

Forecast Comparisons

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Three other organizations — DRI/McGraw-Hill (DRI), the WEFA Group (WEFA), and the Gas Research Institute (GRI) — also produce comprehensive energy projections with a time horizon similar to that of *AEO99*. The most recent projections from these organizations (DRI, April 1998; WEFA, 1998; GRI, August 1998) and others that concentrate on petroleum, natural gas, and international oil markets are compared with the *AEO99* projections in this section.

Economic Growth

Differences in long-run economic forecasts can be traced primarily to different views of the major supply-side determinants of growth: labor force and productivity change. Other forecasts are presented in Table 12. The WEFA forecast shows the highest economic growth compared to the *AEO99* and DRI reference cases, including higher growth rates for the labor force. The *AEO99* long-run forecast of economic growth is higher than the *AEO98* forecast by 0.2 percent, when compared on a similar basis, with a projected annual growth rate for GDP of 1.8 percent from 1997 to 2020.

Table 12. Forecasts of economic growth, 1997-2020

Forecast	Average annual percentage growth		
	Real GDP	Labor force	Productivity
AEO99			
Low growth	1.5	0.5	1.0
Reference	2.1	0.8	1.3
High growth	2.6	1.0	1.6
DRI			
Low	1.8	0.5	1.3
Reference	2.1	0.8	1.3
High	2.3	1.0	1.3
WEFA			
Low	1.9	0.9	1.0
Reference	2.3	1.1	1.2
High	2.6	1.3	1.3

In the 1998 *Economic Report of the President*, real GDP growth of 2.3 percent a year between 1997 and 2005 was projected. *AEO99* projects annual growth of 2.5 percent over the same period.

World Oil Prices

Comparisons with other oil price forecasts—including the International Energy Agency (IEA), Petroleum Economics Ltd. (PEL), Petroleum Industry Research Associates, Inc. (PIRA), Natural Resources Canada (NRCAN), and BT Alex Brown

(BTAB)—are shown in Table 13 (IEA, 1996; PEL, February 1998; PIRA, October 1997; NRCAN, April 1997; BTAB, September 1998). With the exception of IEA in 2005 and PEL, the range between the *AEO99* low and high world oil price cases spans the range of other published forecasts beyond 2005.

Table 13. Forecasts of world oil prices, 2000-2020
1997 dollars per barrel

Forecast	2000	2005	2010	2015	2020
<i>AEO99</i> reference	13.97	19.25	21.30	21.91	22.73
<i>AEO99</i> high price	17.90	24.53	27.33	29.14	29.35
<i>AEO99</i> low price	10.25	14.57	14.57	14.57	14.57
DRI	15.55	16.94	19.06	21.44	24.13
IEA1	18.49	27.19	27.19	NA	NA
IEA2	18.49	18.49	18.49	NA	NA
PEL	15.57	14.21	13.37	12.93	NA
PIRA	20.00	19.00	19.60	NA	NA
WEFA	18.27	19.04	19.75	20.52	21.32
GRI	17.16	16.86	16.81	17.02	NA
NRCAN	20.76	20.76	20.76	20.76	20.76
BTAB	11.71	16.61	16.30	15.89	NA

NA = not available.

Total Energy Consumption

The *AEO99* forecast of end-use sector energy consumption over the next two decades shows far less volatility than has occurred historically. Between 1974 and 1984, volatile world oil markets dampened domestic oil consumption. Consumers switched to electricity-based technologies in the buildings sector, while in the transportation sector new car fuel efficiency nearly doubled. Natural gas use declined as a result of high prices and limitations on new gas hookups. Between 1984 and 1995, however, both petroleum and natural gas consumption rebounded, bolstered by plentiful supplies and declining real energy prices. As a consequence, new car fuel efficiency in 1995 was less than 2 miles per gallon higher than in 1984, and natural gas use (residential, commercial, and industrial) was almost 25 percent higher than it was in 1984.

Given potentially different assumptions about, for example, technological developments over the next 20 years, the forecasts from DRI, GRI, and WEFA have remarkable similarities to those in *AEO99*. Electricity is expected to remain the fastest growing source of delivered energy (Table 14), although its rate of growth is down sharply from historical rates in each of the forecasts, because many traditional

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Table 14. Forecasts of average annual growth rates for energy consumption (percent)

Energy use	History		Projections			
	1974-1984	1984-1996	AEO99 (1997-2020)	DRI (1997-2020)	GRI (1997-2015)	WEFA (1997-2020)
	Petroleum*	-0.1	1.4	1.3	1.2	1.1
Natural gas*	-1.7	2.3	0.9	0.8	1.4	0.8
Coal*	-3.0	-1.5	0.4	-0.7	-0.4	0.2
Electricity	3.0	2.6	1.4	1.4	1.8	1.7
Delivered energy	-0.4	1.9	1.2	1.1	1.2	1.2
Electricity losses	2.5	2.0	0.6	0.7	1.0	0.9
Primary energy	0.2	2.0	1.1	1.0	1.2	1.1

*Excludes consumption by electric utilities.

uses of electricity (such as for air conditioning) approach saturation while average equipment efficiencies rise. Petroleum consumption grows at the same rate as in recent history. Consumption growth for the remaining fuels slows as a result of moderating economic growth, fuel switching, and increased end-use efficiency.

Residential and Commercial Sectors

Growth rates in energy demand for the residential and commercial sectors are expected to decrease by more than 60 percent from the rates between 1984 and 1996, largely because of projected lower growth in population, housing starts, commercial floorspace additions, and colder winter weather in 1996. Other contributing factors include increasing energy efficiency due to technical innovations and legislated standards; voluntary government efficiency programs; and reduced opportunities for additional market penetration of such end uses as air conditioning.

Differing views on the growth of new uses for energy contribute to variations among the forecasts. By fuel, electricity (excluding generation and transmission losses) remains the fastest growing energy source for both sectors across all forecasts (Table 15). Natural gas use also grows but at lower rates, and petroleum use continues to fall.

Industrial Sector

In all the forecasts, the industrial sector shows slower growth in primary energy consumption than

Table 15. Forecasts of average annual growth in residential and commercial energy demand (percent)

Forecast	History		Projections			
	1984-1996	AEO99 (1997-2020)	DRI (1997-2020)	GRI (1997-2015)	WEFA (1997-2020)	
	Residential					
Petroleum	0.6	-1.2	-0.6	-1.2	-0.5	
Natural gas	1.2	0.6	0.8	0.7	0.7	
Electricity	2.8	1.6	1.1	1.7	1.9	
Delivered energy	2.1	0.8	0.7	0.7	1.0	
Electricity losses	2.2	0.8	0.3	0.9	1.1	
Primary energy	2.1	0.8	0.5	0.8	1.1	
Commercial						
Petroleum	-3.9	-1.3	-0.9	-2.9	-0.6	
Natural gas	1.9	0.7	0.5	1.0	0.6	
Electricity	3.3	1.4	1.4	1.6	1.6	
Delivered energy	1.5	0.9	0.8	1.0	1.0	
Electricity losses	2.7	0.6	0.7	0.8	0.8	
Primary energy	2.1	0.7	0.8	0.9	0.9	

it did between 1984 and 1996 (Table 16). The decline is attributable to lower growth for GDP and manufacturing output. In addition, there has been a continuing shift in the industrial output mix toward less energy-intensive products. The growth rates in the industrial sector for different fuels between 1984 and 1996 reflect a shift from petroleum products and coal to a greater reliance on natural gas and electricity. Natural gas use grows more slowly than in recent history across the forecasts, because much of the potential for fuel switching was realized during the 1980s. A key uncertainty in industrial coal forecasts is the environmental acceptability of coal as a boiler fuel.

Table 16. Forecasts of average annual growth in industrial energy demand (percent)

Forecast	History		Projections			
	1984-1996	AEO99 (1997-2020)	DRI (1997-2020)	GRI (1997-2015)	WEFA (1997-2020)	
	Petroleum	1.2	0.9	0.7	1.2	1.5
Natural gas	2.5	1.0	0.8	1.7	0.8	
Coal	-1.3	0.4	0.2	0.0	0.0	
Electricity	1.7	1.1	1.7	2.3	1.5	
Delivered energy	2.1	1.0	0.8	1.4	1.1	
Electricity losses	1.2	0.3	0.9	2.4	1.6	
Primary energy	1.9	0.8	0.8	1.6	1.2	

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Transportation Sector

Overall fuel consumption in the transportation sector is expected to grow more slowly than in the recent past in each of the alternative forecasts (Table 17). All the forecasts anticipate continued rapid growth in air travel as well as significant increases in aircraft efficiency, while growth in light-duty vehicle travel slows considerably.

Table 17. Forecasts of average annual growth in transportation energy demand (percent)

Forecast	History		Projections			
	1974-1984	1984-1995	AEO99 (1997-2020)	DRI (1997-2020)	GRI (1997-2015)	WEFA (1997-2020)
Consumption						
Motor gasoline	0.1	1.4	1.2	1.3	0.5	0.8
Diesel fuel	4.5	2.8	1.5	1.0	1.9	1.3
Jet fuel	1.9	2.4	2.8	2.4	2.3	3.0
Residual fuel	1.4	0.7	2.4	2.4	3.3	2.6
All energy	0.9	1.8	1.7	1.5	1.4	1.4
Key indicators						
Car and light truck travel	2.8	2.8	1.6	2.1	1.4	NA
Air travel (revenue passenger-miles)	7.0	5.0	3.1	3.4	2.8	NA
Average new car fuel efficiency	4.5	0.5	0.6	0.5	0.9	NA
Gasoline prices	1.8	-3.1	0.3	0.5	-0.1	0.1

NA = not available.

Electricity

Comparison across forecasts shows slight variation in projected electricity sales (Table 18). Sales projections for 2020 range from 1,349 billion kilowatthours (DRI) to 1,635 billion kilowatthours (WEFA) for the residential sector, as compared with the AEO99 reference case value of 1,557 billion kilowatthours. The forecasts for total electricity sales in 2020 range from 4,279 billion kilowatthours (DRI) to 4,581 billion kilowatthours (WEFA). All the projections for total electricity sales in 2020 fall within the range of the AEO99 low and high economic

growth cases (4,013 and 4,687 billion kilowatthours, respectively). Different assumptions governing expected economic activity, coupled with diversity in the estimation of penetration rates for energy-efficient technologies, are the primary reasons for variation among the forecasts.

All the forecasts compared here agree that stable fuel prices and slow growth in electricity demand relative to GDP growth will tend to keep the price of electricity stable—or declining in real terms—until 2020.

Both the DRI and GRI forecasts assume that the electric power industry will be fully restructured, resulting in average electricity prices that approach long-run marginal costs. AEO99 also assumes that competitive pressures will grow and continue to push prices down until the later years of the projections. AEO99 also assumes that increased competition in the electric power industry will lead to lower operating and maintenance costs, lower general and administrative costs, early retirement of inefficient generating units, and other cost reductions. Further, in the DRI forecast, it is assumed that time-of-use electricity rates will cause some flattening of electricity demand (lower peak period sales relative to average sales), resulting in better utilization of capacity and capital cost savings.

The distribution of sales among sectors affects the mix of capacity types needed to satisfy sectoral demand. Although the AEO99 mix of capacity among fuels is similar to those in the other forecasts, small differences in sectoral demands across the forecasts lead to significant changes in capacity mix. For example, growth in the residential sector, coupled with an oversupply of baseload capacity, results in a need for more peaking and intermediate capacity than baseload capacity. Consequently, generators are expected to plan for more combustion turbine and fuel cell technology than coal, oil, or gas steam capacity.

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Table 18. Comparison of electricity forecasts (billion kilowatthours, except where noted)

Projection	AEO99			Other forecasts		
	Reference	Low economic growth	High economic growth	WEFA	GRI	DRI
2015						
Average end-use price (1997 cents per kilowatthour)	5.8	5.4	6.3	5.76	5.30	5.40
Residential	7.3	6.7	7.9	7.10	6.90	6.80
Commercial	6.2	5.6	6.8	6.29	6.20	5.80
Industrial	3.8	3.5	4.1	3.82	3.10	3.80
Net energy for load	4,415	4,153	4,680	4,573	4,733	4,639
Coal	2,151	2,081	2,225	2,243	2,563	2,428
Oil	26	23	26	48	32	121
Natural gas	1,213	1,047	1,353	1,187	1,099	1,022
Nuclear	419	411	419	479	453	582
Hydroelectric/other ^a	400	394	412	351	407	444
Nonutility sales to grid ^b	180	170	189	223	168	NA
Net imports	27	27	27	42	39	38
Electricity sales	4,113	3,875	4,355	4,213	4,350	4,062
Residential	1,446	1,389	1,506	1,488	1,456	1,285
Commercial/other ^c	1,387	1,345	1,425	1,365	1,363	1,338
Industrial	1,280	1,141	1,423	1,360	1,532	1,440
Capability (gigawatts)^{d,e}	977	927	1,028	937	881	972
Coal	326	320	336	356	372	403
Oil and gas	470	429	510	392	345	359
Nuclear	56	55	56	65	64	93
Hydroelectric/other ^a	124	123	126	124	123	117
2020						
Average end-use price (1997 cents per kilowatthour)	5.6	5.1	6.1	5.56	NA	5.30
Residential	7.1	6.4	7.7	6.84	NA	6.60
Commercial	6.0	5.3	6.6	6.04	NA	5.70
Industrial	3.6	3.3	4.0	3.70	NA	3.70
Net energy for load	4,661	4,289	5,037	4,974	NA	4,883
Coal	2,298	2,139	2,497	2,472	NA	2,638
Oil	24	20	25	49	NA	130
Natural gas	1,349	1,191	1,474	1,463	NA	1,084
Nuclear	359	342	373	372	NA	549
Hydroelectric/other ^a	419	406	444	351	NA	443
Nonutility sales to grid ^b	184	171	197	223	NA	NA
Net imports	27	27	27	44	NA	36
Electricity sales	4,345	4,013	4,687	4,581	NA	4,279
Residential	1,557	1,478	1,637	1,635	NA	1,349
Commercial/other ^c	1,448	1,389	1,505	1,479	NA	1,397
Industrial	1,339	1,146	1,544	1,467	NA	1,534
Capability (gigawatts)^{d,e}	1,033	963	1,105	1,008	NA	1,013
Coal	343	328	366	389	NA	428
Oil and gas	514	465	557	446	NA	380
Nuclear	49	46	51	48	NA	87
Hydroelectric/other ^a	127	124	132	124	NA	117

^a“Other” includes conventional hydroelectric, geothermal, wood, wood waste, municipal solid waste, other biomass, solar and wind power, plus a small quantity of petroleum coke. For nonutility generators, “other” also includes waste heat, blast furnace gas, and coke oven gas.

^bFor AEO99, includes only net sales from cogeneration; for the other forecasts, also includes nonutility sales to the grid.

^c“Other” includes sales of electricity to government, railways, and street lighting authorities.

^dFor DRI, “capability” represents nameplate capacity; for the others, “capability” represents net summer capability.

^eGRI generating capability includes only central utility and independent power producer capacity. It does not include cogeneration capacity in the commercial and industrial sectors, which would add another 60 gigawatts.

Sources: **AEO99:** AEO99 National Energy Modeling System, runs AEO99B.D100198A (reference case), LMAC99.D100198A (low economic growth case), and HMA99.D100198A (high economic growth case). **WEFA:** The WEFA Group, *U.S. Power Outlook* (1998). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI:** DRI/McGraw-Hill, *World Energy Service: U.S. Outlook* (April 1998).

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Natural Gas

The diversity among published forecasts of natural gas prices, production, consumption, and imports (Table 19) indicates the uncertainty of future market trends. Because the forecasts depend heavily on the underlying assumptions that shape them, the assumptions should be considered when different projections are compared. The forecasts for total natural gas consumption in 2015 vary from a high of 32.99 trillion cubic feet in the *AEO99* high economic growth case to a low of 28.43 trillion cubic feet in the low economic growth case. The variation in the 2020 projections is even greater, with the higher projection only 16 percent above the lower projection in 2015 but 22 percent above the lower projection in 2020. The high projection for 2020 is 34.81 trillion cubic feet in the *AEO99* high economic growth case, compared with a low of 28.58 trillion cubic feet in the DRI forecast.

The American Gas Association (AGA) forecast (July 1998) for growth in residential consumption relative to historical levels is significantly higher than the others, whereas the DRI and WEFA forecasts of growth in commercial consumption lag behind the rest, even by 2020. GRI is the most optimistic about the future of industrial consumption, in both absolute and percentage growth terms. By a large margin, all forecasters expect the greatest growth to be in the electricity generator sector, with WEFA leading the pack. The DRI growth rate for generator consumption of natural gas through 2020 is less than one-third of WEFA's forecast (although it should be noted that DRI includes cogenerators in this category).

The projections of average lower 48 natural gas well-head prices in 2015 in the *AEO99* high economic

growth and reference cases are higher than the other forecasts, with the lowest price across all forecasts coming from WEFA, at 15 percent below the *AEO99* reference case and 3 percent below the low economic growth case. By 2020 the wellhead price forecasts from DRI and WEFA fall within the range of the *AEO99* cases, with DRI above the *AEO99* reference case and WEFA below. Excluding the *AEO99* low economic growth case, the 2015 residential and commercial prices are highest for GRI and lowest for AGA, with a differential between the two of \$0.79 and \$0.97 (13 and 19 percent), respectively, for the two sectors (however, the AGA prices do not include some State and local taxes).

The industrial (and to a lesser extent the electricity generator) sectoral prices are difficult to compare in absolute terms because of differences in definitions across the forecasting groups. For 2015, the *AEO99* reference case, DRI, and WEFA forecast slight growth in industrial prices, GRI a slight decline, and AGA a more significant decline. From 2015 to 2020 the DRI forecast for the industrial price increases more significantly than the others, which show more moderate growth or a slight decline (in the *AEO99* low economic growth case).

There are significant differences in the projected growth rates for natural gas prices to electricity generators. GRI, WEFA, and AGA project a slight decline through 2015, whereas DRI projects slight growth and *AEO99* more significant growth, especially in the high economic growth case. Through 2020, the DRI forecast for gas prices to electricity generators rises more rapidly, coming close to the *AEO99* reference case forecast, with the WEFA and EIA forecasts showing only moderate or no growth.

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Table 19. Comparison of natural gas forecasts (trillion cubic feet, except where noted)

Projection	AEO99			Other forecasts			
	Reference	Low economic growth	High economic growth	WEFA	GRI	DRI	AGA
2015							
Lower 48 wellhead price (1997 dollars per thousand cubic feet)	2.62	2.29	2.91	2.23	2.36 ^a	2.52	2.31 ^a
Dry gas production^b	26.11	23.97	28.01	24.83	27.31	23.47	26.75
Net imports	4.78	4.54	5.07	5.14	3.51 ^c	5.20	4.15
Consumption	30.81	28.43	32.99	30.12	31.28	28.51	30.99
Residential	5.61	5.31	5.90	5.70	5.66	5.79	6.23
Commercial ^d	3.86	3.73	3.97	3.51	3.91	3.55 ^e	4.01
Industrial ^d	9.87	9.20	10.55	9.92	12.95	8.99 ^e	10.84
Electricity generators ^f	8.42	7.33	9.34	8.52	7.19	7.55 ^d	6.77
Other ^g	3.05	2.85	3.23	2.47	1.59 ^h	2.64	3.14
End-use prices (1997 dollars per thousand cubic feet)							
Residential	5.95	5.78	6.11	6.21	6.71	6.61	5.92 ⁱ
Commercial ^d	5.22	4.96	5.47	5.38	5.72	5.69	4.75 ⁱ
Industrial ^d	3.32	2.95	3.65	3.58 ^j	2.93	3.73 ^j	2.76 ^{i,k}
Electricity generators ^f	3.24	2.91	3.52	2.67	2.61	2.93	2.61 ⁱ
2020							
Lower 48 wellhead price (1997 dollars per thousand cubic feet)	2.68	2.29	3.09	2.36	NA	2.82	NA
Dry gas production^b	27.35	24.93	29.62	26.70	NA	23.33	NA
Net imports	5.02	4.69	5.26	5.31	NA	5.41	NA
Consumption	32.30	29.53	34.81	32.18	NA	28.58	NA
Residential	5.77	5.40	6.13	5.92	NA	6.00	NA
Commercial ^d	3.88	3.72	4.04	3.63	NA	3.53 ^e	NA
Industrial ^d	10.24	9.30	11.17	10.15	NA	8.99 ^e	NA
Electricity generators ^f	9.16	8.12	10.00	9.83	NA	7.40 ^d	NA
Other ^g	3.24	3.00	3.48	2.65	NA	2.67	NA
End-use prices (1997 dollars per thousand cubic feet)							
Residential	5.91	5.72	6.14	6.13	NA	6.85	NA
Commercial ^d	5.24	4.93	5.56	5.33	NA	5.93	NA
Industrial ^d	3.40	2.93	3.87	3.68 ^j	NA	4.01 ^j	NA
Electricity generators ^f	3.31	2.90	3.71	2.76	NA	3.23	NA

^aFirst purchase price or field acquisition price, because severance taxes and gathering charges are included.

^bDoes not include supplemental fuels.

^cIncludes supplemental fuels.

^dIncludes gas consumed in cogeneration.

^eDoes not include cogenerators.

^fIncludes independent power producers and does not include cogenerators.

^gIncludes lease and plant fuels and pipeline fuel.

^hIncludes only transportation use.

ⁱDoes not include certain State and local taxes levied on customers.

^jOn-system sales or system gas (i.e., does not include gas delivered for the account of others).

^kVolume-weighted average of "system" gas and "transportation" gas.

NA = Not available.

Note: Assumed conversion factors: electricity generators, 1,022 Btu per cubic foot; other end-use sectors, 1,029 Btu per cubic foot; net imports, 1,022 Btu per cubic foot; production and other consumption, 1,028 Btu per cubic foot.

Sources: **AEO99:** AEO99 National Energy Modeling System, runs AEO99B.D100198A (reference case), LMAC99.D100198A (low economic growth case), and HMA99.D100198A (high economic growth case). **WEFA:** The WEFA Group, *Natural Gas Outlook* (1998). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI:** DRI/McGraw-Hill, *World Energy Service: U.S. Outlook* (April 1998). **AGA:** American Gas Association, *1998 AGA-TERA Base Case* (July 1998).

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Petroleum

Projected prices for crude oil in the *AEO99* low and high oil price cases bound the 2010 and 2020 projections in five other petroleum forecasts (Table 20)—the *AEO99* reference case, WEFA, GRI, DRI, and the Independent Petroleum Association of America (IPAA) (April 1998). Comparisons with GRI and IPAA forecasts, which do not extend to 2020, apply only to 2010. The *AEO99* reference case oil price projection for 2010 is \$1.55 above that of WEFA, \$2.54 above that of DRI, and \$3.80 above that of GRI. By 2020 the *AEO99* reference case oil price falls between the two other forecasts—\$1.41 above WEFA and \$0.95 below DRI.

The *AEO99* reference case projection for domestic oil production in 2010 falls between the WEFA and DRI projections but is 0.50 million barrels per day short of the GRI and IPAA projections. The GRI projection reflects natural gas liquids (NGL) production, which is higher than in any other case, while IPAA reflects the second highest production of both crude oil and NGL. As a result, the GRI and IPAA projections of total domestic production in 2010 are slightly higher than even the *AEO99* high oil price case. The *AEO99* reference case projection for 2020 is comparable to the DRI and WEFA forecasts. All three projections are bounded by the *AEO99* low and high oil price cases.

The three *AEO99* cases reflect relatively high projections for petroleum demand in 2010. The low oil price and reference case projections are higher than the four other cases, and the high oil price projection is higher than the IPAA, GRI, and WEFA forecasts. Demand growth in *AEO99* is relatively

slow between 2010 and 2020, and by 2020 the *AEO99* projections are comparable to the DRI and WEFA forecasts.

Net petroleum imports in the *AEO99* reference and low price cases are well above the levels of the other forecasts. The projected percentage of petroleum consumption from imports, which is an indicator of the relative direction of production, net imports, and consumption, is also highest in the *AEO99* low oil price case, followed by the reference case. For 2010 the import share of consumption ranges from 53 percent (IPAA) to 65 percent in the *AEO99* low oil price case. The low IPAA import share reflects stronger domestic production than in the other forecasts. The relatively high import share in the *AEO99* low oil price case reflects the lowest production and highest consumption projections.

For 2020 the import shares range from 61 percent in the WEFA and *AEO99* high oil price cases to 71 percent in the low price case. The WEFA and *AEO99* high oil price cases have the lowest import shares for different reasons; projected consumption is relatively high in the WEFA case, whereas production is high and demand is low in the *AEO99* high oil price case. Although the *AEO99* reference case and DRI have similar import shares at 65 and 64 percent, respectively, they have different import pictures. The *AEO99* reference case reflects net crude oil imports that are 1.96 million barrels per day higher than in the DRI forecast and petroleum product imports that are 1.61 million barrels per day lower than DRI. The different split between crude oil and product imports reflects a greater capacity for refining petroleum products in the *AEO99* reference case.

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Table 20. Comparison of petroleum forecasts (million barrels per day, except where noted)

Projection	AEO99			Other forecasts			
	Reference	Low world oil price	High world oil price	WEFA	GRI	DRI	IPAA
2010							
World oil price (1997 dollars per barrel)	21.30	14.57	27.33	19.75	17.50^a	18.76	NA
Crude oil and NGL production	7.74	7.07	8.22	7.63	8.24	7.99	8.26
Crude oil	5.59	4.96	6.06	5.44	5.56	5.69 ^b	5.95
Natural gas liquids	2.15	2.11	2.16	2.19	2.68	2.30	2.31
Total net imports	13.70	15.46	12.62	12.06	NA	13.25	11.57
Crude oil	10.97	11.76	10.05	9.79	NA	9.92	NA
Petroleum products	2.73	3.70	2.57	2.27	NA	3.34	NA
Petroleum demand	22.69	23.60	22.13	21.83	21.46	22.15	21.98
Motor gasoline	10.01	10.20	9.77	8.74	8.72	10.03	9.46
Jet fuel	2.46	2.48	2.44	2.31	2.24	2.32	2.17
Distillate fuel	3.99	4.11	3.93	4.03	3.98	3.97	4.14
Residual fuel	0.72	1.08	0.66	0.93	1.07	0.98	0.95
Other	5.51	5.72	5.33	5.82	5.45	5.45	5.26
Import share of product supplied (percent)	60	65	57	55	NA	58	53
2020							
World oil price (1997 dollars per barrel)	22.73	14.57	29.35	21.32	NA	23.68	NA
Crude oil and NGL production	7.41	6.53	7.94	7.40	NA	7.42	NA
Crude oil	4.96	4.12	5.48	4.90	NA	5.18 ^b	NA
Natural gas liquids	2.45	2.41	2.46	2.49	NA	2.24	NA
Total net imports	15.97	18.35	14.63	15.19	NA	15.61	NA
Crude oil	11.97	13.13	11.50	10.95	NA	10.01	NA
Petroleum products	4.00	5.22	3.13	4.24	NA	5.61	NA
Petroleum demand	24.66	25.95	23.96	24.80	NA	24.57	NA
Motor gasoline	10.69	11.01	10.40	9.61	NA	10.73	NA
Jet fuel	3.03	3.08	2.96	3.13	NA	2.76	NA
Distillate fuel	4.28	4.47	4.21	4.39	NA	4.19	NA
Residual fuel	0.83	1.24	0.78	1.04	NA	0.92	NA
Other	5.82	6.15	5.62	6.64	NA	5.97	NA
Import share of product supplied (percent)	65	71	61	61	NA	64	NA

^aComposite of U.S. refiners' acquisition cost.

^bIncludes shale and other.

NA = Not available.

Sources: **AEO99**: AEO99 National Energy Modeling System, runs AEO99B.D100198A (reference case), LWOP99.D100298B (low world oil price case), and HWOP99.D100298B (high world oil price case). **WEFA**: The WEFA Group, *U.S. Energy Outlook* (1998). **GRI**: Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI**: DRI/McGraw-Hill, *World Energy Service: U.S. Outlook* (April 1998). **IPAA**: Independent Petroleum Association of America, *IPAA Supply and Demand Committee Long-Run Report* (April 1998).

Forecast Comparisons

Coal

Coal forecasts by WEFA and DRI are similar to the *AEO99* projections (Table 21). Consumption by electricity generators in 2015 falls within the range spanned by the *AEO99* low economic growth, reference, and high economic growth cases (1,073 to 1,148 million tons). Coal consumption in 2015 at domestic coking plants is slightly higher in both the WEFA (26 million tons) and DRI (24 million tons) forecasts than in *AEO99* (21 to 22 million tons), reflecting the expectation that the replacement of coke-based steelmaking with electric arc technology, less coke-intensive methods with pulverized coal injection, and advanced non-coke-based methods will proceed more gradually than projected in *AEO99*. WEFA and DRI project industrial/other coal consumption in 2015 at values that tend toward the lower end of the *AEO99* range: 73 and 88 million tons, respectively. The *AEO99* range is from 77 through 86 to 94 million tons. The difference is largely attributable to differing views of consumption for cogeneration.

Total domestic demand ranges from 1,200 million tons (WEFA) to 1,247 million tons (DRI), whereas *AEO99* ranges from 1,172 to 1,263 million tons. The WEFA forecast has an optimistic outlook for net coal exports, showing 103 million tons, while DRI has 79 million tons and *AEO99* has 84 million tons in 2015. The difference stems from different views of the competitiveness of U.S. mines in a world market where competitors with low labor costs and undeveloped resources are further aided by the persistent strength of the dollar in international markets. Production forecasts follow from the differences in projected demand, with WEFA suggesting 1,300 million tons in 2015 and DRI 1,327 million tons. *AEO99* brackets these values by projecting 1,253 (low economic growth case), 1,294 (reference case) and 1,346 million tons (high economic growth case).

Although the coal production and consumption values are similar, WEFA forecasts minemouth and delivered prices that are about 6 to 10 cents per million Btu higher than those in *AEO99*, while DRI's delivered price (DRI does not forecast minemouth prices) is another 8 cents per million Btu above WEFA's. Coal's price advantage relative to natural gas at existing steam boilers may exceed 20 cents per million Btu, so that smaller price

differences have little effect on the quantity demanded. The different price forecasts arise from different expectations of labor productivity improvements in mining and from the different market shares projected for the very low cost, low-sulfur coals of the Powder River Basin.

In 2020, WEFA and DRI project production totals that lie between those forecast for the reference and high economic growth cases in *AEO99*, stemming from a different view of total demand and interfuel competition. However, the entire range is bracketed by the *AEO99* high and low growth cases, with projected production of 1,281 and 1,447 million tons, respectively. WEFA and DRI again have slightly higher coking coal consumption, although their industrial consumption forecasts compare closely with the *AEO99* low growth and reference cases. Differences in net exports follow the pattern established in 2015, with *AEO99* and DRI projecting 86 and 80 million tons, respectively, and WEFA 119 million tons. Again, delivered prices are as much as 14 (WEFA) to 20 (DRI) cents per million Btu above the *AEO99* prices, but they have little effect on demand. Other than the differences in export tonnage and in minemouth and delivered prices, the *AEO99* values do not differ significantly from the WEFA and DRI forecasts.

The GRI / Hill & Associates coal forecast (March 1998) describes a different future, especially after 2005 [74]. Although the potential impact of U.S. implementation of the Kyoto Protocol on greenhouse gas emissions is specifically excluded, the authors incorporate the economic burdens that they project would be placed on coal consumption by full implementation of the proposals contained in the Clean Air Power Initiative, which would severely restrict emissions of particulates. The resulting forecast shows production growing as in the other forecasts until 2006. It declines to 957 million tons in 2015 (*AEO99* ranges from 1,253 to 1,346 million tons in 2015). By 2020, coal production has fallen to 938 million tons, while that in the other forecasts rises to between 1,281 and 1,447 million tons.

All elements of the GRI/Hill forecast are equally pessimistic. Net exports are projected at 59 million tons in 2015 and 56 million tons in 2020—about half the WEFA level. Domestic coking coal consumption falls to 19 million tons in 2015 and 16 million tons in

Forecast Comparisons

2020. And industrial coal consumption is only 67 million tons in 2015 and 65 million tons in 2020 (all sectors of domestic consumption are similarly depressed by the Clean Air Power Initiative).

These low consumption levels are reached in spite of low delivered prices to the electricity sector: 95 cents per million Btu in 2015 and 92 cents per million Btu in 2020. The other forecasts range from 96 cents

(*AEO99* low growth case) to 114 cents (DRI) per million Btu in 2015, and from 90 to 110 cents per million Btu in 2020 (again, the *AEO99* low growth case and DRI). The implication is that even if efficient production, vigorous competition, and declining real transportation costs keep coal's delivered prices low and declining, the costs of compliance with the Clean Air Power Initiative will blunt its competitive edge.

Table 21. Comparison of coal forecasts (million short tons, except where noted)

Projection	AEO99			Other forecasts		
	Reference	Low economic growth	High economic growth	WEFA	GRI/Hill	DRI
2015						
Production	1,294	1,253	1,346	1,300	957	1,327
Consumption by sector						
Electricity generation ^a	1,103	1,073	1,148	1,100	801	1,136
Coking plants	22	22	21	26	19	24
Industrial/other	86	77	94	73	67	88
Total	1,211	1,172	1,263	1,200	887	1,247
Net coal exports	84	84	84	103	59	79
Minemouth price						
(1997 dollars per short ton)	13.21	12.98	13.39	15.13	NA	NA
(1997 dollars per million Btu)	0.63	0.62	0.64	0.70	NA	NA
Average delivered price, electricity						
(1997 dollars per short ton)	20.03	19.44	20.53	21.78	18.98	23.33
(1997 dollars per million Btu)	0.99	0.96	1.01	1.06	0.95	1.14
2020						
Production	1,358	1,281	1,447	1,368	938	1,389
Consumption by sector						
Electricity generation ^a	1,166	1,098	1,242	1,199	789	1,196
Coking plants	20	20	19	24	16	21
Industrial/other	89	76	102	76	65	88
Total	1,275	1,195	1,363	1,299	870	1,305
Net coal exports	86	86	86	119	56	80
Minemouth price						
(1997 dollars per short ton)	12.74	12.47	12.89	14.95	NA	NA
(1997 dollars per million Btu)	0.62	0.60	0.62	0.69	NA	NA
Average delivered price, electricity						
(1997 dollars per short ton)	18.77	18.03	19.33	21.42	18.19	22.52
(1997 dollars per million Btu)	0.93	0.90	0.96	1.04	0.92	1.10

^a The DRI and *AEO99* forecasts for electricity generation include nonutility generators. Consumption by industrial cogenerators is included in industrial consumption. The WEFA values for electricity consumption have been adjusted by including consumption by nonutility generators (11.2 million tons in 2015 and 2020).

NA = Not available.

Btu = British thermal unit.

Sources: **AEO99**: AEO99 National Energy Modeling System, runs AEO99B.D100198A (reference case), LMAC99.D100198A (low economic growth case), and HMAC99.D100198A (high economic growth case). **WEFA**: The WEFA Group, *U.S. Energy Outlook* (1998). **GRI/Hill**: Gas Research Institute, *Final Report, Coal Demand and Price Projections*, Vol. I, GRI-98/0053.1 (March 1998). **DRI**: DRI/McGraw-Hill, *World Energy Service: U.S. Outlook* (April 1998).