

# **Forecast Comparisons**

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## Forecast Comparisons

Three other organizations—Standard & Poor’s DRI (DRI), the WEFA Group (WEFA), and the Gas Research Institute (GRI)—also produce comprehensive energy projections with a time horizon similar to that of *AEO2000*. The most recent projections from those organizations (DRI, Spring/Summer 1999; WEFA, 1999; GRI, August 1998), as well as other forecasts that concentrate on petroleum, natural gas, and international oil markets, are compared here with the *AEO2000* projections.

### Economic Growth

Differences in long-run economic forecasts can be traced primarily to different views of the major supply-side determinants of growth in gross domestic product (GDP): labor force and productivity change (Table 15). In comparison with the *AEO2000* and DRI reference cases, the WEFA forecast shows the highest economic growth, including a higher growth rate for the labor force. The *AEO2000* long-run forecast of average annual economic growth from 1998 to 2020 in the reference case is 2.2 percent—0.2 percent higher than the *AEO99* forecast.

The 1999 *Economic Report of the President* projected real GDP growth of 2.2 percent a year between 1998 and 2005. *AEO2000* projects annual growth of 2.6 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 Deutsche Banc Alex. Brown (DBAB)—are shown in Table 16 (IEA, 1998; PEL, December 1998; PIRA, October 1998; NRCan, April 1997; DBAB, June 1999). With the exception of IEA and PEL, the range between the *AEO2000* low and high world oil price cases spans the range of other published forecasts beyond 2005.

### Total Energy Consumption

The *AEO2000* 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 with the *AEO2000* projections. Electricity is expected to remain the fastest growing source of delivered energy (Table 17), although its rate of growth is down sharply from historical rates in each of the forecasts, because many traditional uses of electricity (such as for air conditioning) approach saturation while average equipment efficiencies rise. Petroleum consumption

**Table 15. Forecasts of economic growth, 1998-2020**

Forecast	Average annual percentage growth		
	Real GDP	Labor force	Productivity
<b>AEO2000</b>			
Low growth	1.7	0.6	1.0
Reference	2.2	0.9	1.3
High growth	2.6	1.1	1.5
<b>DRI</b>			
Low	1.8	0.7	1.1
Reference	2.2	0.9	1.3
High	2.7	1.1	1.6
<b>WEFA</b>			
Low	2.0	0.9	1.1
Reference	2.3	1.0	1.3
High	2.7	1.2	1.5

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

**Table 16. Forecasts of world oil prices, 2000-2020**  
1998 dollars per barrel

Forecast	2000	2005	2010	2015	2020
	<i>AEO2000</i> reference	21.19	20.49	21.00	21.53
<i>AEO2000</i> high price	24.23	24.16	26.31	27.86	28.04
<i>AEO2000</i> low price	18.15	14.90	14.90	14.90	14.90
DRI	16.85	15.70	16.66	18.58	19.94
IEA	20.47	20.47	20.47	30.10	30.10
PEL	14.66	14.63	13.64	11.65	NA
PIRA	16.55	17.80	19.45	NA	NA
WEFA	13.46	16.54	18.62	19.28	19.77
GRI	18.31	18.37	19.06	19.59	NA
NRCan	20.97	20.97	20.97	20.97	20.97
DBAB	16.74	17.57	17.86	17.84	18.20

NA = not available.

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 for energy demand in the residential and commercial sectors are expected to decrease by more than 40 percent from the rates between 1984 and 1997, largely because of projected lower growth in population, housing starts, and commercial floorspace additions. 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 18). All the forecasts project similar growth in electricity use through 2015; however, the *AEO2000*, DRI, and WEFA projections show slower growth toward the end of the forecast. GRI appears to have a higher projected growth rate, because its projections extend only through 2015. Natural gas use also grows but at lower rates, and petroleum use continues to fall. GRI projects a more rapid decline in oil use, particularly for commercial space and water heating, than the other forecasts.

### Industrial Sector

In all the forecasts, the industrial sector shows slower growth in primary energy consumption than it did between 1984 and 1997 (Table 19). 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 1997 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. GRI generally projects higher growth in energy

**Table 17. Forecasts of average annual growth rates for energy consumption (percent)**

Energy use	History		Projections			
	1974-1984	1984-1997	AEO2000 (1998-2020)	DRI (1998-2020)	GRI (1997-2015)	WEFA (1998-2020)
Petroleum*	-0.1	1.4	1.4	1.2	1.1	1.2
Natural gas*	-1.7	1.9	1.0	1.1	1.4	1.1
Coal*	-3.0	-1.5	0.2	0.0	-0.4	0.1
Electricity	3.0	2.5	1.4	1.3	1.8	1.4
Delivered energy	-0.4	1.5	1.3	1.2	1.2	1.2
Electricity losses	2.5	1.7	0.7	0.4	1.0	0.4
Primary energy	0.2	1.6	1.1	1.0	1.2	1.0

\*Excludes consumption by electric utilities.

**Table 18. Forecasts of average annual growth in residential and commercial energy demand (percent)**

Forecast	History		Projections			
	1984-1997	AEO2000 (1998-2020)	DRI (1998-2020)	GRI (1997-2015)	WEFA (1998-2020)	
<b>Residential</b>						
Petroleum	0.5	-0.8	-0.1	-1.2	-0.9	
Natural gas	0.7	1.1	1.1	0.7	1.0	
Electricity	2.5	1.5	0.9	1.7	1.5	
Delivered energy	1.5	1.0	0.9	0.7	1.0	
Electricity losses	2.1	0.8	0.0	0.9	0.5	
Primary energy	1.8	0.9	0.5	0.8	0.7	
<b>Commercial</b>						
Petroleum	-4.2	-0.1	-0.5	-2.9	-0.9	
Natural gas	1.9	0.9	0.7	1.0	1.1	
Electricity	3.4	1.2	1.4	1.6	1.4	
Delivered energy	1.7	1.0	0.9	1.0	1.1	
Electricity losses	3.0	0.6	0.5	0.8	0.4	
Primary energy	2.3	0.8	0.7	0.9	0.7	

**Table 19. Forecasts of average annual growth in industrial energy demand (percent)**

Forecast	History		Projections			
	1984-1997	AEO2000 (1998-2020)	DRI (1998-2020)	GRI (1997-2015)	WEFA (1998-2020)	
Petroleum	1.2	1.0	0.9	1.2	1.3	
Natural gas	2.5	0.9	1.1	1.6	1.0	
Coal	-1.4	0.1	0.2	-0.1	0.1	
Electricity	1.6	1.3	1.6	2.2	1.4	
Delivered energy	1.5	1.0	0.9	1.3	1.1	
Electricity losses	0.9	0.6	0.7	1.2	0.4	
Primary energy	1.4	0.9	0.8	1.3	0.9	

## Forecast Comparisons

demand than the other forecasts because of its relatively high projection for industrial output growth, averaging about 2.9 percent a year as compared with 2.0 percent in *AEO2000*.

### Transportation Sector

Overall fuel consumption in the transportation sector is expected to grow slightly more slowly than in the recent past in each of the alternative forecasts (Table 20). Demand for diesel fuel grows more slowly in all the forecasts than it has in the past, whereas the projected growth of residual fuel demand exceeds recent historical rates. All the forecasts anticipate continued rapid growth in air travel and considerably slower growth in light-duty vehicle travel.

GRI projects slower growth in gasoline demand as a result of slower growth in light-duty vehicle travel and more rapid efficiency improvements. GRI also projects the slowest growth in air travel of all the forecasts, leading to slower growth in jet fuel demand. For diesel fuel, however, GRI shows the most rapid growth in demand of all the forecasts, because it projects relatively slow efficiency improvements, at about half the rate expected in *AEO2000*.

### Electricity

Comparison across forecasts shows slight variation in projected electricity sales (Table 21). Sales projections for 2020 range from 1,375 billion kilowatthours (DRI) to 1,563 billion kilowatthours (WEFA) for the residential sector, as compared with the *AEO2000* reference case value of 1,553 billion kilowatthours. The forecasts for total electricity sales in 2020 range from 4,289 billion kilowatthours (DRI) to 4,413 billion kilowatthours (WEFA). All the projections for total electricity sales in 2020 fall within the range of the *AEO2000* low and high economic growth cases (4,087 and 4,653 billion kilowatthours, respectively). Different assumptions related to 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.

**Table 20. Forecasts of average annual growth in transportation energy demand (percent)**

Forecast	History		Projections			
	1974-1984	1984-1996	<i>AEO2000</i> (1998-2020)	<i>DRI</i> (1998-2020)	<i>GRI</i> (1997-2015)	<i>WEFA</i> (1998-2020)
<b>Consumption</b>						
<i>Motor gasoline</i>	0.1	1.4	1.4	1.4	0.5	0.9
<i>Diesel fuel</i>	4.5	3.1	1.0	0.8	1.9	1.3
<i>Jet fuel</i>	1.9	2.6	2.9	2.6	2.3	3.1
<i>Residual fuel</i>	1.4	0.6	2.7	1.8	3.3	2.0
<i>All energy</i>	0.9	1.8	1.7	1.5	1.4	1.4
<b>Key indicators</b>						
<i>Car and light truck travel</i>	2.8	3.1	1.7	1.6	1.4	1.6
<i>Air travel (revenue passenger-miles)</i>	7.0	5.3	4.0	3.6	2.8	3.5
<i>Average new car fuel efficiency</i>	4.5	0.5	0.5	0.5	0.9	0.5
<i>Gasoline prices</i>	1.8	-2.6	0.9	0.8	-0.1	0.6

*NA = not available.*

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. *AEO2000* also assumes that competitive pressures will grow and continue to push prices down until the later years of the projections. *AEO2000* 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 *AEO2000* 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 combined-cycle technology than coal, oil, or gas steam capacity.

## Forecast Comparisons

**Table 21. Comparison of electricity forecasts (billion kilowatthours, except where noted)**

Projection	AEO2000			Other forecasts		
	Reference	Low economic growth	High economic growth	WEFA	GRI	DRI
<b>2015</b>						
<b>Average end-use price (1998 cents per kilowatthour)</b>	<b>5.9</b>	<b>5.6</b>	<b>6.1</b>	<b>5.83</b>	<b>5.40</b>	<b>5.50</b>
Residential	7.3	7.0	7.6	7.22	7.00	7.00
Commercial	6.3	5.9	6.6	6.32	6.30	5.80
Industrial	3.9	3.6	4.1	3.89	3.10	3.80
<b>Net energy for load</b>	<b>4,404</b>	<b>4,220</b>	<b>4,625</b>	<b>4,650</b>	<b>4,733</b>	<b>4,641</b>
Coal	2,200	2,121	2,328	1,823	2,563	2,190
Oil	41	32	58	27	32	128
Natural gas	1,085	991	1,156	1,896	1,099	1,238
Nuclear	511	511	510	377	453	593
Hydroelectric/other <sup>a</sup>	385	386	388	486	407	449
Nonutility sales to grid <sup>b</sup>	162	161	164	NA	168	NA
Net imports	19	19	19	42	39	36
<b>Electricity sales</b>	<b>4,155</b>	<b>3,979</b>	<b>4,364</b>	<b>4,136</b>	<b>4,350</b>	<b>4,053</b>
Residential	1,464	1,438	1,486	1,459	1,456	1,296
Commercial/other <sup>c</sup>	1,388	1,340	1,436	1,325	1,363	1,348
Industrial	1,303	1,201	1,443	1,351	1,532	1,409
<b>Capability (gigawatts)<sup>d,e</sup></b>	<b>970</b>	<b>936</b>	<b>1,016</b>	<b>929</b>	<b>881</b>	<b>968</b>
Coal	316	310	331	277	372	352
Oil and gas	462	435	492	477	345	405
Nuclear	67	67	67	47	64	94
Hydroelectric/other <sup>a</sup>	125	124	127	129	123	117
<b>2020</b>						
<b>Average end-use price (1998 cents per kilowatthour)</b>	<b>5.8</b>	<b>5.5</b>	<b>6.1</b>	<b>5.64</b>	<b>NA</b>	<b>5.30</b>
Residential	7.3	7.0	7.6	6.98	NA	6.80
Commercial	6.2	5.8	6.7	6.08	NA	5.70
Industrial	3.8	3.5	4.2	3.77	NA	3.70
<b>Net energy for load</b>	<b>4,598</b>	<b>4,321</b>	<b>4,917</b>	<b>4,962</b>	<b>NA</b>	<b>4,902</b>
Coal	2,296	2,165	2,578	1,908	NA	2,240
Oil	37	28	61	25	NA	142
Natural gas	1,256	1,122	1,251	2,143	NA	1,472
Nuclear	427	428	440	298	NA	560
Hydroelectric/other <sup>a</sup>	392	392	395	548	NA	449
Nonutility sales to grid <sup>b</sup>	169	166	172	NA	NA	NA
Net imports	20	20	20	42	NA	34
<b>Electricity sales</b>	<b>4,350</b>	<b>4,087</b>	<b>4,653</b>	<b>4,413</b>	<b>NA</b>	<b>4,289</b>
Residential	1,553	1,505	1,583	1,563	NA	1,375
Commercial/other <sup>c</sup>	1,420	1,350	1,490	1,418	NA	1,409
Industrial	1,378	1,232	1,580	1,432	NA	1,505
<b>Capability (gigawatts)<sup>d,e</sup></b>	<b>1,018</b>	<b>967</b>	<b>1,079</b>	<b>986</b>	<b>NA</b>	<b>1,008</b>
Coal	326	311	362	284	NA	363
Oil and gas	508	473	529	526	NA	440
Nuclear	57	57	59	37	NA	88
Hydroelectric/other <sup>a</sup>	127	126	129	139	NA	117

<sup>a</sup>“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.

<sup>b</sup>For AEO2000, includes only net sales from cogeneration; for the other forecasts, also includes nonutility sales to the grid.

<sup>c</sup>“Other” includes sales of electricity to government, railways, and street lighting authorities.

<sup>d</sup>For DRI, “capability” represents nameplate capacity; for the others, “capability” represents net summer capability.

<sup>e</sup>GRI 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: **AEO2000:** AEO2000 National Energy Modeling System, runs AEO2K.D100199A (reference case), LMAC2K.D100199A (low economic growth case), and HMA2K.D100199A (high economic growth case). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (1999). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI:** Standard & Poor’s DRI, *U.S. Energy Outlook* (Spring/Summer 1999).

## Forecast Comparisons

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### Natural Gas

The differences among published forecasts of natural gas prices, production, consumption, and imports (Table 22) 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 32.55 trillion cubic feet in the WEFA forecast to a low of 28.35 trillion cubic feet in the *AEO2000* low economic growth case. The variation in the 2020 projections is even greater, with the highest projection only 15 percent above the lowest for 2015 but 17 percent above the lowest for 2020. The high projection for 2020 is 34.57 trillion cubic feet in the WEFA forecast, compared with a low of 29.49 trillion cubic feet in the *AEO2000* low economic growth case.

The American Gas Association (AGA) forecast for growth in both residential and commercial consumption relative to 1997 historical levels is significantly higher than the others, whereas the *AEO2000* low economic growth and reference case forecasts for growth in residential consumption are even lower than the rest. 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 projections of average lower 48 natural gas wellhead prices by 2015 in the *AEO2000* high economic growth and reference cases are higher than the other forecasts, with the lowest price across all forecasts coming from AGA at 14 percent below the *AEO2000* reference case and 1 percent below the low economic growth case. By 2020 the wellhead price forecasts from WEFA and DRI fall within the range of the *AEO2000* cases, with the *AEO2000* reference case slightly above both the WEFA and DRI forecasts. Excluding the *AEO2000* low economic growth case, the 2015 residential and commercial prices are highest in the *AEO2000* high economic growth case and lowest in the AGA forecast, differing by \$0.94 and \$1.15 per thousand cubic feet (16 and 24 percent), respectively, for the two sectors. The AGA prices, however, do not include some State and local taxes.

The price projections for the industrial and, to a lesser extent, electricity generation sectors are

difficult to compare in absolute terms because of differences in definitions among the forecast groups. From 1997 to 2015, the *AEO2000* high economic growth and reference cases show slight increases in gas prices to the industrial sector. DRI, WEFA, and GRI project slight declines and AGA a more significant decline. The *AEO2000* high economic growth case projects a larger increase in industrial gas prices than the other forecasts from 2015 to 2020. There are significant differences in the projected growth rates for natural gas prices to electricity generators. GRI, WEFA, and AGA project slight declines through 2015, whereas DRI projects slight growth and *AEO2000* more significant growth, especially in the high economic growth case. Through 2020, the *AEO2000* high economic growth and reference cases and the DRI forecast show relatively rapid increases in gas prices to electricity generators, whereas the WEFA forecast and the *AEO2000* low economic growth case show moderate to no growth.

### Petroleum

Projected prices for crude oil in the *AEO2000* low and high oil price cases (Table 23) bound the 2010 and 2020 projections in five other petroleum forecasts: the *AEO2000* reference case, WEFA, GRI, DRI, and the Independent Petroleum Association of America (IPAA, April 1999). Comparisons with GRI and IPAA forecasts, which do not extend to 2020, apply only to 2010. *AEO2000* shows the highest reference case price path of the five forecasts. The *AEO2000* reference case oil price for 2010 is \$2.38 per barrel above the WEFA price, \$3.50 above GRI, and \$4.03 above DRI. After 2010, the *AEO2000* oil price growth slows relative to the other forecasts. By 2020 the *AEO2000* oil price is only \$2.27 above the WEFA projection and \$1.73 above the DRI projection.

All projections, including the *AEO2000* low and high oil price cases, reflect a decline in domestic oil production. The trend of the decline looks somewhat different in *AEO2000*, compared with the four other forecasts. *AEO2000* shows a sharper decline before 2010 than the other projections, resulting in a 2010 reference case projection for crude oil production that is at least 380,000 barrels per day below the other reference case forecasts. In fact, 2010 crude oil production levels in the four other forecasts are even higher than the *AEO2000* high oil price case. All three *AEO2000* projections show a slight recovery in production after 2015, resulting in 2020 production

## Forecast Comparisons

**Table 22. Comparison of natural gas forecasts (trillion cubic feet, except where noted)**

Projection	AEO2000			Other forecasts			
	Reference	Low economic growth	High economic growth	WEFA	GRI	DRI	AGA
<b>2015</b>							
<b>Lower 48 wellhead price</b> (1998 dollars per thousand cubic feet)	2.71	2.36	3.03	2.51	2.39 <sup>a</sup>	2.41	2.33 <sup>a</sup>
<b>Dry gas production<sup>b</sup></b>	25.03	23.85	26.32	27.24	27.31	24.74	26.75
<b>Net imports</b>	4.85	4.51	5.12	5.13	3.51 <sup>c</sup>	5.25	4.15
<b>Consumption</b>	29.88	28.35	31.44	32.55	31.28	30.00	30.99
Residential	5.49	5.41	5.55	5.65	5.66	5.54	6.23
Commercial <sup>d</sup>	3.61	3.50	3.72	3.85	3.91	3.64 <sup>e</sup>	4.01
Industrial <sup>d</sup>	9.64	9.07	10.36	9.74 <sup>h</sup>	11.34	8.61 <sup>e</sup>	10.84
Electricity generators <sup>f</sup>	8.37	7.70	8.93	10.66	7.19	9.28 <sup>d</sup>	6.77
Other <sup>g</sup>	2.77	2.66	2.88	2.65	3.20	2.93	3.14
<b>End-use prices</b> (1998 dollars per thousand cubic feet)							
Residential	6.62	6.29	6.92	6.18	6.78	6.66	5.98 <sup>i</sup>
Commercial <sup>d</sup>	5.64	5.30	5.95	5.39	5.78	5.69	4.80 <sup>i</sup>
Industrial <sup>d</sup>	3.48	3.13	3.81	3.65 <sup>j</sup>	2.96	3.64 <sup>j</sup>	2.79 <sup>i,k</sup>
Electricity generators <sup>f</sup>	3.28	2.93	3.57	2.81	2.64	2.84	2.64 <sup>i</sup>
<b>2020</b>							
<b>Lower 48 wellhead price</b> (1998 dollars per thousand cubic feet)	2.81	2.40	3.27	2.66	NA	2.65	NA
<b>Dry gas production<sup>b</sup></b>	26.40	25.00	27.22	28.74	NA	25.67	NA
<b>Net imports</b>	5.14	4.49	5.50	5.65	NA	5.57	NA
<b>Consumption</b>	31.53	29.49	32.73	34.57	NA	31.24	NA
Residential	5.69	5.57	5.76	5.76	NA	5.79	NA
Commercial <sup>d</sup>	3.65	3.50	3.79	3.98	NA	3.62 <sup>e</sup>	NA
Industrial <sup>d</sup>	9.99	9.18	10.98	9.96 <sup>h</sup>	NA	8.74 <sup>e</sup>	NA
Electricity generators <sup>f</sup>	9.26	8.45	9.15	12.06	NA	10.02 <sup>d</sup>	NA
Other <sup>g</sup>	2.95	2.81	3.05	2.81	NA	3.07	NA
<b>End-use prices</b> (1998 dollars per thousand cubic feet)							
Residential	6.55	6.18	6.99	5.95	NA	6.84	NA
Commercial <sup>d</sup>	5.66	5.26	6.10	5.24	NA	5.86	NA
Industrial <sup>d</sup>	3.60	3.16	4.08	3.69 <sup>j</sup>	NA	3.85 <sup>j</sup>	NA
Electricity generators <sup>f</sup>	3.41	2.95	3.85	2.94	NA	3.08	NA

<sup>a</sup>First purchase price or field acquisition price, because severance taxes and gathering charges are included.

<sup>b</sup>Does not include supplemental fuels.

<sup>c</sup>Includes supplemental fuels.

<sup>d</sup>Includes gas consumed in cogeneration.

<sup>e</sup>Does not include cogenerators.

<sup>f</sup>Includes independent power producers and does not include cogenerators.

<sup>g</sup>Includes lease and plant fuels and pipeline fuel.

<sup>h</sup>Includes nonutility generation.

<sup>i</sup>Does not include certain State and local taxes levied on customers.

<sup>j</sup>On-system sales or system gas (i.e., does not include gas delivered for the account of others).

<sup>k</sup>Volume-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: **AEO2000:** AEO2000 National Energy Modeling System, runs AEO2K.D100199A (reference case), LMAC2K.D100199A (low economic growth case), and HMA2K.D100199A (high economic growth case). **WEFA:** The WEFA Group, *Natural Gas Outlook* (1999). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 1999). **AGA:** American Gas Association, *1998 AGA-TERA Base Case* (July 1998).

## Forecast Comparisons

**Table 23. Comparison of petroleum forecasts (million barrels per day, except where noted)**

Projection	AEO2000			Other forecasts			
	Reference	Low world oil price	High world oil price	WEFA	GRI	DRI	IPAA
<b>2010</b>							
<b>World oil price</b> (1998 dollars per barrel)	<b>21.00</b>	<b>14.90</b>	<b>26.31</b>	<b>18.62</b>	<b>17.50<sup>a</sup></b>	<b>16.97</b>	<b>NA</b>
<b>Crude oil and NGL production</b>	<b>7.23</b>	<b>6.88</b>	<b>7.56</b>	<b>7.67</b>	<b>8.24</b>	<b>7.94</b>	<b>7.77</b>
Crude oil	5.18	4.84	5.50	5.58	5.56	5.68 <sup>b</sup>	5.78
Natural gas liquids	2.05	2.04	2.06	2.09	2.68	2.26	1.99
<b>Total net imports</b>	<b>13.85</b>	<b>15.17</b>	<b>12.95</b>	<b>11.72</b>	<b>NA</b>	<b>13.03</b>	<b>11.92</b>
Crude oil	11.45	12.06	11.10	10.02	NA	9.96	NA
Petroleum products	2.40	3.11	1.85	1.70	NA	3.08	NA
<b>Petroleum demand</b>	<b>22.51</b>	<b>23.31</b>	<b>22.06</b>	<b>21.57</b>	<b>21.46</b>	<b>22.34</b>	<b>23.10</b>
Motor gasoline	10.18	10.38	10.01	9.16	8.72	10.08	NA
Jet fuel	2.35	2.37	2.33	2.31	2.24	2.20	NA
Distillate fuel	3.85	3.95	3.81	3.94	3.98	3.91	NA
Residual fuel	0.77	1.23	0.61	0.70	1.07	0.76	NA
Other	5.37	5.39	5.31	5.46	5.45	5.39	NA
<b>Import share of product supplied</b> (percent)	<b>62</b>	<b>65</b>	<b>59</b>	<b>54</b>	<b>NA</b>	<b>58</b>	<b>52</b>
<b>2020</b>							
<b>World oil price</b> (1998 dollars per barrel)	<b>22.04</b>	<b>14.90</b>	<b>28.04</b>	<b>19.77</b>	<b>NA</b>	<b>20.31</b>	<b>NA</b>
<b>Crude oil and NGL production</b>	<b>7.63</b>	<b>7.00</b>	<b>8.40</b>	<b>7.38</b>	<b>NA</b>	<b>7.54</b>	<b>NA</b>
Crude oil	5.26	4.65	6.02	5.00	NA	5.08 <sup>b</sup>	NA
Natural gas liquids	2.37	2.35	2.38	2.38	NA	2.46	NA
<b>Total net imports</b>	<b>16.04</b>	<b>18.08</b>	<b>14.47</b>	<b>14.49</b>	<b>NA</b>	<b>15.69</b>	<b>NA</b>
Crude oil	11.59	12.47	10.88	11.80	NA	10.57	NA
Petroleum products	4.45	5.61	3.59	2.69	NA	5.12	NA
<b>Petroleum demand</b>	<b>25.10</b>	<b>26.38</b>	<b>24.42</b>	<b>24.21</b>	<b>NA</b>	<b>24.64</b>	<b>NA</b>
Motor gasoline	11.37	11.71	11.06	9.89	NA	10.85	NA
Jet fuel	3.02	3.04	2.94	3.10	NA	2.78	NA
Distillate fuel	4.11	4.33	4.04	4.31	NA	4.28	NA
Residual fuel	0.83	1.48	0.70	0.77	NA	0.69	NA
Other	5.77	5.83	5.68	6.14	NA	6.04	NA
<b>Import share of product supplied</b> (percent)	<b>64</b>	<b>69</b>	<b>59</b>	<b>60</b>	<b>NA</b>	<b>64</b>	<b>NA</b>

<sup>a</sup>Composite of U.S. refiners' acquisition cost.

<sup>b</sup>Includes shale and other.

NA = Not available.

Sources: **AEO2000**: AEO2000 National Energy Modeling System, runs AEO2K.D100199A (reference case), LWOP2K.D100199A (low world oil price case), and HWOP2K.D100199A (high world oil price case). **WEFA**: The WEFA Group, *U.S. Energy Outlook* (1999). **GRI**: Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 1999 Edition (August 1998). **DRI**: Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 1999). **IPAA**: Independent Petroleum Association of America, *IPAA Supply and Demand Committee Long-Run Report* (April 1999).

above 2010 levels. As a result, the *AEO2000* high oil price and reference case production projections for 2020 are above the DRI and WEFA projections. The *AEO2000* projections for production of natural gas liquids are comparable to all but the GRI projections, which show an additional 630,000 barrels per day of production in 2010.

All three *AEO2000* cases project relatively high levels of petroleum consumption, which are mostly attributable to higher gasoline consumption than in the other forecasts. GRI and WEFA project the lowest petroleum consumption for 2010 at around 21.5 million barrels per day. The *AEO2000* low oil price case has the highest 2010 consumption, followed by IPAA, the *AEO2000* reference case, and DRI, which are similar. The *AEO2000* low oil price case also has the highest 2020 projection, followed by the *AEO2000* reference case. The DRI and WEFA consumption projections are significantly lower than the *AEO2000* reference case projection for 2020 but are more in line with the *AEO2000* high oil price. WEFA has the lowest 2020 projection for petroleum consumption, based on a lower level of demand for gasoline.

Net petroleum imports in the *AEO2000* reference and low oil 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 *AEO2000* low oil price case, followed by the reference case. For 2010 the import share of consumption ranges from 52 percent (IPAA) to 65 percent (*AEO2000* low oil price case). The low IPAA import share results from strong consumption projections that are second only to the *AEO2000* low oil price case and production levels that are above those in all three *AEO2000* cases.

The *AEO2000* high oil price case has the lowest share of imports in 2020 at 59 percent, because it projects relatively low petroleum consumption along with the highest level of domestic production. WEFA projects petroleum demand, imports, and the import share of consumption similar to those in the *AEO2000* high oil price case, despite a domestic production forecast that is more than 1 million barrels per day lower than that in the *AEO2000* high oil price case. The lower production in the WEFA forecast is counterbalanced by a refinery processing gain more than 1 million barrels per day higher than in

any of the other forecasts. The relatively high processing gain in the WEFA forecast may reflect more optimistic assumptions about technological development.

### Coal

The coal forecast by DRI is similar to the *AEO2000* coal forecasts, whereas those from WEFA and GRI/Hill [76] show lower production and consumption in the electricity and industrial sectors. The differences stem primarily from whether the forecast includes the effects of the NO<sub>x</sub> and particulate emissions limits proposed by the U.S. Environmental Protection Agency, either of which could force the retirement of many older coal plants. Because the proposed standards must pass through several stages of State and judicial review before adoption, they are not included in the EIA projections. The DRI forecast projects relatively modest coal plant retirements after 2010 in response to the proposed environmental standards.

EIA expects growing domestic consumption but shrinking exports. DRI expects moderate expansion of electricity and industrial sector coal consumption, with exports remaining close to their 1997-1998 levels. WEFA projects sharply reduced electricity and industrial consumption but high exports, and GRI/Hill is the most pessimistic about consumption in the electricity generation and industrial sectors and export levels.

The differences among the forecasts for coal exports are significant. U.S. coal exports have declined from 90 million tons in 1996 to 78 in 1998, and net coal exports in 1998 (after adjustment for imports) were 69 million tons. EIA expects net exports to decline to 38 million tons in 2015 and remain at that level through 2020. GRI/Hill projects a similar decline to 31 million tons in 2015, followed by an increase to 35 million tons in 2020, as environmental restrictions on mining and coal burning suppress domestic coal consumption and imports. The long-term decline in exports results primarily from the inability of the U.S. mining industry to keep pace with strong productivity growth by competing exporters and the loss of markets as Europe moves away from coal for environmental reasons. Both DRI and WEFA, however, project strong growth in U.S. coal exports, at 80 million tons in 2015 and 83 million tons in 2020 (DRI) and 109 million tons in 2015 and 125 million tons in 2020 (WEFA).

## Forecast Comparisons

Table 24. Comparison of coal forecasts (million short tons, except where noted)

Projection	AEO2000			Other forecasts		
	Reference	Low economic growth	High economic growth	WEFA	GRI/Hill	DRI
<b>2015</b>						
<b>Production</b>	<b>1,269</b>	<b>1,229</b>	<b>1,325</b>	<b>1,082</b>	<b>965</b>	<b>1,224</b>
<b>Consumption by sector</b>						
Electricity generation <sup>a</sup>	1,129	1,094	1,182	887	855	1,033
Coking plants	21	22	21	24	19	24
Industrial/other	81	78	85	61	60	87
<b>Total</b>	<b>1,232</b>	<b>1,193</b>	<b>1,288</b>	<b>972</b>	<b>934</b>	<b>1,144</b>
<b>Net coal exports</b>	<b>38</b>	<b>38</b>	<b>38</b>	<b>109</b>	<b>31</b>	<b>80</b>
<b>Minemouth price</b>						
(1998 dollars per short ton)	13.34	13.09	13.52	13.30	NA	NA
(1998 dollars per million Btu)	0.64	0.62	0.64	0.61	NA	NA
<b>Average delivered price, electricity</b>						
(1998 dollars per short ton)	21.19	20.74	21.60	20.29 <sup>b</sup>	21.88	21.11
(1998 dollars per million Btu)	1.03	1.01	1.05	0.99	NA	1.03
<b>2020</b>						
<b>Production</b>	<b>1,316</b>	<b>1,256</b>	<b>1,429</b>	<b>1,129</b>	<b>786</b>	<b>1,210</b>
<b>Consumption by sector</b>						
Electricity generation <sup>a</sup>	1,177	1,123	1,286	919	678	1,018
Coking plants	20	20	19	23	16	23
Industrial/other	82	77	87	63	57	88
<b>Total</b>	<b>1,279</b>	<b>1,219</b>	<b>1,393</b>	<b>1,005</b>	<b>751</b>	<b>1,128</b>
<b>Net coal exports</b>	<b>38</b>	<b>38</b>	<b>38</b>	<b>125</b>	<b>35</b>	<b>83</b>
<b>Minemouth price</b>						
(1998 dollars per short ton)	12.54	12.40	12.58	12.84	NA	NA
(1998 dollars per million Btu)	0.60	0.60	0.61	0.59	NA	NA
<b>Average delivered price, electricity</b>						
(1998 dollars per short ton)	20.01	19.61	20.32	19.47 <sup>b</sup>	21.03	19.84
(1998 dollars per million Btu)	0.98	0.96	1.00	0.95	NA	0.97

<sup>a</sup>The DRI and AEO2000 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.

<sup>b</sup>Computed using a conversion factor of 20.495 million Btu per short ton from the Technical Appendix.

NA = Not available.

Btu = British thermal unit.

Sources: **AEO2000**: AEO2000 National Energy Modeling System, runs AEO2K.D100199A (reference case), LMAC2K.D100199A (low economic growth case), and HMA2K.D100199A (high economic growth case). **WEFA**: The WEFA Group, *U.S. Energy Outlook* (1999). **GRI/Hill**: Gas Research Institute, *Final Report, Coal Demand and Price Projections*, Vol. I, GRI-99/0016.1 (January 1999). **DRI**: Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 1999).

Only EIA and WEFA project national average minemouth coal prices, and they are in close agreement (all are shown in 1998 dollars). In dollars per million Btu, WEFA's slightly lower price at \$0.61 indicates a slightly higher average Btu per ton conversion factor, which, in turn indicates a higher proportion of bituminous (over subbituminous) coal in the WEFA forecast.

The coal forecasts reviewed provide a broad range of views, reflecting the great uncertainties facing the

U.S. coal industry as it must simultaneously adapt to the financial pressures arising from increasing environmental restrictions on coal use (both here and in Europe), deregulation of the U.S. electricity generation industry, and increasing competition from the younger coalfields of international competitors. The uncertainties are, and will continue to be, passed on to U.S. coal producers in the form of demands for higher quality products at ever lower prices.