | 6,018 | 7,222 | 8,204 | 9,417 | 10,707 | 11,730 | 2.8 |
| India | 573 | 1,192 | 1,292 | 1,366 | 1,572 | 1,783 | 1,931 | 2,115 | 2.1 |
| Other Non-OECD Asia | 811 | 1,684 | 1,678 | 1,877 | 2,124 | 2,390 | 2,744 | 3,188 | 2.7 |
| **Middle East** | **704** | **1,393** | **1,456** | **1,686** | **1,830** | **1,939** | **2,088** | **2,279** | **1.9** |
| **Africa** | **659** | **985** | **982** | **1,086** | **1,161** | **1,239** | **1,325** | **1,409** | **1.5** |
| **Central and South America** | **695** | **1,093** | **1,123** | **1,311** | **1,368** | **1,437** | **1,547** | **1,654** | **1.6** |
| Brazil | 235 | 366 | 374 | 437 | 488 | 543 | 612 | 682 | 2.5 |
| Other Central and South America | 460 | 727 | 749 | 874 | 881 | 894 | 935 | 972 | 1.1 |
| **Total Non-OECD** | **9,982** | **14,664** | **15,434** | **17,616** | **19,494** | **21,528** | **23,703** | **25,797** | **2.2** |
| **Total World** | **21,488** | **28,296** | **29,028** | **30,967** | **33,111** | **35,428** | **37,879** | **40,385** | **1.4** |

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A11. World Carbon Dioxide Emissions from Liquids Use by Region, Reference Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **2,637** | **3,188** | **3,159** | **2,889** | **2,933** | **2,969** | **3,022** | **3,149** | **0.0** |
| United States[a] | 2,178 | 2,620 | 2,596 | 2,396 | 2,421 | 2,427 | 2,458 | 2,564 | -0.1 |
| Canada | 227 | 301 | 295 | 295 | 294 | 300 | 310 | 320 | 0.3 |
| Mexico | 233 | 267 | 268 | 198 | 217 | 242 | 255 | 265 | 0.0 |
| **OECD Europe** | **1,884** | **2,134** | **2,135** | **1,978** | **1,974** | **2,031** | **2,044** | **2,052** | **-0.2** |
| **OECD Asia** | **945** | **1,028** | **1,014** | **990** | **1,018** | **1,043** | **1,042** | **1,040** | **0.1** |
| Japan | 687 | 641 | 626 | 554 | 578 | 598 | 582 | 567 | -0.4 |
| South Korea | 144 | 239 | 237 | 299 | 295 | 287 | 295 | 299 | 1.0 |
| Australia/New Zealand | 114 | 148 | 151 | 137 | 145 | 158 | 165 | 174 | 0.6 |
| **Total OECD** | **5,466** | **6,350** | **6,308** | **5,856** | **5,925** | **6,043** | **6,108** | **6,241** | **0.0** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,368** | **686** | **692** | **713** | **730** | **752** | **759** | **765** | **0.4** |
| Russia | 782 | 383 | 389 | 374 | 386 | 399 | 388 | 377 | -0.1 |
| Other | 586 | 303 | 303 | 339 | 344 | 353 | 370 | 388 | 1.0 |
| **Non-OECD Asia** | **960** | **2,077** | **2,170** | **2,414** | **2,780** | **3,260** | **3,679** | **4,071** | **2.7** |
| China | 335 | 889 | 960 | 1,129 | 1,326 | 1,604 | 1,838 | 2,032 | 3.2 |
| India | 160 | 314 | 332 | 305 | 388 | 488 | 537 | 587 | 2.4 |
| Other Non-OECD Asia | 466 | 874 | 878 | 980 | 1,066 | 1,169 | 1,304 | 1,452 | 2.1 |
| **Middle East** | **491** | **814** | **849** | **986** | **1,043** | **1,103** | **1,195** | **1,313** | **1.8** |
| **Africa** | **302** | **423** | **424** | **495** | **507** | **522** | **544** | **560** | **1.2** |
| **Central and South America** | **525** | **761** | **790** | **913** | **916** | **932** | **984** | **1,049** | **1.2** |
| Brazil | 197 | 288 | 294 | 332 | 364 | 397 | 438 | 487 | 2.1 |
| Other Central and South America | 328 | 473 | 496 | 581 | 553 | 536 | 547 | 563 | 0.5 |
| **Total Non-OECD** | **3,646** | **4,760** | **4,926** | **5,522** | **5,977** | **6,570** | **7,161** | **7,758** | **1.9** |
| **Total World** | **9,112** | **11,110** | **11,234** | **11,378** | **11,901** | **12,613** | **13,269** | **13,998** | **0.9** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A12. World Carbon Dioxide Emissions from Natural Gas Use by Region, Reference Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,208** | **1,468** | **1,465** | **1,541** | **1,597** | **1,678** | **1,789** | **1,814** | **0.9** |
| United States[a] | 1,026 | 1,183 | 1,159 | 1,218 | 1,228 | 1,265 | 1,333 | 1,318 | 0.5 |
| Canada | 128 | 185 | 181 | 189 | 211 | 230 | 246 | 259 | 1.5 |
| Mexico | 54 | 100 | 125 | 134 | 157 | 182 | 209 | 237 | 2.7 |
| **OECD Europe** | **593** | **1,053** | **1,047** | **1,113** | **1,173** | **1,234** | **1,283** | **1,315** | **1.0** |
| **OECD Asia** | **165** | **306** | **323** | **344** | **377** | **397** | **403** | **407** | **1.0** |
| Japan | 115 | 181 | 191 | 197 | 213 | 219 | 218 | 215 | 0.5 |
| South Korea | 6 | 64 | 68 | 77 | 90 | 96 | 102 | 105 | 1.8 |
| Australia/New Zealand | 44 | 61 | 64 | 70 | 75 | 82 | 83 | 87 | 1.3 |
| **Total OECD** | **1,966** | **2,827** | **2,835** | **2,997** | **3,147** | **3,308** | **3,475** | **3,536** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,457** | **1,367** | **1,371** | **1,487** | **1,614** | **1,692** | **1,735** | **1,772** | **1.1** |
| Russia | 933 | 865 | 889 | 962 | 1,022 | 1,064 | 1,087 | 1,115 | 0.9 |
| Other | 524 | 502 | 482 | 525 | 591 | 628 | 648 | 658 | 1.3 |
| **Non-OECD Asia** | **161** | **508** | **510** | **621** | **826** | **1,018** | **1,183** | **1,334** | **4.1** |
| China | 30 | 92 | 111 | 146 | 210 | 269 | 325 | 375 | 5.2 |
| India | 24 | 70 | 76 | 98 | 131 | 164 | 187 | 201 | 4.2 |
| Other Non-OECD Asia | 106 | 347 | 324 | 377 | 485 | 585 | 672 | 758 | 3.6 |
| **Middle East** | **200** | **543** | **571** | **665** | **751** | **798** | **853** | **921** | **2.0** |
| **Africa** | **80** | **168** | **168** | **194** | **243** | **291** | **330** | **355** | **3.2** |
| **Central and South America** | **117** | **250** | **255** | **309** | **353** | **395** | **437** | **455** | **2.4** |
| Brazil | 6 | 36 | 38 | 54 | 64 | 78 | 93 | 99 | 4.1 |
| Other Central and South America | 111 | 214 | 218 | 255 | 289 | 318 | 344 | 356 | 2.1 |
| **Total Non-OECD** | **2,015** | **2,837** | **2,876** | **3,275** | **3,788** | **4,195** | **4,538** | **4,838** | **2.2** |
| **Total World** | **3,981** | **5,664** | **5,712** | **6,273** | **6,936** | **7,504** | **8,013** | **8,373** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A13. World Carbon Dioxide Emissions from Coal Use by Region, Reference Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,916** | **2,339** | **2,312** | **2,353** | **2,421** | **2,464** | **2,518** | **2,728** | **0.7** |
| United States[a] | 1,784 | 2,161 | 2,140 | 2,176 | 2,242 | 2,278 | 2,322 | 2,521 | 0.7 |
| Canada | 116 | 142 | 134 | 138 | 140 | 144 | 150 | 152 | 0.5 |
| Mexico | 16 | 36 | 38 | 38 | 39 | 42 | 46 | 55 | 1.5 |
| **OECD Europe** | **1,672** | **1,237** | **1,247** | **1,245** | **1,220** | **1,184** | **1,162** | **1,152** | **-0.3** |
| **OECD Asia** | **485** | **866** | **879** | **888** | **892** | **888** | **901** | **920** | **0.2** |
| Japan | 252 | 427 | 430 | 419 | 414 | 403 | 388 | 375 | -0.6 |
| South Korea | 93 | 194 | 209 | 222 | 229 | 235 | 254 | 276 | 1.2 |
| Australia/New Zealand | 140 | 244 | 240 | 247 | 248 | 251 | 258 | 269 | 0.5 |
| **Total OECD** | **4,073** | **4,443** | **4,438** | **4,486** | **4,534** | **4,537** | **4,581** | **4,800** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,421** | **836** | **823** | **869** | **890** | **879** | **868** | **885** | **0.3** |
| Russia | 678 | 451 | 427 | 466 | 486 | 482 | 475 | 487 | 0.5 |
| Other | 743 | 385 | 396 | 403 | 404 | 397 | 393 | 398 | 0.0 |
| **Non-OECD Asia** | **2,557** | **5,720** | **6,307** | **7,430** | **8,294** | **9,312** | **10,519** | **11,628** | **2.6** |
| China | 1,929 | 4,449 | 4,947 | 5,948 | 6,667 | 7,544 | 8,544 | 9,323 | 2.7 |
| India | 389 | 808 | 883 | 962 | 1,053 | 1,131 | 1,207 | 1,327 | 1.7 |
| Other Non-OECD Asia | 239 | 463 | 476 | 520 | 573 | 636 | 768 | 978 | 3.0 |
| **Middle East** | **14** | **36** | **36** | **35** | **36** | **37** | **40** | **45** | **0.9** |
| **Africa** | **277** | **394** | **389** | **397** | **411** | **426** | **451** | **494** | **1.0** |
| **Central and South America** | **53** | **81** | **77** | **89** | **98** | **110** | **126** | **150** | **2.8** |
| Brazil | 32 | 42 | 42 | 51 | 60 | 69 | 82 | 96 | 3.5 |
| Other Central and South America | 21 | 40 | 36 | 38 | 39 | 41 | 44 | 53 | 1.7 |
| **Total Non-OECD** | **4,321** | **7,067** | **7,632** | **8,819** | **9,729** | **10,763** | **12,005** | **13,201** | **2.3** |
| **Total World** | **8,394** | **11,510** | **12,070** | **13,304** | **14,262** | **15,300** | **16,585** | **18,001** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table A14. World Population by Region, Reference Case, 1990-2030**
(Millions)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **366** | **433** | **438** | **455** | **478** | **500** | **521** | **542** | **0.9** |
| United States[a] | 254 | 297 | 300 | 311 | 327 | 343 | 359 | 375 | 0.9 |
| Canada | 28 | 32 | 33 | 34 | 35 | 37 | 38 | 39 | 0.8 |
| Mexico | 84 | 104 | 105 | 110 | 116 | 121 | 125 | 128 | 0.8 |
| **OECD Europe** | **497** | **536** | **538** | **547** | **555** | **561** | **565** | **568** | **0.2** |
| **OECD Asia** | **187** | **200** | **201** | **202** | **203** | **202** | **200** | **197** | **-0.1** |
| Japan | 124 | 128 | 128 | 128 | 127 | 124 | 122 | 118 | -0.3 |
| South Korea | 43 | 48 | 48 | 49 | 49 | 49 | 49 | 48 | 0.0 |
| Australia/New Zealand | 20 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 0.8 |
| **Total OECD** | **1,050** | **1,169** | **1,176** | **1,204** | **1,235** | **1,262** | **1,286** | **1,307** | **0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **348** | **342** | **342** | **340** | **337** | **333** | **328** | **322** | **-0.2** |
| Russia | 149 | 144 | 143 | 140 | 136 | 132 | 128 | 124 | -0.6 |
| Other | 200 | 198 | 198 | 199 | 200 | 201 | 200 | 198 | 0.0 |
| **Non-OECD Asia** | **2,760** | **3,431** | **3,471** | **3,631** | **3,826** | **4,007** | **4,167** | **4,300** | **0.9** |
| China | 1,149 | 1,313 | 1,321 | 1,352 | 1,389 | 1,421 | 1,446 | 1,458 | 0.4 |
| India | 860 | 1,134 | 1,152 | 1,220 | 1,303 | 1,379 | 1,447 | 1,506 | 1.1 |
| Other Non-OECD Asia | 751 | 984 | 999 | 1,060 | 1,135 | 1,206 | 1,274 | 1,336 | 1.2 |
| **Middle East** | **137** | **193** | **197** | **213** | **234** | **255** | **275** | **294** | **1.7** |
| **Africa** | **637** | **922** | **944** | **1,032** | **1,149** | **1,271** | **1,394** | **1,518** | **2.0** |
| **Central and South America** | **360** | **454** | **460** | **483** | **512** | **539** | **563** | **585** | **1.0** |
| Brazil | 150 | 187 | 189 | 199 | 210 | 220 | 229 | 236 | 0.9 |
| Other Central and South America | 211 | 267 | 270 | 284 | 302 | 319 | 335 | 348 | 1.1 |
| **Total Non-OECD** | **4,243** | **5,342** | **5,413** | **5,699** | **6,058** | **6,405** | **6,728** | **7,020** | **1.1** |
| **Total World** | **5,293** | **6,512** | **6,590** | **6,903** | **7,293** | **7,667** | **8,014** | **8,327** | **1.0** |

[a]Includes the 50 States and the District of Columbia.

Sources: **United States:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo. **Other Countries:** United Nations, Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects (February 25, 2006), web site http://esa.un.org/unpp.

Appendix B

# High Economic Growth Case Projections:

- World Energy Consumption
- Gross Domestic Product
- Carbon Dioxide Emissions

**Table B1. World Total Primary Energy Consumption by Region, High Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **100.7** | **121.6** | **121.3** | **122.0** | **129.3** | **135.9** | **143.7** | **153.8** | **1.0** |
| United States[a] | 84.7 | 100.5 | 100.0 | 100.7 | 105.8 | 110.1 | 115.6 | 123.4 | 0.9 |
| Canada | 11.0 | 14.2 | 14.0 | 14.7 | 15.9 | 17.2 | 18.4 | 19.6 | 1.4 |
| Mexico | 5.0 | 6.9 | 7.4 | 6.6 | 7.6 | 8.7 | 9.7 | 10.8 | 1.6 |
| **OECD Europe** | **70.0** | **81.4** | **81.6** | **82.4** | **86.3** | **90.9** | **94.5** | **97.9** | **0.8** |
| **OECD Asia** | **27.0** | **38.4** | **38.7** | **39.6** | **42.6** | **44.7** | **46.3** | **47.9** | **0.9** |
| Japan | 18.7 | 22.7 | 22.8 | 22.0 | 23.3 | 24.2 | 24.4 | 24.6 | 0.3 |
| South Korea | 3.8 | 9.2 | 9.4 | 11.0 | 11.9 | 12.5 | 13.4 | 14.3 | 1.7 |
| Australia/New Zealand | 4.5 | 6.4 | 6.5 | 6.7 | 7.4 | 8.0 | 8.5 | 9.0 | 1.4 |
| **Total OECD** | **197.7** | **241.3** | **241.7** | **244.1** | **258.2** | **271.5** | **284.6** | **299.6** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **67.3** | **50.6** | **50.7** | **54.2** | **58.7** | **62.5** | **65.3** | **67.8** | **1.2** |
| Russia | 39.4 | 30.1 | 30.4 | 32.3 | 35.0 | 37.2 | 38.8 | 40.3 | 1.2 |
| Other | 28.0 | 20.6 | 20.3 | 21.8 | 23.7 | 25.2 | 26.5 | 27.5 | 1.3 |
| **Non-OECD Asia** | **47.4** | **109.4** | **117.6** | **139.8** | **167.1** | **198.7** | **229.4** | **260.5** | **3.4** |
| China | 27.0 | 66.8 | 73.8 | 90.9 | 108.5 | 129.5 | 149.9 | 169.4 | 3.5 |
| India | 7.9 | 16.3 | 17.7 | 19.2 | 23.4 | 28.0 | 31.4 | 35.0 | 2.9 |
| Other Non-OECD Asia | 12.5 | 26.3 | 26.1 | 29.7 | 35.2 | 41.2 | 48.1 | 56.0 | 3.2 |
| **Middle East** | **11.2** | **22.7** | **23.8** | **27.8** | **31.0** | **33.6** | **36.9** | **41.1** | **2.3** |
| **Africa** | **9.5** | **14.5** | **14.5** | **16.3** | **18.1** | **20.0** | **21.9** | **23.6** | **2.1** |
| **Central and South America** | **14.5** | **23.4** | **24.2** | **28.4** | **31.0** | **33.9** | **37.4** | **40.9** | **2.2** |
| Brazil | 5.8 | 9.4 | 9.6 | 11.4 | 13.2 | 15.1 | 17.3 | 19.5 | 3.0 |
| Other Central and South America | 8.8 | 14.0 | 14.6 | 17.0 | 17.9 | 18.8 | 20.1 | 21.4 | 1.6 |
| **Total Non-OECD** | **149.9** | **220.7** | **230.8** | **266.4** | **305.9** | **348.7** | **390.9** | **433.8** | **2.7** |
| **Total World** | **347.7** | **462.1** | **472.4** | **510.5** | **564.1** | **620.2** | **675.5** | **733.4** | **1.8** |

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B2. World Total Energy Consumption by Region and Fuel, High Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | | | | | | | | | |
| Liquids | 40.5 | 49.6 | 49.2 | 45.9 | 48.5 | 49.9 | 52.0 | 55.3 | 0.5 |
| Natural Gas | 23.0 | 28.0 | 28.0 | 29.4 | 31.3 | 33.4 | 36.2 | 37.1 | 1.2 |
| Coal | 20.6 | 24.7 | 24.3 | 24.8 | 25.7 | 26.5 | 27.6 | 30.8 | 1.0 |
| Nuclear | 6.9 | 9.2 | 9.4 | 9.8 | 10.0 | 10.7 | 11.1 | 12.3 | 1.1 |
| Other | 9.7 | 10.3 | 10.5 | 12.1 | 13.8 | 15.4 | 16.9 | 18.2 | 2.3 |
| **Total** | **100.7** | **121.6** | **121.3** | **122.0** | **129.3** | **135.9** | **143.7** | **153.8** | **1.0** |
| **OECD Europe** | | | | | | | | | |
| Liquids | 28.4 | 32.3 | 32.4 | 30.0 | 30.4 | 31.9 | 32.7 | 33.3 | 0.1 |
| Natural Gas | 11.2 | 19.8 | 19.7 | 21.1 | 22.9 | 24.8 | 26.5 | 27.7 | 1.4 |
| Coal | 17.7 | 12.9 | 13.2 | 13.1 | 12.9 | 12.7 | 12.6 | 12.9 | -0.1 |
| Nuclear | 7.9 | 9.7 | 9.6 | 9.7 | 9.7 | 9.6 | 9.5 | 9.5 | 0.0 |
| Other | 4.8 | 6.5 | 6.6 | 8.5 | 10.3 | 11.9 | 13.3 | 14.4 | 3.3 |
| **Total** | **70.0** | **81.4** | **81.6** | **82.4** | **86.3** | **90.9** | **94.5** | **97.9** | **0.8** |
| **OECD Asia** | | | | | | | | | |
| Liquids | 14.7 | 17.5 | 17.2 | 17.0 | 17.8 | 18.6 | 18.9 | 19.3 | 0.5 |
| Natural Gas | 3.1 | 5.8 | 6.1 | 6.5 | 7.4 | 8.0 | 8.3 | 8.6 | 1.4 |
| Coal | 5.2 | 9.3 | 9.4 | 9.5 | 9.7 | 9.8 | 10.1 | 10.6 | 0.5 |
| Nuclear | 2.5 | 4.3 | 4.3 | 4.5 | 5.0 | 5.6 | 6.0 | 6.4 | 1.7 |
| Other | 1.6 | 1.6 | 1.7 | 2.1 | 2.7 | 2.8 | 2.9 | 3.0 | 2.4 |
| **Total** | **27.0** | **38.4** | **38.7** | **39.6** | **42.6** | **44.7** | **46.3** | **47.9** | **0.9** |
| **Total OECD** | | | | | | | | | |
| Liquids | 83.6 | 99.4 | 98.8 | 92.8 | 96.7 | 100.4 | 103.6 | 108.0 | 0.4 |
| Natural Gas | 37.3 | 53.6 | 53.9 | 57.1 | 61.6 | 66.2 | 71.0 | 73.4 | 1.3 |
| Coal | 43.5 | 46.9 | 46.9 | 47.4 | 48.3 | 48.9 | 50.3 | 54.3 | 0.6 |
| Nuclear | 17.3 | 23.2 | 23.3 | 24.0 | 24.7 | 25.9 | 26.5 | 28.2 | 0.8 |
| Other | 16.0 | 18.3 | 18.8 | 22.8 | 26.7 | 30.1 | 33.1 | 35.7 | 2.7 |
| **Total** | **197.7** | **241.3** | **241.7** | **244.1** | **258.2** | **271.5** | **284.6** | **299.6** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | | | | | | | | | |
| Liquids | 19.6 | 10.1 | 10.2 | 10.5 | 11.0 | 11.5 | 11.8 | 12.2 | 0.7 |
| Natural Gas | 27.5 | 25.8 | 25.8 | 28.2 | 31.1 | 33.3 | 34.8 | 36.3 | 1.4 |
| Coal | 15.1 | 8.9 | 8.7 | 9.3 | 9.6 | 9.6 | 9.6 | 10.1 | 0.6 |
| Nuclear | 2.5 | 2.9 | 2.9 | 3.0 | 3.6 | 4.5 | 5.2 | 5.5 | 2.6 |
| Other | 2.8 | 3.1 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 0.9 |
| **Total** | **67.3** | **50.6** | **50.7** | **54.2** | **58.7** | **62.5** | **65.3** | **67.8** | **1.2** |
| **Non-OECD Asia** | | | | | | | | | |
| Liquids | 14.0 | 31.6 | 33.1 | 36.8 | 43.4 | 52.3 | 60.3 | 68.3 | 3.1 |
| Natural Gas | 3.0 | 9.6 | 9.6 | 11.8 | 16.1 | 20.3 | 24.0 | 27.5 | 4.5 |
| Coal | 27.0 | 60.4 | 66.5 | 79.0 | 89.6 | 103.1 | 119.3 | 135.2 | 3.0 |
| Nuclear | 0.4 | 1.1 | 1.1 | 1.6 | 3.0 | 4.7 | 6.2 | 7.1 | 7.9 |
| Other | 3.0 | 6.6 | 7.2 | 10.7 | 14.9 | 18.2 | 19.5 | 22.4 | 4.9 |
| **Total** | **47.4** | **109.4** | **117.6** | **139.8** | **167.1** | **198.7** | **229.4** | **260.5** | **3.4** |

See notes at end of table.

**Table B2. World Total Energy Consumption by Region and Fuel, High Economic Growth Case, 1990-2030 (Continued)**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD (Continued)** | | | | | | | | | |
| **Middle East** | | | | | | | | | |
| Liquids | 7.2 | 11.9 | 12.4 | 14.4 | 15.6 | 16.9 | 18.7 | 21.1 | 2.2 |
| Natural Gas | 3.8 | 10.2 | 10.8 | 12.6 | 14.5 | 15.7 | 17.1 | 18.9 | 2.4 |
| Coal | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 1.4 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Other | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 3.4 |
| **Total** | **11.2** | **22.7** | **23.8** | **27.8** | **30.9** | **33.6** | **36.9** | **41.1** | **2.3** |
| **Africa** | | | | | | | | | |
| Liquids | 4.3 | 6.1 | 6.1 | 7.1 | 7.5 | 7.9 | 8.4 | 8.8 | 1.5 |
| Natural Gas | 1.5 | 3.2 | 3.2 | 3.7 | 4.8 | 5.8 | 6.7 | 7.4 | 3.6 |
| Coal | 3.0 | 4.2 | 4.2 | 4.3 | 4.5 | 4.7 | 5.1 | 5.7 | 1.3 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Other | 0.6 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **9.5** | **14.5** | **14.5** | **16.3** | **18.1** | **20.0** | **21.9** | **23.6** | **2.1** |
| **Central and South America** | | | | | | | | | |
| Liquids | 7.8 | 11.3 | 11.7 | 13.5 | 13.9 | 14.6 | 15.7 | 17.2 | 1.6 |
| Natural Gas | 2.2 | 4.7 | 4.8 | 5.9 | 7.0 | 8.1 | 9.2 | 9.9 | 3.0 |
| Coal | 0.6 | 0.9 | 0.8 | 0.9 | 1.1 | 1.2 | 1.5 | 1.9 | 3.6 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 2.0 |
| Other | 3.9 | 6.4 | 6.6 | 7.8 | 8.7 | 9.7 | 10.6 | 11.5 | 2.3 |
| **Total** | **14.5** | **23.4** | **24.2** | **28.4** | **31.0** | **33.9** | **37.4** | **40.9** | **2.2** |
| **Total Non-OECD** | | | | | | | | | |
| Liquids | 52.9 | 71.0 | 73.6 | 82.3 | 91.4 | 103.1 | 115.0 | 127.5 | 2.3 |
| Natural Gas | 38.0 | 53.5 | 54.2 | 62.1 | 73.5 | 83.3 | 92.0 | 99.8 | 2.6 |
| Coal | 45.7 | 74.8 | 80.6 | 93.8 | 105.2 | 119.1 | 135.9 | 153.5 | 2.7 |
| Nuclear | 3.1 | 4.3 | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.3 | 4.7 |
| Other | 10.3 | 17.2 | 18.0 | 23.1 | 28.7 | 33.2 | 35.8 | 39.8 | 3.4 |
| **Total** | **149.9** | **220.7** | **230.8** | **266.4** | **305.9** | **348.7** | **390.9** | **433.8** | **2.7** |
| **Total World** | | | | | | | | | |
| Liquids | 136.4 | 170.4 | 172.4 | 175.2 | 188.1 | 203.5 | 218.6 | 235.5 | 1.3 |
| Natural Gas | 75.3 | 107.1 | 108.1 | 119.2 | 135.1 | 149.6 | 163.0 | 173.2 | 2.0 |
| Coal | 89.2 | 121.7 | 127.5 | 141.2 | 153.5 | 168.0 | 186.3 | 207.8 | 2.1 |
| Nuclear | 20.4 | 27.5 | 27.8 | 29.0 | 31.9 | 35.7 | 38.7 | 41.5 | 1.7 |
| Other | 26.3 | 35.5 | 36.8 | 45.9 | 55.4 | 63.3 | 68.9 | 75.4 | 3.0 |
| **Total** | **347.7** | **462.1** | **472.4** | **510.5** | **564.1** | **620.2** | **675.5** | **733.4** | **1.8** |

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, High Economic Growth Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,651** | **14,885** | **15,331** | **16,478** | **19,810** | **22,927** | **26,767** | **31,492** | **3.0** |
| United States[a] | 8,040 | 12,422 | 12,768 | 13,693 | 16,446 | 18,907 | 21,992 | 25,858 | 3.0 |
| Canada | 773 | 1,167 | 1,204 | 1,288 | 1,504 | 1,728 | 1,980 | 2,265 | 2.7 |
| Mexico | 838 | 1,296 | 1,359 | 1,497 | 1,860 | 2,292 | 2,795 | 3,369 | 3.9 |
| **OECD Europe** | **9,703** | **13,756** | **14,224** | **15,165** | **17,427** | **19,948** | **22,705** | **25,728** | **2.5** |
| **OECD Asia** | **4,080** | **5,509** | **5,667** | **6,105** | **7,011** | **7,757** | **8,499** | **9,309** | **2.1** |
| Japan | 3,222 | 3,873 | 3,966 | 4,146 | 4,594 | 4,882 | 5,099 | 5,322 | 1.2 |
| South Korea | 374 | 843 | 886 | 1,050 | 1,325 | 1,580 | 1,860 | 2,157 | 3.8 |
| Australia/New Zealand | 485 | 794 | 815 | 908 | 1,092 | 1,295 | 1,540 | 1,830 | 3.4 |
| **Total OECD** | **23,434** | **34,150** | **35,221** | **37,748** | **44,247** | **50,632** | **57,971** | **66,530** | **2.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3,039** | **2,932** | **3,159** | **3,978** | **5,031** | **6,064** | **7,094** | **8,209** | **4.1** |
| Russia | 1,880 | 1,703 | 1,829 | 2,350 | 2,951 | 3,529 | 4,092 | 4,705 | 4.0 |
| Other | 1,159 | 1,229 | 1,330 | 1,628 | 2,080 | 2,535 | 3,002 | 3,504 | 4.1 |
| **Non-OECD Asia** | **4,457** | **12,272** | **13,408** | **18,102** | **25,426** | **34,622** | **44,882** | **56,407** | **6.2** |
| China | 1,265 | 5,389 | 6,014 | 8,766 | 12,668 | 17,859 | 23,459 | 29,393 | 6.8 |
| India | 1,019 | 2,436 | 2,672 | 3,530 | 5,033 | 6,800 | 8,710 | 10,961 | 6.1 |
| Other Non-OECD Asia | 2,173 | 4,448 | 4,723 | 5,807 | 7,725 | 9,963 | 12,713 | 16,053 | 5.2 |
| **Middle East** | **1,072** | **1,919** | **2,053** | **2,508** | **3,134** | **3,836** | **4,666** | **5,672** | **4.3** |
| **Africa** | **1,387** | **2,211** | **2,341** | **2,898** | **3,735** | **4,643** | **5,622** | **6,622** | **4.4** |
| **Central and South America** | **2,270** | **3,555** | **3,757** | **4,538** | **5,601** | **6,834** | **8,265** | **9,945** | **4.1** |
| Brazil | 1,045 | 1,534 | 1,591 | 1,913 | 2,374 | 2,917 | 3,572 | 4,360 | 4.3 |
| Other Central and South America | 1,224 | 2,021 | 2,165 | 2,625 | 3,226 | 3,917 | 4,693 | 5,585 | 4.0 |
| **Total Non-OECD** | **12,225** | **22,888** | **24,717** | **32,024** | **42,926** | **55,999** | **70,530** | **86,855** | **5.4** |
| **Total World** | **35,659** | **57,038** | **59,939** | **69,772** | **87,173** | **106,632** | **128,500** | **153,384** | **4.0** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** Derived from IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), Table B4.

**Table B4. World Liquids Consumption by Region, High Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.5** | **25.2** | **25.1** | **23.8** | **25.1** | **25.8** | **27.0** | **28.8** | **0.6** |
| United States[a] | 17.0 | 20.8 | 20.7 | 19.9 | 21.0 | 21.4 | 22.3 | 23.8 | 0.6 |
| Canada | 1.7 | 2.3 | 2.3 | 2.3 | 2.3 | 2.4 | 2.6 | 2.7 | 0.7 |
| Mexico | 1.8 | 2.1 | 2.1 | 1.5 | 1.7 | 2.0 | 2.1 | 2.2 | 0.3 |
| **OECD Europe** | **13.7** | **15.7** | **15.7** | **14.5** | **14.7** | **15.4** | **15.8** | **16.1** | **0.1** |
| **OECD Asia** | **7.2** | **8.6** | **8.5** | **8.4** | **8.8** | **9.1** | **9.3** | **9.5** | **0.5** |
| Japan | 5.3 | 5.3 | 5.2 | 4.6 | 4.9 | 5.2 | 5.1 | 5.1 | -0.1 |
| South Korea | 1.0 | 2.2 | 2.2 | 2.8 | 2.8 | 2.8 | 2.9 | 3.0 | 1.3 |
| Australia/New Zealand | 0.8 | 1.1 | 1.1 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.0 |
| **Total OECD** | **41.4** | **49.5** | **49.2** | **46.7** | **48.6** | **50.4** | **52.1** | **54.4** | **0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **9.4** | **4.9** | **5.0** | **5.1** | **5.3** | **5.6** | **5.8** | **5.9** | **0.7** |
| Russia | 5.4 | 2.8 | 2.8 | 2.7 | 2.9 | 3.0 | 3.0 | 2.9 | 0.2 |
| Other | 3.9 | 2.1 | 2.1 | 2.4 | 2.5 | 2.6 | 2.8 | 3.0 | 1.4 |
| **Non-OECD Asia** | **6.6** | **15.3** | **16.0** | **17.8** | **21.0** | **25.4** | **29.3** | **33.1** | **3.1** |
| China | 2.3 | 6.7 | 7.2 | 8.5 | 10.2 | 12.7 | 14.8 | 16.8 | 3.6 |
| India | 1.2 | 2.5 | 2.7 | 2.4 | 3.2 | 4.1 | 4.6 | 5.1 | 2.8 |
| Other Non-OECD Asia | 3.1 | 6.1 | 6.1 | 6.9 | 7.6 | 8.6 | 9.8 | 11.2 | 2.5 |
| **Middle East** | **3.5** | **5.8** | **6.1** | **7.0** | **7.6** | **8.2** | **9.1** | **10.3** | **2.2** |
| **Africa** | **2.1** | **3.0** | **3.0** | **3.5** | **3.6** | **3.8** | **4.1** | **4.3** | **1.5** |
| **Central and South America** | **3.8** | **5.5** | **5.7** | **6.6** | **6.8** | **7.1** | **7.7** | **8.4** | **1.6** |
| Brazil | 1.5 | 2.2 | 2.3 | 2.5 | 2.9 | 3.2 | 3.6 | 4.1 | 2.5 |
| Other Central and South America | 2.3 | 3.3 | 3.4 | 4.0 | 3.9 | 3.9 | 4.1 | 4.3 | 0.9 |
| **Total Non-OECD** | **25.3** | **34.5** | **35.8** | **40.0** | **44.4** | **50.1** | **55.9** | **62.0** | **2.3** |
| **Total World** | **66.7** | **84.0** | **85.0** | **86.7** | **93.0** | **100.5** | **108.0** | **116.3** | **1.3** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B5. World Natural Gas Consumption by Region, High Economic Growth Case, 1990-2030**
(Trillion Cubic Feet)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **22.5** | **27.1** | **27.2** | **28.5** | **30.3** | **32.4** | **35.0** | **35.9** | **1.2** |
| United States[a] | 19.2 | 22.0 | 21.7 | 22.6 | 23.5 | 24.5 | 26.1 | 26.0 | 0.8 |
| Canada | 2.4 | 3.4 | 3.3 | 3.5 | 4.0 | 4.5 | 4.9 | 5.3 | 2.0 |
| Mexico | 0.9 | 1.8 | 2.2 | 2.4 | 2.9 | 3.4 | 4.0 | 4.6 | 3.2 |
| **OECD Europe** | **11.6** | **19.3** | **19.2** | **20.6** | **22.3** | **24.1** | **25.7** | **26.9** | **1.4** |
| **OECD Asia** | **2.9** | **5.2** | **5.5** | **5.9** | **6.7** | **7.3** | **7.6** | **7.8** | **1.4** |
| Japan | 2.0 | 3.1 | 3.2 | 3.4 | 3.8 | 4.0 | 4.1 | 4.1 | 1.0 |
| South Korea | 0.1 | 1.1 | 1.1 | 1.3 | 1.5 | 1.7 | 1.8 | 1.9 | 2.2 |
| Australia/New Zealand | 0.8 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.6 | 1.7 | 1.7 |
| **Total OECD** | **37.0** | **51.7** | **51.9** | **55.0** | **59.3** | **63.7** | **68.3** | **70.6** | **1.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **26.7** | **25.3** | **25.4** | **27.7** | **30.6** | **32.7** | **34.2** | **35.6** | **1.4** |
| Russia | 17.3 | 16.2 | 16.6 | 18.1 | 19.5 | 20.7 | 21.6 | 22.6 | 1.3 |
| Other | 9.5 | 9.1 | 8.8 | 9.6 | 11.1 | 12.0 | 12.6 | 13.1 | 1.7 |
| **Non-OECD Asia** | **2.9** | **9.3** | **9.4** | **11.5** | **15.7** | **19.8** | **23.5** | **26.8** | **4.5** |
| China | 0.5 | 1.7 | 2.0 | 2.6 | 3.9 | 5.1 | 6.3 | 7.3 | 5.6 |
| India | 0.4 | 1.3 | 1.4 | 1.8 | 2.5 | 3.2 | 3.7 | 4.1 | 4.6 |
| Other Non-OECD Asia | 2.0 | 6.4 | 6.0 | 7.1 | 9.3 | 11.5 | 13.5 | 15.4 | 4.0 |
| **Middle East** | **3.6** | **9.8** | **10.3** | **12.0** | **13.8** | **15.0** | **16.4** | **18.0** | **2.4** |
| **Africa** | **1.4** | **3.0** | **2.9** | **3.4** | **4.4** | **5.4** | **6.3** | **6.9** | **3.6** |
| **Central and South America** | **2.0** | **4.4** | **4.5** | **5.5** | **6.6** | **7.6** | **8.7** | **9.3** | **3.0** |
| Brazil | 0.1 | 0.7 | 0.7 | 1.0 | 1.3 | 1.6 | 2.1 | 2.3 | 5.1 |
| Other Central and South America | 1.9 | 3.7 | 3.8 | 4.5 | 5.3 | 6.0 | 6.6 | 7.0 | 2.5 |
| **Total Non-OECD** | **36.5** | **51.8** | **52.5** | **60.2** | **71.1** | **80.6** | **89.0** | **96.6** | **2.6** |
| **Total World** | **73.5** | **103.4** | **104.4** | **115.2** | **130.5** | **144.4** | **157.3** | **167.2** | **2.0** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B6. World Coal Consumption by Region, High Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.6** | **24.7** | **24.3** | **24.8** | **25.7** | **26.5** | **27.6** | **30.8** | **1.0** |
| United States[a] | 19.2 | 22.8 | 22.5 | 22.9 | 23.8 | 24.4 | 25.2 | 28.2 | 1.0 |
| Canada | 1.2 | 1.5 | 1.4 | 1.5 | 1.5 | 1.7 | 1.8 | 2.0 | 1.3 |
| Mexico | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 1.9 |
| **OECD Europe** | **17.7** | **12.9** | **13.2** | **13.1** | **12.9** | **12.7** | **12.6** | **12.9** | **-0.1** |
| **OECD Asia** | **5.2** | **9.3** | **9.4** | **9.5** | **9.7** | **9.8** | **10.1** | **10.6** | **0.5** |
| Japan | 2.7 | 4.6 | 4.6 | 4.5 | 4.5 | 4.4 | 4.3 | 4.3 | -0.3 |
| South Korea | 1.0 | 2.1 | 2.2 | 2.4 | 2.5 | 2.6 | 2.9 | 3.3 | 1.7 |
| Australia/New Zealand | 1.5 | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.9 | 3.1 | 0.7 |
| **Total OECD** | **43.5** | **46.9** | **46.9** | **47.4** | **48.3** | **48.9** | **50.3** | **54.3** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **15.1** | **8.9** | **8.7** | **9.3** | **9.6** | **9.6** | **9.6** | **10.1** | **0.6** |
| Russia | 7.2 | 4.8 | 4.6 | 5.0 | 5.3 | 5.3 | 5.3 | 5.6 | 0.8 |
| Other | 7.9 | 4.1 | 4.2 | 4.3 | 4.3 | 4.3 | 4.4 | 4.5 | 0.3 |
| **Non-OECD Asia** | **27.0** | **60.4** | **66.5** | **79.0** | **89.6** | **103.1** | **119.3** | **135.2** | **3.0** |
| China | 20.3 | 46.9 | 52.0 | 63.1 | 72.0 | 83.5 | 96.8 | 108.3 | 3.1 |
| India | 4.2 | 8.6 | 9.4 | 10.3 | 11.5 | 12.6 | 13.7 | 15.5 | 2.1 |
| Other Non-OECD Asia | 2.6 | 4.9 | 5.1 | 5.5 | 6.2 | 7.0 | 8.7 | 11.5 | 3.5 |
| **Middle East** | **0.1** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.5** | **1.4** |
| **Africa** | **3.0** | **4.2** | **4.2** | **4.3** | **4.5** | **4.7** | **5.1** | **5.7** | **1.3** |
| **Central and South America** | **0.6** | **0.9** | **0.8** | **0.9** | **1.1** | **1.2** | **1.5** | **1.9** | **3.6** |
| Brazil | 0.3 | 0.4 | 0.4 | 0.5 | 0.7 | 0.8 | 1.0 | 1.2 | 4.3 |
| Other Central and South America | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.7 | 2.6 |
| **Total Non-OECD** | **45.7** | **74.8** | **80.6** | **93.8** | **105.2** | **119.1** | **135.9** | **153.5** | **2.7** |
| **Total World** | **89.2** | **121.7** | **127.5** | **141.2** | **153.5** | **168.0** | **186.3** | **207.8** | **2.1** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B7. World Nuclear Energy Consumption by Region, High Economic Growth Case, 1990-2030**
(Billion Kilowatthours)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **649** | **880** | **891** | **930** | **955** | **1,019** | **1,056** | **1,168** | **1.1** |
| United States[a] | 577 | 782 | 787 | 809 | 831 | 888 | 918 | 1,023 | 1.1 |
| Canada | 69 | 87 | 93 | 110 | 113 | 120 | 128 | 135 | 1.6 |
| Mexico | 3 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 0.1 |
| **OECD Europe** | **743** | **932** | **929** | **922** | **915** | **906** | **897** | **905** | **-0.1** |
| **OECD Asia** | **242** | **429** | **430** | **441** | **494** | **547** | **585** | **626** | **1.6** |
| Japan | 192 | 290 | 288 | 299 | 319 | 337 | 360 | 383 | 1.2 |
| South Korea | 50 | 139 | 141 | 142 | 175 | 210 | 225 | 243 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **1,635** | **2,240** | **2,250** | **2,292** | **2,365** | **2,472** | **2,538** | **2,699** | **0.8** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **219** | **264** | **269** | **283** | **342** | **424** | **494** | **520** | **2.8** |
| Russia | 115 | 140 | 144 | 155 | 197 | 251 | 308 | 328 | 3.5 |
| Other | 104 | 124 | 124 | 128 | 145 | 173 | 187 | 192 | 1.8 |
| **Non-OECD Asia** | **38** | **106** | **111** | **151** | **290** | **456** | **601** | **679** | **7.8** |
| China | 0 | 50 | 55 | 65 | 164 | 274 | 366 | 426 | 8.9 |
| India | 6 | 16 | 16 | 37 | 66 | 104 | 134 | 149 | 9.9 |
| Other Non-OECD Asia | 32 | 40 | 40 | 48 | 61 | 77 | 100 | 104 | 4.0 |
| **Middle East** | **0** | **0** | **0** | **0** | **6** | **13** | **13** | **13** | **—** |
| **Africa** | **8** | **12** | **10** | **14** | **15** | **15** | **21** | **21** | **3.2** |
| **Central and South America** | **9** | **16** | **21** | **23** | **28** | **34** | **34** | **34** | **2.1** |
| Brazil | 2 | 10 | 14 | 15 | 18 | 22 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 6 | 7 | 8 | 10 | 12 | 12 | 12 | 2.2 |
| **Total Non-OECD** | **274** | **399** | **411** | **471** | **681** | **942** | **1,163** | **1,267** | **4.8** |
| **Total World** | **1,909** | **2,639** | **2,660** | **2,763** | **3,046** | **3,414** | **3,701** | **3,966** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, High Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9.7** | **10.3** | **10.5** | **12.1** | **13.8** | **15.4** | **16.9** | **18.2** | **2.3** |
| United States[a] | 6.2 | 6.1 | 6.5 | 7.7 | 8.7 | 10.0 | 11.1 | 12.1 | 2.7 |
| Canada | 3.1 | 3.7 | 3.6 | 3.9 | 4.4 | 4.7 | 5.1 | 5.4 | 1.7 |
| Mexico | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.9 |
| **OECD Europe** | **4.8** | **6.5** | **6.6** | **8.5** | **10.3** | **11.9** | **13.3** | **14.4** | **3.3** |
| **OECD Asia** | **1.6** | **1.6** | **1.7** | **2.1** | **2.7** | **2.8** | **2.9** | **3.0** | **2.4** |
| Japan | 1.1 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.3 |
| Australia/New Zealand | 0.4 | 0.5 | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.4 | 4.2 |
| **Total OECD** | **16.0** | **18.3** | **18.8** | **22.8** | **26.7** | **30.1** | **33.1** | **35.7** | **2.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **2.8** | **3.1** | **3.0** | **3.2** | **3.4** | **3.5** | **3.7** | **3.8** | **0.9** |
| Russia | 1.8 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| Other | 1.0 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Non-OECD Asia** | **3.0** | **6.6** | **7.2** | **10.7** | **14.9** | **18.2** | **19.5** | **22.4** | **4.9** |
| China | 1.3 | 4.0 | 4.3 | 7.0 | 9.8 | 11.8 | 12.4 | 14.7 | 5.2 |
| India | 0.7 | 1.1 | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| Other Non-OECD Asia | 0.9 | 1.6 | 1.6 | 2.1 | 2.9 | 3.8 | 4.2 | 4.5 | 4.3 |
| **Middle East** | **0.1** | **0.2** | **0.2** | **0.3** | **0.4** | **0.5** | **0.5** | **0.5** | **3.4** |
| **Africa** | **0.6** | **0.9** | **0.9** | **1.0** | **1.3** | **1.4** | **1.5** | **1.5** | **2.1** |
| **Central and South America** | **3.9** | **6.4** | **6.6** | **7.8** | **8.7** | **9.7** | **10.6** | **11.5** | **2.3** |
| Brazil | 2.2 | 3.5 | 3.6 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 3.0 |
| Other Central and South America | 1.7 | 2.9 | 3.0 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 1.4 |
| **Total Non-OECD** | **10.3** | **17.2** | **18.0** | **23.1** | **28.7** | **33.2** | **35.8** | **39.8** | **3.4** |
| **Total World** | **26.3** | **35.5** | **36.8** | **45.9** | **55.4** | **63.3** | **68.9** | **75.4** | **3.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. U.S. consumption of hydroelectricity and other renewable energy is projected to be 9.4 quadrillion Btu in 2015 in the *updated AEO2009* reference case—7 percent higher than in the earlier projections reported in this table.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B9. World Carbon Dioxide Emissions by Region, High Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **5,762** | **7,007** | **6,948** | **6,826** | **7,139** | **7,412** | **7,765** | **8,316** | **0.8** |
| United States[a] | 4,989 | 5,975 | 5,907 | 5,831 | 6,052 | 6,210 | 6,451 | 6,886 | 0.6 |
| Canada | 471 | 629 | 611 | 623 | 662 | 714 | 767 | 819 | 1.2 |
| Mexico | 302 | 403 | 431 | 372 | 424 | 489 | 547 | 611 | 1.5 |
| **OECD Europe** | **4,149** | **4,424** | **4,429** | **4,349** | **4,460** | **4,633** | **4,767** | **4,902** | **0.4** |
| **OECD Asia** | **1,595** | **2,200** | **2,216** | **2,228** | **2,337** | **2,428** | **2,500** | **2,579** | **0.6** |
| Japan | 1,054 | 1,250 | 1,247 | 1,173 | 1,229 | 1,269 | 1,260 | 1,252 | 0.0 |
| South Korea | 243 | 497 | 515 | 600 | 630 | 649 | 701 | 753 | 1.6 |
| Australia/New Zealand | 298 | 454 | 455 | 455 | 478 | 510 | 538 | 574 | 1.0 |
| **Total OECD** | **11,506** | **13,632** | **13,594** | **13,403** | **13,936** | **14,473** | **15,031** | **15,797** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **4,246** | **2,889** | **2,886** | **3,080** | **3,301** | **3,455** | **3,563** | **3,703** | **1.0** |
| Russia | 2,393 | 1,699 | 1,704 | 1,809 | 1,932 | 2,019 | 2,061 | 2,134 | 0.9 |
| Other | 1,853 | 1,190 | 1,182 | 1,271 | 1,369 | 1,437 | 1,502 | 1,569 | 1.2 |
| **Non-OECD Asia** | **3,678** | **8,305** | **8,987** | **10,516** | **12,188** | **14,265** | **16,519** | **18,729** | **3.1** |
| China | 2,293 | 5,429 | 6,018 | 7,262 | 8,399 | 9,887 | 11,501 | 12,904 | 3.2 |
| India | 573 | 1,192 | 1,292 | 1,372 | 1,611 | 1,867 | 2,067 | 2,316 | 2.5 |
| Other Non-OECD Asia | 811 | 1,684 | 1,678 | 1,882 | 2,178 | 2,511 | 2,950 | 3,509 | 3.1 |
| **Middle East** | **704** | **1,393** | **1,456** | **1,690** | **1,872** | **2,027** | **2,230** | **2,489** | **2.3** |
| **Africa** | **659** | **985** | **982** | **1,089** | **1,187** | **1,293** | **1,411** | **1,532** | **1.9** |
| **Central and South America** | **695** | **1,093** | **1,123** | **1,315** | **1,412** | **1,527** | **1,688** | **1,857** | **2.1** |
| Brazil | 235 | 366 | 374 | 439 | 506 | 583 | 676 | 778 | 3.1 |
| Other Central and South America | 460 | 727 | 749 | 876 | 906 | 944 | 1,012 | 1,079 | 1.5 |
| **Total Non-OECD** | **9,982** | **14,664** | **15,434** | **17,691** | **19,960** | **22,567** | **25,411** | **28,311** | **2.6** |
| **Total World** | **21,488** | **28,296** | **29,028** | **31,094** | **33,896** | **37,041** | **40,442** | **44,108** | **1.8** |

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B10. World Carbon Dioxide Emissions from Liquids Use by Region, High Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **2,637** | **3,188** | **3,159** | **2,914** | **3,038** | **3,130** | **3,232** | **3,429** | **0.3** |
| United States[a] | 2,178 | 2,620 | 2,596 | 2,420 | 2,515 | 2,563 | 2,630 | 2,792 | 0.3 |
| Canada | 227 | 301 | 295 | 295 | 301 | 314 | 330 | 349 | 0.7 |
| Mexico | 233 | 267 | 268 | 198 | 222 | 253 | 271 | 288 | 0.3 |
| **OECD Europe** | **1,884** | **2,134** | **2,135** | **1,978** | **2,009** | **2,106** | **2,154** | **2,201** | **0.1** |
| **OECD Asia** | **945** | **1,028** | **1,014** | **990** | **1,039** | **1,088** | **1,108** | **1,128** | **0.4** |
| Japan | 687 | 641 | 626 | 554 | 589 | 622 | 616 | 611 | -0.1 |
| South Korea | 144 | 239 | 237 | 299 | 302 | 300 | 314 | 326 | 1.3 |
| Australia/New Zealand | 114 | 148 | 151 | 137 | 149 | 166 | 178 | 191 | 1.0 |
| **Total OECD** | **5,466** | **6,350** | **6,308** | **5,881** | **6,086** | **6,323** | **6,495** | **6,758** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,368** | **686** | **692** | **713** | **745** | **783** | **806** | **828** | **0.7** |
| Russia | 782 | 383 | 389 | 374 | 393 | 414 | 410 | 405 | 0.2 |
| Other | 586 | 303 | 303 | 339 | 352 | 369 | 396 | 423 | 1.4 |
| **Non-OECD Asia** | **960** | **2,077** | **2,170** | **2,414** | **2,847** | **3,421** | **3,948** | **4,468** | **3.1** |
| China | 335 | 889 | 960 | 1,129 | 1,357 | 1,682 | 1,971 | 2,229 | 3.6 |
| India | 160 | 314 | 332 | 305 | 397 | 511 | 575 | 643 | 2.8 |
| Other Non-OECD Asia | 466 | 874 | 878 | 980 | 1,092 | 1,228 | 1,402 | 1,597 | 2.5 |
| **Middle East** | **491** | **814** | **849** | **987** | **1,066** | **1,155** | **1,280** | **1,441** | **2.2** |
| **Africa** | **302** | **423** | **424** | **495** | **518** | **546** | **580** | **609** | **1.5** |
| **Central and South America** | **525** | **761** | **790** | **913** | **939** | **979** | **1,057** | **1,153** | **1.6** |
| Brazil | 197 | 288 | 294 | 332 | 373 | 418 | 472 | 538 | 2.5 |
| Other Central and South America | 328 | 473 | 496 | 581 | 566 | 561 | 585 | 615 | 0.9 |
| **Total Non-OECD** | **3,646** | **4,760** | **4,926** | **5,523** | **6,115** | **6,885** | **7,670** | **8,499** | **2.3** |
| **Total World** | **9,112** | **11,110** | **11,234** | **11,404** | **12,201** | **13,208** | **14,165** | **15,257** | **1.3** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B11. World Carbon Dioxide Emissions from Natural Gas Use by Region, High Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,208** | **1,468** | **1,465** | **1,547** | **1,648** | **1,759** | **1,906** | **1,955** | **1.2** |
| United States[a] | 1,026 | 1,183 | 1,159 | 1,222 | 1,267 | 1,321 | 1,411 | 1,404 | 0.8 |
| Canada | 128 | 185 | 181 | 190 | 218 | 245 | 268 | 288 | 2.0 |
| Mexico | 54 | 100 | 125 | 135 | 163 | 193 | 227 | 263 | 3.2 |
| **OECD Europe** | **593** | **1,053** | **1,047** | **1,122** | **1,216** | **1,316** | **1,405** | **1,470** | **1.4** |
| **OECD Asia** | **165** | **306** | **323** | **347** | **392** | **424** | **442** | **455** | **1.4** |
| Japan | 115 | 181 | 191 | 198 | 221 | 235 | 241 | 243 | 1.0 |
| South Korea | 6 | 64 | 68 | 77 | 93 | 102 | 111 | 115 | 2.2 |
| Australia/New Zealand | 44 | 61 | 64 | 71 | 78 | 87 | 91 | 97 | 1.7 |
| **Total OECD** | **1,966** | **2,827** | **2,835** | **3,015** | **3,256** | **3,500** | **3,753** | **3,880** | **1.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,457** | **1,367** | **1,371** | **1,494** | **1,651** | **1,768** | **1,849** | **1,924** | **1.4** |
| Russia | 933 | 865 | 889 | 967 | 1,045 | 1,110 | 1,156 | 1,207 | 1.3 |
| Other | 524 | 502 | 482 | 528 | 606 | 657 | 693 | 716 | 1.7 |
| **Non-OECD Asia** | **161** | **508** | **510** | **626** | **854** | **1,079** | **1,276** | **1,459** | **4.5** |
| China | 30 | 92 | 111 | 147 | 217 | 284 | 348 | 407 | 5.6 |
| India | 24 | 70 | 76 | 99 | 137 | 177 | 205 | 224 | 4.6 |
| Other Non-OECD Asia | 106 | 347 | 324 | 379 | 500 | 618 | 723 | 828 | 4.0 |
| **Middle East** | **200** | **543** | **571** | **668** | **770** | **835** | **910** | **1,000** | **2.4** |
| **Africa** | **80** | **168** | **168** | **196** | **253** | **310** | **358** | **391** | **3.6** |
| **Central and South America** | **117** | **250** | **255** | **313** | **371** | **430** | **491** | **524** | **3.0** |
| Brazil | 6 | 36 | 38 | 55 | 70 | 91 | 113 | 126 | 5.1 |
| Other Central and South America | 111 | 214 | 218 | 258 | 301 | 340 | 377 | 398 | 2.5 |
| **Total Non-OECD** | **2,015** | **2,837** | **2,876** | **3,297** | **3,900** | **4,421** | **4,882** | **5,298** | **2.6** |
| **Total World** | **3,981** | **5,664** | **5,712** | **6,312** | **7,156** | **7,921** | **8,635** | **9,178** | **2.0** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table B12. World Carbon Dioxide Emissions from Coal Use by Region, High Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,916** | **2,339** | **2,312** | **2,354** | **2,441** | **2,511** | **2,615** | **2,921** | **1.0** |
| United States[a] | 1,784 | 2,161 | 2,140 | 2,177 | 2,258 | 2,314 | 2,398 | 2,679 | 0.9 |
| Canada | 116 | 142 | 134 | 138 | 143 | 155 | 169 | 183 | 1.3 |
| Mexico | 16 | 36 | 38 | 38 | 40 | 43 | 48 | 60 | 1.9 |
| **OECD Europe** | **1,672** | **1,237** | **1,247** | **1,250** | **1,235** | **1,211** | **1,208** | **1,231** | **-0.1** |
| **OECD Asia** | **485** | **866** | **879** | **891** | **906** | **916** | **949** | **995** | **0.5** |
| Japan | 252 | 427 | 430 | 420 | 420 | 412 | 403 | 397 | -0.3 |
| South Korea | 93 | 194 | 209 | 223 | 235 | 247 | 276 | 311 | 1.7 |
| Australia/New Zealand | 140 | 244 | 240 | 248 | 251 | 257 | 269 | 287 | 0.7 |
| **Total OECD** | **4,073** | **4,443** | **4,438** | **4,495** | **4,582** | **4,639** | **4,772** | **5,148** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,421** | **836** | **823** | **873** | **905** | **904** | **909** | **952** | **0.6** |
| Russia | 678 | 451 | 427 | 468 | 493 | 494 | 495 | 522 | 0.8 |
| Other | 743 | 385 | 396 | 405 | 412 | 410 | 414 | 430 | 0.3 |
| **Non-OECD Asia** | **2,557** | **5,720** | **6,307** | **7,476** | **8,487** | **9,765** | **11,295** | **12,802** | **3.0** |
| China | 1,929 | 4,449 | 4,947 | 5,986 | 6,825 | 7,921 | 9,182 | 10,269 | 3.1 |
| India | 389 | 808 | 883 | 967 | 1,076 | 1,180 | 1,288 | 1,449 | 2.1 |
| Other Non-OECD Asia | 239 | 463 | 476 | 523 | 586 | 664 | 826 | 1,084 | 3.5 |
| **Middle East** | **14** | **36** | **36** | **35** | **36** | **37** | **41** | **48** | **1.2** |
| **Africa** | **277** | **394** | **389** | **398** | **416** | **437** | **473** | **531** | **1.3** |
| **Central and South America** | **53** | **81** | **77** | **89** | **102** | **117** | **140** | **181** | **3.6** |
| Brazil | 32 | 42 | 42 | 52 | 62 | 74 | 90 | 115 | 4.3 |
| Other Central and South America | 21 | 40 | 36 | 38 | 40 | 43 | 50 | 66 | 2.6 |
| **Total Non-OECD** | **4,321** | **7,067** | **7,632** | **8,871** | **9,946** | **11,261** | **12,858** | **14,514** | **2.7** |
| **Total World** | **8,394** | **11,510** | **12,070** | **13,366** | **14,528** | **15,900** | **17,630** | **19,661** | **2.1** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

Appendix C

# Low Economic Growth Case Projections:

- World Energy Consumption
- Gross Domestic Product
- Carbon Dioxide Emissions

**Table C1. World Total Energy Consumption by Region, Low Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **100.7** | **121.6** | **121.3** | **120.3** | **122.5** | **124.9** | **127.7** | **130.3** | **0.3** |
| United States[a] | 84.7 | 100.5 | 100.0 | 99.2 | 100.0 | 101.1 | 102.6 | 104.2 | 0.2 |
| Canada | 11.0 | 14.2 | 14.0 | 14.6 | 15.3 | 15.9 | 16.5 | 17.0 | 0.8 |
| Mexico | 5.0 | 6.9 | 7.4 | 6.6 | 7.2 | 7.9 | 8.5 | 9.1 | 0.9 |
| **OECD Europe** | **70.0** | **81.4** | **81.6** | **82.0** | **83.3** | **85.0** | **85.8** | **86.2** | **0.2** |
| **OECD Asia** | **27.0** | **38.4** | **38.7** | **39.4** | **40.9** | **41.6** | **41.7** | **41.6** | **0.3** |
| Japan | 18.7 | 22.7 | 22.8 | 21.9 | 22.5 | 22.6 | 22.1 | 21.6 | -0.2 |
| South Korea | 3.8 | 9.2 | 9.4 | 11.0 | 11.4 | 11.5 | 11.9 | 12.2 | 1.1 |
| Australia/New Zealand | 4.5 | 6.4 | 6.5 | 6.6 | 7.1 | 7.4 | 7.6 | 7.8 | 0.8 |
| **Total OECD** | **197.7** | **241.3** | **241.7** | **241.7** | **246.7** | **251.5** | **255.2** | **258.1** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **67.3** | **50.6** | **50.7** | **53.8** | **56.5** | **58.3** | **59.0** | **59.3** | **0.7** |
| Russia | 39.4 | 30.1 | 30.4 | 32.1 | 33.7 | 34.9 | 35.3 | 35.5 | 0.7 |
| Other | 28.0 | 20.6 | 20.3 | 21.7 | 22.8 | 23.4 | 23.7 | 23.8 | 0.7 |
| **Non-OECD Asia** | **47.4** | **109.4** | **117.6** | **138.6** | **159.4** | **182.3** | **202.2** | **220.6** | **2.7** |
| China | 27.0 | 66.8 | 73.8 | 90.1 | 103.4 | 118.8 | 132.1 | 143.4 | 2.8 |
| India | 7.9 | 16.3 | 17.7 | 19.0 | 22.4 | 25.8 | 27.8 | 29.9 | 2.2 |
| Other Non-OECD Asia | 12.5 | 26.3 | 26.1 | 29.5 | 33.6 | 37.7 | 42.3 | 47.3 | 2.5 |
| **Middle East** | **11.2** | **22.7** | **23.8** | **27.6** | **29.6** | **30.8** | **32.5** | **34.6** | **1.6** |
| **Africa** | **9.5** | **14.5** | **14.5** | **16.2** | **17.3** | **18.4** | **19.4** | **20.2** | **1.4** |
| **Central and South America** | **14.5** | **23.4** | **24.2** | **28.2** | **29.7** | **31.2** | **33.1** | **34.8** | **1.5** |
| Brazil | 5.8 | 9.4 | 9.6 | 11.3 | 12.6 | 13.9 | 15.3 | 16.7 | 2.3 |
| Other Central and South America | 8.8 | 14.0 | 14.6 | 16.9 | 17.1 | 17.2 | 17.8 | 18.2 | 0.9 |
| **Total Non-OECD** | **149.9** | **220.7** | **230.8** | **264.4** | **292.5** | **320.8** | **346.2** | **369.5** | **2.0** |
| **Total World** | **347.7** | **462.1** | **472.4** | **506.2** | **539.2** | **572.4** | **601.4** | **627.6** | **1.2** |

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C2. World Total Energy Consumption by Region and Fuel, Low Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | | | | | | | | | |
| Liquids | 40.5 | 49.6 | 49.2 | 45.1 | 45.0 | 44.9 | 44.9 | 45.6 | -0.3 |
| Natural Gas | 23.0 | 28.0 | 28.0 | 29.0 | 29.3 | 30.2 | 31.5 | 31.8 | 0.5 |
| Coal | 20.6 | 24.7 | 24.3 | 24.8 | 25.1 | 25.2 | 25.3 | 26.5 | 0.4 |
| Nuclear | 6.9 | 9.2 | 9.4 | 9.7 | 10.0 | 10.2 | 10.3 | 10.1 | 0.3 |
| Other | 9.7 | 10.3 | 10.5 | 11.8 | 13.0 | 14.4 | 15.6 | 16.2 | 1.8 |
| **Total** | **100.7** | **121.6** | **121.3** | **120.3** | **122.5** | **124.9** | **127.7** | **130.3** | **0.3** |
| **OECD Europe** | | | | | | | | | |
| Liquids | 28.4 | 32.3 | 32.4 | 30.0 | 29.4 | 29.7 | 29.4 | 29.0 | -0.5 |
| Natural Gas | 11.2 | 19.8 | 19.7 | 20.8 | 21.3 | 21.8 | 22.0 | 22.1 | 0.5 |
| Coal | 17.7 | 12.9 | 13.2 | 13.0 | 12.6 | 12.1 | 11.7 | 11.4 | -0.6 |
| Nuclear | 7.9 | 9.7 | 9.6 | 9.7 | 9.6 | 9.6 | 9.5 | 9.5 | -0.1 |
| Other | 4.8 | 6.5 | 6.6 | 8.5 | 10.3 | 11.8 | 13.2 | 14.2 | 3.2 |
| **Total** | **70.0** | **81.4** | **81.6** | **82.0** | **83.3** | **85.0** | **85.8** | **86.2** | **0.2** |
| **OECD Asia** | | | | | | | | | |
| Liquids | 14.7 | 17.5 | 17.2 | 17.0 | 17.1 | 17.1 | 16.7 | 16.4 | -0.2 |
| Natural Gas | 3.1 | 5.8 | 6.1 | 6.4 | 6.9 | 7.0 | 6.9 | 6.8 | 0.5 |
| Coal | 5.2 | 9.3 | 9.4 | 9.5 | 9.4 | 9.2 | 9.2 | 9.1 | -0.1 |
| Nuclear | 2.5 | 4.3 | 4.3 | 4.5 | 5.0 | 5.6 | 5.9 | 6.4 | 1.6 |
| Other | 1.6 | 1.6 | 1.7 | 2.1 | 2.6 | 2.8 | 2.9 | 3.0 | 2.4 |
| **Total** | **27.0** | **38.4** | **38.7** | **39.4** | **40.9** | **41.6** | **41.7** | **41.6** | **0.3** |
| **Total OECD** | | | | | | | | | |
| Liquids | 83.6 | 99.4 | 98.8 | 92.0 | 91.5 | 91.6 | 91.0 | 91.0 | -0.3 |
| Natural Gas | 37.3 | 53.6 | 53.9 | 56.2 | 57.4 | 59.0 | 60.5 | 60.7 | 0.5 |
| Coal | 43.5 | 46.9 | 46.9 | 47.2 | 47.2 | 46.6 | 46.2 | 47.1 | 0.0 |
| Nuclear | 17.3 | 23.2 | 23.3 | 23.9 | 24.7 | 25.3 | 25.7 | 26.0 | 0.4 |
| Other | 16.0 | 18.3 | 18.8 | 22.4 | 25.9 | 29.0 | 31.8 | 33.4 | 2.4 |
| **Total** | **197.7** | **241.3** | **241.7** | **241.7** | **246.7** | **251.5** | **255.2** | **258.1** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | | | | | | | | | |
| Liquids | 19.6 | 10.1 | 10.2 | 10.5 | 10.5 | 10.6 | 10.5 | 10.4 | 0.1 |
| Natural Gas | 27.5 | 25.8 | 25.8 | 27.9 | 29.7 | 30.6 | 30.8 | 30.9 | 0.7 |
| Coal | 15.1 | 8.9 | 8.7 | 9.2 | 9.3 | 9.1 | 8.8 | 8.8 | 0.0 |
| Nuclear | 2.5 | 2.9 | 2.9 | 3.0 | 3.6 | 4.5 | 5.2 | 5.5 | 2.6 |
| Other | 2.8 | 3.1 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 0.9 |
| **Total** | **67.3** | **50.6** | **50.7** | **53.8** | **56.5** | **58.3** | **59.0** | **59.3** | **0.7** |
| **Non-OECD Asia** | | | | | | | | | |
| Liquids | 14.0 | 31.6 | 33.1 | 36.8 | 41.4 | 47.5 | 52.4 | 56.7 | 2.3 |
| Natural Gas | 3.0 | 9.6 | 9.6 | 11.6 | 15.1 | 18.1 | 20.6 | 22.9 | 3.7 |
| Coal | 27.0 | 60.4 | 66.5 | 78.0 | 85.6 | 93.8 | 103.5 | 111.6 | 2.2 |
| Nuclear | 0.4 | 1.1 | 1.1 | 1.6 | 3.0 | 4.7 | 6.2 | 7.0 | 7.9 |
| Other | 3.0 | 6.6 | 7.2 | 10.7 | 14.3 | 18.2 | 19.5 | 22.4 | 4.9 |
| **Total** | **47.4** | **109.4** | **117.6** | **138.6** | **159.4** | **182.3** | **202.2** | **220.6** | **2.7** |

See notes at end of table.

**Table C2. World Total Energy Consumption by Region and Fuel, Low Economic Growth Case, 1990-2030 (Continued)**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD (Continued)** | | | | | | | | | |
| **Middle East** | | | | | | | | | |
| Liquids | 7.2 | 11.9 | 12.4 | 14.4 | 14.9 | 15.4 | 16.3 | 17.5 | 1.4 |
| Natural Gas | 3.8 | 10.2 | 10.8 | 12.5 | 13.8 | 14.4 | 15.1 | 16.0 | 1.7 |
| Coal | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.9 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Other | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 3.4 |
| **Total** | **11.2** | **22.7** | **23.8** | **27.6** | **29.6** | **30.8** | **32.5** | **34.6** | **1.6** |
| **Africa** | | | | | | | | | |
| Liquids | 4.3 | 6.1 | 6.1 | 7.1 | 7.2 | 7.2 | 7.4 | 7.4 | 0.8 |
| Natural Gas | 1.5 | 3.2 | 3.2 | 3.6 | 4.4 | 5.2 | 5.7 | 6.1 | 2.7 |
| Coal | 3.0 | 4.2 | 4.2 | 4.2 | 4.3 | 4.4 | 4.6 | 4.9 | 0.7 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Other | 0.6 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **9.5** | **14.5** | **14.5** | **16.2** | **17.3** | **18.4** | **19.4** | **20.2** | **1.4** |
| **Central and South America** | | | | | | | | | |
| Liquids | 7.8 | 11.3 | 11.7 | 13.5 | 13.3 | 13.2 | 13.7 | 14.3 | 0.8 |
| Natural Gas | 2.2 | 4.7 | 4.8 | 5.8 | 6.3 | 6.8 | 7.3 | 7.4 | 1.8 |
| Coal | 0.6 | 0.9 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 2.0 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 2.0 |
| Other | 3.9 | 6.4 | 6.6 | 7.8 | 8.7 | 9.7 | 10.6 | 11.5 | 2.3 |
| **Total** | **14.5** | **23.4** | **24.2** | **28.2** | **29.7** | **31.2** | **33.1** | **34.8** | **1.5** |
| **Total Non-OECD** | | | | | | | | | |
| Liquids | 52.9 | 71.0 | 73.6 | 82.3 | 87.3 | 93.9 | 100.3 | 106.3 | 1.5 |
| Natural Gas | 38.0 | 53.5 | 54.2 | 61.3 | 69.3 | 75.0 | 79.5 | 83.2 | 1.8 |
| Coal | 45.7 | 74.8 | 80.6 | 92.7 | 100.6 | 108.8 | 118.6 | 127.1 | 1.9 |
| Nuclear | 3.1 | 4.3 | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.2 | 4.7 |
| Other | 10.3 | 17.2 | 18.0 | 23.1 | 28.1 | 33.3 | 35.8 | 39.7 | 3.4 |
| **Total** | **149.9** | **220.7** | **230.8** | **264.4** | **292.5** | **320.8** | **346.2** | **369.5** | **2.0** |
| **Total World** | | | | | | | | | |
| Liquids | 136.4 | 170.4 | 172.4 | 174.3 | 178.8 | 185.6 | 191.3 | 197.3 | 0.6 |
| Natural Gas | 75.3 | 107.1 | 108.1 | 117.5 | 126.8 | 134.0 | 140.0 | 143.9 | 1.2 |
| Coal | 89.2 | 121.7 | 127.5 | 139.9 | 147.8 | 155.4 | 164.8 | 174.1 | 1.3 |
| Nuclear | 20.4 | 27.5 | 27.8 | 28.9 | 31.9 | 35.2 | 37.8 | 39.2 | 1.4 |
| Other | 26.3 | 35.5 | 36.8 | 45.5 | 54.0 | 62.2 | 67.5 | 73.1 | 2.9 |
| **Total** | **347.7** | **462.1** | **472.4** | **506.2** | **539.2** | **572.4** | **601.4** | **627.6** | **1.2** |

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Low Economic Growth Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,651** | **14,885** | **15,331** | **15,677** | **17,752** | **19,774** | **21,830** | **24,164** | **1.9** |
| United States[a] | 8,040 | 12,422 | 12,768 | 12,946 | 14,610 | 16,196 | 17,782 | 19,614 | 1.8 |
| Canada | 773 | 1,167 | 1,204 | 1,263 | 1,404 | 1,536 | 1,677 | 1,827 | 1.8 |
| Mexico | 838 | 1,296 | 1,359 | 1,468 | 1,738 | 2,041 | 2,372 | 2,724 | 2.9 |
| **OECD Europe** | **9,703** | **13,756** | **14,224** | **14,866** | **16,268** | **17,734** | **19,220** | **20,738** | **1.6** |
| **OECD Asia** | **4,080** | **5,509** | **5,667** | **5,985** | **6,546** | **6,895** | **7,191** | **7,499** | **1.2** |
| Japan | 3,222 | 3,873 | 3,966 | 4,065 | 4,287 | 4,335 | 4,308 | 4,278 | 0.3 |
| South Korea | 374 | 843 | 886 | 1,030 | 1,238 | 1,408 | 1,578 | 1,743 | 2.9 |
| Australia/New Zealand | 485 | 794 | 815 | 890 | 1,020 | 1,152 | 1,306 | 1,478 | 2.5 |
| **Total OECD** | **23,434** | **34,150** | **35,221** | **36,528** | **40,566** | **44,402** | **48,241** | **52,401** | **1.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3,039** | **2,932** | **3,159** | **3,902** | **4,704** | **5,403** | **6,020** | **6,634** | **3.1** |
| Russia | 1,880 | 1,703 | 1,829 | 2,305 | 2,760 | 3,144 | 3,472 | 3,801 | 3.1 |
| Other | 1,159 | 1,229 | 1,330 | 1,597 | 1,945 | 2,259 | 2,548 | 2,832 | 3.2 |
| **Non-OECD Asia** | **4,457** | **12,272** | **13,408** | **17,766** | **23,810** | **30,927** | **38,225** | **45,789** | **5.3** |
| China | 1,265 | 5,389 | 6,014 | 8,606 | 11,869 | 15,966 | 19,999 | 23,883 | 5.9 |
| India | 1,019 | 2,436 | 2,672 | 3,464 | 4,713 | 6,074 | 7,417 | 8,896 | 5.1 |
| Other Non-OECD Asia | 2,173 | 4,448 | 4,723 | 5,696 | 7,227 | 8,886 | 10,809 | 13,011 | 4.3 |
| **Middle East** | **1,072** | **1,919** | **2,053** | **2,460** | **2,930** | **3,418** | **3,961** | **4,587** | **3.4** |
| **Africa** | **1,387** | **2,211** | **2,341** | **2,843** | **3,493** | **4,139** | **4,775** | **5,357** | **3.5** |
| **Central and South America** | **2,270** | **3,555** | **3,757** | **4,451** | **5,235** | **6,087** | **7,014** | **8,041** | **3.2** |
| Brazil | 1,045 | 1,534 | 1,591 | 1,877 | 2,220 | 2,598 | 3,032 | 3,526 | 3.4 |
| Other Central and South America | 1,224 | 2,021 | 2,165 | 2,575 | 3,016 | 3,488 | 3,982 | 4,515 | 3.1 |
| **Total Non-OECD** | **12,225** | **22,888** | **24,717** | **31,423** | **40,172** | **49,972** | **59,995** | **70,408** | **4.5** |
| **Total World** | **35,659** | **57,038** | **59,939** | **67,951** | **80,738** | **94,375** | **108,236** | **122,809** | **3.0** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** Derived from IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), Table B4.

**Table C4. World Liquids Consumption by Region, Low Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.5** | **25.2** | **25.1** | **23.3** | **23.3** | **23.2** | **23.3** | **23.7** | **-0.2** |
| United States[a] | 17.0 | 20.8 | 20.7 | 19.5 | 19.4 | 19.2 | 19.2 | 19.5 | -0.2 |
| Canada | 1.7 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.3 | 2.3 | 0.0 |
| Mexico | 1.8 | 2.1 | 2.1 | 1.5 | 1.7 | 1.8 | 1.9 | 1.9 | -0.4 |
| **OECD Europe** | **13.7** | **15.7** | **15.7** | **14.5** | **14.2** | **14.4** | **14.2** | **14.0** | **-0.5** |
| **OECD Asia** | **7.2** | **8.6** | **8.5** | **8.4** | **8.4** | **8.4** | **8.2** | **8.1** | **-0.2** |
| Japan | 5.3 | 5.3 | 5.2 | 4.6 | 4.7 | 4.8 | 4.6 | 4.4 | -0.7 |
| South Korea | 1.0 | 2.2 | 2.2 | 2.8 | 2.7 | 2.5 | 2.5 | 2.5 | 0.6 |
| Australia/New Zealand | 0.8 | 1.1 | 1.1 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 0.2 |
| **Total OECD** | **41.4** | **49.5** | **49.2** | **46.2** | **45.9** | **46.0** | **45.8** | **45.8** | **-0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **9.4** | **4.9** | **5.0** | **5.1** | **5.1** | **5.2** | **5.1** | **5.1** | **0.1** |
| Russia | 5.4 | 2.8 | 2.8 | 2.7 | 2.8 | 2.8 | 2.7 | 2.6 | -0.4 |
| Other | 3.9 | 2.1 | 2.1 | 2.4 | 2.4 | 2.4 | 2.4 | 2.5 | 0.7 |
| **Non-OECD Asia** | **6.6** | **15.3** | **16.0** | **17.8** | **20.1** | **23.0** | **25.4** | **27.5** | **2.3** |
| China | 2.3 | 6.7 | 7.2 | 8.5 | 9.8 | 11.5 | 12.9 | 13.9 | 2.8 |
| India | 1.2 | 2.5 | 2.7 | 2.4 | 3.0 | 3.7 | 4.0 | 4.3 | 2.0 |
| Other Non-OECD Asia | 3.1 | 6.1 | 6.1 | 6.9 | 7.3 | 7.8 | 8.5 | 9.2 | 1.7 |
| **Middle East** | **3.5** | **5.8** | **6.1** | **7.0** | **7.3** | **7.5** | **8.0** | **8.5** | **1.4** |
| **Africa** | **2.1** | **3.0** | **3.0** | **3.5** | **3.5** | **3.5** | **3.6** | **3.6** | **0.8** |
| **Central and South America** | **3.8** | **5.5** | **5.7** | **6.6** | **6.5** | **6.4** | **6.7** | **7.0** | **0.8** |
| Brazil | 1.5 | 2.2 | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.4 | 1.7 |
| Other Central and South America | 2.3 | 3.3 | 3.4 | 4.0 | 3.8 | 3.5 | 3.6 | 3.6 | 0.2 |
| **Total Non-OECD** | **25.3** | **34.5** | **35.8** | **40.0** | **42.4** | **45.6** | **48.7** | **51.6** | **1.5** |
| **Total World** | **66.7** | **84.0** | **85.0** | **86.2** | **88.3** | **91.6** | **94.5** | **97.4** | **0.6** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C5. World Natural Gas Consumption by Region, Low Economic Growth Case, 1990-2030**
(Trillion Cubic Feet)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **22.5** | **27.1** | **27.2** | **28.1** | **28.3** | **29.3** | **30.5** | **30.7** | **0.5** |
| United States[a] | 19.2 | 22.0 | 21.7 | 22.3 | 21.9 | 22.3 | 23.0 | 22.7 | 0.2 |
| Canada | 2.4 | 3.4 | 3.3 | 3.4 | 3.8 | 4.0 | 4.1 | 4.3 | 1.1 |
| Mexico | 0.9 | 1.8 | 2.2 | 2.3 | 2.7 | 3.0 | 3.4 | 3.8 | 2.3 |
| **OECD Europe** | **11.6** | **19.3** | **19.2** | **20.2** | **20.7** | **21.2** | **21.4** | **21.5** | **0.5** |
| **OECD Asia** | **2.9** | **5.2** | **5.5** | **5.8** | **6.2** | **6.3** | **6.3** | **6.2** | **0.5** |
| Japan | 2.0 | 3.1 | 3.2 | 3.3 | 3.5 | 3.5 | 3.3 | 3.2 | 0.0 |
| South Korea | 0.1 | 1.1 | 1.1 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.4 |
| Australia/New Zealand | 0.8 | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 0.8 |
| **Total OECD** | **37.0** | **51.7** | **51.9** | **54.1** | **55.3** | **56.8** | **58.2** | **58.4** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **26.7** | **25.3** | **25.4** | **27.4** | **29.2** | **30.0** | **30.2** | **30.3** | **0.7** |
| Russia | 17.3 | 16.2 | 16.6 | 17.9 | 18.7 | 19.1 | 19.2 | 19.3 | 0.6 |
| Other | 9.5 | 9.1 | 8.8 | 9.5 | 10.5 | 10.9 | 11.0 | 11.0 | 0.9 |
| **Non-OECD Asia** | **2.9** | **9.3** | **9.4** | **11.3** | **14.7** | **17.7** | **20.2** | **22.4** | **3.7** |
| China | 0.5 | 1.7 | 2.0 | 2.6 | 3.7 | 4.6 | 5.5 | 6.2 | 4.9 |
| India | 0.4 | 1.3 | 1.4 | 1.8 | 2.3 | 2.8 | 3.1 | 3.3 | 3.7 |
| Other Non-OECD Asia | 2.0 | 6.4 | 6.0 | 7.0 | 8.7 | 10.3 | 11.6 | 12.9 | 3.2 |
| **Middle East** | **3.6** | **9.8** | **10.3** | **11.9** | **13.2** | **13.7** | **14.4** | **15.2** | **1.7** |
| **Africa** | **1.4** | **3.0** | **2.9** | **3.4** | **4.1** | **4.8** | **5.3** | **5.6** | **2.7** |
| **Central and South America** | **2.0** | **4.4** | **4.5** | **5.4** | **5.9** | **6.4** | **6.8** | **6.9** | **1.8** |
| Brazil | 0.1 | 0.7 | 0.7 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 2.9 |
| Other Central and South America | 1.9 | 3.7 | 3.8 | 4.4 | 4.9 | 5.2 | 5.5 | 5.6 | 1.6 |
| **Total Non-OECD** | **36.5** | **51.8** | **52.5** | **59.4** | **67.1** | **72.6** | **76.9** | **80.5** | **1.8** |
| **Total World** | **73.5** | **103.4** | **104.4** | **113.5** | **122.4** | **129.4** | **135.1** | **139.0** | **1.2** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C6. World Coal Consumption by Region, Low Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.6** | **24.7** | **24.3** | **24.8** | **25.1** | **25.2** | **25.3** | **26.5** | **0.4** |
| United States[a] | 19.2 | 22.8 | 22.5 | 22.9 | 23.2 | 23.4 | 23.5 | 24.6 | 0.4 |
| Canada | 1.2 | 1.5 | 1.4 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | -0.1 |
| Mexico | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 1.2 |
| **OECD Europe** | **17.7** | **12.9** | **13.2** | **13.0** | **12.6** | **12.1** | **11.7** | **11.4** | **-0.6** |
| **OECD Asia** | **5.2** | **9.3** | **9.4** | **9.5** | **9.4** | **9.2** | **9.2** | **9.1** | **-0.1** |
| Japan | 2.7 | 4.6 | 4.6 | 4.5 | 4.4 | 4.2 | 4.0 | 3.8 | -0.8 |
| South Korea | 1.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 0.7 |
| Australia/New Zealand | 1.5 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.7 | 0.2 |
| **Total OECD** | **43.5** | **46.9** | **46.9** | **47.2** | **47.2** | **46.6** | **46.2** | **47.1** | **0.0** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **15.1** | **8.9** | **8.7** | **9.2** | **9.3** | **9.1** | **8.8** | **8.8** | **0.0** |
| Russia | 7.2 | 4.8 | 4.6 | 5.0 | 5.1 | 5.0 | 4.9 | 4.9 | 0.3 |
| Other | 7.9 | 4.1 | 4.2 | 4.2 | 4.2 | 4.1 | 3.9 | 3.9 | -0.3 |
| **Non-OECD Asia** | **27.0** | **60.4** | **66.5** | **78.0** | **85.6** | **93.8** | **103.5** | **111.6** | **2.2** |
| China | 20.3 | 46.9 | 52.0 | 62.3 | 68.6 | 75.7 | 83.8 | 89.2 | 2.3 |
| India | 4.2 | 8.6 | 9.4 | 10.2 | 11.0 | 11.6 | 12.1 | 13.0 | 1.3 |
| Other Non-OECD Asia | 2.6 | 4.9 | 5.1 | 5.5 | 5.9 | 6.5 | 7.6 | 9.4 | 2.6 |
| **Middle East** | **0.1** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.5** | **0.9** |
| **Africa** | **3.0** | **4.2** | **4.2** | **4.2** | **4.3** | **4.4** | **4.6** | **4.9** | **0.7** |
| **Central and South America** | **0.6** | **0.9** | **0.8** | **0.9** | **1.0** | **1.1** | **1.2** | **1.3** | **2.0** |
| Brazil | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 2.9 |
| Other Central and South America | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.7 |
| **Total Non-OECD** | **45.7** | **74.8** | **80.6** | **92.7** | **100.6** | **108.8** | **118.6** | **127.1** | **1.9** |
| **Total World** | **89.2** | **121.7** | **127.5** | **139.9** | **147.8** | **155.4** | **164.8** | **174.1** | **1.3** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C7. World Nuclear Energy Consumption by Region, Low Economic Growth Case, 1990-2030**
(Billion Kilowatthours)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **649** | **880** | **891** | **925** | **955** | **970** | **977** | **962** | **0.3** |
| United States[a] | 577 | 782 | 787 | 809 | 831 | 840 | 840 | 817 | 0.2 |
| Canada | 69 | 87 | 93 | 105 | 113 | 119 | 127 | 134 | 1.5 |
| Mexico | 3 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 0.1 |
| **OECD Europe** | **743** | **932** | **929** | **922** | **914** | **905** | **896** | **899** | **-0.1** |
| **OECD Asia** | **242** | **429** | **430** | **440** | **493** | **545** | **581** | **622** | **1.6** |
| Japan | 192 | 290 | 288 | 299 | 318 | 335 | 357 | 379 | 1.1 |
| South Korea | 50 | 139 | 141 | 142 | 175 | 210 | 225 | 243 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **1,635** | **2,240** | **2,250** | **2,287** | **2,363** | **2,420** | **2,455** | **2,482** | **0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **219** | **264** | **269** | **283** | **342** | **424** | **493** | **518** | **2.8** |
| Russia | 115 | 140 | 144 | 155 | 197 | 250 | 307 | 327 | 3.5 |
| Other | 104 | 124 | 124 | 128 | 145 | 173 | 186 | 191 | 1.8 |
| **Non-OECD Asia** | **38** | **106** | **111** | **151** | **290** | **455** | **599** | **677** | **7.8** |
| China | 0 | 50 | 55 | 65 | 164 | 274 | 366 | 425 | 8.9 |
| India | 6 | 16 | 16 | 37 | 66 | 104 | 134 | 149 | 9.9 |
| Other Non-OECD Asia | 32 | 40 | 40 | 48 | 60 | 77 | 100 | 104 | 4.0 |
| **Middle East** | **0** | **0** | **0** | **0** | **6** | **13** | **13** | **13** | **—** |
| **Africa** | **8** | **12** | **10** | **14** | **15** | **15** | **21** | **21** | **3.2** |
| **Central and South America** | **9** | **16** | **21** | **23** | **28** | **34** | **34** | **34** | **2.1** |
| Brazil | 2 | 10 | 14 | 15 | 18 | 22 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 6 | 7 | 8 | 10 | 12 | 12 | 12 | 2.2 |
| **Total Non-OECD** | **274** | **399** | **411** | **471** | **681** | **941** | **1,161** | **1,264** | **4.8** |
| **Total World** | **1,909** | **2,639** | **2,660** | **2,758** | **3,044** | **3,360** | **3,615** | **3,746** | **1.4** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Low Economic Growth Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9.7** | **10.3** | **10.5** | **11.8** | **13.0** | **14.4** | **15.6** | **16.2** | **1.8** |
| United States[a] | 6.2 | 6.1 | 6.5 | 7.3 | 8.2 | 9.1 | 9.9 | 10.3 | 2.0 |
| Canada | 3.1 | 3.7 | 3.6 | 3.9 | 4.2 | 4.7 | 5.0 | 5.3 | 1.6 |
| Mexico | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.8 |
| **OECD Europe** | **4.8** | **6.5** | **6.6** | **8.5** | **10.3** | **11.8** | **13.2** | **14.2** | **3.2** |
| **OECD Asia** | **1.6** | **1.6** | **1.7** | **2.1** | **2.6** | **2.8** | **2.9** | **3.0** | **2.4** |
| Japan | 1.1 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.1 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.3 |
| Australia/New Zealand | 0.4 | 0.5 | 0.5 | 0.7 | 1.0 | 1.2 | 1.3 | 1.3 | 4.2 |
| **Total OECD** | **16.0** | **18.3** | **18.8** | **22.4** | **25.9** | **29.0** | **31.8** | **33.4** | **2.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **2.8** | **3.1** | **3.0** | **3.2** | **3.4** | **3.5** | **3.7** | **3.8** | **0.9** |
| Russia | 1.8 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| Other | 1.0 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Non-OECD Asia** | **3.0** | **6.6** | **7.2** | **10.7** | **14.3** | **18.2** | **19.5** | **22.4** | **4.9** |
| China | 1.3 | 4.0 | 4.3 | 7.0 | 9.2 | 11.8 | 12.3 | 14.7 | 5.2 |
| India | 0.7 | 1.1 | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| Other Non-OECD Asia | 0.9 | 1.6 | 1.6 | 2.1 | 2.9 | 3.7 | 4.2 | 4.5 | 4.3 |
| **Middle East** | **0.1** | **0.2** | **0.2** | **0.3** | **0.4** | **0.5** | **0.5** | **0.5** | **3.4** |
| **Africa** | **0.6** | **0.9** | **0.9** | **1.0** | **1.3** | **1.4** | **1.5** | **1.5** | **2.1** |
| **Central and South America** | **3.9** | **6.4** | **6.6** | **7.8** | **8.7** | **9.7** | **10.6** | **11.5** | **2.3** |
| Brazil | 2.2 | 3.5 | 3.6 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 3.0 |
| Other Central and South America | 1.7 | 2.9 | 3.0 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 1.4 |
| **Total Non-OECD** | **10.3** | **17.2** | **18.0** | **23.1** | **28.1** | **33.3** | **35.8** | **39.7** | **3.4** |
| **Total World** | **26.3** | **35.5** | **36.8** | **45.5** | **54.0** | **62.2** | **67.5** | **73.1** | **2.9** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. U.S. consumption of hydroelectricity and other renewable energy is projected to be 9.4 quadrillion Btu in 2015 in the *updated AEO2009* reference case—15 percent higher than in the earlier projections reported in this table.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C9. World Carbon Dioxide Emissions by Region, Low Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **5,762** | **7,007** | **6,948** | **6,760** | **6,777** | **6,831** | **6,885** | **7,063** | **0.1** |
| United States[a] | 4,989 | 5,975 | 5,907 | 5,770 | 5,739 | 5,746 | 5,761 | 5,898 | 0.0 |
| Canada | 471 | 629 | 611 | 621 | 634 | 641 | 649 | 657 | 0.3 |
| Mexico | 302 | 403 | 431 | 369 | 403 | 444 | 476 | 508 | 0.7 |
| **OECD Europe** | **4,149** | **4,424** | **4,429** | **4,321** | **4,276** | **4,278** | **4,228** | **4,176** | **-0.2** |
| **OECD Asia** | **1,595** | **2,200** | **2,216** | **2,214** | **2,240** | **2,231** | **2,203** | **2,174** | **-0.1** |
| Japan | 1,054 | 1,250 | 1,247 | 1,166 | 1,180 | 1,172 | 1,122 | 1,071 | -0.6 |
| South Korea | 243 | 497 | 515 | 596 | 599 | 587 | 604 | 614 | 0.7 |
| Australia/New Zealand | 298 | 454 | 455 | 452 | 461 | 472 | 478 | 489 | 0.3 |
| **Total OECD** | **11,506** | **13,632** | **13,594** | **13,296** | **13,292** | **13,341** | **13,317** | **13,413** | **-0.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **4,246** | **2,889** | **2,886** | **3,057** | **3,167** | **3,199** | **3,181** | **3,173** | **0.4** |
| Russia | 2,393 | 1,699 | 1,704 | 1,796 | 1,858 | 1,878 | 1,854 | 1,844 | 0.3 |
| Other | 1,853 | 1,190 | 1,182 | 1,261 | 1,310 | 1,321 | 1,327 | 1,329 | 0.5 |
| **Non-OECD Asia** | **3,678** | **8,305** | **8,987** | **10,412** | **11,616** | **12,944** | **14,321** | **15,488** | **2.3** |
| China | 2,293 | 5,429 | 6,018 | 7,182 | 8,011 | 8,966 | 9,965 | 10,660 | 2.4 |
| India | 573 | 1,192 | 1,292 | 1,359 | 1,535 | 1,703 | 1,804 | 1,932 | 1.7 |
| Other Non-OECD Asia | 811 | 1,684 | 1,678 | 1,871 | 2,071 | 2,275 | 2,551 | 2,896 | 2.3 |
| **Middle East** | **704** | **1,393** | **1,456** | **1,682** | **1,788** | **1,854** | **1,955** | **2,088** | **1.5** |
| **Africa** | **659** | **985** | **982** | **1,083** | **1,136** | **1,187** | **1,245** | **1,297** | **1.2** |
| **Central and South America** | **695** | **1,093** | **1,123** | **1,306** | **1,325** | **1,351** | **1,415** | **1,471** | **1.1** |
| Brazil | 235 | 366 | 374 | 435 | 470 | 505 | 552 | 597 | 2.0 |
| Other Central and South America | 460 | 727 | 749 | 871 | 856 | 846 | 863 | 874 | 0.6 |
| **Total Non-OECD** | **9,982** | **14,664** | **15,434** | **17,539** | **19,032** | **20,536** | **22,117** | **23,517** | **1.8** |
| **Total World** | **21,488** | **28,296** | **29,028** | **30,835** | **32,325** | **33,877** | **35,434** | **36,930** | **1.0** |

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C10. World Carbon Dioxide Emissions from Liquids Use by Region, Low Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **2,637** | **3,188** | **3,159** | **2,873** | **2,838** | **2,831** | **2,805** | **2,855** | **-0.4** |
| United States[a] | 2,178 | 2,620 | 2,596 | 2,380 | 2,337 | 2,312 | 2,276 | 2,318 | -0.5 |
| Canada | 227 | 301 | 295 | 295 | 288 | 287 | 290 | 294 | 0.0 |
| Mexico | 233 | 267 | 268 | 198 | 213 | 232 | 239 | 243 | -0.4 |
| **OECD Europe** | **1,884** | **2,134** | **2,135** | **1,978** | **1,939** | **1,960** | **1,940** | **1,915** | **-0.5** |
| **OECD Asia** | **945** | **1,028** | **1,014** | **990** | **997** | **1,000** | **981** | **959** | **-0.2** |
| Japan | 687 | 641 | 626 | 554 | 566 | 575 | 550 | 526 | -0.7 |
| South Korea | 144 | 239 | 237 | 299 | 289 | 275 | 276 | 275 | 0.6 |
| Australia/New Zealand | 114 | 148 | 151 | 137 | 142 | 150 | 154 | 158 | 0.2 |
| **Total OECD** | **5,466** | **6,350** | **6,308** | **5,840** | **5,774** | **5,791** | **5,726** | **5,730** | **-0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,368** | **686** | **692** | **713** | **715** | **722** | **715** | **707** | **0.1** |
| Russia | 782 | 383 | 389 | 374 | 379 | 384 | 368 | 352 | -0.4 |
| Other | 586 | 303 | 303 | 339 | 336 | 338 | 347 | 356 | 0.7 |
| **Non-OECD Asia** | **960** | **2,077** | **2,170** | **2,414** | **2,715** | **3,106** | **3,428** | **3,709** | **2.3** |
| China | 335 | 889 | 960 | 1,129 | 1,296 | 1,529 | 1,713 | 1,852 | 2.8 |
| India | 160 | 314 | 332 | 305 | 380 | 466 | 502 | 537 | 2.0 |
| Other Non-OECD Asia | 466 | 874 | 878 | 980 | 1,040 | 1,111 | 1,213 | 1,321 | 1.7 |
| **Middle East** | **491** | **814** | **849** | **986** | **1,020** | **1,054** | **1,116** | **1,197** | **1.4** |
| **Africa** | **302** | **423** | **424** | **495** | **496** | **499** | **510** | **515** | **0.8** |
| **Central and South America** | **525** | **761** | **790** | **913** | **894** | **888** | **917** | **956** | **0.8** |
| Brazil | 197 | 288 | 294 | 332 | 354 | 376 | 405 | 440 | 1.7 |
| Other Central and South America | 328 | 473 | 496 | 581 | 540 | 511 | 511 | 515 | 0.2 |
| **Total Non-OECD** | **3,646** | **4,760** | **4,926** | **5,521** | **5,840** | **6,269** | **6,686** | **7,084** | **1.5** |
| **Total World** | **9,112** | **11,110** | **11,234** | **11,361** | **11,614** | **12,060** | **12,412** | **12,814** | **0.5** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C11. World Carbon Dioxide Emissions from Natural Gas Use by Region, Low Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,208** | **1,468** | **1,465** | **1,524** | **1,540** | **1,592** | **1,663** | **1,677** | **0.6** |
| United States[a] | 1,026 | 1,183 | 1,159 | 1,203 | 1,182 | 1,203 | 1,245 | 1,230 | 0.2 |
| Canada | 128 | 185 | 181 | 188 | 207 | 218 | 226 | 233 | 1.1 |
| Mexico | 54 | 100 | 125 | 133 | 151 | 171 | 192 | 214 | 2.3 |
| **OECD Europe** | **593** | **1,053** | **1,047** | **1,103** | **1,131** | **1,158** | **1,169** | **1,174** | **0.5** |
| **OECD Asia** | **165** | **306** | **323** | **341** | **363** | **370** | **366** | **361** | **0.5** |
| Japan | 115 | 181 | 191 | 195 | 204 | 204 | 197 | 188 | 0.0 |
| South Korea | 6 | 64 | 68 | 76 | 86 | 90 | 93 | 94 | 1.4 |
| Australia/New Zealand | 44 | 61 | 64 | 70 | 73 | 76 | 76 | 78 | 0.8 |
| **Total OECD** | **1,966** | **2,827** | **2,835** | **2,968** | **3,035** | **3,120** | **3,199** | **3,212** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,457** | **1,367** | **1,371** | **1,479** | **1,577** | **1,622** | **1,633** | **1,639** | **0.7** |
| Russia | 933 | 865 | 889 | 957 | 1,000 | 1,023 | 1,027 | 1,035 | 0.6 |
| Other | 524 | 502 | 482 | 522 | 577 | 599 | 606 | 603 | 0.9 |
| **Non-OECD Asia** | **161** | **508** | **510** | **616** | **799** | **960** | **1,095** | **1,217** | **3.7** |
| China | 30 | 92 | 111 | 145 | 204 | 255 | 303 | 345 | 4.9 |
| India | 24 | 70 | 76 | 97 | 125 | 152 | 169 | 179 | 3.7 |
| Other Non-OECD Asia | 106 | 347 | 324 | 374 | 470 | 554 | 624 | 693 | 3.2 |
| **Middle East** | **200** | **543** | **571** | **661** | **733** | **764** | **800** | **848** | **1.7** |
| **Africa** | **80** | **168** | **168** | **192** | **234** | **274** | **303** | **322** | **2.7** |
| **Central and South America** | **117** | **250** | **255** | **305** | **336** | **361** | **386** | **391** | **1.8** |
| Brazil | 6 | 36 | 38 | 52 | 59 | 65 | 73 | 75 | 2.9 |
| Other Central and South America | 111 | 214 | 218 | 253 | 278 | 296 | 312 | 317 | 1.6 |
| **Total Non-OECD** | **2,015** | **2,837** | **2,876** | **3,253** | **3,679** | **3,980** | **4,218** | **4,417** | **1.8** |
| **Total World** | **3,981** | **5,664** | **5,712** | **6,221** | **6,713** | **7,100** | **7,417** | **7,628** | **1.2** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table C12. World Carbon Dioxide Emissions from Coal Use by Region, Low Economic Growth Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,916** | **2,339** | **2,312** | **2,352** | **2,387** | **2,397** | **2,405** | **2,519** | **0.4** |
| United States[a] | 1,784 | 2,161 | 2,140 | 2,176 | 2,209 | 2,220 | 2,228 | 2,339 | 0.4 |
| Canada | 116 | 142 | 134 | 138 | 139 | 136 | 133 | 129 | -0.1 |
| Mexico | 16 | 36 | 38 | 38 | 39 | 41 | 44 | 51 | 1.2 |
| **OECD Europe** | **1,672** | **1,237** | **1,247** | **1,241** | **1,206** | **1,160** | **1,120** | **1,087** | **-0.6** |
| **OECD Asia** | **485** | **866** | **879** | **884** | **879** | **861** | **856** | **854** | **-0.1** |
| Japan | 252 | 427 | 430 | 418 | 409 | 393 | 375 | 356 | -0.8 |
| South Korea | 93 | 194 | 209 | 220 | 224 | 223 | 234 | 245 | 0.7 |
| Australia/New Zealand | 140 | 244 | 240 | 246 | 246 | 245 | 248 | 253 | 0.2 |
| **Total OECD** | **4,073** | **4,443** | **4,438** | **4,477** | **4,472** | **4,418** | **4,381** | **4,460** | **0.0** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,421** | **836** | **823** | **864** | **876** | **856** | **833** | **827** | **0.0** |
| Russia | 678 | 451 | 427 | 464 | 479 | 471 | 459 | 457 | 0.3 |
| Other | 743 | 385 | 396 | 400 | 397 | 385 | 374 | 369 | -0.3 |
| **Non-OECD Asia** | **2,557** | **5,720** | **6,307** | **7,382** | **8,102** | **8,878** | **9,797** | **10,562** | **2.2** |
| China | 1,929 | 4,449 | 4,947 | 5,908 | 6,511 | 7,182 | 7,949 | 8,463 | 2.3 |
| India | 389 | 808 | 883 | 957 | 1,030 | 1,086 | 1,133 | 1,216 | 1.3 |
| Other Non-OECD Asia | 239 | 463 | 476 | 517 | 561 | 610 | 714 | 883 | 2.6 |
| **Middle East** | **14** | **36** | **36** | **35** | **36** | **36** | **38** | **43** | **0.7** |
| **Africa** | **277** | **394** | **389** | **395** | **405** | **414** | **431** | **460** | **0.7** |
| **Central and South America** | **53** | **81** | **77** | **88** | **95** | **103** | **113** | **124** | **2.0** |
| Brazil | 32 | 42 | 42 | 50 | 57 | 64 | 74 | 82 | 2.9 |
| Other Central and South America | 21 | 40 | 36 | 37 | 38 | 38 | 40 | 42 | 0.7 |
| **Total Non-OECD** | **4,321** | **7,067** | **7,632** | **8,765** | **9,514** | **10,287** | **11,213** | **12,016** | **1.9** |
| **Total World** | **8,394** | **11,510** | **12,070** | **13,241** | **13,985** | **14,705** | **15,594** | **16,476** | **1.3** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LM2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

Appendix D

# High Oil Price Case Projections:

- World Energy Consumption
- Gross Domestic Product
- Carbon Dioxide Emissions

**Table D1. World Total Primary Energy Consumption by Region, High Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **100.7** | **121.6** | **121.3** | **120.8** | **124.3** | **128.2** | **133.2** | **139.0** | **0.6** |
| United States[a] | 84.7 | 100.5 | 100.0 | 99.6 | 101.9 | 104.0 | 107.5 | 111.8 | 0.5 |
| Canada | 11.0 | 14.2 | 14.0 | 14.6 | 15.3 | 16.2 | 17.0 | 17.8 | 1.0 |
| Mexico | 5.0 | 6.9 | 7.4 | 6.6 | 7.2 | 8.0 | 8.7 | 9.4 | 1.0 |
| **OECD Europe** | **70.0** | **81.4** | **81.6** | **82.2** | **82.0** | **84.3** | **86.2** | **88.0** | **0.3** |
| **OECD Asia** | **27.0** | **38.4** | **38.7** | **39.5** | **40.3** | **41.4** | **42.0** | **42.7** | **0.4** |
| Japan | 18.7 | 22.7 | 22.8 | 21.9 | 22.1 | 22.4 | 22.2 | 22.0 | -0.1 |
| South Korea | 3.8 | 9.2 | 9.4 | 11.0 | 11.1 | 11.4 | 12.0 | 12.5 | 1.2 |
| Australia/New Zealand | 4.5 | 6.4 | 6.5 | 6.7 | 7.1 | 7.5 | 7.8 | 8.1 | 0.9 |
| **Total OECD** | **197.7** | **241.3** | **241.7** | **242.5** | **246.6** | **253.9** | **261.5** | **269.6** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **67.3** | **50.6** | **50.7** | **54.0** | **56.8** | **59.3** | **60.8** | **62.1** | **0.9** |
| Russia | 39.4 | 30.1 | 30.4 | 32.2 | 34.2 | 35.9 | 36.8 | 37.6 | 0.9 |
| Other | 28.0 | 20.6 | 20.3 | 21.7 | 22.6 | 23.4 | 24.1 | 24.6 | 0.8 |
| **Non-OECD Asia** | **47.4** | **109.4** | **117.6** | **139.1** | **158.1** | **183.0** | **206.8** | **230.0** | **2.8** |
| China | 27.0 | 66.8 | 73.8 | 90.4 | 102.8 | 119.6 | 135.5 | 150.2 | 3.0 |
| India | 7.9 | 16.3 | 17.7 | 19.1 | 22.2 | 25.8 | 28.4 | 31.0 | 2.4 |
| Other Non-OECD Asia | 12.5 | 26.3 | 26.1 | 29.6 | 33.1 | 37.6 | 42.9 | 48.9 | 2.6 |
| **Middle East** | **11.2** | **22.7** | **23.8** | **27.7** | **30.5** | **32.5** | **34.7** | **37.4** | **1.9** |
| **Africa** | **9.5** | **14.5** | **14.5** | **16.2** | **16.9** | **18.0** | **19.4** | **20.6** | **1.5** |
| **Central and South America** | **14.5** | **23.4** | **24.2** | **28.3** | **29.3** | **31.2** | **33.6** | **36.0** | **1.7** |
| Brazil | 5.8 | 9.4 | 9.6 | 11.4 | 12.6 | 14.1 | 15.8 | 17.5 | 2.5 |
| Other Central and South America | 8.8 | 14.0 | 14.6 | 16.9 | 16.7 | 17.0 | 17.8 | 18.5 | 1.0 |
| **Total Non-OECD** | **149.9** | **220.7** | **230.8** | **265.3** | **291.6** | **324.0** | **355.4** | **386.2** | **2.2** |
| **Total World** | **347.7** | **462.1** | **472.4** | **507.8** | **538.1** | **577.9** | **616.8** | **655.8** | **1.4** |

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D2. World Total Energy Consumption by Region and Fuel, High Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | | | | | | | | | |
| Liquids | 40.5 | 49.6 | 49.2 | 45.2 | 44.8 | 43.9 | 44.5 | 46.0 | -0.3 |
| Natural Gas | 23.0 | 28.0 | 28.0 | 29.2 | 30.4 | 32.4 | 35.0 | 35.7 | 1.0 |
| Coal | 20.6 | 24.7 | 24.3 | 24.8 | 25.4 | 25.9 | 26.7 | 28.9 | 0.7 |
| Nuclear | 6.9 | 9.2 | 9.4 | 9.8 | 10.1 | 10.5 | 10.7 | 11.2 | 0.7 |
| Other | 9.7 | 10.3 | 10.5 | 11.9 | 13.6 | 15.4 | 16.4 | 17.3 | 2.1 |
| **Total** | **100.7** | **121.6** | **121.3** | **120.8** | **124.3** | **128.2** | **133.2** | **139.0** | **0.6** |
| **OECD Europe** | | | | | | | | | |
| Liquids | 28.4 | 32.3 | 32.4 | 30.0 | 27.0 | 26.0 | 25.6 | 25.3 | -1.0 |
| Natural Gas | 11.2 | 19.8 | 19.7 | 20.9 | 22.2 | 24.2 | 25.4 | 26.3 | 1.2 |
| Coal | 17.7 | 12.9 | 13.2 | 13.0 | 12.8 | 12.6 | 12.4 | 12.4 | -0.3 |
| Nuclear | 7.9 | 9.7 | 9.6 | 9.7 | 9.7 | 9.6 | 9.5 | 9.5 | 0.0 |
| Other | 4.8 | 6.5 | 6.6 | 8.5 | 10.3 | 12.0 | 13.3 | 14.4 | 3.3 |
| **Total** | **70.0** | **81.4** | **81.6** | **82.2** | **82.0** | **84.3** | **86.2** | **88.0** | **0.3** |
| **OECD Asia** | | | | | | | | | |
| Liquids | 14.7 | 17.5 | 17.2 | 17.0 | 15.7 | 15.0 | 14.7 | 14.4 | -0.7 |
| Natural Gas | 3.1 | 5.8 | 6.1 | 6.5 | 7.2 | 8.1 | 8.3 | 8.5 | 1.4 |
| Coal | 5.2 | 9.3 | 9.4 | 9.5 | 9.6 | 9.9 | 10.1 | 10.4 | 0.4 |
| Nuclear | 2.5 | 4.3 | 4.3 | 4.5 | 5.1 | 5.6 | 6.0 | 6.4 | 1.7 |
| Other | 1.6 | 1.6 | 1.7 | 2.1 | 2.7 | 2.8 | 2.9 | 3.0 | 2.4 |
| **Total** | **27.0** | **38.4** | **38.7** | **39.5** | **40.3** | **41.4** | **42.0** | **42.7** | **0.4** |
| **Total OECD** | | | | | | | | | |
| Liquids | 83.6 | 99.4 | 98.8 | 92.2 | 87.5 | 84.9 | 84.8 | 85.7 | -0.6 |
| Natural Gas | 37.3 | 53.6 | 53.9 | 56.6 | 59.9 | 64.7 | 68.7 | 70.5 | 1.1 |
| Coal | 43.5 | 46.9 | 46.9 | 47.3 | 47.8 | 48.4 | 49.1 | 51.6 | 0.4 |
| Nuclear | 17.3 | 23.2 | 23.3 | 24.0 | 24.8 | 25.8 | 26.2 | 27.1 | 0.6 |
| Other | 16.0 | 18.3 | 18.8 | 22.5 | 26.6 | 30.1 | 32.6 | 34.7 | 2.6 |
| **Total** | **197.7** | **241.3** | **241.7** | **242.5** | **246.6** | **253.9** | **261.5** | **269.6** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | | | | | | | | | |
| Liquids | 19.6 | 10.1 | 10.2 | 10.5 | 9.8 | 9.4 | 9.3 | 9.2 | -0.4 |
| Natural Gas | 27.5 | 25.8 | 25.8 | 28.0 | 30.6 | 32.4 | 33.3 | 34.1 | 1.2 |
| Coal | 15.1 | 8.9 | 8.7 | 9.2 | 9.5 | 9.4 | 9.3 | 9.5 | 0.4 |
| Nuclear | 2.5 | 2.9 | 2.9 | 3.0 | 3.7 | 4.5 | 5.2 | 5.5 | 2.6 |
| Other | 2.8 | 3.1 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 0.9 |
| **Total** | **67.3** | **50.6** | **50.7** | **54.0** | **56.8** | **59.3** | **60.8** | **62.1** | **0.9** |
| **Non-OECD Asia** | | | | | | | | | |
| Liquids | 14.0 | 31.6 | 33.1 | 36.8 | 38.0 | 41.9 | 46.6 | 50.9 | 1.8 |
| Natural Gas | 3.0 | 9.6 | 9.6 | 11.7 | 15.7 | 19.9 | 23.3 | 26.5 | 4.3 |
| Coal | 27.0 | 60.4 | 66.5 | 78.3 | 86.8 | 98.2 | 111.1 | 123.2 | 2.6 |
| Nuclear | 0.4 | 1.1 | 1.1 | 1.6 | 3.0 | 4.7 | 6.3 | 7.1 | 7.9 |
| Other | 3.0 | 6.6 | 7.2 | 10.7 | 14.5 | 18.2 | 19.5 | 22.4 | 4.9 |
| **Total** | **47.4** | **109.4** | **117.6** | **139.1** | **158.1** | **183.0** | **206.8** | **230.0** | **2.8** |

See notes at end of table.

**Table D2. World Total Energy Consumption by Region and Fuel, High Oil Price Case, 1990-2030 (Continued)**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD (Continued)** | | | | | | | | | |
| **Middle East** | | | | | | | | | |
| Liquids | 7.2 | 11.9 | 12.4 | 14.4 | 14.8 | 15.0 | 15.6 | 16.6 | 1.2 |
| Natural Gas | 3.8 | 10.2 | 10.8 | 12.6 | 14.9 | 16.6 | 18.0 | 19.6 | 2.5 |
| Coal | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.7 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Other | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 3.4 |
| **Total** | **11.2** | **22.7** | **23.8** | **27.7** | **30.5** | **32.5** | **34.7** | **37.4** | **1.9** |
| **Africa** | | | | | | | | | |
| Liquids | 4.3 | 6.1 | 6.1 | 7.1 | 6.6 | 6.3 | 6.4 | 6.4 | 0.2 |
| Natural Gas | 1.5 | 3.2 | 3.2 | 3.6 | 4.5 | 5.6 | 6.4 | 6.9 | 3.3 |
| Coal | 3.0 | 4.2 | 4.2 | 4.2 | 4.4 | 4.6 | 4.9 | 5.4 | 1.1 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Other | 0.6 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **9.5** | **14.5** | **14.5** | **16.2** | **16.9** | **18.0** | **19.4** | **20.6** | **1.5** |
| **Central and South America** | | | | | | | | | |
| Liquids | 7.8 | 11.3 | 11.7 | 13.5 | 12.4 | 11.9 | 12.3 | 12.9 | 0.4 |
| Natural Gas | 2.2 | 4.7 | 4.8 | 5.8 | 6.7 | 7.9 | 8.8 | 9.3 | 2.8 |
| Coal | 0.6 | 0.9 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.8 | 3.3 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 2.1 |
| Other | 3.9 | 6.4 | 6.6 | 7.8 | 8.8 | 9.8 | 10.7 | 11.6 | 2.4 |
| **Total** | **14.5** | **23.4** | **24.2** | **28.3** | **29.3** | **31.2** | **33.6** | **36.0** | **1.7** |
| **Total Non-OECD** | | | | | | | | | |
| Liquids | 52.9 | 71.0 | 73.6 | 82.3 | 81.5 | 84.5 | 90.2 | 96.0 | 1.1 |
| Natural Gas | 38.0 | 53.5 | 54.2 | 61.7 | 72.3 | 82.4 | 89.8 | 96.5 | 2.4 |
| Coal | 45.7 | 74.8 | 80.6 | 93.1 | 102.1 | 113.8 | 127.2 | 140.5 | 2.3 |
| Nuclear | 3.1 | 4.3 | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.3 | 4.7 |
| Other | 10.3 | 17.2 | 18.0 | 23.2 | 28.4 | 33.4 | 35.9 | 39.8 | 3.4 |
| **Total** | **149.9** | **220.7** | **230.8** | **265.3** | **291.6** | **324.0** | **355.4** | **386.2** | **2.2** |
| **Total World** | | | | | | | | | |
| Liquids | 136.4 | 170.4 | 172.4 | 174.5 | 169.0 | 169.5 | 175.0 | 181.7 | 0.2 |
| Natural Gas | 75.3 | 107.1 | 108.1 | 118.3 | 132.2 | 147.0 | 158.5 | 167.0 | 1.8 |
| Coal | 89.2 | 121.7 | 127.5 | 140.4 | 149.9 | 162.2 | 176.4 | 192.2 | 1.7 |
| Nuclear | 20.4 | 27.5 | 27.8 | 29.0 | 32.0 | 35.7 | 38.4 | 40.4 | 1.6 |
| Other | 26.3 | 35.5 | 36.8 | 45.7 | 55.0 | 63.5 | 68.5 | 74.5 | 3.0 |
| **Total** | **347.7** | **462.1** | **472.4** | **507.8** | **538.1** | **577.9** | **616.8** | **655.8** | **1.4** |

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, High Oil Price Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,651** | **14,885** | **15,331** | **16,039** | **18,645** | **21,352** | **24,425** | **27,950** | **2.5** |
| United States[a] | 8,040 | 12,422 | 12,768 | 13,284 | 15,422 | 17,603 | 20,077 | 22,939 | 2.5 |
| Canada | 773 | 1,167 | 1,204 | 1,275 | 1,453 | 1,629 | 1,822 | 2,035 | 2.2 |
| Mexico | 838 | 1,296 | 1,359 | 1,480 | 1,770 | 2,120 | 2,526 | 2,976 | 3.3 |
| **OECD Europe** | **9,703** | **13,756** | **14,224** | **14,976** | **16,497** | **18,319** | **20,374** | **22,572** | **1.9** |
| **OECD Asia** | **4,080** | **5,509** | **5,667** | **6,027** | **6,623** | **7,106** | **7,611** | **8,155** | **1.5** |
| Japan | 3,222 | 3,873 | 3,966 | 4,092 | 4,320 | 4,444 | 4,535 | 4,629 | 0.6 |
| South Korea | 374 | 843 | 886 | 1,037 | 1,247 | 1,441 | 1,658 | 1,881 | 3.2 |
| Australia/New Zealand | 485 | 794 | 815 | 899 | 1,056 | 1,222 | 1,418 | 1,645 | 3.0 |
| **Total OECD** | **23,434** | **34,150** | **35,221** | **37,042** | **41,766** | **46,777** | **52,410** | **58,678** | **2.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3,039** | **2,932** | **3,159** | **3,940** | **4,869** | **5,729** | **6,540** | **7,384** | **3.6** |
| Russia | 1,880 | 1,703 | 1,829 | 2,332 | 2,899 | 3,398 | 3,842 | 4,305 | 3.6 |
| Other | 1,159 | 1,229 | 1,330 | 1,608 | 1,970 | 2,331 | 2,697 | 3,078 | 3.6 |
| **Non-OECD Asia** | **4,457** | **12,272** | **13,408** | **17,885** | **24,074** | **31,807** | **40,320** | **49,576** | **5.6** |
| China | 1,265 | 5,389 | 6,014 | 8,660 | 11,976 | 16,378 | 21,042 | 25,797 | 6.3 |
| India | 1,019 | 2,436 | 2,672 | 3,485 | 4,742 | 6,208 | 7,778 | 9,579 | 5.5 |
| Other Non-OECD Asia | 2,173 | 4,448 | 4,723 | 5,740 | 7,356 | 9,221 | 11,500 | 14,200 | 4.7 |
| **Middle East** | **1,072** | **1,919** | **2,053** | **2,502** | **3,196** | **3,877** | **4,588** | **5,419** | **4.1** |
| **Africa** | **1,387** | **2,211** | **2,341** | **2,862** | **3,528** | **4,252** | **5,033** | **5,799** | **3.9** |
| **Central and South America** | **2,270** | **3,555** | **3,757** | **4,487** | **5,342** | **6,338** | **7,491** | **8,811** | **3.6** |
| Brazil | 1,045 | 1,534 | 1,591 | 1,895 | 2,296 | 2,753 | 3,292 | 3,922 | 3.8 |
| Other Central and South America | 1,224 | 2,021 | 2,165 | 2,592 | 3,046 | 3,585 | 4,200 | 4,889 | 3.5 |
| **Total Non-OECD** | **12,225** | **22,888** | **24,717** | **31,675** | **41,008** | **52,003** | **63,972** | **76,988** | **4.8** |
| **Total World** | **35,659** | **57,038** | **59,939** | **68,718** | **82,774** | **98,780** | **116,383** | **135,666** | **3.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** Derived from IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), Table B4.

**Table D4. World Liquids Consumption by Region, High Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.5** | **25.2** | **25.1** | **23.4** | **23.3** | **22.9** | **23.3** | **24.0** | **-0.2** |
| United States[a] | 17.0 | 20.8 | 20.7 | 19.6 | 19.7 | 19.3 | 19.7 | 20.4 | -0.1 |
| Canada | 1.7 | 2.3 | 2.3 | 2.3 | 2.1 | 2.0 | 2.0 | 2.0 | -0.5 |
| Mexico | 1.8 | 2.1 | 2.1 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | -1.0 |
| **OECD Europe** | **13.7** | **15.7** | **15.7** | **14.5** | **13.1** | **12.6** | **12.4** | **12.2** | **-1.0** |
| **OECD Asia** | **7.2** | **8.6** | **8.5** | **8.4** | **7.7** | **7.4** | **7.2** | **7.1** | **-0.7** |
| Japan | 5.3 | 5.3 | 5.2 | 4.6 | 4.3 | 4.2 | 4.0 | 3.8 | -1.3 |
| South Korea | 1.0 | 2.2 | 2.2 | 2.8 | 2.4 | 2.2 | 2.2 | 2.2 | 0.1 |
| Australia/New Zealand | 0.8 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | -0.2 |
| **Total OECD** | **41.4** | **49.5** | **49.2** | **46.3** | **44.1** | **42.9** | **42.9** | **43.3** | **-0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **9.4** | **4.9** | **5.0** | **5.1** | **4.7** | **4.6** | **4.5** | **4.5** | **-0.4** |
| Russia | 5.4 | 2.8 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | -0.9 |
| Other | 3.9 | 2.1 | 2.1 | 2.4 | 2.2 | 2.1 | 2.1 | 2.2 | 0.1 |
| **Non-OECD Asia** | **6.6** | **15.3** | **16.0** | **17.8** | **18.4** | **20.3** | **22.6** | **24.7** | **1.8** |
| China | 2.3 | 6.7 | 7.2 | 8.5 | 8.9 | 10.1 | 11.5 | 12.6 | 2.3 |
| India | 1.2 | 2.5 | 2.7 | 2.4 | 2.8 | 3.3 | 3.5 | 3.8 | 1.5 |
| Other Non-OECD Asia | 3.1 | 6.1 | 6.1 | 6.9 | 6.7 | 6.9 | 7.6 | 8.3 | 1.3 |
| **Middle East** | **3.5** | **5.8** | **6.1** | **7.0** | **7.2** | **7.3** | **7.6** | **8.1** | **1.2** |
| **Africa** | **2.1** | **3.0** | **3.0** | **3.5** | **3.2** | **3.1** | **3.1** | **3.1** | **0.2** |
| **Central and South America** | **3.8** | **5.5** | **5.7** | **6.6** | **6.1** | **5.8** | **6.0** | **6.3** | **0.4** |
| Brazil | 1.5 | 2.2 | 2.3 | 2.5 | 2.6 | 2.7 | 2.9 | 3.2 | 1.4 |
| Other Central and South America | 2.3 | 3.3 | 3.4 | 4.0 | 3.5 | 3.1 | 3.1 | 3.1 | -0.4 |
| **Total Non-OECD** | **25.3** | **34.5** | **35.8** | **40.0** | **39.6** | **41.1** | **43.8** | **46.7** | **1.1** |
| **Total World** | **66.7** | **84.0** | **85.0** | **86.3** | **83.7** | **84.0** | **86.7** | **90.0** | **0.2** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D5. World Natural Gas Consumption by Region, High Oil Price Case, 1990-2030**
(Trillion Cubic Feet)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **22.5** | **27.1** | **27.2** | **28.3** | **29.5** | **31.5** | **34.2** | **35.3** | **1.1** |
| United States[a] | 19.2 | 22.0 | 21.7 | 22.5 | 22.8 | 23.7 | 25.5 | 25.7 | 0.7 |
| Canada | 2.4 | 3.4 | 3.3 | 3.4 | 3.9 | 4.4 | 4.7 | 5.0 | 1.8 |
| Mexico | 0.9 | 1.8 | 2.2 | 2.4 | 2.8 | 3.4 | 4.0 | 4.5 | 3.0 |
| **OECD Europe** | **11.6** | **19.3** | **19.2** | **20.4** | **21.6** | **23.5** | **24.7** | **25.6** | **1.2** |
| **OECD Asia** | **2.9** | **5.2** | **5.5** | **5.9** | **6.6** | **7.3** | **7.5** | **7.7** | **1.4** |
| Japan | 2.0 | 3.1 | 3.2 | 3.3 | 3.7 | 4.1 | 4.2 | 4.2 | 1.1 |
| South Korea | 0.1 | 1.1 | 1.1 | 1.3 | 1.5 | 1.7 | 1.8 | 1.9 | 2.1 |
| Australia/New Zealand | 0.8 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.5 |
| **Total OECD** | **37.0** | **51.7** | **51.9** | **54.5** | **57.7** | **62.4** | **66.5** | **68.5** | **1.2** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **26.7** | **25.3** | **25.4** | **27.5** | **30.0** | **31.8** | **32.7** | **33.5** | **1.2** |
| Russia | 17.3 | 16.2 | 16.6 | 18.0 | 19.4 | 20.5 | 20.9 | 21.5 | 1.1 |
| Other | 9.5 | 9.1 | 8.8 | 9.6 | 10.7 | 11.4 | 11.8 | 12.1 | 1.3 |
| **Non-OECD Asia** | **2.9** | **9.3** | **9.4** | **11.4** | **15.3** | **19.5** | **22.8** | **25.8** | **4.3** |
| China | 0.5 | 1.7 | 2.0 | 2.6 | 3.8 | 4.9 | 6.0 | 7.0 | 5.4 |
| India | 0.4 | 1.3 | 1.4 | 1.8 | 2.4 | 3.1 | 3.5 | 3.8 | 4.3 |
| Other Non-OECD Asia | 2.0 | 6.4 | 6.0 | 7.0 | 9.2 | 11.5 | 13.3 | 15.0 | 3.9 |
| **Middle East** | **3.6** | **9.8** | **10.3** | **12.0** | **14.2** | **15.8** | **17.2** | **18.7** | **2.5** |
| **Africa** | **1.4** | **3.0** | **2.9** | **3.4** | **4.2** | **5.2** | **5.9** | **6.4** | **3.3** |
| **Central and South America** | **2.0** | **4.4** | **4.5** | **5.4** | **6.3** | **7.4** | **8.3** | **8.8** | **2.8** |
| Brazil | 0.1 | 0.7 | 0.7 | 1.0 | 1.2 | 1.7 | 2.0 | 2.2 | 5.1 |
| Other Central and South America | 1.9 | 3.7 | 3.8 | 4.5 | 5.0 | 5.7 | 6.3 | 6.6 | 2.3 |
| **Total Non-OECD** | **36.5** | **51.8** | **52.5** | **59.8** | **70.0** | **79.7** | **86.9** | **93.3** | **2.4** |
| **Total World** | **73.5** | **103.4** | **104.4** | **114.3** | **127.7** | **142.1** | **153.4** | **161.9** | **1.8** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D6. World Coal Consumption by Region, High Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.6** | **24.7** | **24.3** | **24.8** | **25.4** | **25.9** | **26.7** | **28.9** | **0.7** |
| United States[a] | 19.2 | 22.8 | 22.5 | 22.9 | 23.5 | 23.9 | 24.5 | 26.5 | 0.7 |
| Canada | 1.2 | 1.5 | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.8 | 0.9 |
| Mexico | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 1.8 |
| **OECD Europe** | **17.7** | **12.9** | **13.2** | **13.0** | **12.8** | **12.6** | **12.4** | **12.4** | **-0.3** |
| **OECD Asia** | **5.2** | **9.3** | **9.4** | **9.5** | **9.6** | **9.9** | **10.1** | **10.4** | **0.4** |
| Japan | 2.7 | 4.6 | 4.6 | 4.5 | 4.5 | 4.5 | 4.4 | 4.2 | -0.4 |
| South Korea | 1.0 | 2.1 | 2.2 | 2.4 | 2.5 | 2.7 | 2.9 | 3.2 | 1.5 |
| Australia/New Zealand | 1.5 | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 0.6 |
| **Total OECD** | **43.5** | **46.9** | **46.9** | **47.3** | **47.8** | **48.4** | **49.1** | **51.6** | **0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **15.1** | **8.9** | **8.7** | **9.2** | **9.5** | **9.4** | **9.3** | **9.5** | **0.4** |
| Russia | 7.2 | 4.8 | 4.6 | 5.0 | 5.2 | 5.2 | 5.2 | 5.3 | 0.6 |
| Other | 7.9 | 4.1 | 4.2 | 4.2 | 4.2 | 4.2 | 4.1 | 4.2 | 0.1 |
| **Non-OECD Asia** | **27.0** | **60.4** | **66.5** | **78.3** | **86.8** | **98.2** | **111.1** | **123.2** | **2.6** |
| China | 20.3 | 46.9 | 52.0 | 62.6 | 69.6 | 79.0 | 89.6 | 98.0 | 2.7 |
| India | 4.2 | 8.6 | 9.4 | 10.3 | 11.2 | 12.2 | 13.1 | 14.4 | 1.8 |
| Other Non-OECD Asia | 2.6 | 4.9 | 5.1 | 5.5 | 6.1 | 6.9 | 8.4 | 10.7 | 3.2 |
| **Middle East** | **0.1** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.5** | **0.6** | **1.7** |
| **Africa** | **3.0** | **4.2** | **4.2** | **4.2** | **4.4** | **4.6** | **4.9** | **5.4** | **1.1** |
| **Central and South America** | **0.6** | **0.9** | **0.8** | **0.9** | **1.1** | **1.2** | **1.4** | **1.8** | **3.3** |
| Brazil | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.8 | 0.9 | 1.1 | 4.0 |
| Other Central and South America | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.7 | 2.4 |
| **Total Non-OECD** | **45.7** | **74.8** | **80.6** | **93.1** | **102.1** | **113.8** | **127.2** | **140.5** | **2.3** |
| **Total World** | **89.2** | **121.7** | **127.5** | **140.4** | **149.9** | **162.2** | **176.4** | **192.2** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D7. World Nuclear Energy Consumption by Region, High Oil Price Case, 1990-2030**
(Billion Kilowatthours)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **649** | **880** | **891** | **928** | **956** | **1,004** | **1,021** | **1,063** | **0.7** |
| United States[a] | 577 | 782 | 787 | 809 | 831 | 872 | 882 | 917 | 0.6 |
| Canada | 69 | 87 | 93 | 108 | 114 | 121 | 128 | 135 | 1.6 |
| Mexico | 3 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 0.1 |
| **OECD Europe** | **743** | **932** | **929** | **922** | **919** | **909** | **900** | **905** | **-0.1** |
| **OECD Asia** | **242** | **429** | **430** | **441** | **496** | **549** | **587** | **627** | **1.6** |
| Japan | 192 | 290 | 288 | 299 | 319 | 338 | 360 | 384 | 1.2 |
| South Korea | 50 | 139 | 141 | 142 | 176 | 211 | 226 | 244 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **1,635** | **2,240** | **2,250** | **2,291** | **2,370** | **2,462** | **2,508** | **2,596** | **0.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **219** | **264** | **269** | **284** | **343** | **426** | **496** | **520** | **2.8** |
| Russia | 115 | 140 | 144 | 155 | 198 | 252 | 308 | 328 | 3.5 |
| Other | 104 | 124 | 124 | 128 | 146 | 174 | 187 | 192 | 1.8 |
| **Non-OECD Asia** | **38** | **106** | **111** | **151** | **291** | **457** | **602** | **679** | **7.8** |
| China | 0 | 50 | 55 | 65 | 164 | 275 | 367 | 426 | 8.9 |
| India | 6 | 16 | 16 | 37 | 66 | 105 | 135 | 149 | 9.9 |
| Other Non-OECD Asia | 32 | 40 | 40 | 48 | 61 | 78 | 100 | 104 | 4.0 |
| **Middle East** | **0** | **0** | **0** | **0** | **6** | **13** | **13** | **13** | **—** |
| **Africa** | **8** | **12** | **10** | **14** | **15** | **16** | **22** | **22** | **3.2** |
| **Central and South America** | **9** | **16** | **21** | **23** | **29** | **34** | **35** | **35** | **2.1** |
| Brazil | 2 | 10 | 14 | 15 | 18 | 22 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 6 | 7 | 8 | 10 | 12 | 12 | 12 | 2.3 |
| **Total Non-OECD** | **274** | **399** | **411** | **471** | **685** | **946** | **1,166** | **1,269** | **4.8** |
| **Total World** | **1,909** | **2,639** | **2,660** | **2,762** | **3,055** | **3,409** | **3,674** | **3,864** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, High Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9.7** | **10.3** | **10.5** | **11.9** | **13.6** | **15.4** | **16.4** | **17.3** | **2.1** |
| United States[a] | 6.2 | 6.1 | 6.5 | 7.5 | 8.6 | 10.0 | 10.6 | 11.2 | 2.3 |
| Canada | 3.1 | 3.7 | 3.6 | 3.9 | 4.4 | 4.8 | 5.1 | 5.4 | 1.7 |
| Mexico | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.9 |
| **OECD Europe** | **4.8** | **6.5** | **6.6** | **8.5** | **10.3** | **12.0** | **13.3** | **14.4** | **3.3** |
| **OECD Asia** | **1.6** | **1.6** | **1.7** | **2.1** | **2.7** | **2.8** | **2.9** | **3.0** | **2.4** |
| Japan | 1.1 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.3 |
| Australia/New Zealand | 0.4 | 0.5 | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.3 | 4.2 |
| **Total OECD** | **16.0** | **18.3** | **18.8** | **22.5** | **26.6** | **30.1** | **32.6** | **34.7** | **2.6** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **2.8** | **3.1** | **3.0** | **3.2** | **3.4** | **3.5** | **3.7** | **3.8** | **0.9** |
| Russia | 1.8 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| Other | 1.0 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Non-OECD Asia** | **3.0** | **6.6** | **7.2** | **10.7** | **14.5** | **18.2** | **19.5** | **22.4** | **4.9** |
| China | 1.3 | 4.0 | 4.3 | 7.0 | 9.4 | 11.8 | 12.4 | 14.7 | 5.2 |
| India | 0.7 | 1.1 | 1.2 | 1.6 | 2.2 | 2.6 | 3.0 | 3.2 | 4.2 |
| Other Non-OECD Asia | 0.9 | 1.6 | 1.6 | 2.1 | 3.0 | 3.8 | 4.2 | 4.5 | 4.3 |
| **Middle East** | **0.1** | **0.2** | **0.2** | **0.3** | **0.4** | **0.5** | **0.5** | **0.5** | **3.4** |
| **Africa** | **0.6** | **0.9** | **0.9** | **1.0** | **1.3** | **1.4** | **1.5** | **1.5** | **2.1** |
| **Central and South America** | **3.9** | **6.4** | **6.6** | **7.8** | **8.8** | **9.8** | **10.7** | **11.6** | **2.4** |
| Brazil | 2.2 | 3.5 | 3.6 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 3.0 |
| Other Central and South America | 1.7 | 2.9 | 3.0 | 3.4 | 3.6 | 3.8 | 4.1 | 4.3 | 1.4 |
| **Total Non-OECD** | **10.3** | **17.2** | **18.0** | **23.2** | **28.4** | **33.4** | **35.9** | **39.8** | **3.4** |
| **Total World** | **26.3** | **35.5** | **36.8** | **45.7** | **55.0** | **63.5** | **68.5** | **74.5** | **3.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. U.S. consumption of hydroelectricity and other renewable energy is projected to be 9.4 quadrillion Btu in 2015 in the *updated AEO2009* reference case—10 percent higher than in the earlier projections reported in this table.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D9. World Carbon Dioxide Emissions by Region, High Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **5,762** | **7,007** | **6,948** | **6,774** | **6,812** | **6,876** | **7,096** | **7,425** | **0.3** |
| United States[a] | 4,989 | 5,975 | 5,907 | 5,782 | 5,795 | 5,785 | 5,938 | 6,203 | 0.2 |
| Canada | 471 | 629 | 611 | 622 | 620 | 649 | 677 | 701 | 0.6 |
| Mexico | 302 | 403 | 431 | 371 | 397 | 443 | 481 | 521 | 0.8 |
| **OECD Europe** | **4,149** | **4,424** | **4,429** | **4,332** | **4,179** | **4,202** | **4,222** | **4,247** | **-0.2** |
| **OECD Asia** | **1,595** | **2,200** | **2,216** | **2,219** | **2,201** | **2,232** | **2,244** | **2,264** | **0.1** |
| Japan | 1,054 | 1,250 | 1,247 | 1,169 | 1,157 | 1,164 | 1,130 | 1,099 | -0.5 |
| South Korea | 243 | 497 | 515 | 597 | 586 | 593 | 624 | 654 | 1.0 |
| Australia/New Zealand | 298 | 454 | 455 | 454 | 458 | 475 | 490 | 511 | 0.5 |
| **Total OECD** | **11,506** | **13,632** | **13,594** | **13,326** | **13,192** | **13,311** | **13,563** | **13,936** | **0.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **4,246** | **2,889** | **2,886** | **3,068** | **3,177** | **3,247** | **3,276** | **3,333** | **0.6** |
| Russia | 2,393 | 1,699 | 1,704 | 1,803 | 1,882 | 1,932 | 1,933 | 1,961 | 0.6 |
| Other | 1,853 | 1,190 | 1,182 | 1,265 | 1,295 | 1,315 | 1,342 | 1,371 | 0.6 |
| **Non-OECD Asia** | **3,678** | **8,305** | **8,987** | **10,451** | **11,544** | **13,091** | **14,803** | **16,399** | **2.5** |
| China | 2,293 | 5,429 | 6,018 | 7,213 | 7,991 | 9,111 | 10,355 | 11,352 | 2.7 |
| India | 573 | 1,192 | 1,292 | 1,364 | 1,525 | 1,722 | 1,862 | 2,041 | 1.9 |
| Other Non-OECD Asia | 811 | 1,684 | 1,678 | 1,875 | 2,028 | 2,259 | 2,586 | 3,006 | 2.5 |
| **Middle East** | **704** | **1,393** | **1,456** | **1,687** | **1,835** | **1,941** | **2,064** | **2,226** | **1.8** |
| **Africa** | **659** | **985** | **982** | **1,085** | **1,104** | **1,161** | **1,241** | **1,323** | **1.2** |
| **Central and South America** | **695** | **1,093** | **1,123** | **1,308** | **1,291** | **1,336** | **1,432** | **1,530** | **1.3** |
| Brazil | 235 | 366 | 374 | 437 | 469 | 518 | 580 | 644 | 2.3 |
| Other Central and South America | 460 | 727 | 749 | 872 | 823 | 818 | 852 | 886 | 0.7 |
| **Total Non-OECD** | **9,982** | **14,664** | **15,434** | **17,598** | **18,951** | **20,776** | **22,817** | **24,810** | **2.0** |
| **Total World** | **21,488** | **28,296** | **29,028** | **30,925** | **32,144** | **34,087** | **36,379** | **38,745** | **1.2** |

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D10. World Carbon Dioxide Emissions from Liquids Use by Region, High Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **2,637** | **3,188** | **3,159** | **2,877** | **2,787** | **2,703** | **2,723** | **2,814** | **-0.5** |
| United States[a] | 2,178 | 2,620 | 2,596 | 2,384 | 2,323 | 2,243 | 2,260 | 2,346 | -0.4 |
| Canada | 227 | 301 | 295 | 295 | 266 | 255 | 256 | 259 | -0.5 |
| Mexico | 233 | 267 | 268 | 198 | 198 | 205 | 207 | 209 | -1.0 |
| **OECD Europe** | **1,884** | **2,134** | **2,135** | **1,978** | **1,780** | **1,718** | **1,690** | **1,667** | **-1.0** |
| **OECD Asia** | **945** | **1,028** | **1,014** | **990** | **918** | **882** | **863** | **847** | **-0.7** |
| Japan | 687 | 641 | 626 | 554 | 522 | 505 | 481 | 460 | -1.3 |
| South Korea | 144 | 239 | 237 | 299 | 263 | 239 | 242 | 242 | 0.1 |
| Australia/New Zealand | 114 | 148 | 151 | 137 | 133 | 137 | 140 | 145 | -0.2 |
| **Total OECD** | **5,466** | **6,350** | **6,308** | **5,844** | **5,486** | **5,302** | **5,277** | **5,328** | **-0.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,368** | **686** | **692** | **713** | **663** | **642** | **632** | **625** | **-0.4** |
| Russia | 782 | 383 | 389 | 374 | 354 | 346 | 331 | 316 | -0.9 |
| Other | 586 | 303 | 303 | 339 | 309 | 296 | 302 | 308 | 0.1 |
| **Non-OECD Asia** | **960** | **2,077** | **2,170** | **2,414** | **2,491** | **2,742** | **3,046** | **3,332** | **1.8** |
| China | 335 | 889 | 960 | 1,129 | 1,181 | 1,344 | 1,522 | 1,669 | 2.3 |
| India | 160 | 314 | 332 | 305 | 349 | 410 | 444 | 478 | 1.5 |
| Other Non-OECD Asia | 466 | 874 | 878 | 980 | 961 | 987 | 1,080 | 1,185 | 1.3 |
| **Middle East** | **491** | **814** | **849** | **986** | **1,009** | **1,022** | **1,067** | **1,133** | **1.2** |
| **Africa** | **302** | **423** | **424** | **495** | **455** | **436** | **443** | **447** | **0.2** |
| **Central and South America** | **525** | **761** | **790** | **913** | **838** | **802** | **827** | **864** | **0.4** |
| Brazil | 197 | 288 | 294 | 332 | 340 | 352 | 379 | 413 | 1.4 |
| Other Central and South America | 328 | 473 | 496 | 581 | 499 | 450 | 448 | 451 | -0.4 |
| **Total Non-OECD** | **3,646** | **4,760** | **4,926** | **5,521** | **5,456** | **5,644** | **6,015** | **6,401** | **1.1** |
| **Total World** | **9,112** | **11,110** | **11,234** | **11,365** | **10,942** | **10,946** | **11,292** | **11,729** | **0.2** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D11. World Carbon Dioxide Emissions from Natural Gas Use by Region, High Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,208** | **1,468** | **1,465** | **1,535** | **1,602** | **1,701** | **1,829** | **1,857** | **1.0** |
| United States[a] | 1,026 | 1,183 | 1,159 | 1,213 | 1,228 | 1,264 | 1,343 | 1,327 | 0.6 |
| Canada | 128 | 185 | 181 | 189 | 214 | 242 | 260 | 276 | 1.8 |
| Mexico | 54 | 100 | 125 | 134 | 160 | 195 | 226 | 254 | 3.0 |
| **OECD Europe** | **593** | **1,053** | **1,047** | **1,111** | **1,178** | **1,284** | **1,348** | **1,397** | **1.2** |
| **OECD Asia** | **165** | **306** | **323** | **343** | **384** | **428** | **440** | **449** | **1.4** |
| Japan | 115 | 181 | 191 | 196 | 217 | 241 | 245 | 245 | 1.1 |
| South Korea | 6 | 64 | 68 | 77 | 91 | 102 | 109 | 112 | 2.1 |
| Australia/New Zealand | 44 | 61 | 64 | 70 | 76 | 85 | 87 | 92 | 1.5 |
| **Total OECD** | **1,966** | **2,827** | **2,835** | **2,989** | **3,164** | **3,412** | **3,618** | **3,703** | **1.1** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,457** | **1,367** | **1,371** | **1,487** | **1,623** | **1,720** | **1,767** | **1,811** | **1.2** |
| Russia | 933 | 865 | 889 | 962 | 1,038 | 1,096 | 1,119 | 1,149 | 1.1 |
| Other | 524 | 502 | 482 | 524 | 585 | 624 | 648 | 662 | 1.3 |
| **Non-OECD Asia** | **161** | **508** | **510** | **621** | **832** | **1,057** | **1,238** | **1,404** | **4.3** |
| China | 30 | 92 | 111 | 146 | 209 | 271 | 331 | 387 | 5.4 |
| India | 24 | 70 | 76 | 98 | 130 | 168 | 193 | 210 | 4.3 |
| Other Non-OECD Asia | 106 | 347 | 324 | 377 | 494 | 618 | 714 | 807 | 3.9 |
| **Middle East** | **200** | **543** | **571** | **666** | **790** | **880** | **954** | **1,042** | **2.5** |
| **Africa** | **80** | **168** | **168** | **193** | **240** | **296** | **339** | **367** | **3.3** |
| **Central and South America** | **117** | **250** | **255** | **307** | **354** | **417** | **469** | **496** | **2.8** |
| Brazil | 6 | 36 | 38 | 53 | 68 | 92 | 112 | 123 | 5.1 |
| Other Central and South America | 111 | 214 | 218 | 254 | 286 | 326 | 357 | 373 | 2.3 |
| **Total Non-OECD** | **2,015** | **2,837** | **2,876** | **3,273** | **3,838** | **4,370** | **4,766** | **5,120** | **2.4** |
| **Total World** | **3,981** | **5,664** | **5,712** | **6,262** | **7,002** | **7,782** | **8,384** | **8,822** | **1.8** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table D12. World Carbon Dioxide Emissions from Coal Use by Region, High Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,916** | **2,339** | **2,312** | **2,350** | **2,411** | **2,461** | **2,532** | **2,742** | **0.7** |
| United States[a] | 1,784 | 2,161 | 2,140 | 2,174 | 2,231 | 2,266 | 2,323 | 2,517 | 0.7 |
| Canada | 116 | 142 | 134 | 138 | 140 | 152 | 161 | 167 | 0.9 |
| Mexico | 16 | 36 | 38 | 38 | 40 | 43 | 48 | 58 | 1.8 |
| **OECD Europe** | **1,672** | **1,237** | **1,247** | **1,244** | **1,222** | **1,201** | **1,183** | **1,183** | **-0.2** |
| **OECD Asia** | **485** | **866** | **879** | **887** | **898** | **922** | **941** | **968** | **0.4** |
| Japan | 252 | 427 | 430 | 419 | 418 | 417 | 405 | 394 | -0.4 |
| South Korea | 93 | 194 | 209 | 221 | 232 | 251 | 274 | 300 | 1.5 |
| Australia/New Zealand | 140 | 244 | 240 | 247 | 249 | 254 | 262 | 274 | 0.6 |
| **Total OECD** | **4,073** | **4,443** | **4,438** | **4,481** | **4,531** | **4,585** | **4,657** | **4,893** | **0.4** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,421** | **836** | **823** | **868** | **892** | **886** | **876** | **897** | **0.4** |
| Russia | 678 | 451 | 427 | 466 | 490 | 490 | 484 | 496 | 0.6 |
| Other | 743 | 385 | 396 | 402 | 401 | 396 | 393 | 401 | 0.1 |
| **Non-OECD Asia** | **2,557** | **5,720** | **6,307** | **7,417** | **8,221** | **9,292** | **10,520** | **11,663** | **2.6** |
| China | 1,929 | 4,449 | 4,947 | 5,938 | 6,601 | 7,496 | 8,502 | 9,296 | 2.7 |
| India | 389 | 808 | 883 | 961 | 1,047 | 1,144 | 1,225 | 1,353 | 1.8 |
| Other Non-OECD Asia | 239 | 463 | 476 | 518 | 573 | 653 | 792 | 1,014 | 3.2 |
| **Middle East** | **14** | **36** | **36** | **35** | **36** | **39** | **43** | **51** | **1.5** |
| **Africa** | **277** | **394** | **389** | **396** | **409** | **430** | **459** | **508** | **1.1** |
| **Central and South America** | **53** | **81** | **77** | **88** | **99** | **116** | **137** | **170** | **3.3** |
| Brazil | 32 | 42 | 42 | 51 | 61 | 74 | 89 | 108 | 4.0 |
| Other Central and South America | 21 | 40 | 36 | 37 | 38 | 42 | 48 | 62 | 2.4 |
| **Total Non-OECD** | **4,321** | **7,067** | **7,632** | **8,804** | **9,658** | **10,762** | **12,035** | **13,289** | **2.3** |
| **Total World** | **8,394** | **11,510** | **12,070** | **13,285** | **14,189** | **15,347** | **16,691** | **18,182** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run HP2009.D121108A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Appendix E**

# Low Oil Price Case Projections:

- **World Energy Consumption**
- **Gross Domestic Product**
- **Carbon Dioxide Emissions**

**Table E1. World Total Energy Consumption by Region, Low Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **100.7** | **121.6** | **121.3** | **122.0** | **130.3** | **134.7** | **140.0** | **146.8** | **0.8** |
| United States[a] | 84.7 | 100.5 | 100.0 | 100.8 | 106.7 | 109.1 | 112.6 | 117.6 | 0.7 |
| Canada | 11.0 | 14.2 | 14.0 | 14.6 | 15.9 | 17.0 | 17.9 | 18.9 | 1.3 |
| Mexico | 5.0 | 6.9 | 7.4 | 6.6 | 7.6 | 8.6 | 9.5 | 10.4 | 1.4 |
| **OECD Europe** | **70.0** | **81.4** | **81.6** | **82.3** | **86.9** | **90.7** | **93.2** | **95.4** | **0.7** |
| **OECD Asia** | **27.0** | **38.4** | **38.7** | **39.6** | **42.9** | **44.7** | **45.6** | **46.6** | **0.8** |
| Japan | 18.7 | 22.7 | 22.8 | 21.9 | 23.4 | 24.2 | 24.1 | 24.0 | 0.2 |
| South Korea | 3.8 | 9.2 | 9.4 | 11.0 | 12.1 | 12.6 | 13.3 | 13.9 | 1.6 |
| Australia/New Zealand | 4.5 | 6.4 | 6.5 | 6.7 | 7.4 | 7.9 | 8.3 | 8.7 | 1.2 |
| **Total OECD** | **197.7** | **241.3** | **241.7** | **243.9** | **260.1** | **270.1** | **278.8** | **288.9** | **0.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **67.3** | **50.6** | **50.7** | **54.0** | **58.4** | **61.4** | **63.2** | **64.7** | **1.0** |
| Russia | 39.4 | 30.1 | 30.4 | 32.2 | 34.8 | 36.6 | 37.5 | 38.3 | 1.0 |
| Other | 28.0 | 20.6 | 20.3 | 21.8 | 23.7 | 24.8 | 25.7 | 26.3 | 1.1 |
| **Non-OECD Asia** | **47.4** | **109.4** | **117.6** | **139.5** | **166.5** | **195.2** | **221.6** | **247.5** | **3.1** |
| China | 27.0 | 66.8 | 73.8 | 90.7 | 107.6 | 126.4 | 143.8 | 159.7 | 3.3 |
| India | 7.9 | 16.3 | 17.7 | 19.2 | 23.3 | 27.6 | 30.5 | 33.5 | 2.7 |
| Other Non-OECD Asia | 12.5 | 26.3 | 26.1 | 29.7 | 35.6 | 41.2 | 47.3 | 54.4 | 3.1 |
| **Middle East** | **11.2** | **22.7** | **23.8** | **27.6** | **31.0** | **33.3** | **36.1** | **39.7** | **2.2** |
| **Africa** | **9.5** | **14.5** | **14.5** | **16.3** | **18.4** | **20.0** | **21.6** | **23.0** | **1.9** |
| **Central and South America** | **14.5** | **23.4** | **24.2** | **28.3** | **31.3** | **33.8** | **36.7** | **39.5** | **2.1** |
| Brazil | 5.8 | 9.4 | 9.6 | 11.4 | 13.2 | 15.0 | 16.9 | 18.8 | 2.8 |
| Other Central and South America | 8.8 | 14.0 | 14.6 | 17.0 | 18.0 | 18.7 | 19.8 | 20.7 | 1.5 |
| **Total Non-OECD** | **149.9** | **220.7** | **230.8** | **265.7** | **305.7** | **343.7** | **379.2** | **414.4** | **2.5** |
| **Total World** | **347.7** | **462.1** | **472.4** | **509.6** | **565.7** | **613.8** | **658.0** | **703.3** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E2. World Total Energy Consumption by Region and Fuel, Low Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | | | | | | | | | |
| Liquids | 40.5 | 49.6 | 49.2 | 46.3 | 50.7 | 52.2 | 54.1 | 57.5 | 0.7 |
| Natural Gas | 23.0 | 28.0 | 28.0 | 29.4 | 30.8 | 31.5 | 33.3 | 33.6 | 0.8 |
| Coal | 20.6 | 24.7 | 24.3 | 24.8 | 25.5 | 25.9 | 26.2 | 28.2 | 0.6 |
| Nuclear | 6.9 | 9.2 | 9.4 | 9.8 | 10.0 | 10.3 | 10.4 | 10.7 | 0.6 |
| Other | 9.7 | 10.3 | 10.5 | 11.8 | 13.3 | 14.7 | 16.0 | 16.8 | 2.0 |
| **Total** | **100.7** | **121.6** | **121.3** | **122.0** | **130.3** | **134.7** | **140.0** | **146.8** | **0.8** |
| **OECD Europe** | | | | | | | | | |
| Liquids | 28.4 | 32.3 | 32.4 | 30.0 | 32.0 | 33.5 | 34.0 | 34.6 | 0.3 |
| Natural Gas | 11.2 | 19.8 | 19.7 | 21.0 | 22.2 | 23.4 | 24.3 | 24.9 | 1.0 |
| Coal | 17.7 | 12.9 | 13.2 | 13.0 | 12.8 | 12.4 | 12.2 | 12.1 | -0.4 |
| Nuclear | 7.9 | 9.7 | 9.6 | 9.7 | 9.6 | 9.5 | 9.4 | 9.5 | -0.1 |
| Other | 4.8 | 6.5 | 6.6 | 8.5 | 10.3 | 11.8 | 13.2 | 14.3 | 3.3 |
| **Total** | **70.0** | **81.4** | **81.6** | **82.3** | **86.9** | **90.7** | **93.2** | **95.4** | **0.7** |
| **OECD Asia** | | | | | | | | | |
| Liquids | 14.7 | 17.5 | 17.2 | 17.0 | 18.5 | 19.3 | 19.5 | 19.7 | 0.6 |
| Natural Gas | 3.1 | 5.8 | 6.1 | 6.5 | 7.1 | 7.5 | 7.6 | 7.7 | 1.0 |
| Coal | 5.2 | 9.3 | 9.4 | 9.5 | 9.6 | 9.5 | 9.7 | 9.9 | 0.2 |
| Nuclear | 2.5 | 4.3 | 4.3 | 4.5 | 5.0 | 5.6 | 5.9 | 6.4 | 1.6 |
| Other | 1.6 | 1.6 | 1.7 | 2.1 | 2.6 | 2.8 | 2.9 | 3.0 | 2.4 |
| **Total** | **27.0** | **38.4** | **38.7** | **39.6** | **42.9** | **44.7** | **45.6** | **46.6** | **0.8** |
| **Total OECD** | | | | | | | | | |
| Liquids | 83.6 | 99.4 | 98.8 | 93.2 | 101.2 | 105.1 | 107.6 | 111.8 | 0.5 |
| Natural Gas | 37.3 | 53.6 | 53.9 | 57.0 | 60.2 | 62.4 | 65.2 | 66.2 | 0.9 |
| Coal | 43.5 | 46.9 | 46.9 | 47.4 | 47.9 | 47.9 | 48.1 | 50.1 | 0.3 |
| Nuclear | 17.3 | 23.2 | 23.3 | 24.0 | 24.7 | 25.4 | 25.8 | 26.6 | 0.5 |
| Other | 16.0 | 18.3 | 18.8 | 22.4 | 26.2 | 29.3 | 32.1 | 34.1 | 2.5 |
| **Total** | **197.7** | **241.3** | **241.7** | **243.9** | **260.1** | **270.1** | **278.8** | **288.9** | **0.7** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | | | | | | | | | |
| Liquids | 19.6 | 10.1 | 10.2 | 10.5 | 11.5 | 12.1 | 12.4 | 12.7 | 0.9 |
| Natural Gas | 27.5 | 25.8 | 25.8 | 28.0 | 30.5 | 31.9 | 32.7 | 33.4 | 1.1 |
| Coal | 15.1 | 8.9 | 8.7 | 9.2 | 9.5 | 9.3 | 9.2 | 9.4 | 0.3 |
| Nuclear | 2.5 | 2.9 | 2.9 | 3.0 | 3.6 | 4.5 | 5.2 | 5.5 | 2.6 |
| Other | 2.8 | 3.1 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 0.9 |
| **Total** | **67.3** | **50.6** | **50.7** | **54.0** | **58.4** | **61.4** | **63.2** | **64.7** | **1.0** |
| **Non-OECD Asia** | | | | | | | | | |
| Liquids | 14.0 | 31.6 | 33.1 | 36.8 | 45.5 | 54.6 | 62.4 | 70.3 | 3.2 |
| Natural Gas | 3.0 | 9.6 | 9.6 | 11.8 | 15.7 | 19.3 | 22.4 | 25.2 | 4.1 |
| Coal | 27.0 | 60.4 | 66.5 | 78.7 | 87.8 | 98.5 | 111.1 | 122.6 | 2.6 |
| Nuclear | 0.4 | 1.1 | 1.1 | 1.6 | 3.0 | 4.7 | 6.2 | 7.0 | 7.9 |
| Other | 3.0 | 6.6 | 7.2 | 10.7 | 14.5 | 18.1 | 19.4 | 22.3 | 4.8 |
| **Total** | **47.4** | **109.4** | **117.6** | **139.5** | **166.5** | **195.2** | **221.6** | **247.5** | **3.1** |

See notes at end of table.

**Table E2. World Total Energy Consumption by Region and Fuel, Low Oil Price Case, 1990-2030 (Continued)**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD (Continued)** | | | | | | | | | |
| **Middle East** | | | | | | | | | |
| Liquids | 7.2 | 11.9 | 12.4 | 14.4 | 16.2 | 17.7 | 19.8 | 22.7 | 2.5 |
| Natural Gas | 3.8 | 10.2 | 10.8 | 12.5 | 14.0 | 14.6 | 15.3 | 16.0 | 1.7 |
| Coal | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Other | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 3.3 |
| **Total** | **11.2** | **22.7** | **23.8** | **27.6** | **31.0** | **33.3** | **36.1** | **39.7** | **2.2** |
| **Africa** | | | | | | | | | |
| Liquids | 4.3 | 6.1 | 6.1 | 7.1 | 7.9 | 8.3 | 8.8 | 9.3 | 1.7 |
| Natural Gas | 1.5 | 3.2 | 3.2 | 3.7 | 4.7 | 5.6 | 6.3 | 6.8 | 3.2 |
| Coal | 3.0 | 4.2 | 4.2 | 4.3 | 4.4 | 4.6 | 4.8 | 5.3 | 1.0 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.2 |
| Other | 0.6 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.0 |
| **Total** | **9.5** | **14.5** | **14.5** | **16.3** | **18.4** | **20.0** | **21.6** | **23.0** | **1.9** |
| **Central and South America** | | | | | | | | | |
| Liquids | 7.8 | 11.3 | 11.7 | 13.5 | 14.5 | 15.0 | 16.1 | 17.4 | 1.7 |
| Natural Gas | 2.2 | 4.7 | 4.8 | 5.9 | 6.8 | 7.6 | 8.4 | 8.8 | 2.5 |
| Coal | 0.6 | 0.9 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.6 | 2.8 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 2.0 |
| Other | 3.9 | 6.4 | 6.6 | 7.8 | 8.6 | 9.5 | 10.5 | 11.4 | 2.3 |
| **Total** | **14.5** | **23.4** | **24.2** | **28.3** | **31.3** | **33.8** | **36.7** | **39.5** | **2.1** |
| **Total Non-OECD** | | | | | | | | | |
| Liquids | 52.9 | 71.0 | 73.6 | 82.4 | 95.5 | 107.8 | 119.4 | 132.2 | 2.5 |
| Natural Gas | 38.0 | 53.5 | 54.2 | 61.8 | 71.7 | 79.2 | 85.1 | 90.2 | 2.1 |
| Coal | 45.7 | 74.8 | 80.6 | 93.5 | 103.2 | 114.0 | 127.0 | 139.3 | 2.3 |
| Nuclear | 3.1 | 4.3 | 4.4 | 5.0 | 7.1 | 9.8 | 12.1 | 13.2 | 4.7 |
| Other | 10.3 | 17.2 | 18.0 | 23.0 | 28.1 | 33.0 | 35.6 | 39.6 | 3.3 |
| **Total** | **149.9** | **220.7** | **230.8** | **265.7** | **305.7** | **343.7** | **379.2** | **414.4** | **2.5** |
| **Total World** | | | | | | | | | |
| Liquids | 136.4 | 170.4 | 172.4 | 175.6 | 196.7 | 212.8 | 227.1 | 244.0 | 1.5 |
| Natural Gas | 75.3 | 107.1 | 108.1 | 118.8 | 131.9 | 141.6 | 150.4 | 156.4 | 1.6 |
| Coal | 89.2 | 121.7 | 127.5 | 140.9 | 151.0 | 161.9 | 175.0 | 189.4 | 1.7 |
| Nuclear | 20.4 | 27.5 | 27.8 | 28.9 | 31.8 | 35.2 | 37.9 | 39.8 | 1.5 |
| Other | 26.3 | 35.5 | 36.8 | 45.4 | 54.3 | 62.3 | 67.6 | 73.7 | 2.9 |
| **Total** | **347.7** | **462.1** | **472.4** | **509.6** | **565.7** | **613.8** | **658.0** | **703.3** | **1.7** |

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E3. World Gross Domestic Product (GDP) by Region Expressed in Purchasing Power Parity, Low Oil Price Case, 1990-2030**
(Billion 2005 Dollars)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9,651** | **14,885** | **15,331** | **16,147** | **19,000** | **21,302** | **24,181** | **27,732** | **2.5** |
| United States[a] | 8,040 | 12,422 | 12,768 | 13,386 | 15,745 | 17,506 | 19,778 | 22,658 | 2.4 |
| Canada | 773 | 1,167 | 1,204 | 1,275 | 1,453 | 1,629 | 1,822 | 2,035 | 2.2 |
| Mexico | 838 | 1,296 | 1,359 | 1,486 | 1,802 | 2,167 | 2,581 | 3,039 | 3.4 |
| **OECD Europe** | **9,703** | **13,756** | **14,224** | **15,060** | **16,879** | **18,854** | **20,959** | **23,197** | **2.1** |
| **OECD Asia** | **4,080** | **5,509** | **5,667** | **6,065** | **6,792** | **7,333** | **7,845** | **8,392** | **1.6** |
| Japan | 3,222 | 3,873 | 3,966 | 4,121 | 4,452 | 4,615 | 4,707 | 4,798 | 0.8 |
| South Korea | 374 | 843 | 886 | 1,044 | 1,285 | 1,496 | 1,720 | 1,949 | 3.3 |
| Australia/New Zealand | 485 | 794 | 815 | 899 | 1,056 | 1,222 | 1,418 | 1,645 | 3.0 |
| **Total OECD** | **23,434** | **34,150** | **35,221** | **37,272** | **42,671** | **47,490** | **52,986** | **59,320** | **2.2** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3,039** | **2,932** | **3,159** | **3,939** | **4,865** | **5,724** | **6,536** | **7,381** | **3.6** |
| Russia | 1,880 | 1,703 | 1,829 | 2,322 | 2,849 | 3,325 | 3,761 | 4,217 | 3.5 |
| Other | 1,159 | 1,229 | 1,330 | 1,617 | 2,016 | 2,399 | 2,775 | 3,164 | 3.7 |
| **Non-OECD Asia** | **4,457** | **12,272** | **13,408** | **17,990** | **24,669** | **32,807** | **41,566** | **51,051** | **5.7** |
| China | 1,265 | 5,389 | 6,014 | 8,716 | 12,297 | 16,933 | 21,742 | 26,623 | 6.4 |
| India | 1,019 | 2,436 | 2,672 | 3,510 | 4,886 | 6,447 | 8,072 | 9,928 | 5.6 |
| Other Non-OECD Asia | 2,173 | 4,448 | 4,723 | 5,765 | 7,486 | 9,427 | 11,753 | 14,500 | 4.8 |
| **Middle East** | **1,072** | **1,919** | **2,053** | **2,464** | **3,011** | **3,599** | **4,264** | **5,048** | **3.8** |
| **Africa** | **1,387** | **2,211** | **2,341** | **2,880** | **3,622** | **4,396** | **5,201** | **5,985** | **4.0** |
| **Central and South America** | **2,270** | **3,555** | **3,757** | **4,503** | **5,424** | **6,460** | **7,631** | **8,968** | **3.7** |
| Brazil | 1,045 | 1,534 | 1,591 | 1,895 | 2,296 | 2,753 | 3,292 | 3,922 | 3.8 |
| Other Central and South America | 1,224 | 2,021 | 2,165 | 2,609 | 3,128 | 3,707 | 4,339 | 5,046 | 3.6 |
| **Total Non-OECD** | **12,225** | **22,888** | **24,717** | **31,778** | **41,590** | **52,986** | **65,198** | **78,432** | **4.9** |
| **Total World** | **35,659** | **57,038** | **59,939** | **69,050** | **84,261** | **100,476** | **118,184** | **137,752** | **3.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** IHS Global Insight *World Overview* (Lexington, MA, various issues). **Projections:** Derived from IHS Global Insight, *World Overview*, Fourth Quarter 2008 (Lexington, MA, January 2009); and Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), Table B4.

**Table E4. World Liquids Consumption by Region, Low Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.5** | **25.2** | **25.1** | **24.0** | **26.2** | **26.9** | **27.9** | **29.5** | **0.7** |
| United States[a] | 17.0 | 20.8 | 20.7 | 20.1 | 21.9 | 22.3 | 23.1 | 24.4 | 0.7 |
| Canada | 1.7 | 2.3 | 2.3 | 2.3 | 2.5 | 2.6 | 2.7 | 2.8 | 0.8 |
| Mexico | 1.8 | 2.1 | 2.1 | 1.5 | 1.8 | 2.0 | 2.2 | 2.3 | 0.5 |
| **OECD Europe** | **13.7** | **15.7** | **15.7** | **14.5** | **15.5** | **16.2** | **16.5** | **16.7** | **0.3** |
| **OECD Asia** | **7.2** | **8.6** | **8.5** | **8.4** | **9.1** | **9.5** | **9.6** | **9.7** | **0.6** |
| Japan | 5.3 | 5.3 | 5.2 | 4.6 | 5.1 | 5.4 | 5.3 | 5.2 | 0.0 |
| South Korea | 1.0 | 2.2 | 2.2 | 2.8 | 2.9 | 2.9 | 3.0 | 3.1 | 1.5 |
| Australia/New Zealand | 0.8 | 1.1 | 1.1 | 1.0 | 1.1 | 1.3 | 1.3 | 1.4 | 1.1 |
| **Total OECD** | **41.4** | **49.5** | **49.2** | **46.8** | **50.8** | **52.7** | **54.0** | **55.9** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **9.4** | **4.9** | **5.0** | **5.1** | **5.6** | **5.9** | **6.0** | **6.2** | **0.9** |
| Russia | 5.4 | 2.8 | 2.8 | 2.7 | 3.0 | 3.2 | 3.1 | 3.1 | 0.4 |
| Other | 3.9 | 2.1 | 2.1 | 2.4 | 2.6 | 2.7 | 2.9 | 3.1 | 1.6 |
| **Non-OECD Asia** | **6.6** | **15.3** | **16.0** | **17.8** | **22.0** | **26.5** | **30.2** | **34.1** | **3.2** |
| China | 2.3 | 6.7 | 7.2 | 8.5 | 10.7 | 13.2 | 15.3 | 17.1 | 3.7 |
| India | 1.2 | 2.5 | 2.7 | 2.4 | 3.3 | 4.2 | 4.7 | 5.2 | 2.9 |
| Other Non-OECD Asia | 3.1 | 6.1 | 6.1 | 6.9 | 8.0 | 9.0 | 10.2 | 11.7 | 2.7 |
| **Middle East** | **3.5** | **5.8** | **6.1** | **7.0** | **7.9** | **8.6** | **9.7** | **11.1** | **2.5** |
| **Africa** | **2.1** | **3.0** | **3.0** | **3.5** | **3.8** | **4.0** | **4.3** | **4.5** | **1.7** |
| **Central and South America** | **3.8** | **5.5** | **5.7** | **6.6** | **7.1** | **7.3** | **7.8** | **8.5** | **1.7** |
| Brazil | 1.5 | 2.2 | 2.3 | 2.5 | 3.0 | 3.3 | 3.7 | 4.1 | 2.5 |
| Other Central and South America | 2.3 | 3.3 | 3.4 | 4.0 | 4.1 | 4.0 | 4.2 | 4.3 | 1.0 |
| **Total Non-OECD** | **25.3** | **34.5** | **35.8** | **40.0** | **46.4** | **52.4** | **58.0** | **64.3** | **2.5** |
| **Total World** | **66.7** | **84.0** | **85.9** | **86.8** | **97.2** | **105.0** | **112.0** | **120.2** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E5. World Natural Gas Consumption by Region, Low Oil Price Case, 1990-2030**
(Trillion Cubic Feet)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **22.5** | **27.1** | **27.2** | **28.5** | **29.8** | **30.5** | **32.2** | **32.5** | **0.8** |
| United States[a] | 19.2 | 22.0 | 21.7 | 22.7 | 23.1 | 23.1 | 24.0 | 23.6 | 0.4 |
| Canada | 2.4 | 3.4 | 3.3 | 3.4 | 3.9 | 4.2 | 4.5 | 4.7 | 1.5 |
| Mexico | 0.9 | 1.8 | 2.2 | 2.4 | 2.8 | 3.2 | 3.7 | 4.2 | 2.7 |
| **OECD Europe** | **11.6** | **19.3** | **19.2** | **20.5** | **21.6** | **22.7** | **23.7** | **24.3** | **1.0** |
| **OECD Asia** | **2.9** | **5.2** | **5.5** | **5.9** | **6.5** | **6.8** | **6.9** | **7.0** | **1.0** |
| Japan | 2.0 | 3.1 | 3.2 | 3.4 | 3.6 | 3.7 | 3.7 | 3.7 | 0.5 |
| South Korea | 0.1 | 1.1 | 1.1 | 1.3 | 1.5 | 1.6 | 1.7 | 1.8 | 1.8 |
| Australia/New Zealand | 0.8 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.3 |
| **Total OECD** | **37.0** | **51.7** | **51.9** | **54.9** | **57.9** | **60.1** | **62.8** | **63.7** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **26.7** | **25.3** | **25.4** | **27.5** | **29.9** | **31.4** | **32.1** | **32.8** | **1.1** |
| Russia | 17.3 | 16.2 | 16.6 | 18.0 | 19.1 | 19.9 | 20.3 | 20.8 | 0.9 |
| Other | 9.5 | 9.1 | 8.8 | 9.6 | 10.8 | 11.5 | 11.9 | 12.0 | 1.3 |
| **Non-OECD Asia** | **2.9** | **9.3** | **9.4** | **11.5** | **15.3** | **18.9** | **21.9** | **24.6** | **4.1** |
| China | 0.5 | 1.7 | 2.0 | 2.6 | 3.8 | 4.9 | 5.9 | 6.8 | 5.2 |
| India | 0.4 | 1.3 | 1.4 | 1.8 | 2.4 | 3.0 | 3.4 | 3.7 | 4.2 |
| Other Non-OECD Asia | 2.0 | 6.4 | 6.0 | 7.1 | 9.1 | 11.0 | 12.6 | 14.2 | 3.6 |
| **Middle East** | **3.6** | **9.8** | **10.3** | **11.9** | **13.4** | **14.0** | **14.6** | **15.2** | **1.7** |
| **Africa** | **1.4** | **3.0** | **2.9** | **3.4** | **4.4** | **5.2** | **5.9** | **6.3** | **3.2** |
| **Central and South America** | **2.0** | **4.4** | **4.5** | **5.5** | **6.4** | **7.2** | **7.9** | **8.2** | **2.5** |
| Brazil | 0.1 | 0.7 | 0.7 | 1.0 | 1.2 | 1.5 | 1.7 | 1.8 | 4.2 |
| Other Central and South America | 1.9 | 3.7 | 3.8 | 4.5 | 5.2 | 5.7 | 6.2 | 6.4 | 2.2 |
| **Total Non-OECD** | **36.5** | **51.8** | **52.5** | **59.9** | **69.4** | **76.6** | **82.4** | **87.2** | **2.1** |
| **Total World** | **73.5** | **103.4** | **104.4** | **114.8** | **127.4** | **136.7** | **145.1** | **151.0** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E6. World Coal Consumption by Region, Low Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **20.6** | **24.7** | **24.3** | **24.8** | **25.5** | **25.9** | **26.2** | **28.2** | **0.6** |
| United States[a] | 19.2 | 22.8 | 22.5 | 22.9 | 23.6 | 23.9 | 24.1 | 26.0 | 0.6 |
| Canada | 1.2 | 1.5 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 0.6 |
| Mexico | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.5 |
| **OECD Europe** | **17.7** | **12.9** | **13.2** | **13.0** | **12.8** | **12.4** | **12.2** | **12.1** | **-0.4** |
| **OECD Asia** | **5.2** | **9.3** | **9.4** | **9.5** | **9.6** | **9.5** | **9.7** | **9.9** | **0.2** |
| Japan | 2.7 | 4.6 | 4.6 | 4.5 | 4.5 | 4.3 | 4.2 | 4.0 | -0.6 |
| South Korea | 1.0 | 2.1 | 2.2 | 2.4 | 2.5 | 2.5 | 2.7 | 3.0 | 1.2 |
| Australia/New Zealand | 1.5 | 2.6 | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.9 | 0.5 |
| **Total OECD** | **43.5** | **46.9** | **46.9** | **47.4** | **47.9** | **47.9** | **48.1** | **50.1** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **15.1** | **8.9** | **8.7** | **9.2** | **9.5** | **9.3** | **9.2** | **9.4** | **0.3** |
| Russia | 7.2 | 4.8 | 4.6 | 5.0 | 5.2 | 5.1 | 5.1 | 5.2 | 0.5 |
| Other | 7.9 | 4.1 | 4.2 | 4.3 | 4.3 | 4.2 | 4.2 | 4.2 | 0.0 |
| **Non-OECD Asia** | **27.0** | **60.4** | **66.5** | **78.7** | **87.8** | **98.5** | **111.1** | **122.6** | **2.6** |
| China | 20.3 | 46.9 | 52.0 | 62.9 | 70.5 | 79.7 | 90.2 | 98.5 | 2.7 |
| India | 4.2 | 8.6 | 9.4 | 10.3 | 11.3 | 12.1 | 12.9 | 14.2 | 1.7 |
| Other Non-OECD Asia | 2.6 | 4.9 | 5.1 | 5.5 | 6.1 | 6.7 | 8.0 | 9.9 | 2.8 |
| **Middle East** | **0.1** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.4** | **0.5** |
| **Africa** | **3.0** | **4.2** | **4.2** | **4.3** | **4.4** | **4.6** | **4.8** | **5.3** | **1.0** |
| **Central and South America** | **0.6** | **0.9** | **0.8** | **0.9** | **1.1** | **1.2** | **1.4** | **1.6** | **2.8** |
| Brazil | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 3.6 |
| Other Central and South America | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.8 |
| **Total Non-OECD** | **45.7** | **74.8** | **80.6** | **93.5** | **103.2** | **114.0** | **127.0** | **139.3** | **2.3** |
| **Total World** | **89.2** | **121.7** | **127.5** | **140.9** | **151.0** | **161.9** | **175.0** | **189.4** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E7. World Nuclear Energy Consumption by Region, Low Oil Price Case, 1990-2030**
(Billion Kilowatthours)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **649** | **880** | **891** | **928** | **954** | **981** | **993** | **1,020** | **0.6** |
| United States[a] | 577 | 782 | 787 | 809 | 831 | 852 | 856 | 876 | 0.4 |
| Canada | 69 | 87 | 93 | 108 | 112 | 118 | 126 | 133 | 1.5 |
| Mexico | 3 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0.1 |
| **OECD Europe** | **743** | **932** | **929** | **922** | **913** | **904** | **895** | **899** | **-0.1** |
| **OECD Asia** | **242** | **429** | **430** | **440** | **492** | **544** | **581** | **622** | **1.6** |
| Japan | 192 | 290 | 288 | 299 | 318 | 335 | 358 | 380 | 1.2 |
| South Korea | 50 | 139 | 141 | 141 | 173 | 208 | 224 | 241 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **1,635** | **2,240** | **2,250** | **2,290** | **2,359** | **2,428** | **2,469** | **2,541** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **219** | **264** | **269** | **283** | **340** | **422** | **491** | **517** | **2.8** |
| Russia | 115 | 140 | 144 | 155 | 196 | 249 | 306 | 327 | 3.5 |
| Other | 104 | 124 | 124 | 128 | 144 | 172 | 185 | 190 | 1.8 |
| **Non-OECD Asia** | **38** | **106** | **111** | **150** | **288** | **453** | **598** | **676** | **7.8** |
| China | 0 | 50 | 55 | 65 | 163 | 273 | 365 | 424 | 8.9 |
| India | 6 | 16 | 16 | 37 | 65 | 103 | 133 | 148 | 9.8 |
| Other Non-OECD Asia | 32 | 40 | 40 | 48 | 60 | 76 | 99 | 103 | 4.0 |
| **Middle East** | **0** | **0** | **0** | **0** | **6** | **12** | **12** | **12** | **—** |
| **Africa** | **8** | **12** | **10** | **14** | **15** | **15** | **21** | **21** | **3.2** |
| **Central and South America** | **9** | **16** | **21** | **22** | **28** | **33** | **34** | **34** | **2.0** |
| Brazil | 2 | 10 | 14 | 15 | 18 | 21 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 6 | 7 | 8 | 10 | 12 | 12 | 12 | 2.0 |
| **Total Non-OECD** | **274** | **399** | **411** | **469** | **676** | **935** | **1,156** | **1,260** | **4.8** |
| **Total World** | **1,909** | **2,639** | **2,660** | **2,760** | **3,035** | **3,364** | **3,625** | **3,801** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Low Oil Price Case, 1990-2030**
(Quadrillion Btu)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **9.7** | **10.3** | **10.5** | **11.8** | **13.3** | **14.7** | **16.0** | **16.8** | **2.0** |
| United States[a] | 6.2 | 6.1 | 6.5 | 7.4 | 8.3 | 9.4 | 10.2 | 10.8 | 2.2 |
| Canada | 3.1 | 3.7 | 3.6 | 3.9 | 4.4 | 4.7 | 5.0 | 5.4 | 1.7 |
| Mexico | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 1.8 |
| **OECD Europe** | **4.8** | **6.5** | **6.6** | **8.5** | **10.3** | **11.8** | **13.2** | **14.3** | **3.3** |
| **OECD Asia** | **1.6** | **1.6** | **1.7** | **2.1** | **2.6** | **2.8** | **2.9** | **3.0** | **2.4** |
| Japan | 1.1 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.2 |
| Australia/New Zealand | 0.4 | 0.5 | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.3 | 4.2 |
| **Total OECD** | **16.0** | **18.3** | **18.8** | **22.4** | **26.2** | **29.3** | **32.1** | **34.1** | **2.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **2.8** | **3.1** | **3.0** | **3.2** | **3.4** | **3.5** | **3.7** | **3.8** | **0.9** |
| Russia | 1.8 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| Other | 1.0 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Non-OECD Asia** | **3.0** | **6.6** | **7.2** | **10.7** | **14.6** | **18.1** | **19.4** | **22.3** | **4.8** |
| China | 1.3 | 4.0 | 4.3 | 7.0 | 9.5 | 11.8 | 12.3 | 14.7 | 5.2 |
| India | 0.7 | 1.1 | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| Other Non-OECD Asia | 0.9 | 1.6 | 1.6 | 2.1 | 2.9 | 3.7 | 4.1 | 4.4 | 4.3 |
| **Middle East** | **0.1** | **0.2** | **0.2** | **0.3** | **0.4** | **0.4** | **0.5** | **0.5** | **3.3** |
| **Africa** | **0.6** | **0.9** | **0.9** | **1.0** | **1.3** | **1.4** | **1.5** | **1.5** | **2.0** |
| **Central and South America** | **3.9** | **6.4** | **6.6** | **7.8** | **8.6** | **9.5** | **10.5** | **11.4** | **2.3** |
| Brazil | 2.2 | 3.5 | 3.6 | 4.4 | 5.1 | 5.8 | 6.6 | 7.3 | 3.0 |
| Other Central and South America | 1.7 | 2.9 | 3.0 | 3.3 | 3.5 | 3.7 | 3.9 | 4.2 | 1.3 |
| **Total Non-OECD** | **10.3** | **17.2** | **18.0** | **23.0** | **28.1** | **33.0** | **35.6** | **39.6** | **3.3** |
| **Total World** | **26.3** | **35.5** | **36.8** | **45.4** | **54.3** | **62.3** | **67.6** | **73.7** | **2.9** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. U.S. consumption of hydroelectricity and other renewable energy is projected to be 9.4 quadrillion Btu in 2015 in the *updated AEO2009* reference case—10 percent higher than in the earlier projections reported in this table.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E9. World Carbon Dioxide Emissions by Region, Low Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **5,762** | **7,007** | **6,948** | **6,859** | **7,269** | **7,457** | **7,693** | **8,155** | **0.7** |
| United States[a] | 4,989 | 5,975 | 5,907 | 5,866 | 6,172 | 6,262 | 6,416 | 6,792 | 0.6 |
| Canada | 471 | 629 | 611 | 622 | 667 | 706 | 740 | 772 | 1.0 |
| Mexico | 302 | 403 | 431 | 371 | 429 | 488 | 537 | 590 | 1.3 |
| **OECD Europe** | **4,149** | **4,424** | **4,429** | **4,341** | **4,511** | **4,639** | **4,700** | **4,762** | **0.3** |
| **OECD Asia** | **1,595** | **2,200** | **2,216** | **2,224** | **2,356** | **2,419** | **2,449** | **2,484** | **0.5** |
| Japan | 1,054 | 1,250 | 1,247 | 1,171 | 1,240 | 1,267 | 1,241 | 1,215 | -0.1 |
| South Korea | 243 | 497 | 515 | 599 | 638 | 647 | 685 | 721 | 1.4 |
| Australia/New Zealand | 298 | 454 | 455 | 454 | 478 | 504 | 523 | 549 | 0.8 |
| **Total OECD** | **11,506** | **13,632** | **13,594** | **13,423** | **14,137** | **14,514** | **14,841** | **15,400** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **4,246** | **2,889** | **2,886** | **3,069** | **3,291** | **3,399** | **3,446** | **3,518** | **0.8** |
| Russia | 2,393 | 1,699 | 1,704 | 1,801 | 1,924 | 1,984 | 1,991 | 2,022 | 0.7 |
| Other | 1,853 | 1,190 | 1,182 | 1,268 | 1,368 | 1,415 | 1,455 | 1,496 | 1.0 |
| **Non-OECD Asia** | **3,678** | **8,305** | **8,987** | **10,488** | **12,127** | **13,921** | **15,794** | **17,551** | **2.8** |
| China | 2,293 | 5,429 | 6,018 | 7,239 | 8,317 | 9,581 | 10,914 | 11,990 | 2.9 |
| India | 573 | 1,192 | 1,292 | 1,369 | 1,603 | 1,831 | 1,990 | 2,188 | 2.2 |
| Other Non-OECD Asia | 811 | 1,684 | 1,678 | 1,880 | 2,207 | 2,508 | 2,890 | 3,373 | 3.0 |
| **Middle East** | **704** | **1,393** | **1,456** | **1,684** | **1,885** | **2,024** | **2,202** | **2,435** | **2.2** |
| **Africa** | **659** | **985** | **982** | **1,089** | **1,208** | **1,301** | **1,397** | **1,492** | **1.8** |
| **Central and South America** | **695** | **1,093** | **1,123** | **1,315** | **1,439** | **1,530** | **1,653** | **1,780** | **1.9** |
| Brazil | 235 | 366 | 374 | 438 | 513 | 579 | 655 | 735 | 2.9 |
| Other Central and South America | 460 | 727 | 749 | 877 | 926 | 950 | 998 | 1,045 | 1.4 |
| **Total Non-OECD** | **9,982** | **14,664** | **15,434** | **17,645** | **19,951** | **22,175** | **24,492** | **26,776** | **2.3** |
| **Total World** | **21,488** | **28,296** | **29,028** | **31,068** | **34,087** | **36,689** | **39,333** | **42,176** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E10. World Carbon Dioxide Emissions from Liquids Use by Region, Low Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **2,637** | **3,188** | **3,159** | **2,944** | **3,217** | **3,324** | **3,437** | **3,695** | **0.7** |
| United States[a] | 2,178 | 2,620 | 2,596 | 2,451 | 2,670 | 2,731 | 2,813 | 3,037 | 0.7 |
| Canada | 227 | 301 | 295 | 295 | 316 | 329 | 343 | 359 | 0.8 |
| Mexico | 233 | 267 | 268 | 198 | 231 | 263 | 281 | 299 | 0.5 |
| **OECD Europe** | **1,884** | **2,134** | **2,135** | **1,978** | **2,109** | **2,211** | **2,245** | **2,284** | **0.3** |
| **OECD Asia** | **945** | **1,028** | **1,014** | **990** | **1,083** | **1,130** | **1,141** | **1,154** | **0.5** |
| Japan | 687 | 641 | 626 | 554 | 611 | 645 | 633 | 624 | 0.0 |
| South Korea | 144 | 239 | 237 | 299 | 316 | 314 | 326 | 336 | 1.5 |
| Australia/New Zealand | 114 | 148 | 151 | 137 | 155 | 171 | 181 | 194 | 1.1 |
| **Total OECD** | **5,466** | **6,350** | **6,308** | **5,912** | **6,408** | **6,665** | **6,822** | **7,133** | **0.5** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,368** | **686** | **692** | **713** | **784** | **824** | **841** | **863** | **0.9** |
| Russia | 782 | 383 | 389 | 375 | 415 | 438 | 430 | 424 | 0.4 |
| Other | 586 | 303 | 303 | 339 | 369 | 387 | 411 | 439 | 1.6 |
| **Non-OECD Asia** | **960** | **2,077** | **2,170** | **2,415** | **2,980** | **3,571** | **4,083** | **4,600** | **3.2** |
| China | 335 | 889 | 960 | 1,130 | 1,422 | 1,754 | 2,031 | 2,272 | 3.7 |
| India | 160 | 314 | 332 | 305 | 414 | 531 | 590 | 655 | 2.9 |
| Other Non-OECD Asia | 466 | 874 | 878 | 980 | 1,144 | 1,286 | 1,462 | 1,674 | 2.7 |
| **Middle East** | **491** | **814** | **849** | **987** | **1,105** | **1,210** | **1,355** | **1,548** | **2.5** |
| **Africa** | **302** | **423** | **424** | **496** | **546** | **576** | **610** | **642** | **1.7** |
| **Central and South America** | **525** | **761** | **790** | **913** | **976** | **1,012** | **1,078** | **1,164** | **1.6** |
| Brazil | 197 | 288 | 294 | 332 | 387 | 430 | 478 | 538 | 2.5 |
| Other Central and South America | 328 | 473 | 496 | 581 | 589 | 582 | 600 | 626 | 1.0 |
| **Total Non-OECD** | **3,646** | **4,760** | **4,926** | **5,524** | **6,391** | **7,193** | **7,967** | **8,817** | **2.5** |
| **Total World** | **9,112** | **11,110** | **11,234** | **11,436** | **12,799** | **13,858** | **14,789** | **15,950** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E11. World Carbon Dioxide Emissions from Natural Gas Use by Region, Low Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,208** | **1,468** | **1,465** | **1,549** | **1,619** | **1,659** | **1,753** | **1,772** | **0.8** |
| United States[a] | 1,026 | 1,183 | 1,159 | 1,225 | 1,249 | 1,245 | 1,296 | 1,275 | 0.4 |
| Canada | 128 | 185 | 181 | 189 | 212 | 231 | 247 | 260 | 1.5 |
| Mexico | 54 | 100 | 125 | 135 | 158 | 183 | 210 | 237 | 2.7 |
| **OECD Europe** | **593** | **1,053** | **1,047** | **1,116** | **1,180** | **1,241** | **1,291** | **1,323** | **1.0** |
| **OECD Asia** | **165** | **306** | **323** | **345** | **379** | **398** | **405** | **408** | **1.0** |
| Japan | 115 | 181 | 191 | 197 | 213 | 219 | 218 | 215 | 0.5 |
| South Korea | 6 | 64 | 68 | 77 | 91 | 97 | 103 | 106 | 1.8 |
| Australia/New Zealand | 44 | 61 | 64 | 70 | 75 | 82 | 83 | 87 | 1.3 |
| **Total OECD** | **1,966** | **2,827** | **2,835** | **3,010** | **3,178** | **3,298** | **3,449** | **3,503** | **0.9** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,457** | **1,367** | **1,371** | **1,487** | **1,616** | **1,695** | **1,736** | **1,772** | **1.1** |
| Russia | 933 | 865 | 889 | 961 | 1,023 | 1,065 | 1,086 | 1,113 | 0.9 |
| Other | 524 | 502 | 482 | 526 | 594 | 630 | 650 | 659 | 1.3 |
| **Non-OECD Asia** | **161** | **508** | **510** | **624** | **833** | **1,025** | **1,189** | **1,339** | **4.1** |
| China | 30 | 92 | 111 | 146 | 211 | 269 | 325 | 375 | 5.2 |
| India | 24 | 70 | 76 | 99 | 132 | 165 | 188 | 202 | 4.2 |
| Other Non-OECD Asia | 106 | 347 | 324 | 379 | 490 | 591 | 677 | 762 | 3.6 |
| **Middle East** | **200** | **543** | **571** | **661** | **743** | **777** | **810** | **848** | **1.7** |
| **Africa** | **80** | **168** | **168** | **196** | **250** | **297** | **335** | **359** | **3.2** |
| **Central and South America** | **117** | **250** | **255** | **312** | **363** | **406** | **447** | **465** | **2.5** |
| Brazil | 6 | 36 | 38 | 54 | 66 | 80 | 95 | 101 | 4.2 |
| Other Central and South America | 111 | 214 | 218 | 258 | 297 | 326 | 352 | 365 | 2.2 |
| **Total Non-OECD** | **2,015** | **2,837** | **2,876** | **3,281** | **3,806** | **4,200** | **4,517** | **4,784** | **2.1** |
| **Total World** | **3,981** | **5,664** | **5,712** | **6,291** | **6,984** | **7,498** | **7,965** | **8,286** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table E12. World Carbon Dioxide Emissions from Coal Use by Region, Low Oil Price Case, 1990-2030**
(Million Metric Tons Carbon Dioxide)

| Region/Country | History | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2005 | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | | | |
| **OECD North America** | **1,916** | **2,339** | **2,312** | **2,355** | **2,421** | **2,462** | **2,492** | **2,676** | **0.6** |
| United States[a] | 1,784 | 2,161 | 2,140 | 2,178 | 2,242 | 2,275 | 2,295 | 2,468 | 0.6 |
| Canada | 116 | 142 | 134 | 138 | 140 | 145 | 151 | 153 | 0.6 |
| Mexico | 16 | 36 | 38 | 38 | 39 | 42 | 46 | 54 | 1.5 |
| **OECD Europe** | **1,672** | **1,237** | **1,247** | **1,247** | **1,222** | **1,187** | **1,164** | **1,155** | **-0.3** |
| **OECD Asia** | **485** | **866** | **879** | **889** | **894** | **890** | **903** | **923** | **0.2** |
| Japan | 252 | 427 | 430 | 420 | 415 | 403 | 389 | 376 | -0.6 |
| South Korea | 93 | 194 | 209 | 223 | 231 | 237 | 256 | 279 | 1.2 |
| Australia/New Zealand | 140 | 244 | 240 | 247 | 248 | 251 | 258 | 268 | 0.5 |
| **Total OECD** | **4,073** | **4,443** | **4,438** | **4,491** | **4,538** | **4,539** | **4,559** | **4,753** | **0.3** |
| **Non-OECD** | | | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,421** | **836** | **823** | **869** | **891** | **880** | **869** | **883** | **0.3** |
| Russia | 678 | 451 | 427 | 466 | 486 | 482 | 475 | 485 | 0.5 |
| Other | 743 | 385 | 396 | 403 | 405 | 398 | 394 | 398 | 0.0 |
| **Non-OECD Asia** | **2,557** | **5,720** | **6,307** | **7,448** | **8,314** | **9,325** | **10,521** | **11,611** | **2.6** |
| China | 1,929 | 4,449 | 4,947 | 5,963 | 6,684 | 7,558 | 8,559 | 9,342 | 2.7 |
| India | 389 | 808 | 883 | 965 | 1,057 | 1,135 | 1,212 | 1,331 | 1.7 |
| Other Non-OECD Asia | 239 | 463 | 476 | 520 | 573 | 632 | 751 | 938 | 2.9 |
| **Middle East** | **14** | **36** | **36** | **35** | **36** | **36** | **37** | **39** | **0.3** |
| **Africa** | **277** | **394** | **389** | **398** | **413** | **428** | **453** | **491** | **1.0** |
| **Central and South America** | **53** | **81** | **77** | **89** | **100** | **112** | **128** | **150** | **2.8** |
| Brazil | 32 | 42 | 42 | 51 | 60 | 70 | 82 | 96 | 3.5 |
| Other Central and South America | 21 | 40 | 36 | 38 | 40 | 42 | 46 | 54 | 1.8 |
| **Total Non-OECD** | **4,321** | **7,067** | **7,632** | **8,839** | **9,754** | **10,781** | **12,008** | **13,174** | **2.3** |
| **Total World** | **8,394** | **11,510** | **12,070** | **13,330** | **14,292** | **15,320** | **16,567** | **17,928** | **1.7** |

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run LP2009.D122308A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

Appendix F

# Reference Case Projections by End-Use Sector and Country Grouping

**Table F1. Total World Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 10.4 | 10.1 | 9.8 | 10.0 | 10.1 | 10.1 | -0.1 |
| Natural Gas | 20.1 | 21.3 | 22.4 | 23.2 | 23.9 | 24.9 | 0.9 |
| Coal | 4.2 | 4.1 | 4.1 | 4.0 | 4.0 | 3.9 | -0.3 |
| Electricity | 15.2 | 16.9 | 18.9 | 21.2 | 23.6 | 26.3 | 2.3 |
| Renewables | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 1.1 |
| **Total** | **50.3** | **52.8** | **55.6** | **58.9** | **62.1** | **65.7** | **1.1** |
| **Commercial** | | | | | | | |
| Liquids | 4.9 | 4.5 | 4.4 | 4.5 | 4.6 | 4.6 | -0.2 |
| Natural Gas | 7.5 | 7.9 | 8.3 | 8.6 | 8.9 | 9.2 | 0.8 |
| Coal | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 0.3 |
| Electricity | 13.0 | 14.3 | 16.0 | 18.1 | 20.4 | 22.8 | 2.4 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| **Total** | **26.4** | **27.8** | **29.8** | **32.2** | **34.9** | **37.7** | **1.5** |
| **Industrial** | | | | | | | |
| Liquids | 60.5 | 59.2 | 61.8 | 64.9 | 67.6 | 70.3 | 0.6 |
| Natural Gas | 42.3 | 46.4 | 52.3 | 56.1 | 59.8 | 62.9 | 1.7 |
| Coal | 43.4 | 46.4 | 50.3 | 54.7 | 57.8 | 59.7 | 1.3 |
| Electricity | 26.2 | 31.0 | 35.7 | 40.1 | 44.5 | 48.4 | 2.6 |
| Renewables | 2.7 | 2.9 | 3.2 | 3.6 | 4.1 | 4.3 | 2.0 |
| **Total** | **175.0** | **185.9** | **203.3** | **219.4** | **233.7** | **245.6** | **1.4** |
| **Transportation** | | | | | | | |
| Liquids | 87.5 | 90.9 | 97.2 | 105.1 | 112.9 | 121.4 | 1.4 |
| Natural Gas | 3.4 | 4.0 | 4.4 | 4.7 | 4.9 | 5.1 | 1.7 |
| Coal | 0.2 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | — |
| Electricity | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.0 |
| **Total** | **91.9** | **96.0** | **102.8** | **111.0** | **118.9** | **127.7** | **1.4** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 163.2 | 164.7 | 173.3 | 184.5 | 195.1 | 206.4 | 1.0 |
| Natural Gas | 73.3 | 79.6 | 87.4 | 92.6 | 97.5 | 102.1 | 1.4 |
| Coal | 48.7 | 51.5 | 55.4 | 59.8 | 62.7 | 64.6 | 1.2 |
| Electricity | 55.2 | 63.2 | 71.6 | 80.4 | 89.5 | 98.6 | 2.4 |
| Renewables | 3.2 | 3.5 | 3.8 | 4.2 | 4.7 | 5.0 | 1.8 |
| **Delivered Energy** | **343.6** | **362.6** | **391.5** | **421.5** | **449.6** | **476.7** | **1.4** |
| Electricity-Related Losses[a] | 128.9 | 145.7 | 160.0 | 174.3 | 187.7 | 201.6 | 1.9 |
| **Total** | **472.4** | **508.3** | **551.5** | **595.7** | **637.3** | **678.3** | **1.5** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 10.1 | 10.0 | 10.1 | 9.7 | 9.5 | 9.3 | -0.3 |
| Natural Gas | 34.3 | 38.8 | 43.6 | 49.1 | 53.8 | 55.9 | 2.1 |
| Coal | 79.1 | 89.1 | 95.3 | 101.9 | 112.5 | 125.6 | 1.9 |
| Nuclear | 27.8 | 29.0 | 31.9 | 35.4 | 38.1 | 40.2 | 1.5 |
| Renewables | 33.6 | 42.0 | 50.7 | 58.5 | 63.2 | 69.0 | 3.0 |
| **Total** | **186.3** | **208.9** | **231.7** | **254.7** | **277.2** | **300.3** | **2.0** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 172.4 | 174.7 | 183.3 | 194.2 | 204.6 | 215.7 | 0.9 |
| Natural Gas | 108.1 | 118.5 | 131.0 | 141.7 | 151.3 | 158.0 | 1.6 |
| Coal | 127.5 | 140.6 | 150.7 | 161.7 | 175.2 | 190.2 | 1.7 |
| Nuclear | 27.8 | 29.0 | 31.9 | 35.4 | 38.1 | 40.2 | 1.6 |
| Renewables | 36.8 | 45.6 | 54.6 | 62.8 | 68.1 | 74.1 | 3.0 |
| **Total** | **472.4** | **508.3** | **551.5** | **595.7** | **637.3** | **678.3** | **1.5** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table F2. Total OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 5.0 | 4.7 | 4.5 | 4.6 | 4.5 | 4.5 | -0.5 |
| Natural Gas | 11.4 | 11.9 | 12.2 | 12.5 | 12.7 | 12.8 | 0.5 |
| Coal | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | -2.1 |
| Electricity | 9.8 | 10.6 | 11.2 | 11.8 | 12.5 | 13.1 | 1.2 |
| Renewables | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 1.1 |
| **Total** | **27.2** | **28.2** | **28.9** | **29.8** | **30.6** | **31.2** | **0.6** |
| **Commercial** | | | | | | | |
| Liquids | 3.1 | 2.8 | 2.8 | 2.9 | 2.9 | 2.9 | -0.3 |
| Natural Gas | 6.1 | 6.4 | 6.6 | 6.7 | 6.9 | 7.0 | 0.6 |
| Coal | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | -0.8 |
| Electricity | 9.7 | 10.6 | 11.5 | 12.4 | 13.3 | 14.1 | 1.6 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| **Total** | **19.2** | **20.1** | **21.1** | **22.3** | **23.3** | **24.3** | **1.0** |
| **Industrial** | | | | | | | |
| Liquids | 31.3 | 27.8 | 28.2 | 28.2 | 28.2 | 28.4 | -0.4 |
| Natural Gas | 19.1 | 19.5 | 20.5 | 21.0 | 21.7 | 22.4 | 0.7 |
| Coal | 9.2 | 8.6 | 8.5 | 8.4 | 8.4 | 8.5 | -0.3 |
| Electricity | 11.2 | 11.5 | 12.3 | 12.8 | 13.2 | 13.7 | 0.8 |
| Renewables | 2.4 | 2.7 | 2.9 | 3.3 | 3.8 | 4.1 | 2.2 |
| **Total** | **73.1** | **70.0** | **72.3** | **73.7** | **75.5** | **77.1** | **0.2** |
| **Transportation** | | | | | | | |
| Liquids | 56.4 | 54.0 | 55.4 | 57.1 | 58.6 | 60.7 | 0.3 |
| Natural Gas | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| **Total** | **57.8** | **55.4** | **57.0** | **58.8** | **60.4** | **62.5** | **0.3** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 95.8 | 89.3 | 90.9 | 92.8 | 94.3 | 96.5 | 0.0 |
| Natural Gas | 37.5 | 38.9 | 40.5 | 41.4 | 42.6 | 43.5 | 0.6 |
| Coal | 10.0 | 9.3 | 9.1 | 9.0 | 9.0 | 9.0 | -0.4 |
| Electricity | 31.1 | 33.0 | 35.3 | 37.4 | 39.4 | 41.3 | 1.2 |
| Renewables | 2.9 | 3.2 | 3.5 | 3.9 | 4.5 | 4.7 | 2.0 |
| **Delivered Energy** | **177.3** | **173.7** | **179.3** | **184.6** | **189.8** | **195.1** | **0.4** |
| Electricity-Related Losses[a] | 64.3 | 69.1 | 73.0 | 76.7 | 79.7 | 83.0 | 1.1 |
| **Total** | **241.7** | **242.8** | **252.4** | **261.3** | **269.5** | **278.2** | **0.6** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 3.8 | 3.1 | 3.1 | 3.0 | 2.9 | 2.8 | -1.3 |
| Natural Gas | 15.9 | 17.8 | 19.1 | 21.1 | 23.1 | 23.3 | 1.6 |
| Coal | 37.2 | 38.0 | 38.7 | 38.8 | 39.3 | 41.6 | 0.5 |
| Nuclear | 23.5 | 24.0 | 24.7 | 25.6 | 26.0 | 27.0 | 0.6 |
| Renewables | 15.9 | 19.1 | 22.6 | 25.5 | 27.7 | 29.5 | 2.6 |
| **Total** | **96.7** | **102.1** | **108.3** | **114.1** | **119.1** | **124.4** | **1.1** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 98.8 | 92.4 | 94.0 | 95.8 | 97.2 | 99.4 | 0.0 |
| Natural Gas | 53.9 | 56.7 | 59.6 | 62.6 | 65.7 | 66.8 | 0.9 |
| Coal | 46.9 | 47.3 | 47.8 | 47.9 | 48.3 | 50.7 | 0.3 |
| Nuclear | 23.3 | 24.0 | 24.7 | 25.6 | 26.0 | 27.0 | 0.6 |
| Renewables | 18.8 | 22.4 | 26.3 | 29.5 | 32.3 | 34.3 | 2.5 |
| **Total** | **241.7** | **242.8** | **252.4** | **261.3** | **269.5** | **278.2** | **0.6** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | -0.6 |
| Natural Gas | 4.5 | 4.9 | 5.0 | 5.1 | 5.1 | 5.1 | 0.5 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| Electricity | 4.6 | 4.8 | 4.9 | 5.1 | 5.4 | 5.7 | 0.9 |
| Renewables | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 1.1 |
| **Total** | **10.8** | **11.4** | **11.5** | **11.9** | **12.1** | **12.4** | **0.6** |
| **Commercial** | | | | | | | |
| Liquids | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | -0.3 |
| Natural Gas | 2.9 | 3.1 | 3.2 | 3.3 | 3.5 | 3.5 | 0.8 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -0.1 |
| Electricity | 4.4 | 4.8 | 5.1 | 5.6 | 5.9 | 6.3 | 1.5 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| **Total** | **8.2** | **8.7** | **9.2** | **9.7** | **10.2** | **10.6** | **1.1** |
| **Industrial** | | | | | | | |
| Liquids | 10.1 | 8.4 | 8.7 | 8.3 | 8.2 | 8.3 | -0.8 |
| Natural Gas | 7.8 | 8.0 | 8.2 | 8.2 | 8.4 | 8.5 | 0.3 |
| Coal | 1.9 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 | 0.6 |
| Electricity | 3.5 | 3.3 | 3.5 | 3.5 | 3.5 | 3.7 | 0.3 |
| Renewables | 2.0 | 2.2 | 2.5 | 2.9 | 3.4 | 3.6 | 2.5 |
| **Total** | **25.3** | **23.8** | **24.8** | **24.7** | **25.6** | **26.3** | **0.2** |
| **Transportation** | | | | | | | |
| Liquids | 28.0 | 27.1 | 27.9 | 28.4 | 29.4 | 31.1 | 0.4 |
| Natural Gas | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 1.1 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 3.6 |
| **Total** | **28.6** | **27.8** | **28.6** | **29.1** | **30.2** | **31.9** | **0.5** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 40.0 | 37.4 | 38.4 | 38.4 | 39.3 | 41.1 | 0.1 |
| Natural Gas | 15.9 | 16.8 | 17.2 | 17.4 | 17.8 | 17.9 | 0.5 |
| Coal | 2.0 | 1.9 | 1.9 | 2.0 | 2.1 | 2.3 | 0.6 |
| Electricity | 12.5 | 12.9 | 13.5 | 14.2 | 14.9 | 15.7 | 1.0 |
| Renewables | 2.5 | 2.8 | 3.1 | 3.5 | 4.0 | 4.2 | 2.2 |
| **Delivered Energy** | **72.9** | **71.7** | **74.1** | **75.4** | **78.2** | **81.3** | **0.5** |
| Electricity-Related Losses[a] | 27.1 | 28.1 | 28.8 | 30.0 | 30.9 | 32.3 | 0.7 |
| **Total** | **100.0** | **99.9** | **102.9** | **105.4** | **109.1** | **113.6** | **0.5** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | -3.5 |
| Natural Gas | 6.0 | 6.4 | 6.2 | 6.7 | 7.6 | 7.1 | 0.7 |
| Coal | 20.7 | 21.0 | 21.7 | 22.0 | 22.3 | 24.3 | 0.7 |
| Nuclear | 8.2 | 8.4 | 8.7 | 9.0 | 9.0 | 9.5 | 0.6 |
| Renewables | 3.6 | 4.5 | 5.1 | 5.9 | 6.2 | 6.5 | 2.5 |
| **Total** | **39.8** | **41.0** | **42.3** | **44.2** | **45.8** | **48.0** | **0.8** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 40.6 | 37.9 | 38.9 | 38.9 | 39.8 | 41.6 | 0.1 |
| Natural Gas | 22.3 | 23.2 | 23.4 | 24.1 | 25.4 | 25.0 | 0.5 |
| Coal | 22.5 | 22.9 | 23.6 | 24.0 | 24.4 | 26.6 | 0.7 |
| Nuclear | 8.2 | 8.4 | 8.7 | 9.0 | 9.0 | 9.5 | 0.6 |
| Renewables | 6.5 | 7.4 | 8.3 | 9.5 | 10.4 | 10.9 | 2.2 |
| **Total** | **100.0** | **99.9** | **102.9** | **105.4** | **109.1** | **113.6** | **0.5** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators. Includes net electricity imports.
Sources: **2006:** Based on Energy Information Administration (EIA), *Annual Energy Review 2007*, DOE/EIA-0384(2007) (Washington, DC, June 2008). **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo.

**Table F4. Delivered Energy Consumption in Canada by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Natural Gas | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.3 |
| Electricity | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 1.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.3** | **1.3** | **1.4** | **1.4** | **1.5** | **1.6** | **1.0** |
| **Commercial** | | | | | | | |
| Liquids | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| Natural Gas | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.9 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.7 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.3** | **1.3** | **1.4** | **1.5** | **1.6** | **1.6** | **1.0** |
| **Industrial** | | | | | | | |
| Liquids | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 0.0 |
| Natural Gas | 1.9 | 2.0 | 2.3 | 2.5 | 2.7 | 2.9 | 1.8 |
| Coal | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.4 |
| Electricity | 0.8 | 0.8 | 0.8 | 0.9 | 1.0 | 1.0 | 1.2 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 |
| **Total** | **4.6** | **4.6** | **5.0** | **5.3** | **5.6** | **6.0** | **1.1** |
| **Transportation** | | | | | | | |
| Liquids | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 2.6 | 0.7 |
| Natural Gas | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 2.4 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -3.1 |
| **Total** | **2.4** | **2.6** | **2.6** | **2.7** | **2.8** | **3.0** | **0.8** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 4.3 | 4.3 | 4.3 | 4.4 | 4.6 | 4.7 | 0.4 |
| Natural Gas | 3.1 | 3.3 | 3.7 | 4.0 | 4.3 | 4.5 | 1.5 |
| Coal | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.4 |
| Electricity | 1.8 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 1.4 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 |
| **Delivered Energy** | **9.6** | **9.8** | **10.4** | **11.0** | **11.6** | **12.2** | **1.0** |
| Electricity-Related Losses[a] | 4.4 | 4.9 | 5.2 | 5.6 | 5.9 | 6.1 | 1.4 |
| **Total** | **14.0** | **14.6** | **15.6** | **16.5** | **17.4** | **18.3** | **1.1** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -0.6 |
| Natural Gas | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 1.3 |
| Coal | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 0.4 |
| Nuclear | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.5 | 1.4 |
| Renewables | 3.5 | 3.8 | 4.3 | 4.6 | 5.0 | 5.3 | 1.7 |
| **Total** | **6.5** | **6.8** | **7.3** | **7.8** | **8.3** | **8.7** | **1.2** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 4.5 | 4.5 | 4.5 | 4.6 | 4.7 | 4.9 | 0.3 |
| Natural Gas | 3.4 | 3.6 | 4.0 | 4.3 | 4.6 | 4.9 | 1.5 |
| Coal | 1.4 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 0.5 |
| Nuclear | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.5 | 1.4 |
| Renewables | 3.6 | 3.9 | 4.4 | 4.7 | 5.1 | 5.4 | 1.7 |
| **Total** | **14.0** | **14.6** | **15.6** | **16.5** | **17.4** | **18.3** | **1.1** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F5. Delivered Energy Consumption in Mexico by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 1.6 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 1.9 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 3.8 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.4** | **0.5** | **0.5** | **0.7** | **0.7** | **0.8** | **2.6** |
| **Commercial** | | | | | | | |
| Liquids | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 1.6 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 5.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.1** | **0.2** | **0.2** | **0.2** | **0.3** | **0.3** | **3.9** |
| **Industrial** | | | | | | | |
| Liquids | 0.8 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.7 |
| Natural Gas | 1.4 | 1.5 | 1.6 | 1.8 | 2.0 | 2.2 | 1.8 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 3.2 |
| Electricity | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 2.0 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.8 |
| **Total** | **2.7** | **2.7** | **3.0** | **3.4** | **3.8** | **4.1** | **1.8** |
| **Transportation** | | | | | | | |
| Liquids | 1.5 | 1.4 | 1.5 | 1.7 | 1.8 | 1.9 | 1.0 |
| Natural Gas | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 2.2 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 |
| **Total** | **1.5** | **1.5** | **1.6** | **1.7** | **1.9** | **2.0** | **1.0** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 2.5 | 2.4 | 2.7 | 3.1 | 3.3 | 3.5 | 1.3 |
| Natural Gas | 1.5 | 1.6 | 1.7 | 1.9 | 2.1 | 2.3 | 1.8 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 3.2 |
| Electricity | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.3 | 3.0 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.8 |
| **Delivered Energy** | **4.8** | **4.8** | **5.3** | **6.1** | **6.7** | **7.3** | **1.8** |
| Electricity-Related Losses[a] | 2.6 | 1.8 | 2.1 | 2.2 | 2.4 | 2.6 | 0.1 |
| **Total** | **7.4** | **6.6** | **7.4** | **8.3** | **9.1** | **9.9** | **1.2** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | -0.5 |
| Natural Gas | 0.8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.1 | 4.1 |
| Coal | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 1.0 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Renewables | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.6 |
| **Total** | **2.3** | **2.5** | **2.9** | **3.2** | **3.5** | **3.9** | **2.2** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 4.0 | 3.0 | 3.3 | 3.7 | 3.9 | 4.0 | 0.0 |
| Natural Gas | 2.4 | 2.5 | 3.0 | 3.4 | 3.9 | 4.5 | 2.7 |
| Coal | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.5 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Renewables | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 1.8 |
| **Total** | **7.4** | **6.6** | **7.4** | **8.3** | **9.1** | **9.9** | **1.2** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F6. Delivered Energy Consumption in OECD Europe by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 2.6 | 2.4 | 2.3 | 2.3 | 2.3 | 2.3 | -0.5 |
| Natural Gas | 5.3 | 5.4 | 5.5 | 5.6 | 5.7 | 5.9 | 0.4 |
| Coal | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 | -2.0 |
| Electricity | 3.0 | 3.5 | 3.8 | 4.0 | 4.2 | 4.4 | 1.5 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **11.5** | **11.7** | **12.0** | **12.3** | **12.6** | **12.8** | **0.5** |
| **Commercial** | | | | | | | |
| Liquids | 1.0 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | -0.8 |
| Natural Gas | 1.9 | 1.9 | 1.9 | 1.9 | 2.0 | 2.1 | 0.4 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.6 |
| Electricity | 2.8 | 3.2 | 3.4 | 3.7 | 3.9 | 4.1 | 1.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **5.7** | **6.0** | **6.2** | **6.5** | **6.8** | **7.0** | **0.9** |
| **Industrial** | | | | | | | |
| Liquids | 10.6 | 9.7 | 9.6 | 9.8 | 9.9 | 10.1 | -0.2 |
| Natural Gas | 6.6 | 6.6 | 6.8 | 6.9 | 7.1 | 7.2 | 0.4 |
| Coal | 3.8 | 3.4 | 3.2 | 3.1 | 3.0 | 2.9 | -1.1 |
| Electricity | 4.6 | 4.8 | 5.1 | 5.4 | 5.6 | 5.8 | 1.0 |
| Renewables | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Total** | **25.8** | **24.8** | **25.0** | **25.5** | **25.9** | **26.2** | **0.1** |
| **Transportation** | | | | | | | |
| Liquids | 17.4 | 16.2 | 16.4 | 17.0 | 17.1 | 17.2 | -0.1 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.4 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Total** | **17.8** | **16.5** | **16.7** | **17.4** | **17.5** | **17.6** | **0.0** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 31.6 | 29.1 | 29.0 | 30.0 | 30.2 | 30.3 | -0.2 |
| Natural Gas | 13.8 | 13.9 | 14.2 | 14.5 | 14.9 | 15.2 | 0.4 |
| Coal | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 | 3.3 | -1.3 |
| Electricity | 10.7 | 11.7 | 12.6 | 13.4 | 14.0 | 14.5 | 1.3 |
| Renewables | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Delivered Energy** | **60.8** | **59.0** | **59.9** | **61.7** | **62.8** | **63.6** | **0.2** |
| Electricity-Related Losses[a] | 20.8 | 23.2 | 24.9 | 26.2 | 27.3 | 28.2 | 1.3 |
| **Total** | **81.6** | **82.2** | **84.8** | **87.9** | **90.0** | **91.8** | **0.5** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.8 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | -0.5 |
| Natural Gas | 5.9 | 7.0 | 7.9 | 8.7 | 9.3 | 9.6 | 2.0 |
| Coal | 8.7 | 9.0 | 9.0 | 8.8 | 8.7 | 8.8 | 0.0 |
| Nuclear | 9.8 | 9.7 | 9.7 | 9.6 | 9.5 | 9.5 | -0.1 |
| Renewables | 6.4 | 8.3 | 10.0 | 11.6 | 13.0 | 14.1 | 3.4 |
| **Total** | **32.0** | **34.9** | **37.5** | **39.5** | **41.3** | **42.7** | **1.2** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 32.4 | 30.0 | 29.9 | 30.8 | 31.0 | 31.1 | -0.2 |
| Natural Gas | 19.7 | 21.0 | 22.1 | 23.3 | 24.2 | 24.8 | 1.0 |
| Coal | 13.2 | 13.0 | 12.8 | 12.4 | 12.2 | 12.0 | -0.4 |
| Nuclear | 9.6 | 9.7 | 9.7 | 9.6 | 9.5 | 9.5 | -0.1 |
| Renewables | 6.6 | 8.5 | 10.3 | 11.9 | 13.3 | 14.4 | 3.3 |
| **Total** | **81.6** | **82.2** | **84.8** | **87.9** | **90.0** | **91.8** | **0.5** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F7. Delivered Energy Consumption in Japan by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | -0.7 |
| Natural Gas | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.2 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 0.7 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **2.1** | **2.0** | **2.1** | **2.2** | **2.2** | **2.2** | **0.2** |
| **Commercial** | | | | | | | |
| Liquids | 0.9 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | -0.2 |
| Natural Gas | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | -0.5 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -1.0 |
| Electricity | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 0.8 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **2.9** | **2.8** | **2.9** | **3.0** | **3.0** | **3.0** | **0.2** |
| **Industrial** | | | | | | | |
| Liquids | 4.3 | 3.7 | 3.9 | 4.0 | 3.9 | 3.8 | -0.5 |
| Natural Gas | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 |
| Coal | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.8 | -0.7 |
| Electricity | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.1 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.6 |
| **Total** | **7.8** | **7.2** | **7.5** | **7.6** | **7.3** | **7.1** | **-0.4** |
| **Transportation** | | | | | | | |
| Liquids | 4.0 | 3.5 | 3.7 | 3.9 | 3.8 | 3.7 | -0.3 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| **Total** | **4.0** | **3.6** | **3.8** | **3.9** | **3.8** | **3.7** | **-0.3** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 9.8 | 8.6 | 9.0 | 9.3 | 9.1 | 8.9 | -0.4 |
| Natural Gas | 1.5 | 1.6 | 1.7 | 1.6 | 1.5 | 1.5 | 0.0 |
| Coal | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | -0.7 |
| Electricity | 3.4 | 3.4 | 3.6 | 3.7 | 3.8 | 3.8 | 0.6 |
| Renewables | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.6 |
| **Delivered Energy** | **16.8** | **15.7** | **16.3** | **16.7** | **16.4** | **16.1** | **-0.2** |
| Electricity-Related Losses[a] | 5.9 | 6.2 | 6.5 | 6.7 | 6.8 | 7.0 | 0.7 |
| **Total** | **22.8** | **21.9** | **22.9** | **23.4** | **23.2** | **23.0** | **0.0** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | -0.4 |
| Natural Gas | 2.1 | 2.1 | 2.3 | 2.5 | 2.6 | 2.6 | 0.8 |
| Coal | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | -0.4 |
| Nuclear | 2.9 | 3.1 | 3.3 | 3.4 | 3.7 | 3.9 | 1.2 |
| Renewables | 1.1 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 0.9 |
| **Total** | **9.4** | **9.7** | **10.1** | **10.4** | **10.6** | **10.8** | **0.6** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 10.5 | 9.3 | 9.7 | 10.0 | 9.8 | 9.5 | -0.4 |
| Natural Gas | 3.6 | 3.7 | 4.0 | 4.1 | 4.1 | 4.0 | 0.5 |
| Coal | 4.6 | 4.5 | 4.5 | 4.3 | 4.2 | 4.0 | -0.6 |
| Nuclear | 2.9 | 3.1 | 3.3 | 3.4 | 3.7 | 3.9 | 1.2 |
| Renewables | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.2 |
| **Total** | **22.8** | **21.9** | **22.9** | **23.4** | **23.2** | **23.0** | **0.0** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F8. Delivered Energy Consumption in South Korea by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -1.7 |
| Natural Gas | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.7 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -3.3 |
| Electricity | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.8** | **0.8** | **0.9** | **0.9** | **0.9** | **0.9** | **0.6** |
| **Commercial** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 |
| Natural Gas | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.6 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 2.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.8** | **0.8** | **0.9** | **1.0** | **1.1** | **1.2** | **1.9** |
| **Industrial** | | | | | | | |
| Liquids | 3.2 | 3.1 | 3.0 | 2.8 | 2.8 | 2.9 | -0.4 |
| Natural Gas | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1.3 |
| Coal | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | -0.2 |
| Electricity | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 2.1 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.5 |
| **Total** | **4.9** | **4.9** | **5.0** | **4.8** | **5.0** | **5.1** | **0.2** |
| **Transportation** | | | | | | | |
| Liquids | 1.9 | 2.0 | 2.1 | 2.2 | 2.2 | 2.3 | 0.7 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 |
| **Total** | **1.9** | **2.0** | **2.1** | **2.2** | **2.3** | **2.3** | **0.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 5.5 | 5.5 | 5.4 | 5.3 | 5.4 | 5.5 | 0.0 |
| Natural Gas | 0.8 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 |
| Coal | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | -0.4 |
| Electricity | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 | 2.1 | 2.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.5 |
| **Delivered Energy** | **8.4** | **8.6** | **8.9** | **8.9** | **9.3** | **9.5** | **0.5** |
| Electricity-Related Losses[a] | 1.0 | 2.4 | 2.8 | 3.1 | 3.4 | 3.7 | 5.5 |
| **Total** | **9.4** | **11.0** | **11.6** | **12.0** | **12.7** | **13.2** | **1.4** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -0.5 |
| Natural Gas | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 2.8 |
| Coal | 1.3 | 1.5 | 1.6 | 1.6 | 1.9 | 2.1 | 2.0 |
| Nuclear | 1.4 | 1.4 | 1.8 | 2.1 | 2.3 | 2.5 | 2.3 |
| Renewables | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 4.9 |
| **Total** | **3.4** | **3.7** | **4.3** | **4.9** | **5.3** | **5.8** | **2.2** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 4.5 | 5.7 | 5.6 | 5.5 | 5.6 | 5.7 | 1.0 |
| Natural Gas | 1.3 | 1.4 | 1.7 | 1.8 | 1.9 | 2.0 | 1.8 |
| Coal | 2.2 | 2.4 | 2.4 | 2.5 | 2.7 | 2.9 | 1.2 |
| Nuclear | 1.4 | 1.4 | 1.8 | 2.1 | 2.3 | 2.5 | 2.4 |
| Renewables | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 5.3 |
| **Total** | **9.4** | **11.0** | **11.6** | **12.0** | **12.7** | **13.2** | **1.4** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F9. Delivered Energy Consumption in Australia/New Zealand by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.2 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 |
| Electricity | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 1.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.4** | **0.4** | **0.5** | **0.5** | **0.5** | **0.5** | **1.3** |
| **Commercial** | | | | | | | |
| Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.3 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| Electricity | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 1.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.3** | **0.3** | **0.3** | **0.4** | **0.4** | **0.4** | **1.5** |
| **Industrial** | | | | | | | |
| Liquids | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.0 |
| Natural Gas | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 |
| Coal | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 1.9 |
| Electricity | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 1.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| **Total** | **1.9** | **2.0** | **2.1** | **2.2** | **2.3** | **2.4** | **0.8** |
| **Transportation** | | | | | | | |
| Liquids | 1.4 | 1.4 | 1.5 | 1.7 | 1.8 | 1.9 | 1.2 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| **Total** | **1.5** | **1.4** | **1.5** | **1.7** | **1.8** | **1.9** | **1.2** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 2.1 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 0.9 |
| Natural Gas | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 | 0.8 |
| Coal | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 1.8 |
| Electricity | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 | 1.5 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| **Delivered Energy** | **4.1** | **4.1** | **4.4** | **4.8** | **5.0** | **5.2** | **1.1** |
| Electricity-Related Losses[a] | 2.4 | 2.5 | 2.8 | 2.9 | 3.1 | 3.2 | 1.1 |
| **Total** | **6.5** | **6.7** | **7.3** | **7.7** | **8.0** | **8.4** | **1.1** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Natural Gas | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 2.2 |
| Coal | 2.3 | 2.4 | 2.4 | 2.4 | 2.4 | 2.5 | 0.3 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Renewables | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.3 | 4.1 |
| **Total** | **3.2** | **3.5** | **3.9** | **4.1** | **4.3** | **4.4** | **1.4** |
| **Total Energy Consumption** | | 1.7 | | | | | |
| Liquids | 2.2 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 0.6 |
| Natural Gas | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.3 |
| Coal | 2.6 | 2.6 | 2.6 | 2.7 | 2.7 | 2.9 | 0.5 |
| Nuclear | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Renewables | 0.5 | 0.7 | 1.1 | 1.2 | 1.3 | 1.3 | 4.2 |
| **Total** | **6.5** | **6.7** | **7.3** | **7.7** | **8.0** | **8.4** | **1.1** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F10. Total Non-OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 5.3 | 5.4 | 5.3 | 5.4 | 5.6 | 5.7 | 0.2 |
| Natural Gas | 8.8 | 9.4 | 10.2 | 10.7 | 11.2 | 12.1 | 1.4 |
| Coal | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 0.0 |
| Electricity | 5.4 | 6.4 | 7.7 | 9.3 | 11.1 | 13.1 | 3.8 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **23.0** | **24.6** | **26.7** | **29.0** | **31.5** | **34.5** | **1.7** |
| **Commercial** | | | | | | | |
| Liquids | 1.8 | 1.7 | 1.6 | 1.6 | 1.7 | 1.7 | -0.2 |
| Natural Gas | 1.4 | 1.5 | 1.7 | 1.9 | 2.0 | 2.2 | 1.8 |
| Coal | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.6 |
| Electricity | 3.3 | 3.8 | 4.6 | 5.7 | 7.1 | 8.8 | 4.2 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **7.2** | **7.7** | **8.6** | **9.9** | **11.6** | **13.5** | **2.7** |
| **Industrial** | | | | | | | |
| Liquids | 29.2 | 31.4 | 33.6 | 36.7 | 39.4 | 41.8 | 1.5 |
| Natural Gas | 23.2 | 26.9 | 31.8 | 35.2 | 38.0 | 40.5 | 2.3 |
| Coal | 34.2 | 37.8 | 41.8 | 46.2 | 49.3 | 51.2 | 1.7 |
| Electricity | 14.9 | 19.6 | 23.4 | 27.4 | 31.3 | 34.6 | 3.6 |
| Renewables | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Total** | **101.9** | **115.9** | **131.0** | **145.7** | **158.2** | **168.5** | **2.1** |
| **Transportation** | | | | | | | |
| Liquids | 31.1 | 36.9 | 41.8 | 48.0 | 54.2 | 60.7 | 2.8 |
| Natural Gas | 2.4 | 2.9 | 3.2 | 3.4 | 3.6 | 3.8 | 1.8 |
| Coal | 0.2 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | — |
| Electricity | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 1.5 |
| **Total** | **34.2** | **40.6** | **45.8** | **52.2** | **58.5** | **65.2** | **2.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 67.4 | 75.4 | 82.4 | 91.7 | 100.8 | 109.9 | 2.1 |
| Natural Gas | 35.8 | 40.7 | 46.9 | 51.2 | 54.9 | 58.5 | 2.1 |
| Coal | 38.7 | 42.2 | 46.3 | 50.7 | 53.7 | 55.6 | 1.5 |
| Electricity | 24.1 | 30.2 | 36.3 | 43.0 | 50.1 | 57.3 | 3.7 |
| Renewables | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Delivered Energy** | **166.2** | **188.9** | **212.2** | **236.9** | **259.8** | **281.6** | **2.2** |
| Electricity-Related Losses[a] | 64.6 | 76.6 | 87.0 | 97.5 | 108.0 | 118.6 | 2.6 |
| **Total** | **230.8** | **265.4** | **299.1** | **334.4** | **367.8** | **400.1** | **2.3** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 6.3 | 6.9 | 7.0 | 6.7 | 6.6 | 6.5 | 0.1 |
| Natural Gas | 18.4 | 21.0 | 24.5 | 27.9 | 30.7 | 32.6 | 2.4 |
| Coal | 41.9 | 51.1 | 56.6 | 63.1 | 73.2 | 84.0 | 2.9 |
| Nuclear | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.2 | 4.7 |
| Renewables | 17.7 | 22.9 | 28.1 | 33.0 | 35.5 | 39.5 | 3.4 |
| **Total** | **89.6** | **106.8** | **123.3** | **140.6** | **158.1** | **175.9** | **2.9** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 73.6 | 82.3 | 89.3 | 98.4 | 107.4 | 116.4 | 1.9 |
| Natural Gas | 54.2 | 61.7 | 71.4 | 79.1 | 85.5 | 91.2 | 2.2 |
| Coal | 80.6 | 93.3 | 102.9 | 113.8 | 126.9 | 139.6 | 2.3 |
| Nuclear | 4.4 | 5.0 | 7.2 | 9.9 | 12.2 | 13.2 | 4.7 |
| Renewables | 18.0 | 23.1 | 28.4 | 33.2 | 35.8 | 39.8 | 3.4 |
| **Total** | **230.8** | **265.4** | **299.1** | **334.4** | **367.8** | **400.1** | **2.3** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F11. Delivered Energy Consumption in Russia by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | -0.4 |
| Natural Gas | 3.2 | 3.2 | 3.3 | 3.3 | 3.4 | 3.5 | 0.5 |
| Coal | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | -2.0 |
| Electricity | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 3.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **4.2** | **4.2** | **4.4** | **4.5** | **4.6** | **4.9** | **0.6** |
| **Commercial** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | -2.2 |
| Natural Gas | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -0.7 |
| Electricity | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 3.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.1** | **1.2** | **1.3** | **1.4** | **1.5** | **1.6** | **1.4** |
| **Industrial** | | | | | | | |
| Liquids | 2.5 | 2.4 | 2.6 | 2.7 | 2.6 | 2.6 | 0.1 |
| Natural Gas | 5.7 | 6.0 | 6.3 | 6.6 | 6.9 | 7.1 | 0.9 |
| Coal | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 0.3 |
| Electricity | 1.7 | 2.0 | 2.3 | 2.6 | 2.7 | 2.8 | 2.1 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.3 |
| **Total** | **11.2** | **11.9** | **12.7** | **13.4** | **13.7** | **13.9** | **0.9** |
| **Transportation** | | | | | | | |
| Liquids | 2.3 | 2.4 | 2.4 | 2.5 | 2.4 | 2.3 | 0.1 |
| Natural Gas | 1.7 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 | 1.5 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **Total** | **4.2** | **4.7** | **4.9** | **5.1** | **5.0** | **5.0** | **0.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 5.2 | 5.2 | 5.4 | 5.6 | 5.4 | 5.3 | 0.1 |
| Natural Gas | 11.1 | 11.8 | 12.4 | 12.8 | 13.2 | 13.7 | 0.9 |
| Coal | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | -0.1 |
| Electricity | 2.7 | 3.2 | 3.7 | 4.1 | 4.4 | 4.7 | 2.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.3 |
| **Delivered Energy** | **20.8** | **22.0** | **23.3** | **24.3** | **24.9** | **25.4** | **0.8** |
| Electricity-Related Losses[a] | 9.6 | 10.3 | 11.1 | 11.6 | 12.0 | 12.3 | 1.0 |
| **Total** | **30.4** | **32.2** | **34.3** | **36.0** | **36.9** | **37.7** | **0.9** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | -0.4 |
| Natural Gas | 5.7 | 6.4 | 6.9 | 7.2 | 7.3 | 7.4 | 1.1 |
| Coal | 2.7 | 3.1 | 3.3 | 3.3 | 3.3 | 3.4 | 0.9 |
| Nuclear | 1.6 | 1.7 | 2.1 | 2.7 | 3.3 | 3.5 | 3.3 |
| Renewables | 1.8 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 1.1 |
| **Total** | **12.2** | **13.4** | **14.8** | **15.7** | **16.4** | **17.0** | **1.4** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 5.8 | 5.6 | 5.7 | 5.9 | 5.8 | 5.6 | -0.1 |
| Natural Gas | 16.7 | 18.1 | 19.3 | 20.1 | 20.5 | 21.0 | 0.9 |
| Coal | 4.6 | 5.0 | 5.2 | 5.1 | 5.1 | 5.2 | 0.5 |
| Nuclear | 1.6 | 1.7 | 2.1 | 2.7 | 3.3 | 3.5 | 3.3 |
| Renewables | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 1.3 |
| **Total** | **30.4** | **32.2** | **34.3** | **36.0** | **36.9** | **37.7** | **0.9** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F12. Delivered Energy Consumption in Other Non-OECD Europe and Eurasia by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -0.4 |
| Natural Gas | 2.6 | 2.8 | 3.0 | 3.0 | 3.0 | 2.9 | 0.5 |
| Coal | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | -3.1 |
| Electricity | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 2.2 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **3.5** | **3.6** | **3.9** | **4.0** | **4.0** | **3.9** | **0.5** |
| **Commercial** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | -0.3 |
| Natural Gas | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.1 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.2 |
| Electricity | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 2.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.7** | **0.7** | **0.8** | **0.8** | **0.9** | **0.9** | **1.1** |
| **Industrial** | | | | | | | |
| Liquids | 1.9 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | -0.7 |
| Natural Gas | 3.6 | 4.0 | 4.6 | 5.0 | 5.2 | 5.4 | 1.7 |
| Coal | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | -0.5 |
| Electricity | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.4 |
| **Total** | **8.5** | **8.8** | **9.5** | **9.9** | **10.1** | **10.3** | **0.8** |
| **Transportation** | | | | | | | |
| Liquids | 2.3 | 2.6 | 2.8 | 2.9 | 3.2 | 3.5 | 1.8 |
| Natural Gas | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 1.6 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -0.1 |
| **Total** | **2.6** | **3.0** | **3.2** | **3.4** | **3.7** | **4.0** | **1.8** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 4.4 | 4.6 | 4.6 | 4.8 | 5.1 | 5.3 | 0.8 |
| Natural Gas | 6.9 | 7.5 | 8.4 | 8.9 | 9.1 | 9.2 | 1.2 |
| Coal | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | -0.7 |
| Electricity | 1.8 | 1.9 | 2.2 | 2.4 | 2.6 | 2.7 | 1.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2.4 |
| **Delivered Energy** | **15.3** | **16.2** | **17.4** | **18.1** | **18.7** | **19.1** | **0.9** |
| Electricity-Related Losses[a] | 5.0 | 5.6 | 5.9 | 6.2 | 6.4 | 6.5 | 1.1 |
| **Total** | **20.3** | **21.7** | **23.3** | **24.3** | **25.0** | **25.6** | **1.0** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | -0.3 |
| Natural Gas | 2.2 | 2.4 | 2.7 | 2.9 | 3.1 | 3.2 | 1.6 |
| Coal | 1.9 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | 0.7 |
| Nuclear | 1.3 | 1.3 | 1.5 | 1.8 | 1.9 | 2.0 | 1.8 |
| Renewables | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 0.2 |
| **Total** | **7.1** | **7.5** | **8.1** | **8.6** | **8.9** | **9.2** | **1.1** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 4.4 | 4.9 | 5.0 | 5.1 | 5.4 | 5.6 | 1.0 |
| Natural Gas | 9.1 | 9.9 | 11.1 | 11.8 | 12.2 | 12.4 | 1.3 |
| Coal | 4.2 | 4.2 | 4.3 | 4.2 | 4.1 | 4.2 | 0.0 |
| Nuclear | 1.4 | 1.3 | 1.5 | 1.8 | 1.9 | 2.0 | 1.6 |
| Renewables | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 0.3 |
| **Total** | **20.3** | **21.7** | **23.3** | **24.3** | **25.0** | **25.6** | **1.0** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F13. Delivered Energy Consumption in China by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.9 | 0.8 | 0.7 | 0.7 | 0.7 | 0.6 | -1.2 |
| Natural Gas | 0.5 | 0.6 | 0.8 | 1.0 | 1.3 | 1.8 | 5.8 |
| Coal | 2.8 | 2.8 | 2.8 | 2.9 | 2.9 | 2.8 | 0.1 |
| Electricity | 1.1 | 1.5 | 1.9 | 2.5 | 3.2 | 4.1 | 5.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **5.2** | **5.6** | **6.2** | **7.0** | **8.0** | **9.3** | **2.4** |
| **Commercial** | | | | | | | |
| Liquids | 1.0 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | -1.0 |
| Natural Gas | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 | 6.9 |
| Coal | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.0 |
| Electricity | 0.5 | 0.5 | 0.7 | 1.0 | 1.4 | 2.0 | 6.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.9** | **1.9** | **2.1** | **2.4** | **3.0** | **3.7** | **2.9** |
| **Industrial** | | | | | | | |
| Liquids | 7.2 | 8.3 | 9.2 | 10.6 | 11.6 | 12.3 | 2.2 |
| Natural Gas | 1.1 | 1.4 | 2.1 | 2.5 | 2.9 | 3.2 | 4.6 |
| Coal | 23.9 | 27.0 | 30.2 | 33.9 | 36.4 | 37.9 | 1.9 |
| Electricity | 7.1 | 10.4 | 12.8 | 15.5 | 18.4 | 20.7 | 4.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| **Total** | **39.3** | **47.1** | **54.3** | **62.5** | **69.3** | **74.1** | **2.7** |
| **Transportation** | | | | | | | |
| Liquids | 5.2 | 6.9 | 9.1 | 12.1 | 14.8 | 17.2 | 5.1 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.2 |
| Coal | 0.2 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | — |
| Electricity | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 4.4 |
| **Total** | **5.4** | **7.2** | **9.4** | **12.4** | **15.0** | **17.4** | **5.0** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 14.3 | 16.9 | 19.9 | 24.2 | 27.8 | 30.9 | 3.3 |
| Natural Gas | 1.6 | 2.2 | 3.0 | 3.8 | 4.6 | 5.5 | 5.2 |
| Coal | 27.1 | 30.2 | 33.5 | 37.2 | 39.6 | 41.0 | 1.7 |
| Electricity | 8.8 | 12.5 | 15.6 | 19.2 | 23.2 | 27.0 | 4.8 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| **Delivered Energy** | **51.8** | **61.8** | **72.1** | **84.4** | **95.3** | **104.4** | **3.0** |
| Electricity-Related Losses[a] | 22.0 | 28.7 | 33.8 | 39.6 | 45.4 | 51.4 | 3.6 |
| **Total** | **73.8** | **90.5** | **105.9** | **124.0** | **140.7** | **155.8** | **3.2** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.1 |
| Natural Gas | 0.4 | 0.6 | 0.9 | 1.2 | 1.5 | 1.5 | 5.3 |
| Coal | 24.9 | 32.5 | 36.8 | 42.4 | 50.5 | 57.3 | 3.5 |
| Nuclear | 0.6 | 0.7 | 1.7 | 2.8 | 3.8 | 4.4 | 9.0 |
| Renewables | 4.3 | 7.0 | 9.5 | 11.8 | 12.3 | 14.7 | 5.2 |
| **Total** | **30.9** | **41.2** | **49.5** | **58.8** | **68.6** | **78.4** | **4.0** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 14.8 | 17.4 | 20.5 | 24.7 | 28.3 | 31.3 | 3.2 |
| Natural Gas | 2.1 | 2.7 | 4.0 | 5.1 | 6.1 | 7.1 | 5.2 |
| Coal | 52.0 | 62.7 | 70.3 | 79.5 | 90.1 | 98.3 | 2.7 |
| Nuclear | 0.6 | 0.7 | 1.7 | 2.8 | 3.8 | 4.4 | 9.0 |
| Renewables | 4.3 | 7.0 | 9.5 | 11.8 | 12.4 | 14.7 | 5.2 |
| **Total** | **73.8** | **90.5** | **105.9** | **124.0** | **140.7** | **155.8** | **3.2** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F14. Delivered Energy Consumption in India by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 3.4 |
| Coal | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 1.6 |
| Electricity | 0.4 | 0.5 | 0.7 | 0.9 | 1.2 | 1.5 | 5.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.3** | **1.4** | **1.7** | **2.1** | **2.4** | **2.7** | **3.1** |
| **Commercial** | | | | | | | |
| Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 2.0 |
| Electricity | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.6 | 5.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.3** | **0.4** | **0.4** | **0.6** | **0.7** | **0.8** | **4.3** |
| **Industrial** | | | | | | | |
| Liquids | 2.4 | 2.5 | 3.2 | 4.0 | 4.3 | 4.6 | 2.8 |
| Natural Gas | 0.8 | 1.0 | 1.2 | 1.4 | 1.5 | 1.6 | 2.7 |
| Coal | 3.2 | 3.4 | 3.8 | 4.2 | 4.3 | 4.4 | 1.3 |
| Electricity | 1.1 | 1.5 | 1.8 | 2.1 | 2.4 | 2.6 | 3.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| **Total** | **7.6** | **8.4** | **10.0** | **11.7** | **12.6** | **13.3** | **2.3** |
| **Transportation** | | | | | | | |
| Liquids | 1.2 | 1.5 | 2.1 | 2.8 | 3.3 | 3.8 | 4.7 |
| Natural Gas | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 2.8 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 3.3 |
| **Total** | **1.3** | **1.6** | **2.2** | **3.0** | **3.4** | **3.9** | **4.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 4.4 | 4.8 | 6.1 | 7.7 | 8.6 | 9.4 | 3.2 |
| Natural Gas | 0.9 | 1.0 | 1.3 | 1.5 | 1.7 | 1.8 | 2.8 |
| Coal | 3.5 | 3.7 | 4.2 | 4.5 | 4.7 | 4.9 | 1.4 |
| Electricity | 1.7 | 2.2 | 2.8 | 3.4 | 4.1 | 4.8 | 4.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| **Delivered Energy** | **10.6** | **11.8** | **14.4** | **17.3** | **19.0** | **20.8** | **2.9** |
| Electricity-Related Losses[a] | 7.1 | 7.3 | 8.5 | 9.6 | 10.5 | 11.5 | 2.0 |
| **Total** | **17.7** | **19.1** | **22.9** | **26.8** | **29.6** | **32.3** | **2.5** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -0.4 |
| Natural Gas | 0.5 | 0.8 | 1.2 | 1.6 | 1.8 | 2.0 | 5.9 |
| Coal | 5.9 | 6.5 | 7.1 | 7.5 | 8.1 | 9.3 | 1.9 |
| Nuclear | 0.2 | 0.4 | 0.7 | 1.1 | 1.4 | 1.6 | 9.2 |
| Renewables | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| **Total** | **8.1** | **9.6** | **11.3** | **13.0** | **14.6** | **16.3** | **3.0** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 5.4 | 5.0 | 6.3 | 7.9 | 8.7 | 9.6 | 2.4 |
| Natural Gas | 1.4 | 1.9 | 2.5 | 3.1 | 3.5 | 3.8 | 4.2 |
| Coal | 9.4 | 10.3 | 11.2 | 12.1 | 12.9 | 14.2 | 1.7 |
| Nuclear | 0.2 | 0.4 | 0.7 | 1.1 | 1.4 | 1.6 | 9.2 |
| Renewables | 1.2 | 1.6 | 2.1 | 2.6 | 3.0 | 3.2 | 4.2 |
| **Total** | **17.7** | **19.1** | **22.9** | **26.8** | **29.6** | **32.3** | **2.5** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F15. Delivered Energy Consumption in Other Non-OECD Asia by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.9 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 0.3 |
| Natural Gas | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 3.3 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| Electricity | 0.9 | 1.0 | 1.2 | 1.4 | 1.7 | 2.0 | 3.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **2.1** | **2.2** | **2.5** | **2.8** | **3.2** | **3.6** | **2.3** |
| **Commercial** | | | | | | | |
| Liquids | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 2.1 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 |
| Electricity | 0.7 | 0.8 | 1.0 | 1.2 | 1.5 | 1.9 | 4.0 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.1** | **1.1** | **1.3** | **1.6** | **1.9** | **2.3** | **3.2** |
| **Industrial** | | | | | | | |
| Liquids | 5.4 | 5.3 | 5.7 | 6.1 | 6.7 | 7.4 | 1.3 |
| Natural Gas | 2.7 | 3.3 | 4.4 | 5.4 | 6.3 | 7.3 | 4.3 |
| Coal | 2.1 | 2.2 | 2.5 | 2.7 | 3.0 | 3.3 | 1.9 |
| Electricity | 1.3 | 1.5 | 1.8 | 2.2 | 2.5 | 3.0 | 3.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| **Total** | **11.4** | **12.2** | **14.3** | **16.4** | **18.6** | **21.0** | **2.6** |
| **Transportation** | | | | | | | |
| Liquids | 6.2 | 7.0 | 7.9 | 8.9 | 10.3 | 11.8 | 2.7 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.9 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 |
| **Total** | **6.3** | **7.0** | **7.9** | **9.0** | **10.4** | **11.9** | **2.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 12.7 | 13.4 | 14.6 | 16.2 | 18.2 | 20.4 | 2.0 |
| Natural Gas | 3.1 | 3.7 | 5.0 | 6.0 | 7.0 | 8.2 | 4.1 |
| Coal | 2.1 | 2.3 | 2.5 | 2.8 | 3.1 | 3.3 | 1.9 |
| Electricity | 2.9 | 3.3 | 4.0 | 4.8 | 5.7 | 6.8 | 3.7 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| **Delivered Energy** | **20.9** | **22.6** | **26.1** | **29.8** | **34.0** | **38.7** | **2.6** |
| Electricity-Related Losses[a] | 5.2 | 7.0 | 8.3 | 9.7 | 11.1 | 12.8 | 3.8 |
| **Total** | **26.1** | **29.6** | **34.4** | **39.5** | **45.1** | **51.5** | **2.9** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | -0.3 |
| Natural Gas | 3.0 | 3.4 | 4.2 | 5.0 | 5.6 | 6.1 | 3.0 |
| Coal | 2.9 | 3.3 | 3.6 | 4.0 | 5.1 | 7.0 | 3.7 |
| Nuclear | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 | 1.1 | 4.2 |
| Renewables | 1.6 | 2.1 | 2.9 | 3.7 | 4.2 | 4.5 | 4.3 |
| **Total** | **9.0** | **10.3** | **12.3** | **14.5** | **16.8** | **19.6** | **3.3** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 12.9 | 14.4 | 15.6 | 17.2 | 19.1 | 21.3 | 2.1 |
| Natural Gas | 6.1 | 7.1 | 9.1 | 11.0 | 12.7 | 14.3 | 3.6 |
| Coal | 5.1 | 5.5 | 6.1 | 6.7 | 8.1 | 10.4 | 3.0 |
| Nuclear | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 | 1.1 | 4.1 |
| Renewables | 1.6 | 2.1 | 2.9 | 3.7 | 4.2 | 4.5 | 4.3 |
| **Total** | **26.1** | **29.6** | **34.4** | **39.5** | **45.1** | **51.5** | **2.9** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F16. Delivered Energy Consumption in the Middle East by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.8 | 0.9 | 0.8 | 0.8 | 0.8 | 0.9 | 0.4 |
| Natural Gas | 1.5 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 0.8 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.9 |
| Electricity | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.6 | 2.5 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **3.2** | **3.6** | **3.8** | **3.9** | **4.1** | **4.3** | **1.2** |
| **Commercial** | | | | | | | |
| Liquids | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.4 |
| Natural Gas | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 2.1 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.5 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 3.2 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.9** | **1.0** | **1.1** | **1.2** | **1.4** | **1.6** | **2.6** |
| **Industrial** | | | | | | | |
| Liquids | 4.0 | 4.8 | 5.0 | 5.3 | 5.9 | 6.5 | 2.1 |
| Natural Gas | 5.1 | 6.3 | 7.4 | 7.7 | 8.1 | 8.6 | 2.2 |
| Coal | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 3.0 |
| Electricity | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 1.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **9.6** | **11.7** | **13.1** | **13.8** | **14.7** | **15.9** | **2.1** |
| **Transportation** | | | | | | | |
| Liquids | 5.0 | 6.0 | 6.6 | 7.2 | 7.9 | 8.9 | 2.4 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **5.0** | **6.0** | **6.6** | **7.2** | **7.9** | **8.9** | **2.4** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 10.0 | 11.8 | 12.6 | 13.5 | 14.9 | 16.5 | 2.1 |
| Natural Gas | 6.8 | 8.3 | 9.5 | 9.8 | 10.2 | 10.8 | 1.9 |
| Coal | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 3.0 |
| Electricity | 1.9 | 2.1 | 2.4 | 2.6 | 3.0 | 3.3 | 2.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Delivered Energy** | **18.8** | **22.3** | **24.5** | **26.1** | **28.1** | **30.7** | **2.1** |
| Electricity-Related Losses[a] | 5.0 | 5.4 | 5.7 | 6.1 | 6.5 | 7.0 | 1.4 |
| **Total** | **23.8** | **27.7** | **30.3** | **32.2** | **34.6** | **37.7** | **1.9** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 2.4 | 2.6 | 2.7 | 2.6 | 2.6 | 2.7 | 0.5 |
| Natural Gas | 3.9 | 4.2 | 4.7 | 5.2 | 5.8 | 6.5 | 2.1 |
| Coal | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.8 |
| Nuclear | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Renewables | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 3.3 |
| **Total** | **6.9** | **7.5** | **8.1** | **8.7** | **9.4** | **10.3** | **1.7** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 12.4 | 14.4 | 15.3 | 16.1 | 17.5 | 19.2 | 1.8 |
| Natural Gas | 10.8 | 12.5 | 14.2 | 15.0 | 16.1 | 17.4 | 2.0 |
| Coal | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 1.1 |
| Nuclear | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Renewables | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 3.4 |
| **Total** | **23.8** | **27.7** | **30.3** | **32.2** | **34.6** | **37.7** | **1.9** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F17. Delivered Energy Consumption in Africa by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | 0.7 |
| Natural Gas | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 3.1 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 2.3 |
| Electricity | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 3.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.6** | **1.8** | **1.9** | **2.2** | **2.4** | **2.7** | **2.1** |
| **Commercial** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.1 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.7 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 2.0 |
| Electricity | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 3.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.3** | **0.4** | **0.4** | **0.5** | **0.6** | **0.7** | **3.2** |
| **Industrial** | | | | | | | |
| Liquids | 1.5 | 1.7 | 1.7 | 1.7 | 1.7 | 1.8 | 0.7 |
| Natural Gas | 1.3 | 1.6 | 2.0 | 2.3 | 2.6 | 2.7 | 3.1 |
| Coal | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.5 | 0.6 |
| Electricity | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.4 | 1.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| **Total** | **5.0** | **5.5** | **6.2** | **6.7** | **7.1** | **7.4** | **1.6** |
| **Transportation** | | | | | | | |
| Liquids | 3.2 | 3.7 | 3.9 | 4.1 | 4.3 | 4.5 | 1.5 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 2.8 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 |
| **Total** | **3.3** | **3.8** | **4.0** | **4.2** | **4.5** | **4.7** | **1.5** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 5.5 | 6.2 | 6.4 | 6.6 | 7.0 | 7.3 | 1.2 |
| Natural Gas | 1.6 | 1.9 | 2.4 | 2.8 | 3.1 | 3.4 | 3.1 |
| Coal | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.7 | 0.8 |
| Electricity | 1.6 | 1.8 | 2.1 | 2.5 | 2.8 | 3.1 | 2.6 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| **Delivered Energy** | **10.2** | **11.5** | **12.5** | **13.6** | **14.6** | **15.5** | **1.8** |
| Electricity-Related Losses[a] | 4.3 | 4.7 | 5.2 | 5.6 | 6.0 | 6.3 | 1.6 |
| **Total** | **14.5** | **16.2** | **17.7** | **19.1** | **20.6** | **21.8** | **1.7** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.6 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 1.0 |
| Natural Gas | 1.6 | 1.7 | 2.2 | 2.7 | 3.1 | 3.3 | 3.2 |
| Coal | 2.7 | 2.8 | 2.8 | 2.9 | 3.1 | 3.6 | 1.1 |
| Nuclear | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Renewables | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **6.0** | **6.6** | **7.3** | **8.0** | **8.7** | **9.4** | **1.9** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 6.1 | 7.1 | 7.3 | 7.5 | 7.8 | 8.1 | 1.2 |
| Natural Gas | 3.2 | 3.7 | 4.6 | 5.5 | 6.2 | 6.7 | 3.2 |
| Coal | 4.2 | 4.2 | 4.4 | 4.6 | 4.8 | 5.3 | 1.0 |
| Nuclear | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 3.3 |
| Renewables | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.5 | 2.1 |
| **Total** | **14.5** | **16.2** | **17.7** | **19.1** | **20.6** | **21.8** | **1.7** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F18. Delivered Energy Consumption in Brazil by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1.1 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.3 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 3.3 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.6** | **0.7** | **0.8** | **0.9** | **1.0** | **1.1** | **2.5** |
| **Commercial** | | | | | | | |
| Liquids | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.3 |
| Natural Gas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 | 0.9 | 4.4 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.4** | **0.5** | **0.6** | **0.7** | **0.9** | **1.0** | **4.1** |
| **Industrial** | | | | | | | |
| Liquids | 1.7 | 1.9 | 2.1 | 2.2 | 2.4 | 2.6 | 1.9 |
| Natural Gas | 0.4 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 2.0 |
| Coal | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 3.2 |
| Electricity | 0.6 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 2.4 |
| Renewables | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 |
| **Total** | **3.3** | **3.8** | **4.2** | **4.7** | **5.1** | **5.5** | **2.1** |
| **Transportation** | | | | | | | |
| Liquids | 2.4 | 2.8 | 3.2 | 3.5 | 4.0 | 4.5 | 2.6 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 3.3 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 |
| **Total** | **2.5** | **2.9** | **3.3** | **3.7** | **4.1** | **4.7** | **2.7** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 4.4 | 5.1 | 5.6 | 6.1 | 6.8 | 7.6 | 2.3 |
| Natural Gas | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 2.4 |
| Coal | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 3.2 |
| Electricity | 1.3 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 3.2 |
| Renewables | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 |
| **Delivered Energy** | **6.8** | **7.9** | **8.9** | **9.9** | **11.1** | **12.3** | **2.5** |
| Electricity-Related Losses[a] | 2.8 | 3.4 | 4.0 | 4.6 | 5.2 | 5.8 | 3.0 |
| **Total** | **9.6** | **11.4** | **12.9** | **14.5** | **16.3** | **18.0** | **2.6** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -0.6 |
| Natural Gas | 0.2 | 0.4 | 0.5 | 0.6 | 0.9 | 0.9 | 7.1 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 5.1 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 2.0 |
| Renewables | 3.4 | 4.3 | 5.0 | 5.7 | 6.4 | 7.1 | 3.1 |
| **Total** | **4.2** | **5.0** | **5.9** | **6.8** | **7.7** | **8.5** | **3.0** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 4.6 | 5.2 | 5.7 | 6.2 | 6.8 | 7.6 | 2.1 |
| Natural Gas | 0.7 | 1.0 | 1.2 | 1.5 | 1.8 | 1.9 | 4.1 |
| Coal | 0.4 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 3.5 |
| Nuclear | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 2.1 |
| Renewables | 3.6 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 3.0 |
| **Total** | **9.6** | **11.4** | **12.9** | **14.5** | **16.3** | **18.0** | **2.6** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

**Table F19. Delivered Energy Consumption in Other Central and South America by End-Use Sector and Fuel, 2006-2030**
(Quadrillion Btu)

| Sector/Fuel | 2006 | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Residential** | | | | | | | |
| Liquids | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.1 |
| Natural Gas | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 2.6 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.7 |
| Electricity | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 2.0 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **1.3** | **1.5** | **1.6** | **1.7** | **1.8** | **2.0** | **1.6** |
| **Commercial** | | | | | | | |
| Liquids | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.7 |
| Natural Gas | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.5 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 2.7 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Total** | **0.5** | **0.5** | **0.6** | **0.6** | **0.7** | **0.8** | **2.1** |
| **Industrial** | | | | | | | |
| Liquids | 2.6 | 2.8 | 2.6 | 2.4 | 2.4 | 2.4 | -0.3 |
| Natural Gas | 2.5 | 2.9 | 3.3 | 3.5 | 3.8 | 3.8 | 1.8 |
| Coal | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 5.8 |
| Electricity | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.2 |
| **Total** | **5.8** | **6.4** | **6.6** | **6.7** | **7.0** | **7.1** | **0.9** |
| **Transportation** | | | | | | | |
| Liquids | 3.4 | 4.1 | 4.0 | 3.9 | 4.1 | 4.3 | 1.1 |
| Natural Gas | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 3.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Electricity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 |
| **Total** | **3.6** | **4.3** | **4.3** | **4.3** | **4.5** | **4.8** | **1.2** |
| **All End-Use Sectors** | | | | | | | |
| Liquids | 6.5 | 7.5 | 7.1 | 6.9 | 7.1 | 7.4 | 0.5 |
| Natural Gas | 3.2 | 3.7 | 4.2 | 4.6 | 4.9 | 5.1 | 2.0 |
| Coal | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 5.8 |
| Electricity | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 1.7 |
| Renewables | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.2 |
| **Delivered Energy** | **11.2** | **12.8** | **13.0** | **13.4** | **14.1** | **14.6** | **1.1** |
| Electricity-Related Losses[a] | 3.4 | 4.2 | 4.4 | 4.6 | 4.8 | 5.0 | 1.6 |
| **Total** | **14.6** | **17.0** | **17.5** | **18.0** | **18.9** | **19.7** | **1.3** |
| **Electric Power[b]** | | | | | | | |
| Liquids | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | -0.7 |
| Natural Gas | 0.9 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 2.3 |
| Coal | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 1.3 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 2.0 |
| Renewables | 3.0 | 3.3 | 3.6 | 3.8 | 4.0 | 4.2 | 1.4 |
| **Total** | **5.3** | **5.7** | **6.1** | **6.4** | **6.8** | **7.1** | **1.3** |
| **Total Energy Consumption** | | | | | | | |
| Liquids | 7.1 | 8.3 | 7.9 | 7.7 | 7.8 | 8.0 | 0.5 |
| Natural Gas | 4.1 | 4.8 | 5.4 | 6.0 | 6.5 | 6.7 | 2.1 |
| Coal | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 1.7 |
| Nuclear | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 2.0 |
| Renewables | 3.0 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 1.4 |
| **Total** | **14.6** | **17.0** | **17.5** | **18.0** | **18.9** | **19.7** | **1.3** |

[a]Electricity losses incurred in the transmission and distribution of electric power. May include some heat production.
[b]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2006:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia. doe.gov/iea. **Projections:** EIA, World Energy Projections Plus (2009).

Appendix G

# Projections of Liquid Fuels and Other Petroleum Production in Five Cases:

- Reference
- High Price
- Low Price
- High Economic Growth
- Low Economic Growth

**Table G1. World Total Liquids Production by Region and Country, Reference Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.7** | **34.4** | **35.6** | **38.1** | **39.9** | **41.4** | **43.8** | **1.0** |
| **Middle East** | **16.1** | **23.6** | **23.1** | **23.8** | **25.4** | **26.7** | **27.8** | **29.5** | **0.9** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 4.0 | 3.8 | 3.9 | 4.2 | 0.1 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.9 | 4.2 | 4.6 | 5.0 | 3.9 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.7 | 2.6 | 2.7 | 2.9 | 0.3 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.9 | 2.1 | 2.3 | 2.5 | 3.3 |
| Saudi Arabia | 7.0 | 10.7 | 10.2 | 10.0 | 10.9 | 11.0 | 11.3 | 12.0 | 0.5 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.0 | 2.9 | 2.9 | 2.9 | -0.1 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.4** | **4.3** | **4.3** | **4.3** | **0.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.7 | 2.8 | 2.8 | 2.8 | 1.1 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.7 | 1.5 | 1.5 | 1.5 | -0.7 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.6** | **5.7** | **5.8** | **6.1** | **1.9** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.5 | 2.4 | 2.5 | 2.7 | 2.7 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.1 | 3.3 | 3.4 | 3.4 | 1.4 |
| **South America** | **2.5** | **3.3** | **3.2** | **2.9** | **2.8** | **3.2** | **3.6** | **3.8** | **0.6** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -0.7 |
| Venezuela | 2.3 | 2.7 | 2.7 | 2.4 | 2.4 | 2.8 | 3.1 | 3.4 | 0.9 |
| **Non-OPEC** | **42.8** | **49.9** | **50.4** | **50.7** | **52.5** | **56.0** | **59.6** | **62.8** | **1.0** |
| **OECD** | **20.0** | **21.7** | **21.7** | **21.5** | **21.5** | **22.1** | **23.8** | **24.8** | **0.6** |
| **OECD North America** | **14.7** | **15.3** | **15.5** | **16.1** | **16.7** | **17.7** | **19.5** | **20.4** | **1.2** |
| United States | 9.7 | 8.3 | 8.6 | 9.7 | 10.2 | 11.3 | 12.4 | 12.7 | 1.8 |
| Canada | 2.0 | 3.3 | 3.4 | 3.7 | 4.3 | 4.6 | 5.0 | 5.4 | 2.1 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.1 | 1.9 | 2.0 | 2.3 | -2.0 |
| **OECD Europe** | **4.5** | **5.6** | **5.4** | **4.6** | **4.0** | **3.6** | **3.5** | **3.5** | **-2.0** |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.8** | **0.8** | **0.9** | **0.8** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 2.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.6 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.3 |
| **Non-OECD** | **22.8** | **28.2** | **28.7** | **29.2** | **31.0** | **34.0** | **35.9** | **38.1** | **1.2** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.6** | **13.6** | **15.2** | **16.0** | **16.8** | **1.3** |
| Russia | 10.1 | 9.7 | 9.9 | 9.4 | 9.5 | 10.9 | 11.5 | 11.9 | 0.9 |
| Caspian Area | 1.1 | 2.3 | 2.6 | 2.9 | 3.8 | 4.1 | 4.3 | 4.6 | 2.9 |
| Other | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -1.4 |
| **Non-OECD Asia** | **6.0** | **7.8** | **7.7** | **7.9** | **7.8** | **7.9** | **8.1** | **8.4** | **0.3** |
| China | 2.8 | 3.9 | 3.9 | 4.1 | 3.8 | 3.8 | 3.9 | 4.1 | 0.3 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 | 1.3 | 1.3 | 1.7 |
| Other | 2.5 | 3.0 | 2.9 | 2.9 | 3.0 | 3.0 | 2.9 | 3.0 | -0.1 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.3** | **1.3** | **1.2** | **-1.2** |
| **Africa** | **1.7** | **2.5** | **2.6** | **2.7** | **2.8** | **2.9** | **3.1** | **3.2** | **1.0** |
| **Central and South America** | **2.2** | **4.0** | **4.1** | **4.5** | **5.3** | **6.5** | **7.4** | **8.4** | **3.2** |
| Brazil | 0.9 | 2.1 | 2.3 | 2.6 | 3.6 | 4.7 | 5.3 | 5.9 | 4.3 |
| Other | 1.3 | 1.8 | 1.8 | 1.8 | 1.7 | 1.8 | 2.1 | 2.5 | 1.4 |
| **Total World** | **66.5** | **84.6** | **84.8** | **86.3** | **90.6** | **95.9** | **101.1** | **106.6** | **1.0** |
| OPEC Share of World Production | 36% | 41% | 41% | 41% | 42% | 42% | 41% | 41% | |
| Persian Gulf Share of World Production | 24% | 28% | 27% | 28% | 28% | 28% | 27% | 28% | |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G2. World Conventional Liquids Production by Region and Country, Reference Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.0** | **33.7** | **35.0** | **37.3** | **38.8** | **40.2** | **42.3** | **0.9** |
| **Middle East** | **16.1** | **23.5** | **23.0** | **23.8** | **25.3** | **26.5** | **27.6** | **29.3** | **0.9** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 4.0 | 3.8 | 3.9 | 4.2 | 0.1 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.9 | 4.2 | 4.6 | 5.0 | 3.9 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.7 | 2.6 | 2.7 | 2.9 | 0.3 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.8 | 1.9 | 2.1 | 2.3 | 3.0 |
| Saudi Arabia | 7.0 | 10.6 | 10.2 | 10.0 | 10.9 | 11.0 | 11.3 | 12.0 | 0.5 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.0 | 2.9 | 2.9 | 2.9 | -0.1 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.4** | **4.3** | **4.3** | **4.3** | **0.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.7 | 2.8 | 2.8 | 2.8 | 1.1 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.7 | 1.5 | 1.5 | 1.5 | -0.7 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.6** | **5.6** | **5.8** | **6.0** | **1.9** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.5 | 2.4 | 2.5 | 2.7 | 2.7 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.1 | 3.2 | 3.3 | 3.3 | 1.3 |
| **South America** | **2.5** | **2.7** | **2.6** | **2.2** | **2.1** | **2.4** | **2.6** | **2.6** | **-0.1** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -0.7 |
| Venezuela | 2.3 | 2.1 | 2.1 | 1.8 | 1.7 | 1.9 | 2.1 | 2.2 | 0.0 |
| **Non-OPEC** | **42.0** | **47.5** | **47.4** | **46.3** | **46.1** | **47.9** | **49.4** | **50.9** | **0.3** |
| **OECD** | **19.5** | **19.8** | **19.4** | **18.0** | **16.5** | **16.1** | **16.6** | **16.7** | **-0.7** |
| **OECD North America** | **14.3** | **13.6** | **13.4** | **13.0** | **12.2** | **12.3** | **12.9** | **13.1** | **-0.2** |
| United States | 9.6 | 7.8 | 7.8 | 8.5 | 8.6 | 9.3 | 10.0 | 10.0 | 1.0 |
| Canada | 1.7 | 2.1 | 2.1 | 1.8 | 1.5 | 1.2 | 1.1 | 1.0 | -2.9 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.1 | 1.8 | 1.9 | 2.1 | -2.4 |
| **OECD Europe** | **4.5** | **5.5** | **5.2** | **4.2** | **3.6** | **3.1** | **2.9** | **2.9** | **-2.7** |
| Denmark | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -5.7 |
| Norway | 1.7 | 2.8 | 2.6 | 2.2 | 1.9 | 1.6 | 1.5 | 1.4 | -2.9 |
| United Kngdom | 2.0 | 1.7 | 1.7 | 1.2 | 1.0 | 0.8 | 0.7 | 0.7 | -3.4 |
| Other | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.1 |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.7** | **0.7** | **0.7** | **0.1** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | -0.3 |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

**Table G2. World Conventional Liquids Production by Region and Country, Reference Case, 1990-2030 (Continued)**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD** | **22.5** | **27.7** | **28.0** | **28.3** | **29.6** | **31.8** | **32.8** | **34.2** | **0.9** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.6** | **13.6** | **15.2** | **16.0** | **16.8** | **1.3** |
| **Russia** | **10.1** | **9.7** | **9.9** | **9.4** | **9.5** | **10.9** | **11.5** | **11.9** | **0.9** |
| **Caspian Area** | **1.1** | **2.3** | **2.6** | **2.9** | **3.8** | **4.1** | **4.3** | **4.6** | **2.9** |
| Azerbaijan | 0.3 | 0.6 | 0.8 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.9 |
| Kazakhstan | 0.6 | 1.4 | 1.4 | 1.6 | 2.5 | 2.7 | 2.9 | 3.2 | 3.6 |
| Turkmenistan | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 2.6 |
| Uzbekistan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.3 |
| **Other** | **0.4** | **0.3** | **0.3** | **0.3** | **0.2** | **0.2** | **0.2** | **0.2** | **-1.4** |
| **Non-OECD Asia** | **6.0** | **7.7** | **7.7** | **7.7** | **7.4** | **7.3** | **7.0** | **6.7** | **-0.6** |
| China | 2.8 | 3.9 | 3.9 | 4.0 | 3.6 | 3.5 | 3.2 | 3.1 | -0.9 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 | 1.0 | 0.4 |
| Brunei | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -2.6 |
| Malaysia | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | -0.2 |
| Thailand | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 |
| Vietnam | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| Other | 1.6 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.1 | 1.0 | -1.3 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.3** | **1.3** | **1.2** | **-1.2** |
| Oman | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.7 | 0.7 | 0.7 | -0.2 |
| Syria | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | -1.5 |
| Yemen | 0.2 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -3.7 |
| Other | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | -0.5 |
| **Africa** | **1.6** | **2.4** | **2.4** | **2.5** | **2.4** | **2.5** | **2.6** | **2.7** | **0.5** |
| Chad | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -4.0 |
| Congo (Brazzaville) | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 2.0 |
| Egypt | 0.9 | 0.7 | 0.7 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | -0.2 |
| Equatorial Guniea | 0.0 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.4 | 0.3 | -0.4 |
| Gabon | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | -2.0 |
| Sao Tome and Principe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | — |
| Sudan | 0.0 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.6 | 0.7 | 2.3 |
| Other | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 |
| **Central and South America** | **2.0** | **3.7** | **3.7** | **4.0** | **4.5** | **5.4** | **6.0** | **6.8** | **2.6** |
| Brazil | 0.7 | 1.9 | 1.9 | 2.2 | 3.0 | 3.9 | 4.4 | 4.8 | 4.1 |
| Argentina | 0.5 | 0.8 | 0.8 | 0.7 | 0.5 | 0.4 | 0.4 | 0.3 | -3.4 |
| Colombia | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -1.8 |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 4.3 |
| Trinidad and Tobago | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -1.4 |
| Other | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.8 | 6.4 |
| **Total World** | **65.7** | **81.5** | **81.1** | **81.3** | **83.4** | **86.7** | **89.6** | **93.1** | **0.6** |
| OPEC Share of World Production | 36% | 42% | 42% | 43% | 45% | 45% | 45% | 45% | |
| Persian Gulf Share of World Production | 25% | 29% | 28% | 29% | 30% | 31% | 31% | 31% | |

Note: Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain.
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G3. World Unconventional Liquids Production by Region and Country, Reference Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **0.0** | **0.7** | **0.7** | **0.6** | **0.8** | **1.1** | **1.3** | **1.5** | **3.3** |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Extra-Heavy Oil (Venezuela) | 0.0 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 1.0 | 1.2 | 2.8 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids (primarily Qatar) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 18.3 |
| **Non-OPEC** | **0.7** | **2.4** | **3.0** | **4.4** | **6.4** | **8.1** | **10.3** | **11.9** | **6.9** |
| **OECD** | **0.5** | **1.9** | **2.3** | **3.5** | **5.0** | **5.9** | **7.2** | **8.1** | **6.3** |
| Biofuels | 0.0 | 0.5 | 0.6 | 1.2 | 1.7 | 2.1 | 2.7 | 2.9 | 8.0 |
| Oil Sands/Bitumen (Canada) | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Extra-Heavy Oil (Mexico) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 14.3 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 26.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| **Non-OECD** | **0.3** | **0.5** | **0.7** | **0.9** | **1.4** | **2.2** | **3.1** | **3.9** | **8.8** |
| Biofuels | 0.2 | 0.3 | 0.4 | 0.7 | 1.2 | 1.7 | 2.4 | 2.9 | 9.3 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.7 | 0.9 | 8.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| **World** | | | | | | | | | |
| Biofuels | 0.2 | 0.8 | 1.1 | 1.9 | 2.8 | 3.9 | 5.1 | 5.9 | 8.6 |
| Oil Sands/Bitumen | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Extra-Heavy Oil | 0.0 | 0.6 | 0.6 | 0.7 | 0.7 | 0.9 | 1.0 | 1.2 | 3.0 |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 0.8 | 1.2 | 9.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 19.3 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 13.9 |
| **World Total** | **0.8** | **3.1** | **3.7** | **5.0** | **7.2** | **9.2** | **11.5** | **13.4** | **6.3** |
| **Selected Country Highlights** | | | | | | | | | |
| **Biofuels** | | | | | | | | | |
| Brazil | 0.2 | 0.3 | 0.3 | 0.4 | 0.6 | 0.8 | 0.9 | 1.0 | 5.6 |
| China | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 12.9 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 18.5 |
| United States | 0.0 | 0.3 | 0.5 | 0.9 | 1.2 | 1.4 | 1.8 | 1.9 | 7.4 |
| **Coal-to-Liquids** | | | | | | | | | |
| Australia and New Zealand | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| China | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.5 | — |
| Germany | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| South Africa | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.6 |
| United States | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | — |
| **Gas-to-Liquids** | | | | | | | | | |
| Qatar | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 17.1 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G4. World Total Liquids Production by Region and Country, High Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.7** | **34.4** | **35.4** | **31.1** | **29.0** | **28.2** | **28.2** | **-0.9** |
| **Middle East** | **16.1** | **23.6** | **23.1** | **23.8** | **20.8** | **19.6** | **19.0** | **19.1** | **-0.9** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 3.2 | 2.7 | 2.6 | 2.6 | -1.9 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.3 | 2.9 | 2.9 | 3.0 | 1.7 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.2 | 1.9 | 1.8 | 1.8 | -1.6 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.6 | 1.7 | 1.7 | 1.9 | 2.0 |
| Saudi Arabia | 7.0 | 10.7 | 10.2 | 10.0 | 9.1 | 8.2 | 7.9 | 7.9 | -1.2 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 2.5 | 2.2 | 2.0 | 1.9 | -1.7 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **3.6** | **3.2** | **2.9** | **2.8** | **-1.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.2 | 2.0 | 1.9 | 1.8 | -0.6 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.4 | 1.1 | 1.0 | 1.0 | -2.4 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **4.5** | **4.0** | **3.9** | **3.8** | **-0.1** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.0 | 1.7 | 1.6 | 1.6 | 0.5 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 2.5 | 2.4 | 2.3 | 2.2 | -0.5 |
| **South America** | **2.5** | **3.3** | **3.2** | **2.8** | **2.2** | **2.3** | **2.4** | **2.5** | **-1.1** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | -2.8 |
| Venezuela | 2.3 | 2.7 | 2.7 | 2.3 | 1.9 | 2.0 | 2.1 | 2.2 | -0.9 |
| **Non-OPEC** | **42.8** | **49.9** | **50.4** | **50.8** | **52.6** | **54.9** | **58.5** | **61.8** | **0.9** |
| **OECD** | **20.0** | **21.7** | **21.7** | **21.5** | **22.0** | **24.1** | **26.9** | **27.8** | **1.0** |
| **OECD North America** | **14.7** | **15.3** | **15.5** | **16.2** | **17.4** | **20.1** | **23.0** | **23.8** | **1.8** |
| United States | 9.7 | 8.3 | 8.6 | 9.7 | 10.5 | 12.4 | 13.9 | 14.3 | 2.3 |
| Canada | 2.0 | 3.3 | 3.4 | 3.7 | 4.7 | 6.0 | 7.3 | 7.6 | 3.5 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.1 | 1.7 | 1.8 | 2.0 | -2.6 |
| **OECD Europe** | **4.5** | **5.6** | **5.4** | **4.6** | **4.0** | **3.4** | **3.2** | **3.2** | **-2.3** |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.7** | **0.7** | **0.8** | **0.3** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.8 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.6 | -0.2 |
| **Non-OECD** | **22.8** | **28.2** | **28.7** | **29.3** | **30.5** | **30.8** | **31.6** | **34.0** | **0.8** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.7** | **13.3** | **13.5** | **13.5** | **14.1** | **0.6** |
| Russia | 10.1 | 9.7 | 9.9 | 9.4 | 9.3 | 9.6 | 9.5 | 9.8 | 0.1 |
| Caspian Area | 1.1 | 2.3 | 2.6 | 2.9 | 3.8 | 3.7 | 3.8 | 4.1 | 2.4 |
| Other | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -2.1 |
| **Non-OECD Asia** | **6.0** | **7.8** | **7.7** | **7.9** | **7.6** | **7.2** | **7.5** | **8.3** | **0.3** |
| China | 2.8 | 3.9 | 3.9 | 4.1 | 3.7 | 3.5 | 3.6 | 4.4 | 0.5 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 1.2 | 1.2 | 1.5 |
| Other | 2.5 | 3.0 | 2.9 | 2.9 | 3.0 | 2.7 | 2.6 | 2.7 | -0.5 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.5** | **1.2** | **1.1** | **1.0** | **-1.9** |
| **Africa** | **1.7** | **2.5** | **2.6** | **2.7** | **2.7** | **2.7** | **2.7** | **2.9** | **0.5** |
| **Central and South America** | **2.2** | **4.0** | **4.1** | **4.5** | **5.3** | **6.2** | **6.9** | **7.7** | **2.8** |
| Brazil | 0.9 | 2.1 | 2.3 | 2.7 | 3.6 | 4.4 | 4.9 | 5.3 | 3.8 |
| Other | 1.3 | 1.8 | 1.8 | 1.8 | 1.7 | 1.8 | 2.0 | 2.4 | 1.1 |
| **Total World** | **66.5** | **84.6** | **84.8** | **86.2** | **83.7** | **84.0** | **86.7** | **90.0** | **0.3** |
| OPEC Share of World Production | 36% | 41% | 41% | 41% | 37% | 35% | 33% | 31% | |
| Persian Gulf Share of World Production | 24% | 28% | 27% | 28% | 25% | 23% | 22% | 21% | |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G5. World Conventional Liquids Production by Region and Country, High Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.0** | **33.7** | **34.8** | **30.5** | **28.3** | **27.3** | **27.2** | **-0.9** |
| **Middle East** | **16.1** | **23.5** | **23.0** | **23.7** | **20.7** | **19.4** | **18.8** | **18.9** | **-0.9** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 3.2 | 2.7 | 2.6 | 2.6 | -1.9 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.3 | 2.9 | 2.9 | 3.0 | 1.7 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.2 | 1.9 | 1.8 | 1.8 | -1.6 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.6 |
| Saudi Arabia | 7.0 | 10.6 | 10.2 | 10.0 | 9.1 | 8.2 | 7.9 | 7.9 | -1.2 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 2.5 | 2.2 | 2.0 | 1.9 | -1.7 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **3.6** | **3.2** | **2.9** | **2.8** | **-1.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.2 | 2.0 | 1.9 | 1.8 | -0.6 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.4 | 1.1 | 1.0 | 1.0 | -2.4 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **4.5** | **4.0** | **3.8** | **3.7** | **-0.1** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.0 | 1.7 | 1.6 | 1.6 | 0.5 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 2.5 | 2.3 | 2.2 | 2.1 | -0.6 |
| **South America** | 2.5 | 2.7 | 2.6 | 2.2 | 1.7 | 1.7 | 1.8 | 1.7 | -1.9 |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | -2.8 |
| Venezuela | 2.3 | 2.1 | 2.1 | 1.8 | 1.4 | 1.4 | 1.5 | 1.4 | -1.7 |
| **Non-OPEC** | **42.0** | **47.5** | **47.4** | **46.3** | **45.2** | **44.1** | **44.2** | **45.1** | **-0.2** |
| **OECD** | **19.5** | **19.8** | **19.4** | **18.0** | **16.4** | **16.0** | **16.7** | **16.6** | **-0.7** |
| **OECD North America** | **14.3** | **13.6** | **13.4** | **13.0** | **12.2** | **12.7** | **13.6** | **13.6** | **0.0** |
| United States | 9.6 | 7.8 | 7.8 | 8.5 | 8.7 | 10.0 | 11.1 | 11.0 | 1.4 |
| Canada | 1.7 | 2.1 | 2.1 | 1.8 | 1.5 | 1.1 | 1.0 | 0.9 | -3.4 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.0 | 1.6 | 1.6 | 1.7 | -3.2 |
| **OECD Europe** | **4.5** | **5.5** | **5.2** | **4.2** | **3.5** | **2.8** | **2.5** | **2.4** | **-3.4** |
| Denmark | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -6.5 |
| Norway | 1.7 | 2.8 | 2.6 | 2.2 | 1.8 | 1.4 | 1.3 | 1.2 | -3.5 |
| United Kngdom | 2.0 | 1.7 | 1.7 | 1.2 | 0.9 | 0.7 | 0.6 | 0.6 | -4.1 |
| Other | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | -0.9 |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.6** | **0.6** | **0.6** | **-0.7** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | -1.0 |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

**Table G5. World Conventional Liquids Production by Region and Country, High Oil Price Case, 1990-2030 (Continued)**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD** | **22.5** | **27.7** | **28.0** | **28.3** | **28.8** | **28.0** | **27.5** | **28.4** | **0.1** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.6** | **13.3** | **13.5** | **13.5** | **14.1** | **0.6** |
| **Russia** | **10.1** | **9.7** | **9.9** | **9.4** | **9.3** | **9.6** | **9.5** | **9.8** | **0.1** |
| **Caspian Area** | **1.1** | **2.3** | **2.6** | **2.9** | **3.8** | **3.7** | **3.8** | **4.1** | **2.4** |
| Azerbaijan | 0.3 | 0.6 | 0.8 | 1.1 | 1.0 | 0.9 | 0.9 | 0.9 | 1.4 |
| Kazakhstan | 0.6 | 1.4 | 1.4 | 1.6 | 2.5 | 2.5 | 2.6 | 2.9 | 3.1 |
| Turkmenistan | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.0 |
| Uzbekistan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.7 |
| **Other** | **0.4** | **0.3** | **0.3** | **0.3** | **0.2** | **0.2** | **0.2** | **0.2** | **-2.2** |
| **Non-OECD Asia** | **6.0** | **7.7** | **7.7** | **7.7** | **7.2** | **6.4** | **5.8** | **5.5** | **-1.4** |
| China | 2.8 | 3.9 | 3.9 | 4.0 | 3.4 | 3.0 | 2.6 | 2.5 | -1.8 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | -0.2 |
| Brunei | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -3.3 |
| Malaysia | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | -0.9 |
| Thailand | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 |
| Vietnam | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | -0.4 |
| Other | 1.6 | 1.4 | 1.3 | 1.3 | 1.3 | 1.0 | 0.9 | 0.9 | -2.0 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.5** | **1.2** | **1.1** | **1.0** | **-1.9** |
| Oman | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.6 | 0.6 | 0.6 | -0.9 |
| Syria | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 | -2.1 |
| Yemen | 0.2 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | -4.5 |
| Other | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | -1.2 |
| **Africa** | **1.6** | **2.4** | **2.4** | **2.5** | **2.4** | **2.2** | **2.1** | **2.2** | **-0.4** |
| Chad | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | -4.8 |
| Congo (Brazzaville) | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1.2 |
| Egypt | 0.9 | 0.7 | 0.7 | 0.5 | 0.5 | 0.6 | 0.5 | 0.5 | -0.9 |
| Equatorial Guniea | 0.0 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | -1.2 |
| Gabon | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -2.8 |
| Sao Tome and Principe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Sudan | 0.0 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 1.4 |
| Other | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | -0.4 |
| **Central and South America** | **2.0** | **3.7** | **3.7** | **4.0** | **4.4** | **4.8** | **5.0** | **5.6** | **1.7** |
| Brazil | 0.7 | 1.9 | 1.9 | 2.2 | 2.9 | 3.4 | 3.6 | 3.9 | 3.2 |
| Argentina | 0.5 | 0.8 | 0.8 | 0.7 | 0.5 | 0.4 | 0.3 | 0.3 | -4.0 |
| Colombia | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 | -2.7 |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 3.6 |
| Trinidad and Tobago | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -1.7 |
| Other | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.7 | 5.5 |
| **Total World** | **65.7** | **81.5** | **81.1** | **81.2** | **75.8** | **72.4** | **71.6** | **72.2** | **-0.5** |
| OPEC Share of World Production | 36% | 42% | 42% | 43% | 40% | 39% | 38% | 38% | |
| Persian Gulf Share of World Production | 25% | 29% | 28% | 29% | 27% | 27% | 26% | 26% | |

Note: Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain.
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G6. World Unconventional Liquids Production by Region and Country, High Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **0.0** | **0.7** | **0.7** | **0.6** | **0.6** | **0.7** | **0.9** | **1.1** | **1.9** |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Extra-Heavy Oil (Venezuela) | 0.0 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.6 | 0.8 | 1.0 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids (primarily Qatar) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 18.1 |
| **Non-OPEC** | **0.7** | **2.4** | **3.0** | **4.5** | **7.3** | **10.9** | **14.3** | **16.7** | **8.5** |
| **OECD** | **0.5** | **1.9** | **2.3** | **3.5** | **5.6** | **8.1** | **10.2** | **11.1** | **7.7** |
| Biofuels | 0.0 | 0.5 | 0.6 | 1.3 | 1.9 | 2.7 | 3.1 | 3.3 | 8.6 |
| Oil Sands/Bitumen (Canada) | 0.4 | 1.2 | 1.4 | 1.9 | 3.2 | 4.7 | 6.1 | 6.5 | 7.2 |
| Extra-Heavy Oil (Mexico) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 15.4 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 26.6 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| **Non-OECD** | **0.3** | **0.5** | **0.7** | **1.0** | **1.7** | **2.8** | **4.1** | **5.5** | **10.4** |
| Biofuels | 0.2 | 0.3 | 0.4 | 0.7 | 1.4 | 2.2 | 3.1 | 3.8 | 10.5 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.5 | 0.9 | 1.7 | 10.7 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 |
| **World** | | | | | | | | | |
| Biofuels | 0.2 | 0.8 | 1.1 | 2.0 | 3.4 | 5.0 | 6.2 | 7.2 | 9.5 |
| Oil Sands/Bitumen | 0.4 | 1.2 | 1.4 | 1.9 | 3.2 | 4.7 | 6.1 | 6.5 | 7.2 |
| Extra-Heavy Oil | 0.0 | 0.6 | 0.6 | 0.6 | 0.5 | 0.6 | 0.7 | 0.8 | 1.4 |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.6 | 1.1 | 2.0 | 11.4 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.7 | 23.1 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 14.0 |
| **World Total** | **0.8** | **3.1** | **3.7** | **5.0** | **7.9** | **11.6** | **15.2** | **17.8** | **7.6** |
| **Selected Country Highlights** | | | | | | | | | |
| **Biofuels** | | | | | | | | | |
| Brazil | 0.2 | 0.3 | 0.3 | 0.4 | 0.7 | 1.0 | 1.2 | 1.3 | 6.7 |
| China | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 14.2 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 19.9 |
| United States | 0.0 | 0.3 | 0.5 | 0.9 | 1.4 | 1.8 | 1.9 | 2.0 | 7.7 |
| **Coal-to-Liquids** | | | | | | | | | |
| Australia and New Zealand | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| China | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 1.2 | — |
| Germany | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| South Africa | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 3.2 |
| United States | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | — |
| **Gas-to-Liquids** | | | | | | | | | |
| Qatar | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 16.9 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G7. World Total Liquids Production by Region and Country, Low Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.7** | **34.4** | **36.2** | **44.9** | **49.1** | **53.2** | **57.4** | **2.1** |
| **Middle East** | **16.1** | **23.6** | **23.1** | **24.1** | **29.3** | **32.2** | **34.8** | **37.6** | **2.0** |
| Iran | 3.1 | 4.1 | 4.0 | 4.3 | 4.7 | 4.8 | 5.1 | 5.6 | 1.2 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 3.4 | 5.3 | 6.0 | 6.7 | 5.1 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.8 | 3.2 | 3.2 | 3.4 | 3.8 | 1.4 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 2.1 | 2.4 | 2.6 | 2.9 | 3.9 |
| Saudi Arabia | 7.0 | 10.7 | 10.2 | 10.1 | 12.4 | 13.1 | 14.0 | 15.2 | 1.5 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.5 | 3.5 | 3.6 | 3.5 | 0.8 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **5.0** | **5.2** | **5.3** | **5.5** | **1.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 3.0 | 3.3 | 3.5 | 3.5 | 2.1 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 2.0 | 1.9 | 1.9 | 2.0 | 0.3 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **6.6** | **7.0** | **7.5** | **8.0** | **3.0** |
| Angola | 0.5 | 1.4 | 1.8 | 2.4 | 3.0 | 3.0 | 3.3 | 3.6 | 3.9 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.5 | 3.6 | 4.0 | 4.2 | 4.3 | 2.4 |
| **South America** | **2.5** | **3.3** | **3.2** | **3.1** | **4.0** | **4.7** | **5.6** | **6.4** | **2.8** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.5 |
| Venezuela | 2.3 | 2.7 | 2.7 | 2.7 | 3.5 | 4.2 | 5.0 | 5.8 | 3.1 |
| **Non-OPEC** | **42.8** | **49.9** | **50.4** | **50.6** | **52.3** | **55.9** | **58.8** | **62.7** | **1.0** |
| **OECD** | **20.0** | **21.7** | **21.7** | **21.4** | **20.7** | **20.5** | **21.2** | **22.0** | **0.1** |
| **OECD North America** | **14.7** | **15.3** | **15.5** | **16.1** | **15.9** | **16.1** | **17.1** | **17.8** | **0.6** |
| United States | 9.7 | 8.3 | 8.6 | 9.8 | 10.1 | 10.0 | 10.3 | 10.4 | 0.9 |
| Canada | 2.0 | 3.3 | 3.4 | 3.7 | 3.7 | 4.1 | 4.5 | 4.8 | 1.6 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.2 | 2.0 | 2.2 | 2.6 | -1.4 |
| **OECD Europe** | **4.5** | **5.6** | **5.4** | **4.5** | **4.0** | **3.6** | **3.4** | **3.3** | **-2.2** |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.8** | **0.8** | **0.8** | **0.9** | **0.7** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 2.5 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.0 |
| **Non-OECD** | **22.8** | **28.2** | **28.7** | **29.1** | **31.6** | **35.5** | **37.6** | **40.8** | **1.5** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.7** | **14.2** | **16.8** | **18.3** | **20.4** | **2.1** |
| Russia | 10.1 | 9.7 | 9.9 | 9.5 | 10.0 | 12.1 | 13.2 | 14.6 | 1.7 |
| Caspian Area | 1.1 | 2.3 | 2.6 | 3.0 | 4.0 | 4.5 | 4.8 | 5.5 | 3.7 |
| Other | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -1.6 |
| **Non-OECD Asia** | **6.0** | **7.8** | **7.7** | **7.9** | **7.9** | **7.9** | **7.5** | **7.4** | **-0.2** |
| China | 2.8 | 3.9 | 3.9 | 4.1 | 3.9 | 3.8 | 3.6 | 3.5 | -0.4 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 | 1.2 | 1.1 | 1.1 |
| Other | 2.5 | 3.0 | 2.9 | 2.9 | 3.1 | 3.0 | 2.8 | 2.7 | -0.4 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.4** | **1.2** | **1.2** | **-1.4** |
| **Africa** | **1.7** | **2.5** | **2.6** | **2.6** | **2.7** | **2.8** | **2.8** | **2.8** | **0.3** |
| **Central and South America** | **2.2** | **4.0** | **4.1** | **4.4** | **5.2** | **6.7** | **7.8** | **9.1** | **3.5** |
| Brazil | 0.9 | 2.1 | 2.3 | 2.5 | 3.5 | 4.9 | 5.8 | 6.8 | 4.9 |
| Other | 1.3 | 1.8 | 1.8 | 1.8 | 1.7 | 1.8 | 2.0 | 2.3 | 1.0 |
| **Total World** | **66.5** | **84.6** | **84.8** | **86.8** | **97.2** | **105.0** | **112.0** | **120.2** | **1.5** |
| OPEC Share of World Production | 36% | 41% | 41% | 42% | 46% | 47% | 47% | 48% | |
| Persian Gulf Share of World Production | 24% | 28% | 27% | 28% | 30% | 31% | 31% | 31% | |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G8. World Conventional Liquids Production by Region and Country, Low Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.0** | **33.7** | **35.3** | **43.2** | **47.0** | **50.6** | **54.2** | **2.0** |
| **Middle East** | **16.1** | **23.5** | **23.0** | **24.1** | **29.2** | **32.0** | **34.6** | **37.5** | **2.0** |
| Iran | 3.1 | 4.1 | 4.0 | 4.3 | 4.7 | 4.8 | 5.1 | 5.6 | 1.2 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 3.4 | 5.3 | 6.0 | 6.7 | 5.1 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.8 | 3.2 | 3.2 | 3.4 | 3.8 | 1.4 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 2.0 | 2.2 | 2.4 | 2.7 | 3.7 |
| Saudi Arabia | 7.0 | 10.6 | 10.2 | 10.1 | 12.4 | 13.1 | 14.0 | 15.2 | 1.5 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.5 | 3.5 | 3.6 | 3.5 | 0.8 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **5.0** | **5.2** | **5.3** | **5.5** | **1.4** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 3.0 | 3.3 | 3.5 | 3.5 | 2.1 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 2.0 | 1.9 | 1.9 | 2.0 | 0.3 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **6.6** | **7.0** | **7.5** | **7.9** | **3.0** |
| Angola | 0.5 | 1.4 | 1.8 | 2.4 | 3.0 | 3.0 | 3.3 | 3.6 | 3.9 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.5 | 3.6 | 3.9 | 4.2 | 4.3 | 2.4 |
| **South America** | **2.5** | **2.7** | **2.6** | **2.3** | **2.4** | **2.8** | **3.2** | **3.3** | **0.9** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.5 |
| Venezuela | 2.3 | 2.1 | 2.1 | 1.8 | 1.9 | 2.3 | 2.6 | 2.7 | 1.0 |
| **Non-OPEC** | **42.0** | **47.5** | **47.4** | **46.6** | **47.4** | **49.5** | **50.7** | **53.6** | **0.5** |
| **OECD** | **19.5** | **19.8** | **19.4** | **18.1** | **16.7** | **15.4** | **15.1** | **15.3** | **-1.1** |
| **OECD North America** | **14.3** | **13.6** | **13.4** | **13.1** | **12.2** | **11.4** | **11.4** | **11.7** | **-0.6** |
| United States | 9.6 | 7.8 | 7.8 | 8.6 | 8.5 | 8.3 | 8.2 | 8.2 | 0.2 |
| Canada | 1.7 | 2.1 | 2.1 | 1.8 | 1.5 | 1.2 | 1.1 | 1.0 | -3.0 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.2 | 1.9 | 2.1 | 2.5 | -1.6 |
| **OECD Europe** | **4.5** | **5.5** | **5.2** | **4.3** | **3.7** | **3.2** | **3.0** | **2.8** | **-2.7** |
| Denmark | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -5.9 |
| Norway | 1.7 | 2.8 | 2.6 | 2.2 | 1.9 | 1.6 | 1.4 | 1.3 | -3.1 |
| United Kngdom | 2.0 | 1.7 | 1.7 | 1.2 | 1.0 | 0.8 | 0.7 | 0.7 | -3.6 |
| Other | 0.7 | 0.7 | 0.7 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.8** | **0.8** | **0.7** | **0.8** | **0.2** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 1.8 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.8 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | -0.4 |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

**Table G8. World Conventional Liquids Production by Region and Country, Low Oil Price Case, 1990-2030 (Continued)**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD** | **22.5** | **27.7** | **28.0** | **28.5** | **30.7** | **34.1** | **35.6** | **38.3** | **1.4** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.7** | **14.2** | **16.8** | **18.3** | **20.4** | **2.1** |
| **Russia** | **10.1** | **9.7** | **9.9** | **9.5** | **10.0** | **12.1** | **13.2** | **14.6** | **1.7** |
| **Caspian Area** | **1.1** | **2.3** | **2.6** | **3.0** | **4.0** | **4.5** | **4.8** | **5.5** | **3.7** |
| Azerbaijan | 0.3 | 0.6 | 0.8 | 1.1 | 1.1 | 1.1 | 1.2 | 1.3 | 2.8 |
| Kazakhstan | 0.6 | 1.4 | 1.4 | 1.6 | 2.6 | 3.0 | 3.3 | 3.9 | 4.4 |
| Turkmenistan | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 2.3 |
| Uzbekistan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.5 |
| **Other** | **0.4** | **0.3** | **0.3** | **0.3** | **0.2** | **0.2** | **0.2** | **0.2** | **-1.5** |
| **Non-OECD Asia** | **6.0** | **7.7** | **7.7** | **7.7** | **7.7** | **7.5** | **6.9** | **6.4** | **-0.8** |
| China | 2.8 | 3.9 | 3.9 | 4.0 | 3.7 | 3.6 | 3.2 | 3.0 | -1.0 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 | 0.9 | 0.3 |
| Brunei | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | -2.8 |
| Malaysia | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | -0.4 |
| Thailand | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 |
| Vietnam | 0.1 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.0 |
| Other | 1.6 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.1 | 1.0 | -1.5 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.4** | **1.2** | **1.2** | **-1.4** |
| Oman | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.7 | 0.7 | 0.7 | -0.4 |
| Syria | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | -1.7 |
| Yemen | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | -4.0 |
| Other | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | -0.5 |
| **Africa** | **1.6** | **2.4** | **2.4** | **2.5** | **2.5** | **2.6** | **2.5** | **2.5** | **0.2** |
| Chad | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -4.2 |
| Congo (Brazzaville) | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 1.7 |
| Egypt | 0.9 | 0.7 | 0.7 | 0.5 | 0.6 | 0.7 | 0.6 | 0.6 | -0.4 |
| Equatorial Guniea | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | -0.7 |
| Gabon | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | -2.2 |
| Sao Tome and Principe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | — |
| Sudan | 0.0 | 0.4 | 0.5 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 2.0 |
| Other | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 |
| **Central and South America** | **2.0** | **3.7** | **3.7** | **4.0** | **4.7** | **5.9** | **6.7** | **7.8** | **3.2** |
| Brazil | 0.7 | 1.9 | 1.9 | 2.2 | 3.2 | 4.4 | 5.1 | 6.0 | 5.0 |
| Argentina | 0.5 | 0.8 | 0.8 | 0.8 | 0.5 | 0.4 | 0.4 | 0.3 | -3.5 |
| Colombia | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | -2.0 |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 4.1 |
| Trinidad and Tobago | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -1.5 |
| Other | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.8 | 6.2 |
| **Total World** | **65.7** | **81.5** | **81.1** | **81.9** | **90.7** | **96.5** | **101.4** | **107.8** | **1.2** |
| OPEC Share of World Production | 36% | 42% | 42% | 43% | 48% | 49% | 50% | 50% | |
| Persian Gulf Share of World Production | 25% | 29% | 28% | 29% | 32% | 33% | 34% | 35% | |

Note: Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain.
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G9. World Unconventional Liquids Production by Region and Country, Low Oil Price Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **0.0** | **0.7** | **0.7** | **0.9** | **1.6** | **2.1** | **2.6** | **3.3** | **6.7** |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Extra-Heavy Oil (Venezuela) | 0.0 | 0.6 | 0.6 | 0.9 | 1.5 | 1.9 | 2.3 | 3.0 | 7.0 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids (primarily Qatar) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 16.9 |
| **Non-OPEC** | **0.7** | **2.4** | **3.0** | **4.0** | **4.9** | **6.4** | **8.1** | **9.1** | **5.8** |
| **OECD** | **0.5** | **1.9** | **2.3** | **3.3** | **4.0** | **5.0** | **6.1** | **6.7** | **5.4** |
| Biofuels | 0.0 | 0.5 | 0.6 | 1.2 | 1.4 | 1.8 | 2.3 | 2.5 | 7.3 |
| Oil Sands/Bitumen (Canada) | 0.4 | 1.2 | 1.4 | 1.8 | 2.1 | 2.8 | 3.3 | 3.7 | 4.6 |
| Extra-Heavy Oil (Mexico) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Non-OECD** | **0.3** | **0.5** | **0.7** | **0.7** | **0.9** | **1.4** | **2.0** | **2.5** | **6.8** |
| Biofuels | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 1.2 | 1.8 | 2.2 | 8.1 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 1.6 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.4 |
| **World** | | | | | | | | | |
| Biofuels | 0.2 | 0.8 | 1.1 | 1.7 | 2.2 | 3.1 | 4.1 | 4.8 | 7.7 |
| Oil Sands/Bitumen | 0.4 | 1.2 | 1.4 | 1.8 | 2.1 | 2.8 | 3.3 | 3.7 | 4.6 |
| Extra-Heavy Oil | 0.0 | 0.6 | 0.6 | 0.9 | 1.5 | 1.9 | 2.4 | 3.1 | 7.0 |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 2.4 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 17.2 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.4 |
| **World Total** | **0.8** | **3.1** | **3.7** | **4.9** | **6.5** | **8.5** | **10.7** | **12.4** | **6.0** |
| **Selected Country Highlights** | | | | | | | | | |
| **Biofuels** | | | | | | | | | |
| Brazil | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 | 4.4 |
| China | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 11.7 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 17.3 |
| United States | 0.0 | 0.3 | 0.5 | 0.9 | 1.1 | 1.3 | 1.7 | 1.7 | 7.0 |
| **Coal-to-Liquids** | | | | | | | | | |
| Australia and New Zealand | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| China | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| Germany | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.5 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| South Africa | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -3.4 |
| United States | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| **Gas-to-Liquids** | | | | | | | | | |
| Qatar | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 15.7 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G10. World Total Liquids Production by Region and Country, High Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.7** | **34.4** | **35.7** | **39.2** | **42.0** | **44.4** | **47.9** | **1.4** |
| **Middle East** | **16.1** | **23.6** | **23.1** | **23.9** | **26.0** | **28.1** | **29.7** | **32.3** | **1.3** |
| Iran | 3.1 | 4.1 | 4.0 | 4.3 | 4.1 | 4.1 | 4.3 | 4.7 | 0.6 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 3.0 | 4.5 | 5.0 | 5.6 | 4.4 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 3.2 | 0.8 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.9 | 2.2 | 2.4 | 2.7 | 3.7 |
| Saudi Arabia | 7.0 | 10.7 | 10.2 | 10.0 | 11.2 | 11.4 | 11.9 | 12.8 | 0.8 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.1 | 3.1 | 3.1 | 3.1 | 0.3 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.5** | **4.6** | **4.6** | **4.8** | **0.8** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.7 | 2.9 | 3.0 | 3.1 | 1.6 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.8 | 1.6 | 1.6 | 1.7 | -0.2 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.8** | **6.0** | **6.3** | **6.8** | **2.4** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.6 | 2.6 | 2.7 | 3.0 | 3.2 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.2 | 3.5 | 3.6 | 3.8 | 1.8 |
| **South America** | **2.5** | **3.3** | **3.2** | **2.9** | **2.9** | **3.3** | **3.7** | **4.0** | **0.9** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | -0.3 |
| Venezuela | 2.3 | 2.7 | 2.7 | 2.4 | 2.4 | 2.9 | 3.2 | 3.5 | 1.1 |
| **Non-OPEC** | **42.8** | **49.9** | **50.4** | **50.9** | **53.8** | **58.6** | **63.6** | **68.4** | **1.3** |
| **OECD** | **20.0** | **21.7** | **21.7** | **21.6** | **21.8** | **22.6** | **24.7** | **26.2** | **0.8** |
| **OECD North America** | **14.7** | **15.3** | **15.5** | **16.2** | **16.9** | **18.1** | **20.2** | **21.5** | **1.4** |
| United States | 9.7 | 8.3 | 8.6 | 9.8 | 10.3 | 11.5 | 12.9 | 13.5 | 2.0 |
| Canada | 2.0 | 3.3 | 3.4 | 3.7 | 4.4 | 4.7 | 5.1 | 5.5 | 2.1 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.2 | 2.0 | 2.2 | 2.5 | -1.6 |
| **OECD Europe** | **4.5** | **5.6** | **5.4** | **4.6** | **4.1** | **3.7** | **3.7** | **3.8** | **-1.7** |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.8** | **0.8** | **0.9** | **0.9** | **1.1** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 2.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.6 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.7 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| **Non-OECD** | **22.8** | **28.2** | **28.7** | **29.3** | **32.0** | **35.9** | **38.9** | **42.2** | **1.7** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.7** | **14.1** | **16.2** | **17.4** | **18.8** | **1.8** |
| Russia | 10.1 | 9.7 | 9.9 | 9.5 | 9.9 | 11.6 | 12.5 | 13.4 | 1.4 |
| Caspian Area | 1.1 | 2.3 | 2.6 | 3.0 | 4.0 | 4.4 | 4.7 | 5.2 | 3.4 |
| Other | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | -1.0 |
| **Non-OECD Asia** | **6.0** | **7.8** | **7.7** | **7.9** | **8.0** | **8.3** | **8.7** | **9.2** | **0.7** |
| China | 2.8 | 3.9 | 3.9 | 4.1 | 3.9 | 4.0 | 4.2 | 4.6 | 0.7 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 1.0 | 1.2 | 1.4 | 1.4 | 2.0 |
| Other | 2.5 | 3.0 | 2.9 | 2.9 | 3.1 | 3.1 | 3.1 | 3.2 | 0.3 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.4** | **1.4** | **1.4** | **-0.7** |
| **Africa** | **1.7** | **2.5** | **2.6** | **2.7** | **2.9** | **3.1** | **3.4** | **3.6** | **1.5** |
| **Central and South America** | **2.2** | **4.0** | **4.1** | **4.5** | **5.4** | **6.9** | **8.0** | **9.2** | **3.6** |
| Brazil | 0.9 | 2.1 | 2.3 | 2.6 | 3.7 | 4.9 | 5.7 | 6.5 | 4.7 |
| Other | 1.3 | 1.8 | 1.8 | 1.8 | 1.7 | 1.9 | 2.3 | 2.8 | 1.7 |
| **Total World** | **66.5** | **84.6** | **84.8** | **86.6** | **93.0** | **100.5** | **108.0** | **116.3** | **1.3** |
| OPEC Share of World Production | 36% | 41% | 41% | 41% | 42% | 42% | 41% | 41% | |
| Persian Gulf Share of World Production | 24% | 28% | 27% | 28% | 28% | 28% | 27% | 28% | |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G11. World Conventional Liquids Production by Region and Country, High Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.0** | **33.7** | **35.1** | **38.3** | **40.9** | **43.2** | **46.5** | **1.3** |
| **Middle East** | **16.1** | **23.5** | **23.0** | **23.9** | **25.9** | **27.9** | **29.5** | **32.1** | **1.3** |
| Iran | 3.1 | 4.1 | 4.0 | 4.3 | 4.1 | 4.1 | 4.3 | 4.7 | 0.6 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 3.0 | 4.5 | 5.0 | 5.6 | 4.4 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 3.2 | 0.8 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.8 | 2.0 | 2.2 | 2.5 | 3.3 |
| Saudi Arabia | 7.0 | 10.6 | 10.2 | 10.0 | 11.2 | 11.4 | 11.9 | 12.8 | 0.8 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 3.1 | 3.1 | 3.1 | 3.1 | 0.3 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.5** | **4.6** | **4.6** | **4.8** | **0.8** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.7 | 2.9 | 3.0 | 3.1 | 1.6 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.8 | 1.6 | 1.6 | 1.7 | -0.2 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.7** | **6.0** | **6.3** | **6.8** | **2.3** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.6 | 2.6 | 2.7 | 3.0 | 3.2 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.2 | 3.4 | 3.6 | 3.7 | 1.8 |
| **South America** | **2.5** | **2.7** | **2.6** | **2.3** | **2.2** | **2.5** | **2.8** | **2.9** | **0.3** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | -0.3 |
| Venezuela | 2.3 | 2.1 | 2.1 | 1.8 | 1.7 | 2.0 | 2.3 | 2.4 | 0.4 |
| **Non-OPEC** | **42.0** | **47.5** | **47.4** | **46.5** | **47.3** | **50.4** | **53.1** | **56.1** | **0.7** |
| **OECD** | **19.5** | **19.8** | **19.4** | **18.1** | **16.8** | **16.6** | **17.4** | **17.8** | **-0.4** |
| **OECD North America** | **14.3** | **13.6** | **13.4** | **13.0** | **12.3** | **12.6** | **13.5** | **13.9** | **0.1** |
| United States | 9.6 | 7.8 | 7.8 | 8.5 | 8.7 | 9.5 | 10.3 | 10.5 | 1.2 |
| Canada | 1.7 | 2.1 | 2.1 | 1.8 | 1.5 | 1.3 | 1.1 | 1.1 | -2.7 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.2 | 1.9 | 2.0 | 2.3 | -2.0 |
| **OECD Europe** | **4.5** | **5.5** | **5.2** | **4.3** | **3.7** | **3.3** | **3.1** | **3.1** | **-2.3** |
| Denmark | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | -5.2 |
| Norway | 1.7 | 2.8 | 2.6 | 2.2 | 1.9 | 1.7 | 1.6 | 1.5 | -2.5 |
| United Kngdom | 2.0 | 1.7 | 1.7 | 1.2 | 1.0 | 0.8 | 0.8 | 0.8 | -3.1 |
| Other | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.3 |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.7** | **0.8** | **0.8** | **0.4** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.2 |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

**Table G11. World Conventional Liquids Production by Region and Country, High Economic Growth Case, 1990-2030 (Continued)**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD** | **22.5** | **27.7** | **28.0** | **28.4** | **30.5** | **33.7** | **35.8** | **38.2** | **1.3** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.7** | **14.1** | **16.2** | **17.4** | **18.8** | **1.8** |
| **Russia** | **10.1** | **9.7** | **9.9** | **9.5** | **9.9** | **11.6** | **12.5** | **13.4** | **1.4** |
| **Caspian Area** | **1.1** | **2.3** | **2.6** | **3.0** | **4.0** | **4.4** | **4.7** | **5.2** | **3.4** |
| Azerbaijan | 0.3 | 0.6 | 0.8 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 2.4 |
| Kazakhstan | 0.6 | 1.4 | 1.4 | 1.6 | 2.6 | 2.9 | 3.1 | 3.6 | 4.0 |
| Turkmenistan | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 3.1 |
| Uzbekistan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.0 |
| **Other** | **0.4** | **0.3** | **0.3** | **0.3** | **0.2** | **0.2** | **0.2** | **0.2** | **-1.1** |
| **Non-OECD Asia** | **6.0** | **7.7** | **7.7** | **7.7** | **7.7** | **7.7** | **7.6** | **7.4** | **-0.2** |
| China | 2.8 | 3.9 | 3.9 | 4.0 | 3.7 | 3.7 | 3.5 | 3.5 | -0.4 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | 1.1 | 1.0 | 0.8 |
| Brunei | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | -2.1 |
| Malaysia | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.2 |
| Thailand | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.9 |
| Vietnam | 0.1 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.7 |
| Other | 1.6 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.1 | -0.8 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.6** | **1.4** | **1.4** | **1.4** | **-0.7** |
| Oman | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.8 | 0.8 | 0.8 | 0.3 |
| Syria | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | -1.1 |
| Yemen | 0.2 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -3.2 |
| Other | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | -0.2 |
| **Africa** | **1.6** | **2.4** | **2.4** | **2.5** | **2.5** | **2.7** | **2.8** | **3.0** | **1.0** |
| Chad | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -3.4 |
| Congo (Brazzaville) | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 2.6 |
| Egypt | 0.9 | 0.7 | 0.7 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 0.3 |
| Equatorial Guniea | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.1 |
| Gabon | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | -1.4 |
| Sao Tome and Principe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| Sudan | 0.0 | 0.4 | 0.5 | 0.6 | 0.5 | 0.6 | 0.6 | 0.8 | 2.9 |
| Other | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 1.0 |
| **Central and South America** | **2.0** | **3.7** | **3.7** | **4.0** | **4.7** | **5.8** | **6.6** | **7.6** | **3.1** |
| Brazil | 0.7 | 1.9 | 1.9 | 2.2 | 3.1 | 4.2 | 4.8 | 5.4 | 4.6 |
| Argentina | 0.5 | 0.8 | 0.8 | 0.8 | 0.5 | 0.4 | 0.4 | 0.4 | -3.1 |
| Colombia | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -1.3 |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 4.8 |
| Trinidad and Tobago | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | -1.1 |
| Other | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.6 | 0.9 | 7.0 |
| **Total World** | **65.7** | **81.5** | **81.1** | **81.6** | **85.7** | **91.3** | **96.3** | **102.5** | **1.0** |
| OPEC Share of World Production | 36% | 42% | 42% | 43% | 45% | 45% | 45% | 45% | |
| Persian Gulf Share of World Production | 25% | 29% | 28% | 29% | 30% | 31% | 31% | 31% | |

Note: Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain.
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G12. World Unconventional Liquids Production by Region and Country, High Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **0.0** | **0.7** | **0.7** | **0.7** | **0.8** | **1.1** | **1.2** | **1.4** | **3.1** |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Extra-Heavy Oil (Venezuela) | 0.0 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 2.6 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids (primarily Qatar) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 18.3 |
| **Non-OPEC** | **0.7** | **2.4** | **3.0** | **4.4** | **6.5** | **8.2** | **10.5** | **12.4** | **7.1** |
| **OECD** | **0.5** | **1.9** | **2.3** | **3.5** | **5.0** | **6.0** | **7.3** | **8.4** | **6.4** |
| Biofuels | 0.0 | 0.5 | 0.6 | 1.2 | 1.7 | 2.1 | 2.7 | 3.1 | 8.3 |
| Oil Sands/Bitumen (Canada) | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Extra-Heavy Oil (Mexico) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 14.8 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 26.1 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| **Non-OECD** | **0.3** | **0.5** | **0.7** | **0.9** | **1.5** | **2.2** | **3.2** | **4.0** | **8.9** |
| Biofuels | 0.2 | 0.3 | 0.4 | 0.7 | 1.2 | 1.7 | 2.4 | 2.9 | 9.3 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.7 | 1.0 | 8.2 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| **World** | | | | | | | | | |
| Biofuels | 0.2 | 0.8 | 1.1 | 1.9 | 2.8 | 3.9 | 5.2 | 6.1 | 8.8 |
| Oil Sands/Bitumen | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.3 | 3.8 | 4.2 | 5.3 |
| Extra-Heavy Oil | 0.0 | 0.6 | 0.6 | 0.7 | 0.7 | 0.9 | 1.0 | 1.2 | 2.9 |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 0.9 | 1.2 | 9.3 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 19.4 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 14.0 |
| **World Total** | **0.8** | **3.1** | **3.7** | **5.0** | **7.3** | **9.3** | **11.7** | **13.8** | **6.5** |
| **Selected Country Highlights** | | | | | | | | | |
| **Biofuels** | | | | | | | | | |
| Brazil | 0.2 | 0.3 | 0.3 | 0.4 | 0.6 | 0.8 | 1.0 | 1.0 | 5.6 |
| China | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 13.0 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 18.6 |
| United States | 0.0 | 0.3 | 0.5 | 0.9 | 1.2 | 1.4 | 1.8 | 2.0 | 7.8 |
| **Coal-to-Liquids** | | | | | | | | | |
| Australia and New Zealand | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| China | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.6 | — |
| Germany | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| South Africa | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.9 |
| United States | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | — |
| **Gas-to-Liquids** | | | | | | | | | |
| Qatar | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 17.2 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G13. World Total Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.7** | **34.4** | **35.6** | **37.3** | **38.1** | **38.5** | **39.7** | **0.6** |
| **Middle East** | **16.1** | **23.6** | **23.1** | **23.8** | **24.8** | **25.5** | **25.9** | **26.9** | **0.5** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 3.8 | 3.6 | 3.6 | 3.7 | -0.4 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.8 | 3.9 | 4.2 | 4.4 | 3.3 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.6 | 2.5 | 2.5 | 2.6 | -0.2 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.8 | 2.1 | 2.2 | 2.3 | 3.0 |
| Saudi Arabia | 7.0 | 10.7 | 10.2 | 10.0 | 10.8 | 10.7 | 10.8 | 11.3 | 0.2 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | -0.5 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.2** | **4.1** | **3.9** | **3.9** | **-0.1** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.6 | 2.6 | 2.6 | 2.5 | 0.7 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.7 | 1.5 | 1.4 | 1.4 | -1.1 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.4** | **5.4** | **5.3** | **5.4** | **1.4** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.4 | 2.3 | 2.3 | 2.4 | 2.1 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.0 | 3.1 | 3.1 | 3.0 | 0.9 |
| **South America** | **2.5** | **3.3** | **3.2** | **2.9** | **2.8** | **3.1** | **3.4** | **3.6** | **0.4** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -1.3 |
| Venezuela | 2.3 | 2.7 | 2.7 | 2.4 | 2.4 | 2.7 | 3.0 | 3.2 | 0.6 |
| **Non-OPEC** | **42.8** | **49.9** | **50.4** | **50.6** | **51.1** | **53.6** | **56.0** | **57.7** | **0.6** |
| **OECD** | **20.0** | **21.7** | **21.7** | **21.4** | **21.1** | **21.5** | **23.1** | **23.8** | **0.4** |
| **OECD North America** | **14.7** | **15.3** | **15.5** | **16.1** | **16.5** | **17.3** | **19.0** | **19.8** | **1.1** |
| United States | 9.7 | 8.3 | 8.6 | 9.7 | 10.2 | 11.1 | 12.3 | 12.5 | 1.7 |
| Canada | 2.0 | 3.3 | 3.4 | 3.7 | 4.3 | 4.5 | 4.9 | 5.3 | 2.0 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.1 | 1.8 | 1.9 | 2.0 | -2.5 |
| **OECD Europe** | **4.5** | **5.6** | **5.4** | **4.6** | **3.9** | **3.4** | **3.3** | **3.2** | **-2.3** |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.7** | **0.8** | **0.8** | **0.5** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 2.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.6 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.6 | -0.1 |
| **Non-OECD** | **22.8** | **28.2** | **28.7** | **29.1** | **29.9** | **32.0** | **32.9** | **33.9** | **0.8** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.6** | **13.1** | **14.3** | **14.5** | **14.7** | **0.7** |
| Russia | 10.1 | 9.7 | 9.9 | 9.4 | 9.2 | 10.2 | 10.4 | 10.4 | 0.3 |
| Caspian Area | 1.1 | 2.3 | 2.6 | 2.9 | 3.7 | 3.9 | 3.9 | 4.1 | 2.4 |
| Other | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | -1.8 |
| **Non-OECD Asia** | **6.0** | **7.8** | **7.7** | **7.9** | **7.5** | **7.5** | **7.5** | **7.6** | **-0.1** |
| China | 2.8 | 3.9 | 3.9 | 4.1 | 3.7 | 3.6 | 3.6 | 3.7 | -0.2 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | 1.2 | 1.2 | 1.4 |
| Other | 2.5 | 3.0 | 2.9 | 2.9 | 2.9 | 2.8 | 2.7 | 2.7 | -0.5 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.5** | **1.3** | **1.2** | **1.1** | **-1.6** |
| **Africa** | **1.7** | **2.5** | **2.6** | **2.7** | **2.7** | **2.8** | **2.8** | **2.9** | **0.6** |
| **Central and South America** | **2.2** | **4.0** | **4.1** | **4.5** | **5.1** | **6.2** | **6.9** | **7.5** | **2.7** |
| Brazil | 0.9 | 2.1 | 2.3 | 2.6 | 3.5 | 4.4 | 4.9 | 5.2 | 3.8 |
| Other | 1.3 | 1.8 | 1.8 | 1.8 | 1.6 | 1.8 | 2.0 | 2.3 | 1.0 |
| **Total World** | **66.5** | **84.6** | **84.8** | **86.1** | **88.3** | **91.6** | **94.5** | **97.4** | **0.6** |
| OPEC Share of World Production | 36% | 41% | 41% | 41% | 42% | 42% | 41% | 41% | |
| Persian Gulf Share of World Production | 24% | 28% | 27% | 28% | 28% | 28% | 27% | 28% | |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G14. World Conventional Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **23.7** | **34.0** | **33.7** | **34.9** | **36.4** | **37.0** | **37.3** | **38.2** | **0.5** |
| **Middle East** | **16.1** | **23.5** | **23.0** | **23.8** | **24.7** | **25.3** | **25.7** | **26.7** | **0.5** |
| Iran | 3.1 | 4.1 | 4.0 | 4.2 | 3.8 | 3.6 | 3.6 | 3.7 | -0.4 |
| Iraq | 2.1 | 2.0 | 2.1 | 2.5 | 2.8 | 3.9 | 4.2 | 4.4 | 3.3 |
| Kuwait | 1.2 | 2.7 | 2.6 | 2.7 | 2.6 | 2.5 | 2.5 | 2.6 | -0.2 |
| Qatar | 0.4 | 1.1 | 1.1 | 1.4 | 1.7 | 1.9 | 2.0 | 2.1 | 2.6 |
| Saudi Arabia | 7.0 | 10.6 | 10.2 | 10.0 | 10.8 | 10.7 | 10.8 | 11.3 | 0.3 |
| United Arab Emirates | 2.3 | 2.9 | 2.9 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | -0.5 |
| **North Africa** | **2.7** | **3.9** | **4.0** | **4.1** | **4.2** | **4.1** | **3.9** | **3.9** | **-0.1** |
| Algeria | 1.3 | 2.1 | 2.2 | 2.2 | 2.6 | 2.6 | 2.6 | 2.5 | 0.7 |
| Libya | 1.4 | 1.8 | 1.8 | 1.9 | 1.7 | 1.5 | 1.4 | 1.4 | -1.1 |
| **West Africa** | **2.3** | **3.9** | **4.1** | **4.8** | **5.4** | **5.3** | **5.3** | **5.3** | **1.3** |
| Angola | 0.5 | 1.4 | 1.8 | 2.3 | 2.4 | 2.3 | 2.3 | 2.4 | 2.1 |
| Nigeria | 1.8 | 2.4 | 2.4 | 2.4 | 3.0 | 3.1 | 3.0 | 3.0 | 0.8 |
| **South America** | **2.5** | **2.7** | **2.6** | **2.2** | **2.0** | **2.2** | **2.4** | **2.3** | **-0.6** |
| Ecuador | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | -1.3 |
| Venezuela | 2.3 | 2.1 | 2.1 | 1.8 | 1.7 | 1.8 | 2.0 | 1.9 | -0.4 |
| **Non-OPEC** | **42.0** | **47.5** | **47.4** | **46.2** | **44.6** | **45.4** | **45.8** | **45.8** | **-0.2** |
| **OECD** | **19.5** | **19.8** | **19.4** | **18.0** | **16.1** | **15.6** | **15.9** | **15.8** | **-0.9** |
| **OECD North America** | **14.3** | **13.6** | **13.4** | **12.9** | **11.9** | **11.9** | **12.5** | **12.5** | **-0.4** |
| United States | 9.6 | 7.8 | 7.8 | 8.5 | 8.4 | 9.1 | 9.8 | 9.7 | 0.9 |
| Canada | 1.7 | 2.1 | 2.1 | 1.8 | 1.5 | 1.2 | 1.1 | 1.0 | -3.1 |
| Mexico | 3.0 | 3.7 | 3.5 | 2.7 | 2.0 | 1.7 | 1.7 | 1.8 | -2.9 |
| **OECD Europe** | **4.5** | **5.5** | **5.2** | **4.2** | **3.5** | **3.0** | **2.7** | **2.6** | **-3.0** |
| Denmark | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -6.2 |
| Norway | 1.7 | 2.8 | 2.6 | 2.2 | 1.8 | 1.5 | 1.4 | 1.2 | -3.3 |
| United Kngdom | 2.0 | 1.7 | 1.7 | 1.2 | 0.9 | 0.7 | 0.7 | 0.7 | -3.8 |
| Other | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | -0.1 |
| **OECD Asia** | **0.8** | **0.7** | **0.8** | **0.8** | **0.7** | **0.7** | **0.7** | **0.7** | **-0.2** |
| Japan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.2 |
| South Korea | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.1 |
| Australia and New Zealand | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | -0.7 |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

**Table G14. World Conventional Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030 (Continued)**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **Non-OECD** | **22.5** | **27.7** | **28.0** | **28.2** | **28.5** | **29.8** | **29.8** | **30.0** | **0.3** |
| **Non-OECD Europe and Eurasia** | **11.6** | **12.3** | **12.8** | **12.6** | **13.1** | **14.3** | **14.5** | **14.7** | **0.7** |
| **Russia** | **10.1** | **9.7** | **9.9** | **9.4** | **9.2** | **10.2** | **10.4** | **10.4** | **0.3** |
| **Caspian Area** | **1.1** | **2.3** | **2.6** | **2.9** | **3.7** | **3.9** | **3.9** | **4.1** | **2.4** |
| Azerbaijan | 0.3 | 0.6 | 0.8 | 1.1 | 1.0 | 0.9 | 0.9 | 0.9 | 1.3 |
| Kazakhstan | 0.6 | 1.4 | 1.4 | 1.6 | 2.4 | 2.6 | 2.6 | 2.8 | 3.0 |
| Turkmenistan | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.0 |
| Uzbekistan | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -1.7 |
| **Other** | **0.4** | **0.3** | **0.3** | **0.3** | **0.2** | **0.2** | **0.2** | **0.2** | **-1.8** |
| **Non-OECD Asia** | **6.0** | **7.7** | **7.7** | **7.7** | **7.2** | **6.9** | **6.4** | **6.0** | **-1.1** |
| China | 2.8 | 3.9 | 3.9 | 3.9 | 3.4 | 3.2 | 2.9 | 2.8 | -1.4 |
| India | 0.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 | 0.9 | 0.1 |
| Brunei | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -3.0 |
| Malaysia | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | -0.7 |
| Thailand | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Vietnam | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | -0.2 |
| Other | 1.6 | 1.4 | 1.3 | 1.3 | 1.3 | 1.1 | 1.0 | 0.9 | -1.7 |
| **Middle East (Non-OPEC)** | **1.3** | **1.6** | **1.5** | **1.5** | **1.5** | **1.3** | **1.2** | **1.1** | **-1.6** |
| Oman | 0.7 | 0.7 | 0.7 | 0.7 | 0.9 | 0.7 | 0.6 | 0.6 | -0.7 |
| Syria | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | -1.9 |
| Yemen | 0.2 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | -4.3 |
| Other | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | -0.8 |
| **Africa** | **1.6** | **2.4** | **2.4** | **2.4** | **2.3** | **2.3** | **2.3** | **2.3** | **-0.1** |
| Chad | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | -4.5 |
| Congo (Brazzaville) | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1.4 |
| Egypt | 0.9 | 0.7 | 0.7 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | -0.7 |
| Equatorial Guniea | 0.0 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | -1.0 |
| Gabon | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | -2.6 |
| Sao Tome and Principe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Sudan | 0.0 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 1.7 |
| Other | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.0 |
| **Central and South America** | **2.0** | **3.7** | **3.7** | **4.0** | **4.4** | **5.1** | **5.5** | **6.0** | **2.0** |
| Brazil | 0.7 | 1.9 | 1.9 | 2.2 | 2.9 | 3.7 | 4.0 | 4.2 | 3.5 |
| Argentina | 0.5 | 0.8 | 0.8 | 0.7 | 0.5 | 0.4 | 0.3 | 0.3 | -3.7 |
| Colombia | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | -2.4 |
| Peru | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 3.8 |
| Trinidad and Tobago | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | -1.6 |
| Other | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.7 | 5.8 |
| **Total World** | **65.7** | **81.5** | **81.1** | **81.1** | **81.1** | **82.4** | **83.0** | **84.1** | **0.1** |
| OPEC Share of World Production | 36% | 42% | 42% | 43% | 45% | 45% | 45% | 45% | |
| Persian Gulf Share of World Production | 25% | 29% | 28% | 29% | 31% | 31% | 31% | 32% | |

Note: Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain.
Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

**Table G15. World Unconventional Liquids Production by Region and Country, Low Economic Growth Case, 1990-2030**
(Million Barrels per Day)

| Region/Country | History (Estimates) | | | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2006 | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OPEC[a]** | **0.0** | **0.7** | **0.7** | **0.7** | **0.8** | **1.1** | **1.3** | **1.5** | **3.4** |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Extra-Heavy Oil (Venezuela) | 0.0 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 1.0 | 1.2 | 2.9 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Gas-to-Liquids (primarily Qatar) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 18.3 |
| **Non-OPEC** | **0.7** | **2.4** | **3.0** | **4.4** | **6.4** | **8.1** | **10.2** | **11.9** | **6.9** |
| **OECD** | **0.5** | **1.9** | **2.3** | **3.5** | **5.0** | **6.0** | **7.2** | **8.0** | **6.3** |
| Biofuels | 0.0 | 0.5 | 0.6 | 1.2 | 1.7 | 2.1 | 2.7 | 2.9 | 8.0 |
| Oil Sands/Bitumen (Canada) | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.2 | 3.7 | 4.1 | 5.2 |
| Extra-Heavy Oil (Mexico) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 14.3 |
| Coal-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 26.0 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| **Non-OECD** | **0.3** | **0.5** | **0.7** | **0.9** | **1.4** | **2.2** | **3.0** | **3.8** | **8.7** |
| Biofuels | 0.2 | 0.3 | 0.4 | 0.7 | 1.2 | 1.7 | 2.3 | 2.9 | 9.2 |
| Extra-Heavy Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.6 | 0.9 | 7.8 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| **World** | | | | | | | | | |
| Biofuels | 0.2 | 0.8 | 1.1 | 1.9 | 2.8 | 3.8 | 5.0 | 5.8 | 8.6 |
| Oil Sands/Bitumen | 0.4 | 1.2 | 1.4 | 1.9 | 2.8 | 3.2 | 3.7 | 4.1 | 5.2 |
| Extra-Heavy Oil | 0.0 | 0.6 | 0.6 | 0.7 | 0.7 | 0.9 | 1.0 | 1.3 | 3.1 |
| Coal-to-Liquids | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 0.8 | 1.1 | 8.9 |
| Gas-to-Liquids | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 19.3 |
| Shale Oil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 13.9 |
| **World Total** | **0.8** | **3.1** | **3.7** | **5.0** | **7.3** | **9.2** | **11.5** | **13.4** | **6.3** |
| **Selected Country Highlights** | | | | | | | | | |
| **Biofuels** | | | | | | | | | |
| Brazil | 0.2 | 0.3 | 0.3 | 0.4 | 0.6 | 0.8 | 0.9 | 1.0 | 5.5 |
| China | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 12.8 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 18.5 |
| United States | 0.0 | 0.3 | 0.5 | 0.9 | 1.2 | 1.4 | 1.8 | 1.9 | 7.4 |
| **Coal-to-Liquids** | | | | | | | | | |
| Australia and New Zealand | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — |
| China | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.5 | — |
| Germany | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | — |
| South Africa | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 2.6 |
| United States | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | — |
| **Gas-to-Liquids** | | | | | | | | | |
| Qatar | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 17.1 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | — |

[a]OPEC = Organization of the Petroleum Exporting Countries (OPEC-12).

Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2009).

Appendix H

# Reference Case Projections for Electricity Capacity and Generation by Fuel

**Table H1. World Total Installed Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **1,132** | **1,209** | **1,231** | **1,284** | **1,367** | **1,453** | **1.0** |
| United States[a] | 959 | 1,021 | 1,024 | 1,061 | 1,130 | 1,201 | 0.9 |
| Canada | 123 | 133 | 146 | 156 | 163 | 170 | 1.4 |
| Mexico | 51 | 55 | 61 | 68 | 74 | 81 | 1.9 |
| **OECD Europe** | **754** | **838** | **925** | **978** | **1,039** | **1,067** | **1.5** |
| **OECD Asia** | **374** | **386** | **410** | **420** | **428** | **436** | **0.6** |
| Japan | 251 | 253 | 259 | 259 | 257 | 255 | 0.1 |
| South Korea | 64 | 70 | 80 | 87 | 94 | 102 | 1.9 |
| Australia/New Zealand | 58 | 63 | 71 | 74 | 77 | 79 | 1.3 |
| **Total OECD** | **2,261** | **2,433** | **2,566** | **2,682** | **2,834** | **2,956** | **1.1** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | 400 | 430 | 463 | 486 | 502 | 515 | 1.1 |
| Russia | 218 | 241 | 264 | 280 | 291 | 300 | 1.3 |
| Other | 182 | 189 | 199 | 206 | 211 | 215 | 0.7 |
| **Non-OECD Asia** | **870** | **1,210** | **1,407** | **1,674** | **1,942** | **2,224** | **4.0** |
| China | 518 | 801 | 924 | 1,116 | 1,310 | 1,510 | 4.6 |
| India | 144 | 177 | 213 | 247 | 278 | 310 | 3.3 |
| Other Non-OECD Asia | 209 | 231 | 270 | 311 | 354 | 404 | 2.8 |
| **Middle East** | **145** | **156** | **167** | **179** | **192** | **208** | **1.5** |
| **Africa** | **110** | **123** | **139** | **154** | **169** | **182** | **2.1** |
| **Central and South America** | **220** | **241** | **278** | **315** | **346** | **366** | **2.1** |
| Brazil | 93 | 108 | 132 | 154 | 177 | 189 | 3.0 |
| Other Central and South America | 127 | 134 | 146 | 161 | 169 | 177 | 1.4 |
| **Total Non-OECD** | **1,746** | **2,160** | **2,453** | **2,808** | **3,151** | **3,496** | **2.9** |
| **Total World** | **4,006** | **4,593** | **5,019** | **5,490** | **5,985** | **6,452** | **2.0** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H2. World Installed Liquids-Fired Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **140** | **140** | **124** | **123** | **122** | **120** | **-0.6** |
| United States[a] | 121 | 121 | 104 | 104 | 104 | 103 | -0.7 |
| Canada | 5 | 5 | 5 | 5 | 5 | 5 | -0.6 |
| Mexico | 14 | 14 | 14 | 13 | 13 | 12 | -0.5 |
| **OECD Europe** | **54** | **54** | **54** | **51** | **49** | **47** | **-0.6** |
| **OECD Asia** | **64** | **65** | **65** | **62** | **59** | **56** | **-0.6** |
| Japan | 57 | 57 | 57 | 55 | 52 | 50 | -0.6 |
| South Korea | 6 | 6 | 6 | 6 | 5 | 5 | -0.5 |
| Australia/New Zealand | 1 | 1 | 1 | 1 | 1 | 1 | -0.4 |
| **Total OECD** | **258** | **259** | **243** | **236** | **230** | **223** | **-0.6** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **29** | **30** | **30** | **28** | **27** | **26** | **-0.5** |
| Russia | 9 | 9 | 9 | 9 | 8 | 8 | -0.5 |
| Other | 21 | 21 | 21 | 20 | 19 | 18 | -0.6 |
| **Non-OECD Asia** | **57** | **59** | **59** | **56** | **54** | **52** | **-0.4** |
| China | 15 | 16 | 16 | 16 | 15 | 15 | -0.2 |
| India | 6 | 6 | 6 | 6 | 6 | 5 | -0.4 |
| Other Non-OECD Asia | 36 | 36 | 37 | 35 | 33 | 32 | -0.4 |
| **Middle East** | **43** | **45** | **46** | **44** | **44** | **45** | **0.2** |
| **Africa** | **10** | **14** | **14** | **14** | **13** | **12** | **1.0** |
| **Central and South America** | **27** | **26** | **26** | **25** | **24** | **23** | **-0.7** |
| Brazil | 3 | 3 | 3 | 3 | 3 | 3 | -0.6 |
| Other Central and South America | 24 | 23 | 23 | 22 | 21 | 20 | -0.7 |
| **Total Non-OECD** | **165** | **174** | **175** | **168** | **162** | **158** | **-0.2** |
| **Total World** | **423** | **433** | **418** | **404** | **392** | **380** | **-0.4** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H3. World Installed Natural-Gas-Fired Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **348** | **379** | **387** | **415** | **476** | **512** | **1.6** |
| United States[a] | 322 | 351 | 353 | 375 | 430 | 460 | 1.5 |
| Canada | 8 | 8 | 8 | 9 | 9 | 9 | 0.7 |
| Mexico | 18 | 20 | 25 | 31 | 37 | 42 | 3.6 |
| **OECD Europe** | **173** | **191** | **205** | **218** | **227** | **230** | **1.2** |
| **OECD Asia** | **103** | **105** | **109** | **114** | **115** | **115** | **0.5** |
| Japan | 72 | 72 | 74 | 76 | 75 | 74 | 0.1 |
| South Korea | 18 | 20 | 22 | 23 | 25 | 25 | 1.4 |
| Australia/New Zealand | 12 | 13 | 13 | 15 | 15 | 16 | 1.0 |
| **Total OECD** | **624** | **675** | **701** | **747** | **818** | **857** | **1.3** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **144** | **160** | **177** | **187** | **192** | **196** | **1.3** |
| Russia | 97 | 110 | 120 | 127 | 128 | 130 | 1.2 |
| Other | 47 | 51 | 57 | 61 | 64 | 66 | 1.4 |
| **Non-OECD Asia** | **121** | **136** | **163** | **192** | **214** | **228** | **2.7** |
| China | 26 | 29 | 35 | 42 | 47 | 49 | 2.7 |
| India | 18 | 24 | 30 | 37 | 42 | 46 | 3.9 |
| Other Non-OECD Asia | 77 | 83 | 98 | 113 | 125 | 134 | 2.3 |
| **Middle East** | **88** | **92** | **100** | **109** | **121** | **133** | **1.7** |
| **Africa** | **37** | **40** | **48** | **58** | **65** | **69** | **2.6** |
| **Central and South America** | **46** | **54** | **58** | **63** | **70** | **72** | **1.9** |
| Brazil | 9 | 13 | 15 | 17 | 21 | 23 | 4.1 |
| Other Central and South America | 37 | 41 | 43 | 46 | 48 | 50 | 1.2 |
| **Total Non-OECD** | **437** | **483** | **546** | **609** | **661** | **699** | **2.0** |
| **Total World** | **1,060** | **1,158** | **1,247** | **1,356** | **1,479** | **1,556** | **1.6** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H4. World Installed Coal-Fired Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **340** | **352** | **358** | **360** | **364** | **391** | **0.6** |
| United States[a] | 314 | 325 | 331 | 333 | 335 | 360 | 0.6 |
| Canada | 20 | 21 | 21 | 22 | 23 | 23 | 0.5 |
| Mexico | 6 | 6 | 6 | 6 | 7 | 8 | 0.9 |
| **OECD Europe** | **197** | **201** | **201** | **196** | **193** | **192** | **-0.1** |
| **OECD Asia** | **95** | **99** | **100** | **100** | **104** | **110** | **0.6** |
| Japan | 44 | 44 | 43 | 42 | 41 | 40 | -0.4 |
| South Korea | 21 | 24 | 25 | 27 | 31 | 36 | 2.2 |
| Australia/New Zealand | 29 | 31 | 31 | 31 | 32 | 34 | 0.6 |
| **Total OECD** | **633** | **652** | **658** | **656** | **661** | **693** | **0.4** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **98** | **108** | **112** | **111** | **110** | **115** | **0.6** |
| Russia | 44 | 51 | 54 | 54 | 53 | 56 | 1.1 |
| Other | 54 | 57 | 58 | 57 | 57 | 58 | 0.3 |
| **Non-OECD Asia** | **477** | **685** | **721** | **844** | **1,030** | **1,217** | **4.0** |
| China | 350 | 543 | 562 | 668 | 821 | 950 | 4.2 |
| India | 78 | 88 | 99 | 108 | 120 | 142 | 2.6 |
| Other Non-OECD Asia | 49 | 54 | 60 | 68 | 88 | 124 | 3.9 |
| **Middle East** | **5** | **5** | **5** | **5** | **6** | **7** | **1.0** |
| **Africa** | **39** | **40** | **41** | **43** | **47** | **55** | **1.5** |
| **Central and South America** | **9** | **10** | **11** | **11** | **12** | **14** | **1.7** |
| Brazil | 2 | 3 | 3 | 3 | 4 | 5 | 3.2 |
| Other Central and South America | 7 | 7 | 7 | 8 | 8 | 10 | 1.2 |
| **Total Non-OECD** | **629** | **848** | **890** | **1,014** | **1,205** | **1,407** | **3.4** |
| **Total World** | **1,261** | **1,500** | **1,548** | **1,670** | **1,866** | **2,101** | **2.1** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H5. World Installed Nuclear Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **115** | **118** | **121** | **126** | **127** | **132** | **0.6** |
| United States[a] | 100 | 101 | 104 | 108 | 108 | 113 | 0.5 |
| Canada | 13 | 15 | 15 | 16 | 17 | 18 | 1.3 |
| Mexico | 1 | 1 | 1 | 1 | 1 | 1 | 0.1 |
| **OECD Europe** | **132** | **130** | **127** | **119** | **121** | **121** | **-0.4** |
| **OECD Asia** | **67** | **66** | **74** | **80** | **84** | **88** | **1.2** |
| Japan | 50 | 49 | 52 | 54 | 56 | 58 | 0.7 |
| South Korea | 17 | 17 | 22 | 26 | 28 | 30 | 2.4 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **314** | **314** | **322** | **325** | **331** | **341** | **0.3** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **42** | **41** | **49** | **59** | **68** | **71** | **2.2** |
| Russia | 23 | 23 | 28 | 35 | 42 | 44 | 2.7 |
| Other | 19 | 18 | 20 | 24 | 26 | 27 | 1.5 |
| **Non-OECD Asia** | **16** | **21** | **39** | **60** | **78** | **88** | **7.4** |
| China | 7 | 9 | 22 | 36 | 47 | 54 | 9.0 |
| India | 3 | 5 | 9 | 14 | 18 | 20 | 7.7 |
| Other Non-OECD Asia | 6 | 6 | 8 | 10 | 13 | 14 | 3.8 |
| **Middle East** | **0** | **0** | **1** | **2** | **2** | **2** | **—** |
| **Africa** | **2** | **2** | **2** | **2** | **3** | **3** | **2.0** |
| **Central and South America** | **3** | **3** | **4** | **5** | **5** | **5** | **1.7** |
| Brazil | 2 | 2 | 3 | 3 | 3 | 3 | 1.7 |
| Other Central and South America | 1 | 1 | 1 | 2 | 2 | 2 | 1.7 |
| **Total Non-OECD** | **63** | **67** | **95** | **128** | **156** | **168** | **4.2** |
| **Total World** | **377** | **381** | **416** | **453** | **487** | **509** | **1.3** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H6. World Installed Hydroelectric Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **160** | **164** | **169** | **175** | **178** | **180** | **0.5** |
| United States[a] | 77 | 77 | 78 | 78 | 78 | 78 | 0.0 |
| Canada | 72 | 75 | 80 | 85 | 86 | 87 | 0.8 |
| Mexico | 11 | 11 | 11 | 13 | 14 | 15 | 1.3 |
| **OECD Europe** | **146** | **152** | **156** | **163** | **170** | **173** | **0.7** |
| **OECD Asia** | **37** | **37** | **38** | **38** | **38** | **38** | **0.1** |
| Japan | 22 | 22 | 23 | 23 | 23 | 23 | 0.2 |
| South Korea | 2 | 2 | 2 | 2 | 2 | 2 | 0.0 |
| Australia/New Zealand | 13 | 13 | 13 | 13 | 13 | 13 | 0.1 |
| **Total OECD** | **342** | **353** | **363** | **376** | **386** | **391** | **0.6** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **87** | **90** | **93** | **98** | **104** | **107** | **0.8** |
| Russia | 46 | 48 | 51 | 55 | 59 | 61 | 1.2 |
| Other | 41 | 42 | 42 | 43 | 44 | 45 | 0.4 |
| **Non-OECD Asia** | **188** | **276** | **381** | **457** | **480** | **493** | **4.1** |
| China | 117 | 186 | 265 | 310 | 315 | 318 | 4.2 |
| India | 32 | 44 | 55 | 68 | 77 | 83 | 4.0 |
| Other Non-OECD Asia | 38 | 47 | 62 | 79 | 87 | 93 | 3.8 |
| **Middle East** | **9** | **13** | **13** | **15** | **17** | **17** | **2.9** |
| **Africa** | **22** | **25** | **29** | **31** | **33** | **33** | **1.7** |
| **Central and South America** | **128** | **139** | **168** | **200** | **225** | **240** | **2.6** |
| Brazil | 71 | 79 | 99 | 118 | 137 | 147 | 3.1 |
| Other Central and South America | 58 | 60 | 69 | 82 | 87 | 94 | 2.0 |
| **Total Non-OECD** | **434** | **543** | **685** | **801** | **857** | **891** | **3.0** |
| **Total World** | **776** | **896** | **1,047** | **1,178** | **1,243** | **1,283** | **2.1** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H7. World Installed Wind-Powered Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **12** | **37** | **48** | **51** | **61** | **70** | **7.6** |
| United States[a] | 11 | 30 | 31 | 33 | 39 | 44 | 5.8 |
| Canada | 1 | 7 | 16 | 16 | 20 | 24 | 16.0 |
| Mexico | 0 | 1 | 2 | 2 | 2 | 2 | — |
| **OECD Europe** | **41** | **88** | **149** | **194** | **240** | **263** | **8.1** |
| **OECD Asia** | **2** | **6** | **12** | **12** | **13** | **14** | **8.5** |
| Japan | 1 | 3 | 3 | 3 | 3 | 3 | 4.5 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | 1.9 |
| Australia/New Zealand | 1 | 3 | 8 | 9 | 10 | 10 | 11.5 |
| **Total OECD** | **55** | **131** | **209** | **258** | **314** | **346** | **8.0** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **0** | **1** | **2** | **2** | **2** | **2** | **9.6** |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 2.9 |
| Other | 0 | 1 | 2 | 2 | 2 | 2 | 9.8 |
| **Non-OECD Asia** | **5** | **23** | **29** | **50** | **72** | **132** | **14.3** |
| China | 1 | 14 | 20 | 40 | 60 | 120 | 23.6 |
| India | 4 | 8 | 9 | 9 | 9 | 9 | 2.9 |
| Other Non-OECD Asia | 0 | 0 | 0 | 2 | 3 | 3 | 14.7 |
| **Middle East** | **0** | **1** | **1** | **1** | **1** | **1** | **—** |
| **Africa** | **0** | **1** | **4** | **4** | **4** | **4** | **12.4** |
| **Central and South America** | **0** | **2** | **4** | **4** | **4** | **4** | **14.6** |
| Brazil | 0 | 1 | 3 | 3 | 3 | 3 | 20.5 |
| Other Central and South America | 0 | 0 | 2 | 2 | 2 | 2 | 11.1 |
| **Total Non-OECD** | **6** | **27** | **40** | **62** | **83** | **143** | **14.2** |
| **Total World** | **61** | **159** | **249** | **319** | **397** | **490** | **9.1** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. As a result, U.S. installed wind-powered generating capacity would be 66 gigawatts in 2015 and 68 gigawatts in 2030 in the *updated AEO2009* reference case—114 percent higher in 2015 and 54 percent higher in 2030 than in the earlier projections reported in this table.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H8. World Installed Geothermal Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **3** | **3** | **4** | **4** | **4** | **4** | **1.0** |
| United States[a] | 2 | 3 | 3 | 3 | 3 | 3 | 1.1 |
| Canada | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Mexico | 1 | 1 | 1 | 1 | 1 | 1 | 0.8 |
| **OECD Europe** | **1** | **2** | **2** | **2** | **2** | **2** | **1.1** |
| **OECD Asia** | **1** | **1** | **2** | **2** | **3** | **3** | **4.1** |
| Japan | 1 | 1 | 1 | 1 | 1 | 1 | 0.0 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Australia/New Zealand | 0 | 1 | 1 | 2 | 2 | 2 | 6.4 |
| **Total OECD** | **6** | **6** | **7** | **8** | **8** | **8** | **1.8** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **0** | **0** | **0** | **0** | **0** | **0** | **5.0** |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 4.5 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Non-OECD Asia** | **3** | **4** | **5** | **5** | **5** | **5** | **2.3** |
| China | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 |
| India | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Other Non-OECD Asia | 3 | 4 | 5 | 5 | 5 | 5 | 2.1 |
| **Middle East** | **0** | **0** | **0** | **0** | **0** | **0** | **—** |
| **Africa** | **0** | **0** | **0** | **0** | **0** | **0** | **3.8** |
| **Central and South America** | **0** | **1** | **1** | **1** | **1** | **1** | **5.8** |
| Brazil | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Other Central and South America | 0 | 1 | 1 | 1 | 1 | 1 | 5.8 |
| **Total Non-OECD** | **3** | **5** | **6** | **6** | **6** | **7** | **2.9** |
| **Total World** | **9** | **11** | **14** | **14** | **15** | **15** | **2.2** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. As a result, U.S. installed geothermal generating capacity would be 3.0 gigawatts in 2015 and 3.3 gigawatts in 2030 in the *updated AEO2009* reference case—16 percent higher in 2015 and 10 percent higher in 2030 than in the earlier projections reported in this table.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H9. World Installed Other Renewable Generating Capacity by Region and Country, 2006-2030**
(Gigawatts)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **12** | **15** | **21** | **30** | **36** | **43** | **5.4** |
| United States[a] | 11 | 14 | 20 | 27 | 32 | 40 | 5.4 |
| Canada | 1 | 1 | 1 | 3 | 4 | 4 | 4.5 |
| Mexico | 0 | 0 | 0 | 0 | 0 | 0 | 6.9 |
| **OECD Europe** | **10** | **21** | **31** | **35** | **39** | **40** | **5.9** |
| **OECD Asia** | **5** | **7** | **12** | **12** | **12** | **12** | **3.5** |
| Japan | 4 | 5 | 6 | 6 | 6 | 6 | 1.7 |
| South Korea | 0 | 1 | 3 | 3 | 3 | 3 | 16.9 |
| Australia/New Zealand | 1 | 1 | 2 | 2 | 2 | 2 | 3.9 |
| **Total OECD** | **28** | **43** | **64** | **77** | **86** | **96** | **5.3** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **0** | **0** | **0** | **0** | **0** | **0** | **—** |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Non-OECD Asia** | **3** | **6** | **9** | **9** | **9** | **9** | **4.9** |
| China | 1 | 4 | 4 | 4 | 4 | 4 | 5.7 |
| India | 2 | 2 | 5 | 5 | 5 | 5 | 4.4 |
| Other Non-OECD Asia | 0 | 0 | 0 | 0 | 0 | 0 | 5.9 |
| **Middle East** | **0** | **0** | **1** | **2** | **2** | **3** | **—** |
| **Africa** | **0** | **0** | **0** | **2** | **4** | **5** | **—** |
| **Central and South America** | **6** | **6** | **6** | **6** | **6** | **6** | **0.1** |
| Brazil | 6 | 6 | 6 | 6 | 6 | 6 | 0.0 |
| Other Central and South America | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 |
| **Total Non-OECD** | **9** | **13** | **16** | **19** | **22** | **23** | **3.9** |
| **Total World** | **37** | **56** | **80** | **96** | **108** | **119** | **5.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. Although projections for U.S. solar and municipal waste installed capacity are higher in the *updated AEO2009* reference case, they are offset by lower projections for U.S. installed wood and other biomass generating capacity; as a result, U.S. "other renewable generating capacity" would be 40 gigawatts in 2030 in both the *published* and *updated AEO2009* reference cases.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H10. World Total Net Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **4,889** | **5,095** | **5,356** | **5,694** | **6,052** | **6,420** | **1.1** |
| United States[a] | 4,063 | 4,217 | 4,381 | 4,618 | 4,879 | 5,153 | 1.0 |
| Canada | 601 | 628 | 680 | 737 | 788 | 831 | 1.4 |
| Mexico | 225 | 250 | 295 | 339 | 385 | 436 | 2.8 |
| **OECD Europe** | **3,356** | **3,681** | **3,967** | **4,205** | **4,403** | **4,569** | **1.3** |
| **OECD Asia** | **1,691** | **1,782** | **1,928** | **2,038** | **2,137** | **2,233** | **1.2** |
| Japan | 1,038 | 1,063 | 1,115 | 1,148 | 1,168 | 1,187 | 0.6 |
| South Korea | 376 | 412 | 477 | 534 | 591 | 650 | 2.3 |
| Australia/New Zealand | 277 | 308 | 335 | 357 | 377 | 397 | 1.5 |
| **Total OECD** | **9,936** | **10,558** | **11,251** | **11,937** | **12,592** | **13,223** | **1.2** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **1,522** | **1,737** | **1,980** | **2,178** | **2,320** | **2,445** | **2.0** |
| Russia | 913 | 1,070 | 1,234 | 1,365 | 1,458 | 1,540 | 2.2 |
| Other | 609 | 667 | 746 | 813 | 862 | 905 | 1.7 |
| **Non-OECD Asia** | **4,391** | **5,886** | **7,295** | **8,896** | **10,642** | **12,419** | **4.4** |
| China | 2,773 | 3,968 | 4,944 | 6,079 | 7,338 | 8,547 | 4.8 |
| India | 691 | 863 | 1,067 | 1,276 | 1,467 | 1,687 | 3.8 |
| Other Non-OECD Asia | 927 | 1,055 | 1,284 | 1,542 | 1,837 | 2,186 | 3.6 |
| **Middle East** | **646** | **711** | **791** | **879** | **980** | **1,099** | **2.2** |
| **Africa** | **543** | **607** | **703** | **802** | **902** | **996** | **2.6** |
| **Central and South America** | **946** | **1,084** | **1,209** | **1,339** | **1,480** | **1,601** | **2.2** |
| Brazil | 413 | 505 | 594 | 686 | 789 | 874 | 3.2 |
| Other Central and South America | 533 | 579 | 614 | 653 | 691 | 727 | 1.3 |
| **Total Non-OECD** | **8,047** | **10,026** | **11,978** | **14,094** | **16,323** | **18,559** | **3.5** |
| **Total World** | **17,982** | **20,584** | **23,228** | **26,031** | **28,915** | **31,782** | **2.4** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H11. World Net Liquids-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **136** | **129** | **130** | **127** | **125** | **124** | **-0.4** |
| United States[a] | 64 | 56 | 57 | 58 | 59 | 60 | -0.2 |
| Canada | 16 | 16 | 16 | 15 | 15 | 14 | -0.6 |
| Mexico | 56 | 56 | 56 | 54 | 51 | 49 | -0.5 |
| **OECD Europe** | **69** | **70** | **70** | **67** | **64** | **61** | **-0.5** |
| **OECD Asia** | **99** | **100** | **100** | **96** | **92** | **88** | **-0.5** |
| Japan | 80 | 81 | 81 | 78 | 75 | 72 | -0.5 |
| South Korea | 17 | 18 | 18 | 17 | 16 | 15 | -0.5 |
| Australia/New Zealand | 1 | 1 | 1 | 1 | 1 | 1 | 0.4 |
| **Total OECD** | **303** | **298** | **300** | **289** | **280** | **273** | **-0.4** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **52** | **55** | **56** | **53** | **51** | **49** | **-0.3** |
| Russia | 26 | 27 | 27 | 26 | 25 | 24 | -0.3 |
| Other | 26 | 28 | 28 | 27 | 26 | 25 | -0.3 |
| **Non-OECD Asia** | **158** | **168** | **170** | **163** | **157** | **152** | **-0.2** |
| China | 46 | 52 | 53 | 51 | 49 | 47 | 0.1 |
| India | 19 | 20 | 20 | 19 | 18 | 17 | -0.4 |
| Other Non-OECD Asia | 93 | 97 | 97 | 93 | 90 | 87 | -0.3 |
| **Middle East** | **228** | **243** | **248** | **243** | **244** | **254** | **0.5** |
| **Africa** | **58** | **84** | **84** | **80** | **77** | **73** | **1.0** |
| **Central and South America** | **78** | **76** | **76** | **73** | **69** | **66** | **-0.7** |
| Brazil | 5 | 5 | 5 | 5 | 5 | 5 | -0.6 |
| Other Central and South America | 72 | 71 | 71 | 67 | 64 | 61 | -0.7 |
| **Total Non-OECD** | **574** | **628** | **634** | **612** | **598** | **593** | **0.1** |
| **Total World** | **877** | **926** | **934** | **901** | **878** | **866** | **-0.1** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H12. World Net Natural-Gas-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **913** | **940** | **981** | **1,114** | **1,313** | **1,320** | **1.5** |
| United States[a] | 812 | 814 | 815 | 898 | 1,050 | 1,012 | 0.9 |
| Canada | 22 | 25 | 24 | 33 | 38 | 39 | 2.5 |
| Mexico | 80 | 100 | 141 | 183 | 225 | 268 | 5.2 |
| **OECD Europe** | **729** | **878** | **1,001** | **1,116** | **1,200** | **1,244** | **2.3** |
| **OECD Asia** | **360** | **387** | **434** | **485** | **512** | **526** | **1.6** |
| Japan | 265 | 270 | 297 | 323 | 331 | 334 | 1.0 |
| South Korea | 60 | 73 | 89 | 102 | 115 | 122 | 3.0 |
| Australia/New Zealand | 35 | 45 | 47 | 60 | 66 | 70 | 2.9 |
| **Total OECD** | **2,002** | **2,204** | **2,415** | **2,715** | **3,025** | **3,089** | **1.8** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **526** | **656** | **791** | **891** | **943** | **993** | **2.7** |
| Russia | 359 | 458 | 542 | 605 | 627 | 658 | 2.6 |
| Other | 166 | 198 | 249 | 287 | 317 | 335 | 3.0 |
| **Non-OECD Asia** | **430** | **542** | **755** | **970** | **1,132** | **1,232** | **4.5** |
| China | 59 | 79 | 125 | 168 | 199 | 206 | 5.3 |
| India | 43 | 83 | 135 | 190 | 230 | 255 | 7.7 |
| Other Non-OECD Asia | 328 | 380 | 496 | 611 | 704 | 771 | 3.6 |
| **Middle East** | **365** | **403** | **470** | **549** | **641** | **741** | **3.0** |
| **Africa** | **134** | **159** | **222** | **297** | **356** | **391** | **4.6** |
| **Central and South America** | **134** | **193** | **220** | **256** | **303** | **322** | **3.7** |
| Brazil | 24 | 55 | 69 | 86 | 115 | 124 | 7.1 |
| Other Central and South America | 110 | 138 | 151 | 170 | 189 | 198 | 2.5 |
| **Total Non-OECD** | **1,589** | **1,953** | **2,457** | **2,963** | **3,375** | **3,680** | **3.6** |
| **Total World** | **3,591** | **4,157** | **4,872** | **5,678** | **6,401** | **6,769** | **2.7** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H13. World Net Coal-Fired Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **2,138** | **2,207** | **2,272** | **2,313** | **2,358** | **2,594** | **0.8** |
| United States[a] | 1,992 | 2,057 | 2,121 | 2,156 | 2,191 | 2,415 | 0.8 |
| Canada | 106 | 111 | 111 | 117 | 125 | 128 | 0.8 |
| Mexico | 40 | 39 | 39 | 40 | 43 | 51 | 1.1 |
| **OECD Europe** | **967** | **1,000** | **1,003** | **982** | **977** | **987** | **0.1** |
| **OECD Asia** | **641** | **669** | **676** | **680** | **711** | **753** | **0.7** |
| Japan | 294 | 292 | 288 | 279 | 272 | 266 | -0.4 |
| South Korea | 153 | 174 | 183 | 192 | 222 | 256 | 2.2 |
| Australia/New Zealand | 194 | 204 | 204 | 208 | 217 | 231 | 0.7 |
| **Total OECD** | **3,746** | **3,877** | **3,950** | **3,975** | **4,046** | **4,334** | **0.6** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **372** | **437** | **470** | **472** | **479** | **524** | **1.4** |
| Russia | 207 | 253 | 276 | 277 | 277 | 301 | 1.6 |
| Other | 165 | 185 | 194 | 195 | 203 | 223 | 1.3 |
| **Non-OECD Asia** | **2,987** | **4,014** | **4,707** | **5,585** | **6,904** | **8,230** | **4.3** |
| China | 2,178 | 3,092 | 3,670 | 4,426 | 5,513 | 6,427 | 4.6 |
| India | 489 | 564 | 639 | 707 | 795 | 951 | 2.8 |
| Other Non-OECD Asia | 320 | 358 | 398 | 451 | 597 | 852 | 4.2 |
| **Middle East** | **30** | **30** | **31** | **31** | **34** | **41** | **1.3** |
| **Africa** | **247** | **253** | **263** | **277** | **309** | **365** | **1.6** |
| **Central and South America** | **49** | **56** | **59** | **61** | **69** | **85** | **2.4** |
| Brazil | 6 | 12 | 14 | 15 | 19 | 25 | 6.2 |
| Other Central and South America | 43 | 44 | 45 | 46 | 49 | 60 | 1.4 |
| **Total Non-OECD** | **3,684** | **4,791** | **5,530** | **6,427** | **7,795** | **9,245** | **3.9** |
| **Total World** | **7,430** | **8,668** | **9,480** | **10,401** | **11,841** | **13,579** | **2.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H14. World Net Nuclear Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **891** | **928** | **955** | **992** | **1,004** | **1,053** | **0.7** |
| United States[a] | 787 | 809 | 831 | 862 | 867 | 907 | 0.6 |
| Canada | 93 | 108 | 113 | 120 | 127 | 135 | 1.5 |
| Mexico | 10 | 11 | 11 | 11 | 11 | 11 | 0.1 |
| **OECD Europe** | **929** | **922** | **915** | **905** | **896** | **902** | **-0.1** |
| **OECD Asia** | **430** | **441** | **494** | **546** | **583** | **624** | **1.6** |
| Japan | 288 | 299 | 319 | 336 | 358 | 381 | 1.2 |
| South Korea | 141 | 142 | 175 | 210 | 225 | 243 | 2.3 |
| Australia/New Zealand | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Total OECD** | **2,250** | **2,291** | **2,364** | **2,443** | **2,484** | **2,579** | **0.6** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **269** | **283** | **342** | **424** | **494** | **519** | **2.8** |
| Russia | 144 | 155 | 197 | 251 | 307 | 328 | 3.5 |
| Other | 124 | 128 | 145 | 173 | 187 | 191 | 1.8 |
| **Non-OECD Asia** | **111** | **151** | **290** | **455** | **600** | **678** | **7.8** |
| China | 55 | 65 | 164 | 274 | 366 | 425 | 8.9 |
| India | 16 | 37 | 66 | 104 | 134 | 149 | 9.9 |
| Other Non-OECD Asia | 40 | 48 | 61 | 77 | 100 | 104 | 4.0 |
| **Middle East** | **0** | **0** | **6** | **13** | **13** | **13** | **—** |
| **Africa** | **10** | **14** | **15** | **15** | **21** | **21** | **3.2** |
| **Central and South America** | **21** | **23** | **28** | **34** | **34** | **34** | **2.1** |
| Brazil | 14 | 15 | 18 | 22 | 22 | 22 | 2.0 |
| Other Central and South America | 7 | 8 | 10 | 12 | 12 | 12 | 2.2 |
| **Total Non-OECD** | **411** | **471** | **681** | **941** | **1,162** | **1,266** | **4.8** |
| **Total World** | **2,660** | **2,761** | **3,045** | **3,385** | **3,646** | **3,844** | **1.5** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H15. World Net Hydroelectric Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **671** | **656** | **714** | **742** | **767** | **789** | **0.7** |
| United States[a] | 289 | 271 | 298 | 299 | 300 | 301 | 0.2 |
| Canada | 352 | 354 | 384 | 407 | 427 | 447 | 1.0 |
| Mexico | 30 | 32 | 32 | 36 | 39 | 41 | 1.3 |
| **OECD Europe** | **476** | **532** | **545** | **569** | **592** | **604** | **1.0** |
| **OECD Asia** | **127** | **133** | **137** | **137** | **137** | **137** | **0.3** |
| Japan | 85 | 88 | 91 | 91 | 91 | 91 | 0.3 |
| South Korea | 3 | 4 | 4 | 4 | 4 | 4 | 0.4 |
| Australia/New Zealand | 39 | 41 | 41 | 42 | 42 | 42 | 0.3 |
| **Total OECD** | **1,274** | **1,321** | **1,396** | **1,447** | **1,496** | **1,530** | **0.8** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **300** | **303** | **317** | **332** | **347** | **354** | **0.7** |
| Russia | 174 | 177 | 191 | 206 | 221 | 228 | 1.1 |
| Other | 126 | 126 | 126 | 126 | 126 | 127 | 0.0 |
| **Non-OECD Asia** | **670** | **929** | **1,250** | **1,560** | **1,643** | **1,693** | **3.9** |
| China | 431 | 642 | 876 | 1,071 | 1,089 | 1,098 | 4.0 |
| India | 113 | 138 | 174 | 215 | 244 | 262 | 3.6 |
| Other Non-OECD Asia | 126 | 148 | 200 | 274 | 309 | 333 | 4.1 |
| **Middle East** | **23** | **33** | **33** | **37** | **41** | **44** | **2.7** |
| **Africa** | **91** | **91** | **106** | **117** | **122** | **126** | **1.4** |
| **Central and South America** | **640** | **704** | **785** | **865** | **946** | **1,026** | **2.0** |
| Brazil | 345 | 396 | 458 | 521 | 584 | 647 | 2.6 |
| Other Central and South America | 294 | 308 | 326 | 344 | 362 | 379 | 1.1 |
| **Total Non-OECD** | **1,723** | **2,060** | **2,491** | **2,911** | **3,098** | **3,242** | **2.7** |
| **Total World** | **2,997** | **3,381** | **3,887** | **4,359** | **4,594** | **4,773** | **2.0** |

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H16. World Net Wind-Powered Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **29** | **87** | **108** | **127** | **156** | **183** | **7.9** |
| United States[a] | 27 | 81 | 85 | 93 | 113 | 131 | 6.8 |
| Canada | 2 | 4 | 18 | 29 | 38 | 48 | 13.1 |
| Mexico | 0 | 2 | 4 | 5 | 5 | 5 | 19.4 |
| **OECD Europe** | **80** | **160** | **283** | **414** | **522** | **621** | **8.9** |
| **OECD Asia** | **4** | **12** | **27** | **31** | **35** | **38** | **9.8** |
| Japan | 2 | 4 | 6 | 7 | 8 | 9 | 7.4 |
| South Korea | 0 | 0 | 0 | 0 | 1 | 1 | 2.7 |
| Australia/New Zealand | 2 | 7 | 22 | 24 | 27 | 28 | 11.5 |
| **Total OECD** | **113** | **258** | **418** | **572** | **713** | **842** | **8.7** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **0** | **2** | **3** | **4** | **4** | **4** | **12.9** |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 5.9 |
| Other | 0 | 2 | 3 | 4 | 4 | 4 | 13.1 |
| **Non-OECD Asia** | **12** | **45** | **62** | **92** | **124** | **343** | **14.8** |
| China | 2 | 28 | 42 | 70 | 99 | 315 | 23.2 |
| India | 10 | 16 | 19 | 20 | 22 | 23 | 3.5 |
| Other Non-OECD Asia | 0 | 1 | 1 | 2 | 4 | 4 | 12.3 |
| **Middle East** | **0** | **1** | **2** | **2** | **2** | **3** | **—** |
| **Africa** | **1** | **3** | **9** | **10** | **11** | **11** | **11.1** |
| **Central and South America** | **1** | **2** | **5** | **7** | **9** | **11** | **13.4** |
| Brazil | 0 | 1 | 3 | 4 | 6 | 7 | 14.8 |
| Other Central and South America | 0 | 1 | 2 | 3 | 3 | 4 | 11.8 |
| **Total Non-OECD** | **14** | **53** | **82** | **115** | **150** | **372** | **14.6** |
| **Total World** | **127** | **312** | **500** | **687** | **864** | **1,214** | **9.9** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. As a result, U.S. installed wind-powered generation would be 203 billion kilowatthours in 2015 and 208 billion kilowatthours in 2030 in the *updated AEO2009* reference case—138 percent higher in 2015 and 59 percent higher in 2030 than in the earlier projections reported in this table.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H17. World Net Geothermal Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **21** | **25** | **27** | **28** | **28** | **30** | **1.5** |
| United States[a] | 15 | 18 | 19 | 19 | 20 | 22 | 1.7 |
| Canada | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Mexico | 7 | 7 | 9 | 9 | 9 | 9 | 0.9 |
| **OECD Europe** | **8** | **11** | **12** | **12** | **12** | **12** | **1.8** |
| **OECD Asia** | **6** | **9** | **14** | **17** | **19** | **20** | **5.1** |
| Japan | 3 | 4 | 4 | 4 | 4 | 4 | 1.3 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Australia/New Zealand | 3 | 6 | 10 | 13 | 15 | 16 | 7.1 |
| **Total OECD** | **35** | **45** | **54** | **57** | **59** | **62** | **2.4** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **0** | **1** | **1** | **1** | **2** | **2** | **6.5** |
| Russia | 0 | 0 | 1 | 1 | 1 | 2 | 5.9 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Non-OECD Asia** | **16** | **23** | **32** | **33** | **34** | **35** | **3.4** |
| China | 0 | 0 | 0 | 0 | 0 | 0 | — |
| India | 0 | 0 | 1 | 1 | 1 | 1 | — |
| Other Non-OECD Asia | 16 | 23 | 30 | 32 | 33 | 34 | 3.2 |
| **Middle East** | **0** | **0** | **0** | **0** | **0** | **0** | **—** |
| **Africa** | **1** | **2** | **2** | **2** | **2** | **2** | **4.0** |
| **Central and South America** | **2** | **3** | **4** | **5** | **6** | **7** | **5.5** |
| Brazil | 0 | 0 | 0 | 0 | 0 | 0 | — |
| Other Central and South America | 2 | 3 | 4 | 5 | 6 | 7 | 5.5 |
| **Total Non-OECD** | **19** | **29** | **40** | **42** | **45** | **47** | **3.8** |
| **Total World** | **55** | **75** | **93** | **99** | **104** | **109** | **2.9** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. As a result, U.S. installed geothermal generation would be 22 billion kilowatthours in 2015 and 24 billion kilowatthours in 2030 in the *updated AEO2009* reference case—17 percent higher in 2015 and 11 percent higher in 2030 than in the earlier projections reported in this table.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

**Table H18. World Net Other Renewable Electricity Generation From Central Producers by Region and Country, 2006-2030**
(Billion Kilowatthours)

| Region/Country | History | Projections | | | | | Average Annual Percent Change, 2006-2030 |
|---|---|---|---|---|---|---|---|
| | 2006 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| **OECD** | | | | | | | |
| **OECD North America** | **90** | **123** | **169** | **252** | **300** | **328** | **5.5** |
| United States[a] | 78 | 111 | 153 | 234 | 279 | 305 | 5.8 |
| Canada | 9 | 9 | 13 | 16 | 18 | 21 | 3.5 |
| Mexico | 3 | 3 | 3 | 3 | 3 | 2 | -0.2 |
| **OECD Europe** | **99** | **109** | **139** | **139** | **139** | **138** | **1.4** |
| **OECD Asia** | **24** | **32** | **46** | **47** | **47** | **48** | **2.9** |
| Japan | 21 | 25 | 29 | 29 | 29 | 29 | 1.4 |
| South Korea | 0 | 2 | 8 | 8 | 9 | 9 | 12.8 |
| Australia/New Zealand | 2 | 5 | 9 | 9 | 9 | 10 | 5.8 |
| **Total OECD** | **212** | **263** | **354** | **438** | **487** | **513** | **3.7** |
| **Non-OECD** | | | | | | | |
| **Non-OECD Europe and Eurasia** | **3** | **0** | **0** | **0** | **0** | **0** | **—** |
| Russia | 3 | 0 | 0 | 0 | 0 | 0 | — |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | — |
| **Non-OECD Asia** | **7** | **13** | **30** | **39** | **47** | **56** | **9.2** |
| China | 1 | 8 | 14 | 19 | 23 | 28 | 13.2 |
| India | 2 | 5 | 15 | 20 | 24 | 28 | 10.8 |
| Other Non-OECD Asia | 3 | 0 | 0 | 0 | 0 | 0 | -10.1 |
| **Middle East** | **0** | **0** | **1** | **3** | **3** | **3** | **—** |
| **Africa** | **1** | **0** | **1** | **3** | **5** | **5** | **8.9** |
| **Central and South America** | **23** | **27** | **33** | **38** | **44** | **50** | **3.3** |
| Brazil | 19 | 21 | 27 | 33 | 38 | 44 | 3.6 |
| Other Central and South America | 4 | 5 | 6 | 6 | 6 | 6 | 1.2 |
| **Total Non-OECD** | **33** | **41** | **64** | **83** | **100** | **114** | **5.3** |
| **Total World** | **246** | **304** | **418** | **521** | **587** | **628** | **4.0** |

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. Numbers for the United States in this table are based on the *published AEO2009* reference case (March 2009). In the *updated AEO2009* reference case (April 2009), which incorporates provisions from the American Recovery and Reinvestment Act of 2009 (ARRA2009) that stimulate increased renewable generation, greater use of renewable fuels is projected. Although the projections for U.S. solar and municipal waste generation are higher in the *updated AEO2009* reference case, they are more than offset by lower U.S. generation from wood and other biomass; as a result, U.S. "other renewable generation" would be 266 billion kilowatthours in 2030 in the *updated AEO2009* reference case—4 percent lower than in the earlier projections reported in this table.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, March 2009), AEO2009 National Energy Modeling System, run AEO2009.D120908A, web site www.eia.doe.gov/oiaf/aeo; and World Energy Projections Plus (2009).

## Appendix I

# Comparisons With International Energy Agency and *IEO2008* Projections

## Comparisons with IEA's *World Energy Outlook 2008*

The International Energy Agency (IEA) in its *World Energy Outlook 2008* provides projections that can be compared with those in *IEO2009*. In both reports the latest historical year of data upon which the projections are based is 2006, and both projection horizons extend to 2030. Two time periods were chosen for purposes of comparison—2006 to 2015 and 2015 to 2030.

Before turning to a discussion of similarities and differences between the *IEO2009* and IEA projections, the divergent aims of the two publications should be recognized. *IEO2009* is most directly comparable with the *World Energy Outlook 2008*'s "Part A, Global Energy Trends to 2030." In contrast to the *World Energy Outlook 2008*, which presents a single reference case scenario, *IEO2009* presents alternative scenarios reflecting high and low economic growth assumptions and high and low oil price assumptions. Economic growth and oil prices, the latter of which can be affected significantly by above-the-ground factors as well as the physical availability of petroleum resources, are two major sources of uncertainly in all energy projections, as is readily shown by a review of past projections.

EIA believes that a full understanding of energy trends under current laws and policies requires consideration of the uncertainties. For example, in the *IEO2009* reference case, projected demand for liquid fuels in 2030 is 106.6 barrels per day, or 100.7 barrel per day if biofuels are excluded to provide a figure directly comparable with the 106.4 barrels per day of traditional (non-biofuel) liquids in 2030 in the IEA reference case, which has a world price trajectory similar to that in the *IEO2009* reference case. In the *IEO2009* low oil price case, however, in which oil remains at $50 per barrel through 2030, projected world demand for traditional liquids in 2030 is significantly higher, at 115.4 million barrels per day; and in the high oil price case, in which oil prices rise steadily to $200 per barrel (2007 dollars) in 2030, world demand for traditional liquids in 2030 is only 82.8 million barrels per day.

EIA encourages users of its projections to consider how key energy market and economic uncertainties, as well as policy decisions, can affect future energy demand. As shown in *IEO2009*, alternative oil price scenarios also

**Table I1. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Region, 2006-2015**
(Average Annual Percent Growth)

| Region | *IEO2009* | | | IEA Reference Scenario |
|---|---|---|---|---|
| | Low Growth | Reference | High Growth | |
| **OECD** | **0.2** | **0.5** | **0.7** | **0.7** |
| North America | 0.1 | 0.4 | 0.7 | 0.7 |
| United States | 0.0 | 0.3 | 0.6 | 0.5 |
| Europe | 0.2 | 0.4 | 0.6 | 0.6 |
| Asia | 0.6 | 0.8 | 1.1 | 0.9 |
| **Non-OECD** | **2.7** | **2.7** | **3.2** | **3.3** |
| Europe and Eurasia | 1.2 | 1.4 | 1.7 | 1.8 |
| China | 3.8 | 4.1 | 4.4 | 4.8 |
| India | 2.7 | 2.9 | 3.2 | 3.5 |
| Other Non-OECD Asia | 2.8 | 3.1 | 3.4 | 2.1 |
| Middle East | 2.4 | 2.7 | 3.0 | 3.9 |
| Africa | 2.0 | 2.3 | 2.5 | 1.8 |
| Central and South America | 2.3 | 2.5 | 2.8 | 2.7 |
| **Total World** | **1.5** | **1.7** | **2.0** | **2.1** |

Sources: ***IEO2009*:** Energy Information Administration (EIA), World Energy Projections Plus (2009). **IEA:** International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), pp. 506-539.

have significant impacts on the projected composition of liquids supply, because they affect the mix between unconventional and conventional oil sources and the composition of the unconventional component of supply.

Most of the comparisons in this appendix focus on comparisons of projections for energy demand in the *IEO2009* reference case and the IEA's *World Energy Outlook 2008*; however, there is one noteworthy difference in views regarding the natural gas market in North America, especially the United States. IEA projects much stronger growth in U.S. natural gas prices (with the average U.S. imported price of natural gas reaching $16.13 per million Btu in 2007 dollars in 2030), as well as declining domestic production and flat demand. *IEO2009* also expects U.S. natural gas prices to rise, but at a much more modest rate, with the average imported price reaching $8.88 per million Btu in 2030. The *IEO2009* analysis of prospects for North American natural gas, based on work in EIA's *Annual Energy Outlook 2009*, reflects a much brighter outlook for production of unconventional natural gas, particularly from gas shale, than is assumed by IEA. In EIA's reference case projection, the United States becomes virtually self-sufficient in natural gas supply, at a price much lower than that assumed necessary to attract significant amounts of liquefied natural gas (LNG) to the United States in the IEA reference scenario.

In the projection period from the present to 2015, the IEA reference scenario reflects growth that more closely resembles the *IEO2009* high economic growth case than its reference case. The IEA reference scenario projects an increase in world energy consumption that averages 2.1 percent per year, as compared with 2.0 percent per year in the *IEO2009* high economic growth. In the *IEO2009* reference case, world energy use increases by an average of 1.7 percent per year (Table I1).

The slower projected near-term growth in the *IEO2009* reference case may reflect, in part, the different release dates for *IEO2009* and the *World Energy Outlook 2008*. The *IEO2009* projections were prepared when preliminary assessments of the global recession were becoming available (specifically reflected in the near-term GDP estimates in IHS Global Insight's November 2008 release), whereas the *World Energy Outlook 2008* was released in November 2008, and its projections were formulated several months in advance of the release. Thus, the IEA report may not have incorporated expectations based on the impact of the growing global recession.

On a regional basis, both outlooks project much slower growth in energy demand among the OECD nations than among the non-OECD nations. The *IEO2009* reference case, however, projects slower growth in each of the OECD regions than do the IEA projections. The largest difference among the OECD projections is for the United States, with IEA projecting an 0.7-percent average yearly increase and the *IEO2009* reference case projecting an average of 0.4 percent per year.

There is wider variation between the IEA and *IEO2009* reports in their projections for the non-OECD regions. For the non-OECD as a whole, the IEA projections again resemble those in the *IEO2009* high economic growth case rather than the *IEO2009* reference case. On a regional basis, IEA projects non-OECD growth rates that exceed the *IEO2009* projections for non-OECD Europe and Eurasia, China, India, and the Middle East. For each of those regions and countries, IEA projects higher growth rates than those in the *IEO2009* high economic growth case.

For two non-OECD regions—other Asia (non-OECD Asia, excluding China and India) and Africa—IEA projects much slower growth in energy demand to 2015 than does the *IEO2009* reference case. For other non-OECD Asia, IEA's projected 2.1-percent average annual growth rate for energy consumption is lower than the projection of 3.1 percent per year in the *IEO2009* reference case. In fact, the IEA growth rate falls below the rate in the *IEO2009* low economic growth case. Similarly, IEA projects only a 1.8-percent annual increase in Africa's energy use to 2015, compared with 2.3 percent per year in the *IEO2009* reference case. Again, the IEA projected growth rate falls below that in the *IEO2009* low growth case.

In the later years of the projections, the differences between the *IEO2009* and IEA narrow substantially, with worldwide energy demand growing by 1.4 percent per year between 2015 and 2030 in the *IEO2009* reference case and 1.3 percent per year in the IEA projection (Table I2). There remain, however, some substantial regional differences between the outlooks. For the OECD region, the largest difference is between the projections for OECD Europe. The IEA projections for annual growth in OECD Europe's energy consumption from 2015 to 2030 are considerably lower than those for 2006 to 2015, and they are substantially lower than those in the *IEO2009* reference case. In the IEA projections, OECD Europe's energy use grows by 0.1 percent per year from 2015 to 2030, which compares with 0.5 percent per year in the *IEO2009* reference case and is lower than the projected rate in the *IEO2009* low economic growth case.

For the non-OECD region, the greatest differences between the two outlooks are for non-OECD Asia (China, India, and other non-OECD Asia) and the Middle East. For China and other non-OECD Asia, IEA anticipates that energy demand growth will slow to 2.0 percent per year and 1.5 percent per year, respectively, for the final 15 years of the outlook, whereas the *IEO2009* reference case shows China maintaining a 2.6-percent

annual growth rate in energy demand and other non-OECD Asia a 2.7-percent average growth rate from 2015 to 2030. For both China and other non-OECD Asia, the IEA projections for energy use are below those in the *IEO2009* low economic growth case.

In contrast, for India and the Middle East, the IEA projections for energy demand growth from 2015 to 2030 are much higher than those in the *IEO2009* reference case. The IEA reference scenario projects energy demand growth in India averaging 3.4 percent per year from 2015 to 2030, whereas the *IEO2009* reference case projects an average of 2.3 percent per year. For the Middle East, IEA expects energy demand to grow by 2.8 percent per year from 2015 to 2030, as compared with 1.5 percent per year in the *IEO2009* reference case. For both India and the Middle East, the IEA projections exceed those in the *IEO2009* high economic growth case.

The projections vary not only with respect to levels of total world energy demand but also with respect to the mix of primary energy inputs. In the 2006 to 2015 period, IEA expects faster growth in the use of liquids and coal and slower growth in the use of nuclear and renewable energy sources than does *IEO2009* (Table I3). World liquids consumption in the *IEO2009* reference case increases by 0.7 percent per year from 2006 to 2015, compared with 1.4 percent per year in the IEA reference scenario. The *IEO2009* projections incorporate near-term projections for liquids consumption from EIA's February 2009 *Short-Term Energy Outlook*, in which growth rates remain low or decline through 2010. Again, IEA

**Table I2. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Region, 2015-2030**
(Average Annual Percent Growth)

| Region | *IEO2009* | | | IEA Reference Scenario |
|---|---|---|---|---|
| | Low Growth | Reference | High Growth | |
| **OECD** | **0.3** | **0.7** | **1.0** | **0.3** |
| North America | 0.4 | 0.8 | 1.2 | 0.5 |
| United States | 0.3 | 0.7 | 1.0 | 0.4 |
| Europe | 0.2 | 0.5 | 0.8 | 0.1 |
| Asia | 0.1 | 0.4 | 0.8 | 0.2 |
| **Non-OECD** | **1.6** | **1.8** | **2.4** | **1.9** |
| Europe and Eurasia | 0.3 | 0.6 | 1.0 | 0.7 |
| China | 2.2 | 2.6 | 3.0 | 2.0 |
| India | 1.9 | 2.3 | 2.7 | 3.4 |
| Other Non-OECD Asia | 2.3 | 2.7 | 3.1 | 1.5 |
| Middle East | 1.1 | 1.5 | 1.9 | 2.8 |
| Africa | 1.0 | 1.4 | 1.8 | 1.2 |
| Central and South America | 1.1 | 1.5 | 1.9 | 1.7 |
| **Total World** | **1.0** | **1.4** | **1.8** | **1.3** |

Sources: ***IEO2009*:** Energy Information Administration (EIA), World Energy Projections Plus (2009). **IEA:** International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), pp. 506-539.

**Table I3. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Fuel, 2006-2015**
(Average Annual Percent Growth)

| Fuel | *IEO2009* | | | IEA Reference Scenario |
|---|---|---|---|---|
| | Low Growth | Reference | High Growth | |
| Liquids | 0.4 | 0.7 | 1.0 | 1.3 |
| Natural Gas | 1.8 | 2.2 | 2.5 | 2.1 |
| Coal | 1.7 | 1.9 | 2.1 | 3.1 |
| Nuclear | 1.6 | 1.6 | 1.6 | 1.3 |
| Renewable/Other | 4.3 | 4.5 | 4.7 | 2.3 |
| **Total** | **1.5** | **1.7** | **2.0** | **2.1** |

Note: In the IEA projections, Renewable/Other includes traditional biomass.
Sources: ***IEO2009*:** Energy Information Administration (EIA), World Energy Projections Plus (2009). **IEA:** International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), pp. 592-630.

does not include revisions to near-term economic and demand expectations that may have been made after November 2008.

The IEA projection for worldwide growth in coal consumption from 2006 to 2015 is bullish in comparison with the *IEO2009* projection for all parts of the world. For China, IEA projects average annual growth of 5.1 percent in coal demand from 2006 to 2015, compared with 4.8 percent per year in the *IEO2009* reference case. Similarly, India's coal use grows by 3.9 percent per year in the IEA reference scenario from 2006 to 2015, compared with 2.2 percent per year in the *IEO2009* reference case. For OECD Europe, IEA projects increases in coal averaging 0.4 percent per year, compared with a *decline* of 0.4 percent per year in the *IEO2009* reference case from 2006 to 2015.

Differences between the projections for consumption of renewables may be explained by the fact that IEA includes an estimate for traditional, nonmarketed biomass in its renewable energy projections, whereas the *IEO2009* projections do not attempt to estimate the use of nonmarketed renewable fuels (which, in fact, is not likely to expand significantly, because developing countries tend to move away from traditional fuels to commercial fuels as their energy infrastructures and standards of living increase). On the other hand, consumption of traditional fuels in some developing countries is estimated to be quite large, with effects on total renewable energy use that would tend to mask any growth in the consumption of energy from marketed, commercial renewable sources—particularly, wind and other nonhydroelectric renewables.

Differences between the IEA and *IEO2009* projections for nuclear energy are explained in large part by differing expectations for the OECD region, which account for 85 percent of the world's total nuclear power use. Although IEA projects more rapid growth for nuclear power in the OECD Asia region than is projected in the *IEO2009* reference case, it also projects a decline in OECD Europe. In contrast, in the *IEO2009* reference case, nuclear power use in OECD Europe remains flat through 2015. Because OECD Europe consumes more than twice as much nuclear electricity as OECD Asia, the decline projected by IEA for OECD Europe offsets the projected increases for other OECD and non-OECD regions (including OECD Asia, Non-OECD Europe and Eurasia, and China) that are larger than those in the *IEO2009* reference case.

For the period from 2015 to 2030, the *IEO2009* reference case and IEA projections are largely in agreement, except for nuclear power and renewable energy sources, for which the IEA growth projections fall significantly below those in the *IEO2009* low economic growth case (Table I4). In the IEA projection, the average annual growth rate for world nuclear electricity consumption slows from 1.3 percent in the 2006-2015 period to 0.7 percent in the 2015-2030 period. *IEO2009* projects average increases of 1.6 percent per year from 2006 to 2015 and from 2015 to 2030. The IEA reference scenario projects more rapid growth for renewable energy use in the later years, increasing from 2.0 percent per year in the 2006-2015 period to 2.3 percent per year from 2015 to 2030. The *IEO2009* reference case also expects the rate of growth for renewable energy consumption to be higher from 2015 to 2030 than from 2006 to 2015, but the increment is even larger. In the *IEO2009* reference case, renewable energy use increases by 3.0 percent from 2006 to 2015 and by 4.5 percent per year from 2015 to 2030.

## Comparisons With *IEO2008*

The *IEO2009* outlook for total energy consumption in 2015 is largely the same as the outlook published in *IEO2008*. In *IEO2009*, total marketed energy consumption in 2015 is projected to be 552 quadrillion Btu, as compared with 563 quadrillion Btu in *IEO2008* (Table I5). There are some relatively modest regional differences between the two *IEO*s, centered mostly in North America. In *IEO2009*, total energy consumption for the OECD countries in 2015 is about 8 quadrillion Btu lower

**Table I4. Comparison of *IEO2009* and IEA World Energy Consumption Growth Rates by Fuel, 2015-2030**
(Average Annual Percent Growth)

| Fuel | *IEO2009* | | | IEA Reference Scenario |
|---|---|---|---|---|
| | Low Growth | Reference | High Growth | |
| Liquids | 0.7 | 1.1 | 1.5 | 0.8 |
| Natural Gas | 0.9 | 1.3 | 1.7 | 1.6 |
| Coal | 1.1 | 1.6 | 2.0 | 1.3 |
| Nuclear | 1.4 | 1.6 | 1.8 | 0.7 |
| Renewable/Other | 2.0 | 2.1 | 2.1 | 1.8 |
| **Total** | **1.0** | **1.4** | **1.8** | **1.3** |

Note: In the IEA projections, Renewable/Other includes traditional biomass.

Sources: ***IEO2009*:** Energy Information Administration (EIA), World Energy Projections Plus (2009). **IEA:** International Energy Agency, *World Energy Outlook 2008* (Paris, France, November 2008), pp. 592-630.

than was projected in *IEO2008*. More than one-half (6 quadrillion Btu) of the difference is attributed to lower demand in North America, with 4 quadrillion Btu of that difference attributed to the United States, largely because the economic recession dampens demand for energy in the near term.

For the non-OECD countries, the differences between the projections for 2015 in *IEO2009* and *IEO2008* are also modest. In *IEO2009*, non-OECD energy use in 2015 is 3 quadrillion Btu (about 1 percent) lower than in the *IEO2008* projection. Lower growth in energy demand projected for non-OECD Europe and Eurasia and non-OECD Asia (excluding China) is offset in part by higher demand in China and the Middle East. Again, lower economic growth projected for the near term in non-OECD Europe and non-OECD Asia excluding China, in view of the recent economic downturn, largely explains the slower projection for growth in non-OECD energy demand in *IEO2009* compared with *IEO2008*.

The near-term differences between the *IEO2009* and *IEO2008* projections continue through to 2030. The *IEO2009* reference case projection for total energy use worldwide in 2030 is 7 quadrillion Btu (about 1 percent) lower than the *IEO2008* projection. Again, the largest regional differences between the 2030 projections are for the United States and for non-OECD Europe and Eurasia. In the *IEO2009* reference case, the lower U.S. energy demand is attributed to a combination of higher energy prices and greater use of more efficient appliances and vehicles in response to the requirements of the Energy Independence and Security Act of 2007 (EISA2007) and the Energy Improvement and Extension Act of 2008 (EIEA2008). The reference case projection for U.S. total energy use in 2030 is 4 quadrillion Btu (4 percent) lower in *IEO2009* than was projected in *IEO2008*.

For non-OECD Europe and Eurasia, the projections for economic growth were reassessed and lowered substantially in *IEO2009*. In *IEO2008*, GDP growth in non-OECD Europe and Eurasia was projected to average 4.4 percent per year from 2005 to 2030; in *IEO2009*, the average is 3.8 percent per year. As a result of the downward adjustment in GDP growth, energy consumption in non-OECD Europe and Eurasia in 2030 is 6 quadrillion Btu lower in *IEO2009* than was projected in *IEO2008*.

Along with regional differences between the *IEO2009* and *IEO2008* projections, there are some differences between the two projections in the mix of energy resources consumed (Table I6). The *IEO2009* projections for worldwide consumption of liquid fuels are 11 quadrillion Btu lower in 2015 and 14 quadrillion Btu lower in 2030 than the corresponding *IEO2008* projections. The difference can be explained largely by the higher world oil prices in *IEO2009*. World oil prices in the *IEO2009* reference case are 80 percent higher in 2030 than they were in the *IEO2008* reference case.

**Table I5. Comparison of *IEO2009* and *IEO2008* Total World Energy Consumption, Reference Case, 2015 and 2030**
(Quadrillion Btu)

| Region | 2015 | | 2030 | | Change in *IEO2009* | |
|---|---|---|---|---|---|---|
| | *IEO2009* | *IEO2008* | *IEO2009* | *IEO2008* | 2015 | 2030 |
| **OECD** | **252** | **260** | **278** | **286** | **-8** | **-8** |
| North America | 126 | 132 | 142 | 149 | -6 | -7 |
| United States | 103 | 107 | 114 | 118 | -4 | -4 |
| Europe | 85 | 87 | 92 | 92 | -2 | 0 |
| Asia | 42 | 41 | 45 | 45 | 0 | 0 |
| **Non-OECD** | **357** | **362** | **463** | **478** | **-5** | **-14** |
| Europe and Eurasia | 58 | 59 | 63 | 69 | -2 | -6 |
| Russia | 34 | 35 | 38 | 40 | -1 | -2 |
| Other Non-OECD Europe and Eurasia | 23 | 25 | 26 | 29 | -1 | -4 |
| China | 106 | 104 | 156 | 155 | 2 | 1 |
| India | 23 | 23 | 32 | 33 | 0 | -1 |
| Other Non-OECD Asia | 34 | 37 | 51 | 52 | -3 | -1 |
| Middle East | 30 | 30 | 38 | 37 | 1 | 1 |
| Africa | 18 | 19 | 22 | 24 | -1 | -2 |
| Central and South America | 30 | 31 | 38 | 38 | 0 | -1 |
| **Total World** | **552** | **563** | **678** | **695** | **-12** | **-16** |

Sources: ***IEO2009***: Energy Information Administration (EIA), World Energy Projections Plus (2009). ***IEO2008***: EIA, *International Energy Outlook 2008*, DOE/EIA-0484(2008) (Washington, DC, September 2008), Table A1, p. 103.

There are also differences between the *IEO2009* and *IEO-2008* projections for consumption of the other fossil fuels: the projections for both coal and natural gas consumption are lower in *IEO2009*, largely because renewable energy use is much higher in this year's projections. As a result, renewable energy displaces some of the demand for coal and natural gas in the electric power sector. A more detailed assessment of the worldwide potential for renewable electric power generation, undertaken in preparing for *IEO2009*, resulted in an increase of 13 quadrillion Btu (21 percent) in renewable energy consumption in 2030 as compared with *IEO2008*. The projections for nuclear power in *IEO2009* are virtually unchanged on a Btu basis from those in *IEO2008*, with nuclear power use in 2030 only 1 quadrillion Btu higher in *IEO2009* than was projected in *IEO2008*.

**Table I6. Comparison of *IEO2009* and *IEO2008* World Energy Consumption by Fuel, Reference Case, 2015 and 2030**
(Quadrillion Btu)

| Fuel | 2015 | | 2030 | | Change in *IEO2009* | |
|---|---|---|---|---|---|---|
| | *IEO2009* | *IEO2008* | *IEO2009* | *IEO2008* | 2015 | 2030 |
| Liquids | 183 | 194 | 216 | 229 | -11 | -14 |
| Natural Gas | 131 | 134 | 158 | 165 | -3 | -7 |
| Coal | 151 | 158 | 190 | 202 | -7 | -12 |
| Nuclear | 32 | 31 | 40 | 39 | 0 | 1 |
| Renewable/Other | 55 | 48 | 74 | 61 | 7 | 13 |
| **Total** | **552** | **563** | **678** | **695** | **-12** | **-16** |

Sources: ***IEO2009***: Energy Information Administration (EIA), World Energy Projections Plus (2009). ***IEO2008***: EIA, *International Energy Outlook 2008*, DOE/EIA-0484(2008) (Washington, DC, September 2008), Table A2, pp. 104-105.

## Appendix J

# Models Used To Generate the *IEO2009* Projections

The *IEO2009* projections of world energy consumption and supply were generated from EIA's World Energy Projections Plus (WEPS+) model. WEPS+ consists of a system of individual sectoral energy models, using an integrated iterative solution process that allows for convergence of consumption and prices to an equilibrium solution. It is used primarily to provide alternative energy projections based on different assumptions for GDP growth and fossil fuel prices and can also be used to perform other analyses.

WEPS+ produces projections for 16 regions or countries of the world, including North America (United States, Canada, and Mexico), OECD Europe, OECD Asia (Japan, South Korea, and Australia/New Zealand), Russia, other non-OECD Europe and Eurasia, China, India, other non-OECD Asia, Brazil, and other Central and South America. Currently, the projections extend to 2030.

The WEPS+ platform allows the various individual models to communicate with each other through a common, shared database and provides a comprehensive, central series of output reports for analysis. In the individual models, the detail also extends to the subsector level. In WEPS+, the end-use demand models (residential, commercial, industrial, and transportation) project consumption of the key primary energy sources: several petroleum products, other liquids, natural gas, coal, nuclear power, hydropower, wind, geothermal, and other renewable sources. These models also provide intermediate consumption projections for electricity in the end-use demand sectors.

The end use model projections generally depend on retail supply prices, economic activity as represented by GDP, and population. The transformation models (power generation and district heat) satisfy electricity and heat requirements and also project consumption of primary energy sources at resulting price levels. The supply models (petroleum, natural gas, and coal) make supply projections for the key supply sources corresponding to the primary consumption sources. The main model in the WEPS+ system monitors the convergence sequence for all the models and projects carbon dioxide emissions from the combustion of fossil fuels at a regional level.

Several model enhancements were implemented in this year's version of the WEPS+ model, including an improved modeling platform and improvements in the individual models. The transportation sector model includes an extensive level of detail for modes and vehicle types. The other end use demand models are now dynamic simulations with additional product detail. The new electric power generation model is a technology-based stock/flow model using a least-cost solution technique. There is a distinct district heat model, and the supply models now provide retail price feedback. The natural gas supply model interfaces with the International Natural Gas Model (INGM) to provide supply prices.

WEPS+ includes a detailed model of the world's transportation sector, which provides projections by four transport modes: road, rail, water, and air. A variety of services are represented for each mode, such as light-duty vehicles, two/three-wheel vehicles, heavy trucks, passenger rail, and freight rail. WEPS+ separates service demand (e.g., road travel by cars, commercial trucks, and heavy trucks) from vehicle efficiency and bases the projections on economic growth (as measured by GDP) and fuel prices.

A new detailed regional power generation model has also been incorporated into WEPS+. This model uses a stock/flow approach, keeping track of electricity generating capacity, generation, and consumption within remaining, new, and added vintages. The model is technology-based, with a wide variety of technologies for fossil fuels along with their characteristics, such as costs and heat rates. The model solves for new capacity and generation in each year, based on the new generation requirements from the end use demand models, after accounting for transmission and distribution losses. The solution technique is a least-cost market share, using levelized costs for each technology within various load segments based on the system load shape. The overall system load shape is built from sectoral load shapes that are fitted to annual loads from each of the demand models.

The other demand models in WEPS+ (residential, commercial, and industrial) are now represented in a dynamic simulation, in which the projections are built up over the projection horizon based on changes in GDP, retail prices, consumption in the previous year, and a trend. These core sections of WEPS+ are based on a dynamic microeconomic model and are used primarily to provide a reference case and alternative case energy projections under different assumptions about GDP growth and fossil fuel prices. The reference case reflects accumulated knowledge from the results of other complex models that focus on specific supply or demand

series; reflects the behavioral expectations as represented in the elasticities and trends; and incorporates the analysts' judgments on the potential for demand by end-use sector and fuel type on a regional basis. After the reference case is established, WEPS+ is used to run alternative cases that reflect different assumptions about future economic growth and energy prices. WEPS+ also can be used for other analyses, such as the effects of carbon prices.

The Generate World Oil Balance Model (GWOB) is used to create a "bottom up" projection of world liquids supply—based on current production capacity, planned future additions to capacity, resource data, geopolitical constraints, and prices—and is used to generate conventional crude oil production cases. The scenarios (oil price cases) are developed through an iterative process of examining demand levels at given prices and considering the price and income sensitivity on both the demand and supply sides of the equation. Projections of conventional liquids production for 2009 through 2015 are based on analysis of investment and development trends around the globe. Data from EIA's *Short-Term Energy Outlook* are integrated to ensure consistency between short- and long-term modeling efforts. Projections of unconventional liquids production are based on exogenous analysis.

Ten major streams of liquids production are tracked on a volume basis: (1) crude oil and lease condensate, (2) natural gas plant liquids, (3) refinery gains, (4) Canadian oil sands, (5) extra-heavy oils, (6) coal-to-liquids, (7) gas-to-liquids, (8) shale oils, (9) ethanol, and (10) biodiesel. Biofuels are tracked on both a volume basis and an oil equivalent basis. All liquid fuels are reported in physical volumes, unless otherwise stated.

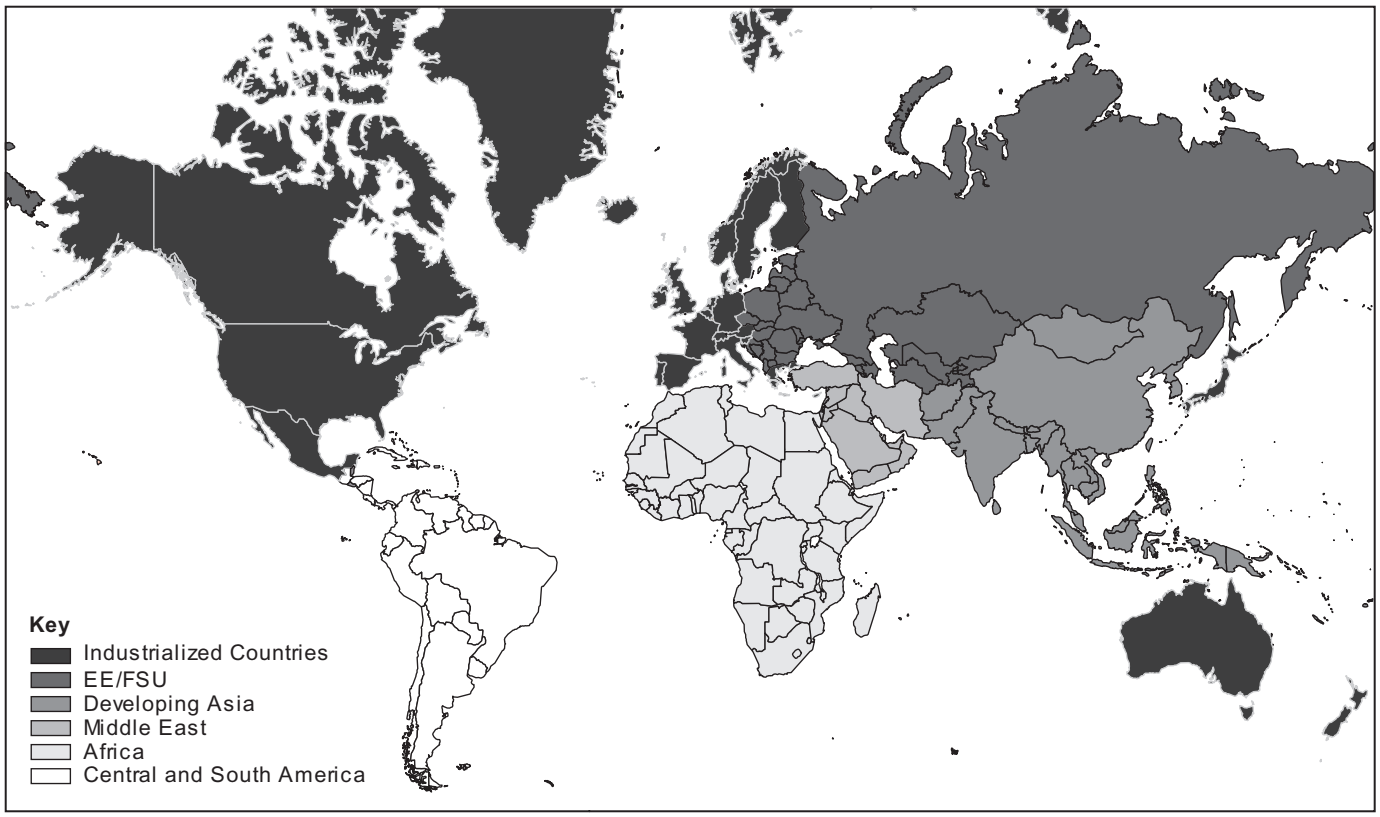
## Appendix K

# Regional Definitions

The six basic country groupings used in this report (Figure K1) are defined as follows:

- **OECD** (18 percent of the 2009 world population): **North America**—United States, Canada, and Mexico; **OECD Europe**—Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. **OECD Asia**—Japan, South Korea, Australia, and New Zealand.
- **Non-OECD** (82 percent of the 2009 world population):
  - **Non-OECD Europe and Eurasia** (5 percent of the 2009 world population)—Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Malta, Moldova, Montenegro, Romania, Russia, Serbia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.
  - **Non-OECD Asia** (53 percent of the 2009 world population)—Afghanistan, American Samoa, Bangladesh, Bhutan, Brunei, Cambodia (Kampuchea), China, Cook Islands, Fiji, French Polynesia, Guam, Hong Kong, India, Indonesia, Kiribati, Laos, Macau, Malaysia, Maldives, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, Niue, North Korea, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Timor-Leste (East Timor), Tonga, U.S. Pacific Islands, Vanuatu, Vietnam, and Wake Islands.
  - **Middle East** (3 percent of the 2009 world population)—Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen.
  - **Africa** (14 percent of the 2009 world population)—Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Kinshasa), Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon,

**Figure K1. Map of the Six Basic Country Groupings**




Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, St. Helena, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Western Sahara, Zambia, and Zimbabwe.

- **Central and South America** (7 percent of the 2009 world population)—Antarctica, Antigua and Barbuda, Argentina, Aruba, The Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Kitts-Nevis, St. Lucia, St. Vincent/Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, U.S. Virgin Islands, and Venezuela.

In addition, the following commonly used country groupings are referenced in this report:

- **Countries that have ratified, accepted, acceded, or approved the Kyoto Climate Change Protocol on Greenhouse Gas Emissions as of January 14, 2009:** Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chile, China, Colombia, Comoros, Congo (Brazzaville), Congo (Kinshasa), Cook Islands, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, The Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Lesotho, Liberia, Libya, Liechtenstein, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Moldova, Monaco, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Niue, North Korea, Norway, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, Solomon Islands, South Africa, South Korea, Spain, Sri Lanka, St. Lucia, St. Kitts and Nevis, St. Vincent/Grenadines, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syria, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Yemen, and Zambia.
- **Annex I Countries participating in the Kyoto Climate Change Protocol on Greenhouse Gas Emissions:** Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom.[50]
- **European Union (EU):** Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.
- **Organization of the Petroleum Exporting Countries (OPEC):** Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.
- **Persian Gulf Countries:** Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.
- **BRIC Countries:** Brazil, Russia, India, and China.

[50] Turkey is an Annex I nation that has not ratified the Framework Convention on Climate Change and did not commit to quantifiable emissions targets under the Kyoto Protocol. In 2001, the United States withdrew from the Protocol.