Notes and Sources

Text Notes

Overview

[*1*] The projections in *AEO2005* are based on Federal and State laws and regulations in effect on October 31, 2004. The potential impacts of pending or proposed legislation, regulations, and standards—or of sections of legislation that have been enacted but that require funds or implementing regulations that have not been provided or specified—are not reflected in the projections.

Legislation and Regulations

[*2*] The SEER is a measure of cooling performance that is used to rate the efficiency of central air conditioners and heat pumps. It is defined as the ratio of cooling output (in Btu) to total electric energy input (in watthours) during normal annual usage.

[*3*] National Resources Defense Council v. Abraham, U.S. Court of Appeals, 2nd District.

[*4*] U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters," 40 CFR Part 63 (February 26, 2004), web site www.epa.gov/ttn/atw/boiler/ria-final.pdf.

[*5*] U.S. Environmental Protection Agency, *Regulatory Impact Analysis for the Industrial Boilers and Process Heaters NESHAP*, EPA-452/R-04-002 (Washington, DC, February 2004), web site www.epa.gov/ttn/atw/boiler/ria-final.pdf.

[*6*] U.S. Environmental Protection Agency, "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule," 40 CFR Parts 9, 69, et al. (May 11, 2004).

[*7*] Tier 4 refers to the fourth set of emissions standards applying to nonroad diesel emissions. The standards do not apply to locomotive and marine applications, which are covered by separate EPA regulations.

[*8*] U.S. Environmental Protection Agency, "Control of Emissions of Air Pollution From New Locomotive Engines and New Marine Compression Ignition Engines Less Than 30 Liters per Cylinder: Proposed Rule," 40 CFR Parts 92 and 94 (June 29, 2004).

[*9*] U.S. Environmental Protection Agency, *Clean Air Nonroad Diesel Summary*, EPA-420-F-04-029 (Washington, DC, May 2004), web site www. epa.gov/otaq/regs/nonroad/equip-hd/2004fr/420f04029.htm.

[*10*] The EPA has designated seven regional Credit Trading Areas (CTAs) in the United States, organized along State lines. See web site www.npradc.org/issues/fuels/pdf/diesel_summary.pdf.

[*11*] Transmix is the mixture in a pipeline at the interface between adjoining batches of petroleum product with dissimilar physical characteristics, which cannot be absorbed into adjoining batches.

[*12*] U.S. Environmental Protection Agency, *Clean Air Nonroad Diesel Rule Facts and Figures*, EPA-420-F-04-037 (Washington, DC, May 2004), web site www.epa.gov/nonroad-diesel/2004fr/420f04037.htm.

[*13*] This section describes the bill known as PL 108-357 (H.R. 4520), "American Jobs Creation Act of 2004." For the full text of the bill, see web site http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_bills&docid= f:h4520enr.txt.pdf.

[*14*] Carry-back refers to the practice of using a credit from taxable income for a prior tax period. Carry-forward refers to using a credit in a future taxable period.

[*15*] The reference price for a taxable year is the price in the calendar year preceding the claendar year in which the taxable year begins. This price is determined as: (a) in the case of qualified crude oil production, the Secretary of the Treasury's estimate of the average annual wellhead price per barrel for all domestic crude oil (the price of which is not subject to regulation by the United States), and (b) in the case of qualified natural gas production, the Secretary of the Treasury's estimate of the average annual wellhead price per 1,000 cubic feet for all domestic natural gas.

[*16*] Extension of the in-service date for wind, closed-loop biomass, and poultry litter through 2005 was also part of the Working Families Tax Relief Act of 2004.

[*17*] Transmix is the mixture in a pipeline at the interface between adjoining batches of petroleum product with dissimilar physical characteristics, which cannot be absorbed into adjoining batches.

[*18*] This section describes the bill known as P.L. 108-311 (H.R. 1308), "Working Families Tax Relief Act of 2004." For the full text of the bill, see web site http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_public_ laws&docid=f:publ311.108.pdf.

[*19*] This section describes the bill known as P.L. 108-324 (H.R. 4837), "Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005." For the full text of the bill, see web site http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_ cong_public_laws&docid=f:publ324.108.pdf.

[*20*] Connecticut Department of Environmental Protection, "Regulations of Connecticut State Agencies (RCSA)," Title 22a, Section 22a-174-1 to 22a-174-200, "Abatement of Air Pollution," web site www.dep.state.ct.us/air2/regs/mainregs.htm.

[*21*] State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO), "Comparison of State Multi-Pollutant Strategies for Power Plants" (April 2003).

[*22*] Northeast States for Coordinated Air Use Management, "Mercury Emissions from Coal-Fired Power Plants —The Case for Regulatory Action" (October 2003), web site www.nescaum.org.

[*23*] State of Maine, "An Act to Provide Leadership in Addressing the Threat of Climate Change," Chapter 237, H.P. 622—L.D. 845, Session Laws of the State of Maine, 121st Legislature (Approved May 21, 2003), web site http://janus. state.me.us/legis.

[*24*] Maine Greenhouse Gas Initiative, web site http://maineghg.raabassociates.org.

[*25*] Massachusetts Department of Environmental Protection, "Regulations and Notices," web site www.mass.gov/dep/bwp/daqc/daqcpubs.htm#regs.

[*26*] Massachusetts Department of Environmental Protection, "Emission Control Plans," web site www.mass.gov/dep/bwp/daqc/daqcpubs.htm#ecp.

[*27*] Web site www.mass.gov/ocd/climate.html.

[*28*] Massachusetts Department of Environmental Protection, web sites www.mass.gov/dep/bwp/hgres.htm and www.mass.gov/dep/bwp/daqc/daqcpubs.htm#regs.

[*29*] "Air Quality Standards, Definitions, Sampling and Reference Methods and Air Pollution Control Regulations for the Entire State of Missouri," Chapter 6, web site www.sos.mo.gov/ adrules/csr/current/10csr/10csr.asp.

[*30*] State of New Hampshire, New Hampshire Code of Administrative Rules, "Multiple Pollutant and Annual Budget Trading and Banking Program," Chapter Env-A2900, web site www.des.state.nh.us/rules/air.htm.

[*31*] B.G. Rabe, "Greenhouse and Statehouse: The Evolving State Government Role in Climate Change" (Pew Center on Global Climate Change, November 2002), web site www.pewclimate.org.

[*32*] State of New York, Department of Environmental Conservation, "Acid Deposition Reduction Budget Trading Programs," web site www.dec.state.ny.us/website/dar/adopted.html.

[*33*] State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO), "Comparison of State Multi-Pollutant Strategies for Power Plants" (April 2003).

[*34*] North Carolina Department of Environment and Natural Resources, *Implementation of the "Clean Smokestacks Act"* (May 30, 2003), web site http://daq.state.nc.us/news/leg/.

[*35*] North Carolina Department of Environment and Natural Resources, *Mercury Clean Smokestacks Act Second Interim Report* (September 2004), web site http://daq.state.nc.us/news/leg/.

[*36*] North Carolina Department of Environment and Natural Resources, *CO_2 Clean Smokestacks Act, Second Interim Report* (September 2004), web site http://daq.state.nc.us/news/leg/.

[*37*] North Carolina Department of Environment and Natural Resources, web site http://daq.state.nc.us/news/leg/.

[*38*] State of Oregon, Oregon Administrative Rules, Chapter 345, Division 24, "Specific Standards for Siting Non-Nuclear Facilities and Related or Supporting Facilities," web site http://arcweb.sos.state.or.us/banners/rules.htm.

[*39*] Energy Information Administration, "State Electricity Profiles for Oregon, 2002," web site www.eia.doe.gov/emeu/states/main_or.html.

[*40*] S. Sadler, "Oregon Carbon Dioxide Emission Standards for New Energy Facilities," Oregon Office of Energy, Oregon Energy Facility Siting Council, Rule Division 24, OAR 345-024-0500 (1997), web sites www.energy.state.or.us and www.climatetrust.org.

[*41*] Assuming a plant heat rate of 10,000 Btu per kilowatthour and a CO_2 emission factor of 25.50 kg carbon per million Btu.

[*42*] Texas Natural Resource Conservation Commission, web site www.tnrcc.state.tx.us/permitting/airperm/grandfathered.

[*43*] Web sites http://www1.leg.wa.gov/legislature and www.efsec.wa.gov.

[*44*] On December 7, 2004, the Alliance of Automobile Manufacturers and several California auto dealerships filed suit in the U.S. District Court in Fresno, California, against A.B. 1493.

[*45*] Conversion methodology assumes 70.22 kilograms of carbon dioxide per million Btu of gasoline and 125,000 Btu per gallon of gasoline, which equates to 8.78 kilograms of carbon dioxide per gallon of gasoline.

[*46*] The Clean Air Act allows States to opt out of Federal light-duty vehicle exhaust emissions standard requirements if they choose to adopt California's standards. Connecticut, New Jersey, and Rhode Island have also passed legislation adopting California's light vehicle emissions standards, excluding the new greenhouse gas emission standards. The California Low Emission Vehicle Program (LEVP) requires more stringent criteria emission standards and minimum sales requirements for zero-emission vehicles, which include hybrid, electric, and fuel cell vehicles. Because these States were not expected to adopt the California light vehicle greenhouse gas emission standards, the associated light vehicle fuel economy impact from the sales of zero-emission vehicles due to their opting into the California LEVP are not represented in the *AEO2005* reference case and, therefore, were not included in the A.B. 1493 sensitivity cases.

[*47*] California Environmental Protection Agency Air Resources Board, *Addendum Presenting And Describing Revisions To: Initial Statement of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles* (September 10, 2004), p. 1, web site www.arb.ca.gov/regact/grnhsgas/addendum.pdf.

[*48*] California Environmental Protection Agency Air Resources Board, *Addendum Presenting And Describing Revisions To: Initial Statement of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles* (September 10, 2004), Table 8.2-1, p. 17, web site www.arb.ca.gov/regact/grnhsgas/addendum.pdf.

[*49*] Percentages derived from EMFAC model runs (April 23, 2002) provided by Jonathan Taylor, California Air Resources Board (December 20, 2004).

[*50*] The NEMS model does not capture State-specific sales, stocks, or vehicle miles traveled. The impact of the fuel economy equivalent standards were modeled nationally and applied regionally in subsequent runs based on State-specific distributions of light vehicle energy use and travel.

[*51*] Analysis of the National Highway Traffic Safety Administration model year 2001 CAFE data indicated that 12.3 percent of new light trucks sold (trucks less than 8,500 pounds gross vehicle weight) have a loaded vehicle weight less than 3,750 pounds.

[*52*] The EMFAC model was used to develop the baseline CO_2 equivalent emissions in the CARB analysis. Reductions were estimated on the basis of a NESCCAF model and applied to the EMFAC baseline.

[*53*] Census Division 9 includes the following States: Alaska, California, Hawaii, Oregon, and Washington.

[*54*] Census Division 1 includes the following States: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. Census Division 2 includes the following States: New Jersey, New York, and Pennsylvania.

[*55*] Energy Information Administration, *Analysis of S. 1844, the Clear Skies Act of 2003; S. 843, the Clean Air Planning Act of 2003; and S. 366, the Clean Power Act of 2003*, SR/OIAF/2004-05 (Washington, DC, May 2005),

web site www.eia. doe.gov/oiaf/servicerpt/csa/pdf/sroiaf (2004)05.pdf.

[*56*] U.S. Environmental Protection Agency, "Interstate Air Quality Rule," web site www.epa.gov/interstateair quality.

[*57*]*Federal Register*, Vol. 69, No. 20, 40 CFR parts 51, 72, 75, and 96 (January 30, 2004).

[*58*] *Federal Register*, Vol. 69, No. 112, 40 CFR Parts 51, 72, 73, 74, 77, 78, and 96 (June 10, 2004).

[*59*] U.S. Environmental Protection Agency, "Utility Mercury Reductions Rule," web site www.epa.gov/air/ mercuryrule.

[*60*] *Federal Register*, Vol. 69, No. 20, 40 CFR Parts 60 and 63 (January 30, 2004).

[*61*] *Federal Register*, Vol. 69, No. 51, 40 CFR Parts 60, 72, and 75 (March 16, 2004).

[*62*] Energy Information Administration, *Annual Energy Review 2002*, DOE/EIA-0384(2002) (Washington, DC, October 2003), Table 8.2a, p. 224.

[*63*] The bill covers emissions of the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_x), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

[*64*] This section describes the provisions proposed in S.A. 3546 and H.R. 4067, both titled the Climate Stewardship Act of 2004. For the full text of the bill, see web site http:// frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname= 108_cong_bills& docid=f:h4067ih.txt.pdf.

[*65*]The commercial sector includes government entities.

[*66*] In the definition of a covered entity, the clarification that the 10,000 metric ton threshold applies to emissions "from any single facility owned by the entity" was not present in the original version of the bill (S. 139). Because few commercial facilities would have emissions above the threshold, most entities in the commercial sector would be exempt. Addition of the "single facility" restriction clears up a key uncertainty in the definition of a "covered entity" in S. 139. The most recent bill also requires that all of a covered entity's emissions be subject to allowance requirements—not just the emissions from facilities that exceed the threshold. This interpretation suggests a possible avoidance strategy: an entity might design, organize, and operate its facilities to ensure that no single facility's emissions exceeded the threshold.

[*67*] The bill allows each covered entity to obtain 15 percent of its emission allowances from alternative compliance sources, including purchase of allowances from certified reduction or sequestration programs, both domestically and abroad. As an incentive for early action, entities reducing their emissions below 1990 levels by 2010 may be granted a limit of 20 percent of their target reductions from alternative compliance sources from 2010 to 2016.

[*68*] Covered entities would be required to submit allowances for their covered emissions or, to a limited extent, offsetting emission reduction credits from noncovered entities. Therefore, the covered emissions, less any offset credits, would be subject to the allowance cap.

[*69*] This provision would require the entity to show that a specific capital project is underway to reduce emissions and to return any allowances borrowed, at an effective interest rate of 10 percent per year. In addition, borrowed allowances would count against the limit on alternative compliance offsets. Therefore, in the aggregate, allowance borrowing would likely be minimal.

[*70*] The emissions for 2000 cited in the bill match the levels reported in U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000,* EPA-430-R-02-003 (Washington, DC, April 2002), after adjusting for the residential and agricultural sectors and U.S. territories.

[*71*]Energy Information Administration, *Analysis of S. 139, the Climate Stewardship Act of 2003*, SR/OIAF/2003-02 (Washington, DC, June 2003). For the full report, see web site www.eia.doe.gov/oiaf/servicerpt/ml/pdf/sroiaf(2003) 02.pdf. For a summary, see web site www.eia.doe.gov/ oiaf/servicerpt/ml/pdf/summary.pdf. A followup analysis of the amended (single phase) version of the bill, *Analysis of Senate Amendment 2028, the Climate Stewardship Act of 2003*, is available at web site www.eia.doe.gov/oiaf/ analysispaper/sacsa/index.html.

[*72*] A provision entitled "Dedicated Program for Sequestration in Agricultural Soils" would allow an entity to satisfy up to 1.5 percent of its total allowance submission requirements with registered increases in net carbon sequestration in agricultural soils. Entities would remain subject to an overall limit on offsets of 15 percent, or 20 percent if they met certain early action criteria.

[*73*] Refineries, as industrial entities, would be required to obtain allowance permits for the fuel they burned in refining oil, in addition to allowances for downstream emissions of the transportation fuel they sold. The costs would be passed on to consumers.

Issues in Focus

[*74*] For a description of the SAGE model, see Energy Information Administration, *International Energy Outlook 2004*, DOE/EIA-0484(2004) (Washington, DC, April 2004).

[*75*] For a detailed review of real GDP and oil projections by country and region, see *International Energy Outlook 2004*.

[*76*] A more rigorous determination of income elasticities, which controlled for price changes, was also undertaken. It involved a statistical estimation of the relationship between the projected demand for oil and projected real GDP and world oil prices. The numbers quoted here for income elasticities are similar to those that were statistically estimated.

[*77*] For a recent study and a review of the empirical literature see D. Gately and H.G. Huntington, "The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand," OP50, Energy Modeling Forum (Stanford, CA: Stanford University, August 2001).

[*78*] D. Gately and H.G. Huntington, "The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand," OP50, Energy Modeling Forum (Stanford, CA: Stanford University, August 2001).

[*79*] Cumulative production in a year is obtained by multiplying oil production per day by 365. For oil-producing countries, it is assumed that oil is sold domestically at the same world oil price.

[*80*] G.A. Smook, *Handbook for Pulp and Paper Technologies*, 2nd Edition (Bellingham, WA: Angus Wilde Publications, 1992).

[*81*] American Forest and Paper Association, *Statistics of Paper, Paperboard and Wood Pulp*, 41st Edition (Washington, DC, 2004).

[*82*] American Forest and Paper Association, *Statistics of Paper, Paperboard and Wood Pulp*, 41st Edition (Washington, DC, 2004).

[*83*] Note that the output forecasts were disaggregated into the four components of bulk chemicals in previous *AEO*s. The history and prospects for agricultural chemicals were discussed in *Annual Energy Outlook 2004*.

[*84*] American Chemical Council, *Guide to the Business of Chemistry 2003*, p. 169.

[*85*] For example, PotashCorp, "The PotashCorp Letter" (June 2003).

[*86*] For example, see Celanese AG, "Celanese To Source Methanol from Southern Chemical Company" (press release, July 22, 2003).

[*87*] National Highway Traffic Safety Administration, *Summary of Fuel Economy Performance* (Washington, DC, March 2004).

[*88*] National Highway Traffic Safety Administration, *Automotive Fuel Economy Program Annual Update Calendar Year 2002* (Washington, DC, September 2003), Table II-4.

[*89*] U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004* (Ann Arbor, MI, April 2004), Table E-3.

[*90*] S.C. Davis and S.W. Diegel, *Transportation Energy Data Book Edition 24*, ORNL-6970 (Oak Ridge, TN: Oak Ridge National Laboratory, October 2003), Table 4.9.

[*91*] "President Announces Clear Skies & Global Climate Change Initiatives" (February 14, 2002), web site www.whitehouse.gov/news/releases/2002/02/20020214-5.html.

[*92*] See the Addendum to the *Global Climate Change Policy Book*, web site www.whitehouse.gov/news/releases/2002/02/climatechange.html. The BAU projections cited in the Addendum are somewhat higher than those in a Policies and Measures case developed by the EPA for the *U.S. Climate Action Report 2002*. EIA has adjusted the Addendum projections to reflect the most recent (2002 and 2003) data on emissions published by EIA, as well as to estimate the intervening years of the projections (the EPA projections were provided for 5-year intervals). In addition, EIA has extrapolated the projections to estimate emissions for 2025.

[*93*] U.S. Department of State, *U.S. Climate Action Report 2002* (Washington, DC, May 2002), Chapter 5, "Projected Greenhouse Gas Emissions," pp. 70-80, web site http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsUSClimateActionReport.html.

[*94*] U.S. Environmental Protection Agency, *U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions,* EPA 30-R-99-013 (Washington, DC, September 1999), web site www.epa.gov/ghginfo/pdfs/07-complete.pdf; and *Addendum to the U.S. Methane Emissions 1990-2020: Update for Inventories, Projections, and Opportunities for Reductions* (December 2001), web site www.epa.gov/ghginfo/pdfs/final_addendum2.pdf.

[*95*] U.S. Environmental Protection Agency, *U.S. High GWP Gas Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions,* EPA 000-F-97-000 (Washington, DC, June 2001), web site www.epa.gov/ghginfo/pdfs/gwp_gas_emissions_6_01.pdf.

[*96*] U.S. Environmental Protection Agency, *U.S. Adipic Acid and Nitric Acid N_2O Emissions 1990-2020: Inventories, Projections and Opportunities for Reductions* (Washington, DC, December 2001), web site www.epa.gov/ghginfo/pdfs/adipic.pdf.

[*97*] A degree-day is defined as the difference between the average daily temperature (in degrees Fahrenheit) and 65. Averages above 65 degrees Fahrenheit count as cooling degree-days, and averages below 65 degrees Fahrenheit count as heating degree-days. For example, if the average temperature on a given day is 40 degrees Fahrenheit, then 25 heating degree-days are counted.

[*98*] The rate was later raised to 15 percent by the Crude Oil Windfall Profits Act of 1980, which extended the credit to December 31, 1985, when it was allowed to lapse for wind.

[*99*] Dollars are expressed in year 2003 values, except as otherwise noted.

[*100*]See IRS Form 8835, "Renewable Electricity Production Credit," for the year 2003, web site www.irs.gov/pub/irs-pdf/f8835.pdf.

[*101*]Interstate Renewable Energy Council, Database of State Incentives for Renewable Energy, web site www.dsire.org (September 22, 2003). Note: 425 megawatts, the original mandated term in 1994, has been extended to 825 megawatts in 2006 and 1,125 megawatts in 2010.

[*102*]"Tax Relief Extension Act of 1999," Public Law 106-170.

[*103*]The American Wind Energy Association estimates 1,697 megawatts of installations of all sizes in 2001 (see web site www.awea.org/faq/ instcap.html).

[*104*]"Job Creation and Worker Assistance Act of 2002," Public Law 107-147.

[*105*]The American Wind Energy Association estimates 1,689 megawatts net capacity growth in 2003 (see web site www.awea.org/faq/instcap.html).

[*106*]Wind power facilities also receive a 5-year accelerated depreciation allowance on Federal income tax.

[*107*]For further discussion of cost and performance improvements, see C. Namovicz, "Modeling Wind and Intermittent Generation in the National Energy Modeling System (NEMS)," in American Wind Energy Association, *WindPower 2003 Conference Proceedings* (2003).

[*108*]Cost includes "busbar" costs plus transmission interconnection charge, but does not include additional grid services that may be required to facilitate integration of wind power. Excellent wind resources refer to sites in wind power Class 6 or better, defined by the Pacific Northwest Laboratory as a site with an annual average wind speed at 50 meter hub height of 8.0 meters per second (17.9 miles per hour) or higher. See D.L. Elliot et al., *Wind Energy Resource Atlas of the United States* (Pacific Northwest Laboratory, March 1987), p. 3.

[*109*]Note that the levelized cost of both natural gas and coal plants depends on expected utilization rates. For comparison purposes, an 85-percent utilization rate is assumed for coal and 87 percent for combined cycle.

Effective utilization rates (capacity factors) for current-technology wind plants range from 33 to 40 percent, depending on quality of the wind resource. The 40-percent capacity factor corresponds to the lowest levelized wind cost.

[*110*]Claiming the PTC precludes these facilities from claiming the 10-percent investment tax credit also available to geothermal and solar plants. Also, the tax credit applies only to generation sold to a non-related party, and thus would not be available to facilities using photovoltaics or other "distributed generation" technology to provide on-site power.

[*111*]For example, leading Danish wind turbine manufacturer Vestas announced in early 2003 plans to build a significant factory in Oregon, but uncertainty over PTC extension was cited as the primary reason for delaying or curtailing the plan. See B. Jacklet, *Portland Tribune* (June 13, 2003), web site www.portlandtribune.com/archview.cgi?id=18698.

[*112*]The distributed generation projections for the residential and commercial sectors currently use an average electricity price in energy savings calculations without specific consideration of the time-of-day or demand-charge rates applicable to some customers. These projections focus only on baseload electricity requirements. However, potential investment decisions involving PV systems do use an "air-conditioning" electricity price in energy savings calculations, since maximum PV generation correlates with the air conditioning season.

[*113*]Distributed generation technologies are assumed to receive the grid's marginal cost of generation—the avoided cost of generation only, without transmission and distribution costs that are included in the retail rate.

[*114*]PV installed costs are per kilowatt of peak capacity and represent grid-connected systems with no battery storage or power backup. Installed costs for all other distributed generation technologies represent grid-connected CHP systems. Installed capital costs for all technologies include costs for equipment, labor and materials, interconnection, project and construction management, engineering and contingency fees.

[*115*]Electrical conversion efficiency for PV is the system efficiency as opposed to solar cell efficiency. For a more detailed description of residential and commercial distributed generation assumptions, including combined electrical and thermal efficiency for CHP systems, see *Assumptions for the Annual Energy Outlook 2005*, web site www.eia.doe.gov/oiaf/aeo/assumption/index.html.

[*116*]For PV and fuel cell technologies, a doubling of cumulative shipments results in an assumed 13-percent reduction in installed capital costs. For microturbines, a doubling results in an assumed 10-percent reduction in costs.

[*117*]ONSITE SYCOM Energy Corporation, *The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector* (January 2000), p. 17.

[*118*]Absorption chillers use heat instead of an electric motor in the compression phase of the cooling cycle. The waste heat produced during the generation process may be used with an absorption chiller to provide cooling in a CHP system.

[*119*]A discussion of the regulation issues and a database providing basic State-by-State permitting information for distributed generation projects is on the Energy and Environmental Analysis, Inc., web site at www.eea-inc.com/rrdb/DGRegProject/guide.html.

[*120*]The IEEE standard was announced in July 2003. See web site http://standards.ieee.org/announcements/1547idr.html.

[*121*]The types of pollutants responsible for designation as a nonattainment zone vary by region. A list of nonattainment areas is available at web site www.epa.gov/oar/oaqps/greenbk.

[*122*]Distributed generation projections in the buildings sectors are developed at the Census division level to include variation between geographical regions. There are nine Census divisions in the United States. For a map showing the States included in each division, see web site www.eia.doe.gov/geography.html.

[*123*]Energy Information Administration, Form EIA-860, "Annual Electric Generator Report" (preliminary).

[*124*]Current tax law includes a 10-percent investment tax credit available to businesses that install a qualifying solar PV system. In addition, commercial PV owners may depreciate their equipment using an accelerated depreciation schedule and a 5-year economic life. The depreciable basis only needs to be reduced by half of the investment tax credit.

[*125*]See Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004), Table 10.6 (annual PV shipments, 1989-2002). The approach used to develop the estimate, based on shipment data, provides an upper estimate of the size of the PV stock, including both grid-based and off-grid PV. It will overestimate the size of the stock, because shipments include a substantial number of units that are exported, and each year some of the PV units installed earlier will be retired from service or abandoned.

[*126*]For further information on the California Energy Commission rebate program, see web site www.energy.ca.gov/renewables/emerging_renewables. html. For a discussion of State renewable energy requirements see T. Petersik, "State Renewable Energy Requirements and Goals: Status Through 2003" (July 2004), web site www.eia.doe.gov/oiaf/analysispaper/rps/index.html. For information on renewable energy incentives throughout the United States, see the North Carolina Solar Center's Database of State Incentives for Renewable Energy, web site www.dsireusa.org.

[*127*]The buildings sector technology cases assume that current equipment and building standards are met but do not include feedback effects on energy prices or economic growth.

[*128*]The high technology case assumptions call for PV costs to decline by 17 percent, fuel cell costs to decline by 29 percent, and costs for microturbines to decline by 13 percent with a doubling of cumulative shipments.

Market Trends

[*129*]Energy-intensive industries include food, paper, bulk chemicals, petroleum refining, glass, cement, steel, and aluminum.

[*130*]The reference case assumes the Organization of Petroleum Exporting Countries' (OPEC) members will continue to demonstrate a disciplined production approach that reflects a strategy of price defense in which the larger producers are willing to increase or decrease production levels to maintain fairly stable prices (in real dollar terms) to discourage the development of alternative crude oil supplies or energy sources, allow for continued robust worldwide economic growth, and maintain compliance with quotas, particularly for smaller OPEC producers. Under this strategy, prices are assumed to be kept in a range from $27 to $30 per barrel in 2003 dollars, near the high end of the current OPEC price target range. Since OPEC, particularly the Persian Gulf nations, are expected to be the dominant supplier of oil in the international market over the mid-term, the organization's production choices will significantly affect world oil prices. The low oil price scenario could result from a future market where all oil production becomes more competitive. The high A and B price scenarios could result from a more cohesive and market-assertive OPEC with lower production goals and other non-financial (geopolitical) considerations or from the development of a less optimistic oil resource situation than currently expected.

[*131*]The intensities shown were disaggregated using the divisia index. The divisia index is a weighted sum of growth rates and is separated into a sectoral shift or "output" effect and an energy efficiency or "substitution" effect. It has at least two properties that make it superior to other indexes. First, it is not sensitive to where in the time period or in which direction the index is computed. Second, when the effects are separated, the individual components have the same magnitude, regardless of which is calculated first. See Energy Information Administration, "Structural Shift and Aggregate Energy Efficiency in Manufacturing" (unpublished working paper in support of the National Energy Strategy, May 1990); and Boyd et al., "Separating the Changing Effects of U.S. Manufacturing Production from Energy Efficiency Improvements," *Energy Journal*, Vol. 8, No. 2 (1987).

[*132*]Estimated as consumption of alternative transportation fuels in crude oil Btu equivalence. Alternative fuels include ethanol, electricity, hydrogen, natural gas, and propane.

[*133*]Small light trucks (compact pickup trucks and compact vans) are used primarily as passenger vehicles, whereas medium light trucks (compact utility trucks and standard vans) and large light trucks (standard utility trucks and standard pickup trucks) are used more heavily for commercial purposes.

[*134*]Values for incremental investments and energy expenditure savings are discounted back to 2004 at a 7-percent real discount rate.

[*135*]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, ORNL/CON-444 (Washington, DC, September 1997); J. DeCicco et al., *Technical Options for Improving the Fuel Economy of U.S. Cars and Light Trucks by 2010-2015* (Washington, DC: American Council for an Energy Efficient Economy, April 2001); M.A. Weiss et al., *On the Road in 2020: A Life-Cycle Analysis of New Automotive Technologies* (Cambridge, MA: Massachusetts Institute of Technology, October 2000); A. Vyas, C. Saricks, and F. Stodolsky, *Projected Effect of Future Energy Efficiency and Emissions Improving Technologies on Fuel Consumption of Heavy Trucks* (Argonne, IL: Argonne National Laboratory, 2001); and Energy and Environmental Analysis, Inc., *Documentation of Technologies included in the NEMS Fuel Economy Model for Passenger Cars and Light Trucks* (prepared for Energy Information Administration, September 30, 2002).

[*136*]Unless otherwise noted, the term "capacity" in the discussion of electricity generation indicates utility, nonutility, and combined heat and power capacity. The costs reflect the arithmetic average of the regional cost.

[*137*]*AEO2005* does not include off-grid photovoltaics (PV). Based on annual PV shipments from 1989 through 2002, EIA estimates that as much as 134 megawatts of remote electricity generation PV applications (i.e., off-grid power systems) were in service in 2002, plus an additional 362 megawatts in communications, transportation, and assorted other non-grid-connected, specialized applications. See *Annual Energy Review 2003*, Table 10.6 (annual PV shipments, 1989-2002). The approach used to develop the estimate, based on shipment data, provides an upper estimate of the size of the PV stock, including both grid-based and off-grid PV. It will overestimate the size of the stock, because shipments include a substantial number of units that are exported, and each year some of the PV units installed earlier will be retired from service or abandoned.

[*138*]Avoided cost estimates the incremental cost of fuel and capacity displaced by a unit of the specified resource and more accurately reflects its as-dispatched energy value than comparison to the levelized cost of other individual technologies. It does not reflect system reliability cost nor does it necessarily indicate the lowest cost alternative for meeting system energy and capacity needs.

[*139*]Associated-dissolved natural gas is produced in conjunction with crude oil. Nonassociated gas is produced without crude oil production.

[*140*]Unconventional gas includes tight (low permeability), sandstone gas, shale gas, and coalbed methane.

[*141*]Gas exports from the United States to Mexico continue to exceed imports from Mexico through the end of the projections.

[*142*]Energy Information Administration, *Analysis of Oil and Gas Production in the Arctic National Wildlife Refuge*, SR/OIAF/2004-04 (Washington, DC, March 2004).

[*143*]**Buildings:** Energy Information Administration (EIA), *Technology Forecast Updates—Residential and Commercial Building Technologies—Advanced Adoption Case* (Navigant Consulting, Inc., September 2004). Industrial: EIA, *Industrial Model: Update on Energy Use and Industrial Characteristics* (Arthur D. Little, Inc., September 2001). **Transportation:** U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, ORNL/CON-444 (Washington, DC, September 1997); J. DeCicco and M. Ross, *An Updated Assessment of the Near-Term Potential for Improving Automotive Fuel Economy* (Washington, DC: American Council for an Energy-Efficient Economy, November 1993); and A. Vyas, C. Saricks, and F. Stodolsky, *Projected Effect of Future Energy Efficiency and Emissions Improving Technologies on Fuel Consumption of Heavy Trucks* (Argonne,

IL: Argonne National Laboratory, 2001). **Fossil-fired generating technologies:** U.S. Department of Energy, Office of Fossil Energy. **Renewable generating technologies:** U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, and Electric Power Research Institute, *Renewable Energy Technology Characterizations*, EPRI-TR-109496 (Washington, DC, December 1997).

[*144*]U.S. Environmental Protection Agency, *Control of Mercury Emissions from Coal-fired Electric Utility Boilers: Interim Report*, EPA-600/R-01-109, April 2002, Table ES-1, Page ES-10.

Table Notes and Sources

Note: Tables indicated as sources in these notes refer to the tables in Appendixes A, B, C, D, and E of this report.

Table 1. Total energy supply and disposition in the *AEO2005* reference case: summary, 2002-2025: AEO-2005 National Energy Modeling System, run AEO2005. D102004A. **Notes:** Quantities are derived from historical volumes and assumed thermal conversion factors. Other production includes liquid hydrogen, methanol, supplemental natural gas, and some inputs to refineries. Net imports of petroleum include crude oil, petroleum products, unfinished oils, alcohols, ethers, and blending components. Other net imports include coal coke and electricity. Some refinery inputs appear as petroleum product consumption. Other consumption includes net electricity imports, liquid hydrogen, and methanol.

Table 2. Impacts of 13 SEER central air conditioner and heat pump standard compared with 12 SEER standard, 2006-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and SEER12.D110204A. **Note:** Future costs and savings (energy bill savings, equipment cost increase, and net present value) are discounted back to 2005 at a 7-percent real discount rate.

Table 3. Final nonroad diesel emissions standards: U.S. Environmental Protection Agency, *Clean Air Nonroad Diesel Rule, Exhaust Emission Standards*, EPA-420-F-04-032 (Washington, DC, May 2004), web site www.epa.gov/nonroad-diesel/2004fr/420f04032.htm. **Notes:** For rated engine power 25 to less than 75 horsepower, the 3.5 standard includes both NO_x and nonmethane hydrocarbons. For rated engine power 750 horsepower or more, the 5.0 standard for NO_x applies to generator sets over 1,200 horsepower. For all generator sets, the 0.02 standard for particulate matter applies to generator sets, and the 0.03 standard applies to other engines; the 0.50 standard for NO_x applies to generator sets only.

Table 4. Timeline for implementing nonroad diesel fuel sulfur limits: Energy Information Administration, Office of Integrated Analysis and Forecasting. **Notes:** For all standards, the effective date is June 1 of the year indicated. For small refiners in 2014 and after, the NRLM diesel downgrade to 500 ppm is allowed indefinitely; the 15 ppm standard is required at the refinery gate only.

Table 5. Key projections for distillate fuel markets in two cases, 2007-2014: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO2005. NONONROAD.D102704A.

Table 6. Basic features of State renewable energy requirements as of December 31, 2003: Energy Information Administration, Office of Integrated Analysis and Forecasting. **Notes:** The Minnesota mandate specifies various dates, beginning in 2003. The original requirement for 125 megawatts of biomass capacity has been reduced. For the Minnesota goal, specific characteristics are being determined. See web site www.puc.state.mn.us, Docket 03-869. NS = not specified in the State requirement. NA = not applicable.

Table 7. Estimated capacity contributing to State renewable energy programs through 2003: Energy Information Administration, Office of Integrated Analysis and Forecasting. **Notes:** Biomass includes biomass co-firing and cogeneration capacity, but none is known to have been built. In Arizona, a 3-megawatt biomass-fueled plant slated for 2003 entered service in early 2004 and is not shown here. In addition to capacity shown here, the Salt River project added a 4-megawatt landfill gas project under a separate requirement. In California, new capacity that contributes to the State's RPS requirement but was built for other reasons. In Wisconsin, 20 kilowatts of solar capacity was also built. The RPS also spurred biomass co-firing in varying proportions at 79 megawatts of existing fossil-fueled capacity, as well as refurbishment and operation of 7.2 megawatts of existing hydroelectric capacity. Pennsylvania's program has resulted in 10 megawatts of new renewables capacity. In addition, 118 megawatts of new wind capacity in Pennsylvania and 66 megawatts in West Virginia were supported by separate sustainable development funds. Fewer than one-half of the States accept mass-burn municipal solid waste, and specific requirements vary by State. Totals shown in the table may not equal the sum of their components, due to independent rounding.

Table 8. Existing State air emissions legislation with potential impacts on the electricity generation sector: Sources cited in the text.

Table 9. CARB CO_2 equivalent emission standards for light-duty vehicles, model years 2009-2016: California Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing To Consider Adoption of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles* (Sacramento, CA, August 6, 2004).

Table 10. CARB fuel economy equivalent standards for light-duty vehicles, model years 2009-2016: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Table 11. Comparison of key factors in the CARB and EIA analyses, 2020: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Table 12. Emissions targets in multi-pollutant legislation: Energy Information Administration, *Analysis of S. 1844, the Clear Skies Act of 2003; S. 843, the Clean Air Planning Act of 2003; and S. 366, the Clean Power Act of 2003*, SR/OIAF/2004-05 (Washington, DC, May 2005), web site www.eia.doe.gov/oiaf/servicerpt/csa/pdf/sroiaf(2004)05.pdf. **Notes:** The limits on NO_x emissions under S. 1844 are split between two regions: 1.47 million tons in Zone 1 (the East) in 2008 to 2017 and 0.72 million tons in Zone 2 (the West) from 2008 through 2017; and 1.07 million tons in Zone 1 and 0.72 million tons in Zone 2 in 2018. The 2009 limit on SO_2 emissions under S. 366 is split between

two regions: 0.275 million tons in the West and 1.975 million tons in the other regions. Under S. 366, minimum facility-specific reductions of mercury emissions without trading are required in 2008. Under S. 843, minimum facility-specific reductions of mercury emissions between 50 percent (2009 to 2012) and 70 percent (after 2012) are required. Under S. 366, the 2009 limit on CO_2 emissions from the electricity sector is the estimated 1990 emissions level. Under S. 843, the 2009 to 2012 limit on CO_2 emissions is based on EIA's *AEO2004* projection of 2006 emissions, and the limit for 2013 and subsequent years is based on the estimated 2001 emissions level.

Table 13. Key projections from EIA's 2004 analysis of proposed multi-pollutant control bills, 2025: Energy Information Administration, AEO2004 National Energy Modeling System, runs AEO2004.D101703E, INBASE. D040904A, INCS3PWS.D040904A, INCA4P.D040904A, INCA4PLO.D040904A, and INJF4P.D041604A. **Note:** mercury emissions in 2003 are NEMS estimates, not actual amounts.

Table 14. Historical emissions and proposed future caps for the combination of affected pCAIR States: 2002: U.S. Environmental Protection Agency, web site http://cfpub.epa.gov/gdm. **Future emissions caps:** U.S. Environmental Protection Agency, web site www.epa.gov/interstateair quality/rule.html.

Table 15. Key electricity sector projections from EIA's analysis of proposed pCAIR regulations, 2015 and 2025: 2003 SO_2 allowance price: U.S. Environmental Protection Agency, web site www.epa.gov/airmarkets/auctions/2003/03summary.html. **Other 2003 values and projections:** Energy Information Administration, AEO-2005 National Energy Modeling System, runs AEO2005. D102004A and CAIR2005.D010505A. **Note:** Coal-fired capacity retrofits include currently planned and unplanned (projected) FGD and SCR installations.

Table 16. Projected growth in world gross domestic product, oil consumption, and oil intensity in the *AEO2005* reference case, 2003-2025: United States: AEO2005 National Energy Modeling System, run AEO2005.D102004A. **Other countries:** Energy Information Administration, *International Energy Outlook 2004*, DOE/EIA-0484(2004) (Washington, DC, April 2004).

Table 17. Key projections in the reference case, 2003-2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Table 18. Key projections in the high A world oil price case, 2003-2025: AEO2005 National Energy Modeling System, run HW2005.D102004A.

Table 19. Key projections in the high B world oil price case, 2003-2025: AEO2005 National Energy Modeling System, run VHW2005.D010705A.

Table 20. Key projections in the low world oil price case, 2003-2025: AEO2005 National Energy Modeling System, run LW2005.D102004A.

Table 21. Projected changes in U.S. greenhouse gas emissions, gross domestic product, and greenhouse gas intensity, 2002-2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Table 22. Levelized costs of new conventional and renewable generation in two cases, 2010: AEO2005 National Energy Modeling System, runs AEO2005. D102004A and PTCEXT05.D102904A. **Notes:** Cost "at the busbar," does not include transmission investment or additional costs to accommodate intermittent renewable resources. Costs reflect national averages for best available regional resources; comparative costs within specific regions may differ significantly. Fuel costs are slightly reduced with the PTC, reflecting reduced demand from the electric power sector. It is assumed that PV will continue to take advantage of the higher-value investment tax credit (ITC) rather than the PTC. Avoided costs represent estimates of the incremental cost of fuel and capacity displaced by a unit of the specified resource and more accurately reflect their as-dispatched energy value. They do not reflect system reliability costs, nor do they necessarily indicate the lowest cost alternative for meeting system energy and capacity needs.

Table 23. Renewable electricity capacity and generation in two cases, 2005, 2015, and 2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and PTCEXT05.D102904A.

Table 24. Projected installed costs and electrical conversion efficiencies for distributed generation technologies by year and technology, 2004, 2010, 2020, 2025: Energy Information Administration, *Assumptions to the Annual Energy Outlook 2005*, DOE/EIA-0554 (2005) (Washington, DC, February 2005), web site www.eia.doe.gov/oiaf/aeo/assumption/index.html.

Table 25. Buildings sector distributed electricity generation in alternative cases: difference from the reference case in 2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, BLDFRZN. D102104A, BLDHIGH.D110404A, LW2005.D102004A, and HW2005.D102004A.

Table 26. New car and light truck horsepower ratings and market shares, 1990-2025: History: U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Light-Duty Automotive Technology And Fuel Economy Trends: 1975-2003*, EPA-420-S-03-004, April 2003. **Projections:** AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Table 27. Costs of producing electricity from new plants, 2015 and 2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Table 28. Technically recoverable U.S. natural gas resources as of January 1, 2003: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Table 29. Crude oil production from Gulf of Mexico offshore, 2003-2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Table 30. Technically recoverable U.S. oil resources as of January 1, 2003: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Table 31. Onshore and offshore lower 48 crude oil production in three cases, 2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, LW2005. D102004A, and HW2005.D102004A.

Figure Notes and Sources

Note: Tables indicated as sources in these notes refer to the tables in Appendixes A, B, C, D, and E of this report.

Figure 1. Energy prices, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* compared: *AEO2004* projections:** Energy Information Administration, *Annual Energy Outlook 2004*, DOE/EIA-0383(2004) (Washington, DC, January 2004). ***AEO2005* projections:** Table A1.

Figure 2. Delivered energy consumption by sector, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* projections:** Table A2.

Figure 3. Energy consumption by fuel, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* projections:** Tables A1 and A18.

Figure 4. Energy use per capita and per dollar of gross domestic product, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* projections:** Table A20.

Figure 5. Electricity generation by fuel, 1970-2025: History: Energy Information Administration (EIA), Form EIA-860B, "Annual Electric Generator Report—Nonutility", EIA, *Annual Energy Review 2003*, DOE/EIA-0384 (2003) (Washington, DC, September 2004), and Edison Electric Institute. ***AEO2004* and *AEO2005* projections:** Table A8.

Figure 6. Total energy production and consumption, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* projections:** Table A1.

Figure 7. Energy production by fuel, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). ***AEO2004* and *AEO2005* projections:** Tables A1 and A18.

Figure 8. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2025: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2003*, DOE/EIA-0573(2003) (Washington, DC, December 2004). **Projections:** Table A19.

Figure 9. Projected electricity prices under proposed multi-pollutant control bills, 2010, 2020, and 2025: Energy Information Administration, AEO2004 National Energy Modeling System, runs AEO2004.D101703E, INBASE.D040904A, INCS3PWS.D040904A, INCA4P.D040904A, INCA4PLO.D040904A, and INJF4P.D041604A.

Figure 10. Projected electricity generation by fuel in two cases, 2025: Energy Information Administration, AEO2005 National Energy Modeling System runs AEO2005.D102004A and CAIR2005.D010505A.

Figure 11. Projected coal production by region in two cases, 2025: Energy Information Administration, AEO2005 National Energy Modeling System runs AEO2005.D102004A and CAIR2005.D010505A.

Figure 12. World oil prices in the reference, October oil futures, high A, high B, and low oil price cases, 1990-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, LW2005.D102004A, HW2005.D102004A, VHW2005.D120304A, and CF2005.D111104A.

Figure 13. OPEC oil production in four world oil price cases, 1990-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, LW2005.D102004A, HW2005.D102004A, and VHW2005.D120304A.

Figure 14. Non-OPEC oil production in four world oil price cases, 1990-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, LW2005.D102004A, HW2005.D102004A, and VHW2005.D120304A.

Figure 15. Projected growth in output for energy-intensive industries in *AEO2004* and *AEO2005*, 2003-2025: AEO2004 National Energy Modeling System, run AEO2004.D101703E, and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 16. Projected growth in energy consumption for the pulp and paper industry in *AEO2004* and *AEO2005*, 2003-2025: AEO2004 National Energy Modeling System, run AEO2004.D101703E, and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 17. Projected output growth for components of the bulk chemicals industry in *AEO2004* and *AEO2005*, 2003-2025: AEO2004 National Energy Modeling System, run AEO2004.D101703E, and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 18. Projected growth in energy consumption for the bulk chemicals industry by energy source in *AEO2004* and *AEO2005*, 2003-2025: AEO2004 National Energy Modeling System, run AEO2004.D101703E, and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 19. Average fuel economy for new light-duty vehicles, 1980-2004: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 20. Projected improvement in U.S. greenhouse gas intensity in three cases, 2002-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, LTRKITEN.D111504A, and HTRKITEN.D111604A.

Figure 21. U.S. average heating and cooling degree-days, 1973-2003: National Oceanic and Atmospheric Administration.

Figure 22. Projected U.S. average heating degree-days in three cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, WARMER.D102604A and COLDER.D102604B.

Figure 23. Projected U.S. average cooling degree-days in three cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, WARMER.D102604A and COLDER.D102604B.

Figure 24. Cumulative projected change from the reference case in buildings sector electricity and fossil fuel use in two cases, 2006-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, WARMER.D102604A and COLDER.D102604B.

Figure 25. Present value of projected change from the reference case in buildings sector expenditures for electricity and fossil fuel use in two cases, 2006-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A, WARMER.D102604A and COLDER.D102604B.

Figure 26. U.S. installed wind capacity, 1981-2003: 1981-1989: California Energy Commission, *Draft Final Report, California Historical Energy Statistics*, p300-98-001 (January 1998). **1990-2003:** Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004), Table 8.7a.

Figure 27. Projected buildings sector electricity generation by selected distributed resources in the reference case, 2003-2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 28. Projected buildings sector generation by fossil fuel-fired and photovoltaic systems by Census division in the reference case, 2003 and 2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 29. Lower 48 average wellhead natural gas price in two cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 30. Total U.S. natural gas consumption in two cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 31. U.S. natural gas consumption for electric power generation in two cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 32. U.S. net imports of liquefied natural gas in two cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 33. Total U.S. natural gas production in two cases, 2000-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 34. Total end-use expenditures on natural gas in two cases, 2003-2025: AEO2005 National Energy Modeling System, runs AEO2005.D102004A and AEO.OUTPUT.RESSUP.D102704A.

Figure 35. Average annual growth rates of real GDP and economic factors, 1995-2025: History: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Department of Labor, Bureau of Labor Statistics. **Projections:** AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 36. Sectoral composition of output growth rates, 2003-2025: History: Global Insight U.S. Industry Service. **Projections:** AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 37. Sectoral composition of gross output, 2003, 2010, and 2025: History: Global Insight U.S. Industry Service. **Projections:** AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 38. Average annual real growth rates of economic factors in three cases, 2003-2025: History: U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Department of Labor, Bureau of Labor Statistics. **Projections:** AEO2005 National Energy Modeling System, runs AEO2005.D102004A, HM2005.D102004A, and LM2005.D102004A.

Figure 39. Average annual real GDP growth rate, 1970-2025: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2005 National Energy Modeling System, runs AEO2005.D102004A, HM2005.D102004A, and LM2005.D102004A.

Figure 40. World oil prices in four cases, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Tables A1, C1, and D1.

Figure 41. U.S. gross petroleum imports by source, 2000-2025: AEO2005 National Energy Modeling System, run AEO2005.D102004A; and World Oil, Refining, Logistics, and Demand (WORLD) Model, run AEO04B.

Figure 42. Energy use per capita and per dollar of gross domestic product, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). Projections: Table A2.

Figure 43. Primary energy use by fuel, 2003-2025: History: Energy Information Administration, *Annual Energy Review 2003,* DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A1.

Figure 44. Delivered energy use by fuel, 1970-2025: History: Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A2.

Figure 45. Primary energy consumption by sector, 1970-2025: History: Energy Information Administration, *State Energy Data Report 2001*, DOE/EIA-0214(2001) (Washington, DC, November 2004), and *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A2.

Figure 46. Residential delivered energy consumption by fuel, 1970-2025: History: Energy Information Administration, *State Energy Data Report 2001*, DOE/EIA-0214(2001) (Washington, DC, November 2004), and *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A2.

Figure 47. Residential delivered energy consumption by end use, 1990, 2003, 2010, and 2025: History: Energy Information Administration, Residential Energy Consumption Survey. **Projections:** Table A4. **Note:** Although 2001 is the last year of historical data for many of the detailed end-use consumption concepts (e.g., space heating, cooling), 2003 data, taken from the *Annual Energy Review 2003*, is used as the base year for the more aggregate statistics shown in *AEO2005*. For illustrative purposes, the EIA estimates for the detailed end-use consumption concepts, consistent with this historical information, are used to show growth rates.

Figure 48. Efficiency indicators for selected residential appliances, 2003 and 2025: Navigant Consulting, , Inc., "EIA Technology Forecast Updates-Residential and Commercial Building Technologies-Reference Case," Reference No. 117943 (September 2004), and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 49. Commercial delivered energy consumption by fuel, 1970-2025: History: Energy Information Administration, *State Energy Data Report 2001*, DOE/EIA-0214 (2001) (Washington, DC, November 2004), and *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A2.

Figure 50. Commercial delivered energy consumption by end use, 2003, 2010, and 2025: Table A5.

Figure 51. Efficiency indicators for selected commercial equipment, 2003 and 2025: Navigant Consulting, Inc., "EIA-Technology Forecast Updates—Residential and Commercial Building Technologies—Reference Case," Reference No. 117943 (September 2004), and AEO2005 National Energy Modeling System, run AEO2005.D102004A.

Figure 52. Industrial delivered energy consumption by fuel, 1970-2025: History: Energy Information Administration, *State Energy Data Report 2001*, DOE/EIA-0214 (2001) (Washington, DC, November 2004), and *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** Table A2.

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