

## Forecast Comparisons

Two other organizations—DRI-WEFA and the Gas Research Institute (GRI)—also produce comprehensive energy projections with a time horizon similar to that of *AEO2002*. The most recent projections from those organizations (DRI-WEFA, Spring/Summer 2001; GRI, March 2001), as well as other forecasts that concentrate on petroleum, coal, and international oil markets, are compared here with the *AEO2002* projections.

### Economic Growth

The *AEO2002* and DRI-WEFA reference cases project the same rates of economic growth, labor force growth, and productivity growth (Table 16). The *AEO2002* long-run forecast of average annual economic growth from 2000 to 2020 in the reference case is 3.0 percent—0.1 percent higher than the *AEO2001* forecast for 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 17 (IEA, November 2000; PEL, June 2001; PIRA, October 2001; NRCan, January 2000; DBAB, July 2001). With the exception of PEL, the range between the *AEO2002* low and high world oil price cases spans the range of other published forecasts.

### Total Energy Consumption

The *AEO2002* 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.

Electricity is expected to remain one of the fastest growing sources of delivered energy (Table 18), although its projected rate of growth is down 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 use and natural gas consumption are projected to grow at rates similar to those of recent years. For other fuels, future growth in consumption is expected to slow as a result of moderating economic growth, fuel switching, and increased end-use efficiency.

### Residential and Commercial Sectors

Growth rates for primary energy demand in the residential and commercial sectors generally are expected to decrease significantly from the rates between 1984 and 1999, largely because of projected lower growth in population and housing starts. 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.

**Table 16. Forecasts of economic growth, 2000-2020**

Forecast	Average annual percentage growth		
	Real GDP	Labor force	Productivity
<b>AEO2002</b>			
Low growth	2.4	0.6	1.9
Reference	3.0	0.8	2.2
High growth	3.4	1.0	2.4
<b>DRI-WEFA</b>			
Reference	3.0	0.8	2.2

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

**Table 17. Forecasts of world oil prices, 2000-2020**

Forecast	2000 dollars per barrel				
	2000	2005	2010	2015	2020
<i>AEO2002</i> reference	27.72	22.73	23.36	24.00	24.68
<i>AEO2002</i> high price		29.56	30.01	30.44	30.58
<i>AEO2002</i> low price		17.41	17.64	17.64	17.64
<i>DRI-WEFA</i>	27.68	19.13	20.07	21.55	22.86
<i>IEA</i>	20.41	20.41	20.41	NA	27.83
<i>PEL</i>	28.00	13.53	14.77	13.38	NA
<i>PIRA</i>	30.31	24.31	24.21	27.75	NA
<i>GRI</i>	26.54	18.70	18.70	18.70	18.70
<i>NRCan</i>	21.79	21.79	21.79	21.79	21.79
<i>DBAB</i>	27.69	17.90	17.58	17.95	18.30

NA = not available.

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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 19). All the forecasts project substantial growth in electricity use, with the *AEO2002* and GRI projections showing slower growth toward the end of the forecast and DRI-WEFA projecting the lowest growth rate. Natural gas use also is projected to grow but at lower rates, and projected petroleum use either is stable or continues to fall. GRI projects a more rapid decline in oil use, particularly for commercial uses, than the other forecasts. *AEO2002* projects growth in commercial oil demand while GRI and DRI-WEFA project declines, because GRI projects growth in commercial floorspace of 1.0 percent per year to 2020, compared with 1.7 percent in *AEO2002*. In addition, DRI-WEFA projects a shift from oil to electricity for heating and more rapid improvement in building shell efficiency than is projected in *AEO2002*.

### Industrial Sector

The projected growth rates for delivered energy consumption in the industrial sector range from 1.1 percent to 1.4 percent per year (Table 20), and *AEO2002* is the lowest forecast, reflecting a continuing shift in the industrial output mix toward less energy-intensive products. For *AEO2002* and DRI-WEFA, the projected growth rates are similar to the actual rate from 1984 to 1999, whereas GRI projects somewhat higher growth.

The growth rates for different fuels in the industrial sector between 1984 and 1999 reflect a shift from petroleum products and coal to greater reliance on natural gas and electricity. In all the forecasts, natural gas use is expected to grow more slowly than in recent history, 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.

### Transportation Sector

Overall fuel consumption in the transportation sector is expected to grow at a rate similar to its growth rate over the recent past in both the *AEO2002* and DRI-WEFA forecasts (Table 21). The projections for gasoline demand and light-duty vehicle travel and efficiency are similar in the two forecasts, but

**Table 18. Forecasts of average annual growth rates for energy consumption (percent)**

Energy use	History		Projections (2000-2020)		
	1974-1984	1984-1999	AEO2002	DRI-WEFA	GRI
Petroleum*	-0.1	1.5	1.6	1.7	0.9
Natural gas*	-1.7	1.4	1.2	1.2	1.7
Coal*	-3.0	-1.0	0.1	0.2	-1.1
Electricity	3.0	2.5	1.8	1.5	2.3
Delivered energy	-0.2	1.4	1.5	1.5	1.3
Electricity losses	2.5	2.0	1.1	0.3	1.1
Primary energy	0.4	1.6	1.4	1.2	1.3

\*Excludes consumption by electricity generators.

**Table 19. Forecasts of average annual growth in residential and commercial energy demand (percent)**

Forecast	History (1984-1999)	Projections (2000-2020)		
		AEO2002	DRI-WEFA	GRI
<b>Residential</b>				
Petroleum	0.6	-0.7	0.2	-0.7
Natural gas	0.2	0.9	1.1	1.1
Electricity	2.6	1.7	1.2	2.5
Delivered energy	0.6	1.0	1.0	1.4
Electricity losses	2.1	1.0	0.1	1.4
Primary energy	1.2	1.0	0.6	1.4
<b>Commercial</b>				
Petroleum	-4.0	0.4	-0.7	-1.0
Natural gas	1.3	1.6	0.5	1.6
Electricity	3.4	2.3	1.7	2.2
Delivered energy	1.5	1.9	1.0	1.7
Electricity losses	2.9	1.6	0.5	1.1
Primary energy	2.2	1.7	0.8	1.4

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

Forecast	History (1984-1999)	Projections (2000-2020)		
		AEO2002	DRI-WEFA	GRI
Petroleum	0.9	1.2	1.2	1.5
Natural gas	2.1	1.1	1.5	1.8
Coal	-0.8	0.0	0.2	-1.1
Electricity	1.6	1.4	1.5	2.0
Delivered energy	1.2	1.1	1.2	1.4
Electricity losses	1.0	0.7	0.8	1.3
Primary energy	1.2	1.1	1.1	1.4

DRI-WEFA projects more rapid growth in jet fuel consumption, due to more rapid growth in air travel, and slower growth in diesel fuel demand. All the forecasts anticipate slower growth both in light-duty

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vehicle travel and air travel than in recent history. Demand for diesel fuel is also expected to grow more slowly in all three forecasts than it has in the past.

Total transportation energy demand in the GRI projections is expected to grow at a rate that is much slower than the historical rate and the rates in the other forecasts. GRI projects no growth in gasoline demand as a result of slower growth in light-duty vehicle travel and more rapid efficiency improvements than are projected in the *AEO2002* and DRI-WEFA forecasts. 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 projects growth in demand more comparable with that in the *AEO2002* forecast, because it projects similar annual growth in freight travel.

**Table 21. Forecasts of average annual growth in transportation energy demand (percent)**

Forecast	History		Projections (2000-2020)		
	1975-1985	1985-1999	AEO2002	DRI-WEFA	GRI
<b>Consumption</b>					
Motor gasoline	0.2	1.6	1.6	1.7	0.0
Diesel fuel	4.2	3.5	2.4	1.7	2.0
Jet fuel	2.1	2.3	2.5	3.4	2.1
Residual fuel	1.0	0.1	-0.2	0.8	-0.2
All energy	1.0	1.9	1.9	2.0	0.9
<b>Key indicators</b>					
Car and light truck travel	2.9	3.0	2.2	2.3	1.5
Air travel (revenue passenger-miles)	7.3	4.7	3.2	4.0	2.9
Average new car fuel efficiency	5.5	0.2	0.5	0.5	2.2
Gasoline prices	0.5	-2.3	-0.4	-1.0	-0.6

### Electricity

Comparison across forecasts shows significant variation in projected electricity sales (Table 22). The forecasts for total electricity sales in 2020 range from 5,298 billion kilowatthours (GRI) to 4,578 billion kilowatthours (DRI-WEFA), compared with the *AEO2002* reference case value of 4,916 billion kilowatthours. In 2020, GRI's sales projection of 5,298

billion kilowatthours exceeds the *AEO2002* high economic growth projection of 5,173 billion kilowatthours, while the DRI-WEFA projection of 4,578 billion kilowatthours is below the *AEO2002* low economic growth projection of 4,691 billion kilowatthours. All the forecasts compared here agree that competition in wholesale markets 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-WEFA and GRI forecasts assume that the electric power industry will be fully restructured, resulting in average electricity prices that approach long-run marginal costs. *AEO2002* assumes that partial restructuring will lead to increased competition in the electric power industry, lower operating and maintenance costs, lower general and administrative costs, early retirement of inefficient generating units, and other cost reductions. *AEO2002* and GRI project slight increases in electricity prices in the last 5 years of the forecast, whereas DRI-WEFA projects a slight decrease, based on different projections for the rate of growth in electricity demand.

The distribution of sales among sectors affects the mix of capacity types needed to satisfy sectoral demand. Although the *AEO2002* mix of capacity among fuels is similar to those in the other forecasts, small differences in sectoral demands across the forecasts could lead to significant differences in the expected mix of capacity types. In general, recent growth in the residential sector results in a need for more peaking and intermediate capacity than baseload capacity. Consequently, generators are expected to build mostly natural-gas-fired power plants, either combustion turbine or combined cycle. All the forecasts project growth rates for electricity demand in the commercial sector that equal or exceed those for the residential sector, leading to moderate increases in the share of baseload capacity relative to all additions. In the GRI forecast, additions of coal-fired plants using pulverized coal or integrated gasification combined cycle technologies are roughly equal to those in the *AEO2002* projections; however, GRI's projection of 420 gigawatts of total coal-fired capacity in 2020 also includes the repowering of approximately 72 gigawatts of existing capacity.

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**Table 22. Comparison of electricity forecasts (billion kilowatthours, except where noted)**

Projection	2000	AEO2002			Other forecasts	
		Reference	Low economic growth	High economic growth	DRI-WEFA	GRI
<b>2015</b>						
<b>Average end-use price (2000 cents per kilowatthour)</b>	<b>6.9</b>	<b>6.3</b>	<b>6.2</b>	<b>6.6</b>	<b>5.8</b>	<b>5.6</b>
Residential	8.3	7.6	7.3	7.9	7.1	7.1
Commercial	7.5	6.8	6.6	7.1	6.0	6.5
Industrial	4.6	4.3	4.2	4.5	4.1	3.2
<b>Net energy for load, including cogeneration</b>	<b>4,005</b>	<b>5,278</b>	<b>5,109</b>	<b>5,481</b>	<b>4,802</b>	<b>5,225</b>
Coal	1,969	2,341	2,279	2,418	2,296	2,295
Oil	102	43	44	45	173	71
Natural gas	625	1,488	1,400	1,599	1,233	1,412
Nuclear	752	707	697	707	649	705
Hydroelectric/other <sup>a</sup>	357	453	449	457	417	492
Nonutility sales to grid <sup>b</sup>	163	204	202	207	NA	216
Net imports	35	41	39	47	34	35
<b>Electricity sales</b>	<b>3,426</b>	<b>4,556</b>	<b>4,404</b>	<b>4,735</b>	<b>4,271</b>	<b>4,871</b>
Residential	1,193	1,554	1,523	1,575	1,421	1,764
Commercial/other <sup>c</sup>	1,162	1,673	1,637	1,705	1,514	1,663
Industrial	1,071	1,329	1,244	1,455	1,336	1,444
<b>Capability, including cogeneration (gigawatts)<sup>d,e</sup></b>	<b>809</b>	<b>1,049</b>	<b>1,017</b>	<b>1,083</b>	<b>1,096</b>	<b>1,113</b>
Coal	313	322	315	331	364	414
Oil and gas	282	509	487	533	518	467
Nuclear	98	89	87	89	94	91
Hydroelectric/other <sup>a</sup>	116	130	129	130	121	151
<b>2020</b>						
<b>Average end-use price (2000 cents per kilowatthour)</b>	<b>6.9</b>	<b>6.5</b>	<b>6.2</b>	<b>6.8</b>	<b>5.6</b>	<b>5.8</b>
Residential	8.3	7.7	7.3	8.1	6.8	7.3
Commercial	7.5	6.9	6.6	7.3	5.8	6.7
Industrial	4.6	4.5	4.2	4.7	3.9	3.3
<b>Net energy for load, including cogeneration</b>	<b>4,005</b>	<b>5,683</b>	<b>5,426</b>	<b>5,978</b>	<b>5,137</b>	<b>5,682</b>
Coal	1,969	2,472	2,355	2,693	2,482	2,455
Oil	102	49	48	55	190	99
Natural gas	625	1,733	1,619	1,777	1,408	1,507
Nuclear	752	702	691	702	612	706
Hydroelectric/other <sup>a</sup>	357	464	459	478	414	654
Nonutility sales to grid <sup>b</sup>	163	224	219	230	NA	226
Net imports	35	40	36	44	32	34
<b>Electricity sales</b>	<b>3,426</b>	<b>4,916</b>	<b>4,691</b>	<b>5,173</b>	<b>4,578</b>	<b>5,298</b>
Residential	1,193	1,672	1,623	1,701	1,528	1,932
Commercial/other <sup>c</sup>	1,162	1,830	1,775	1,876	1,603	1,778
Industrial	1,071	1,415	1,293	1,596	1,447	1,588
<b>Capability, including cogeneration (gigawatts)<sup>d,e</sup></b>	<b>809</b>	<b>1,138</b>	<b>1,092</b>	<b>1,187</b>	<b>1,155</b>	<b>1,166</b>
Coal	313	338	324	367	389	420
Oil and gas	282	580	552	598	559	480
Nuclear	98	88	87	88	88	89
Hydroelectric/other <sup>a</sup>	116	132	131	134	119	177

<sup>a</sup>“Other” includes conventional hydroelectric, pumped storage, 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 AEO2002, includes only net sales from cogeneration; for GRI, also includes distributed generation and backup power purchases.

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

<sup>d</sup>For DRI-WEFA, “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 129 gigawatts in 2015 and 149 gigawatts in 2020.

Sources: **AEO2002:** AEO2002 National Energy Modeling System, runs AEO2002.D102001B (reference case), LM2002.D102001B (low economic growth case), and HM2002.D102001B (high economic growth case). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand to 2020*, 2001 Edition (March 2001). **DRI-WEFA:** DRI-WEFA, *U.S. Energy Outlook* (Spring/Summer 2001).

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### Natural Gas

The differences among published forecasts of natural gas prices, production, consumption, and imports (Table 23) indicate 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. For instance, the forecast from GRI incorporates a cyclical price trend based on exploration and production cycles, which can be deceptive when isolated years are considered.

In 2020, the forecast with the highest natural gas consumption is GRI (35.6 trillion cubic feet); and the forecast with the lowest level is DRI-WEFA (31.6 trillion cubic feet). The GRI forecast shows the greatest expected growth in natural gas consumption for the residential and industrial sectors from 2000 to 2020, whereas the *AEO2002* high economic growth case and reference case project the greatest growth for the commercial and electricity generator sectors, respectively.

GRI projects average annual growth in residential natural gas consumption of 1.1 percent between 2000 and 2020, whereas the *AEO2002* low economic growth forecast shows the lowest growth in this sector (0.7 percent). The *AEO2002* high economic growth case projects 1.7-percent annual growth in commercial natural gas consumption between 2000 and 2020, whereas the DRI-WEFA forecast shows the lowest expected growth in this sector (0.5 percent). The growth rate for commercial consumption in the GRI forecast is around 3 times higher than the DRI-WEFA projection, which is significantly lower than the other forecasts, due in part to definitional differences.

For consumption of natural gas in the industrial and electricity generation sectors, the forecasts are not strictly comparable because of differences in definitions. The *AEO2002* reference, low economic growth, and high economic growth cases all project lower growth in industrial consumption by 2020 than do the other forecasts. All the forecasts project the strongest growth in natural gas consumption for the electricity generation sector. Through 2020, the *AEO2002* high economic growth case has the highest projected annual growth rate for electricity sector natural gas consumption (4.6 percent), with DRI-WEFA coming in lowest (2.8 percent).

Domestic natural gas consumption is met by domestic production and imports. GRI projects the highest level of net imports in 2020, 2.6 trillion cubic feet higher than the *AEO2002* reference case projections. GRI also projects the highest share of imports relative to total supply, at 24 percent. The *AEO2002* low economic growth case projects the lowest share of imports relative to total supply in 2020 at 16 percent. For domestic natural gas production, the *AEO2002* reference and high economic growth case projections for 2020 both exceed the other forecasts; however, the GRI forecast shows the highest annual growth rate for domestic production, starting from a lower estimate of production in 2000. The *AEO2002* reference case projection for 2020 is 2.8 trillion cubic feet higher than the lowest projection, from DRI-WEFA.

GRI projects the lowest wellhead prices, even though it projects production levels that are nearly equal to those in the DRI-WEFA forecast for 2020. The DRI-WEFA wellhead natural gas price projections are relatively high given the relatively low production levels in the forecast, exceeded only by the price projections in the *AEO2002* high economic growth case, which projects significantly higher production.

For the residential and commercial sectors in 2020, DRI-WEFA projects the highest end-use margins relative to the wellhead, and GRI's tend to be the lowest. Across all the forecasts, residential margins are projected to decline from 2000 to 2020.

Because of definitional differences industrial prices are not as readily comparable, although on-system sale prices would generally be expected to be higher than an estimate of the average price to all industrial customers. Margins to the industrial sector are expected to decline or remain relatively stable through 2020 in all the forecasts. GRI projects the largest decline in industrial margins, by 44 cents per thousand cubic feet (30 percent) over the forecast period.

All the forecasts show margins to electricity generators dropping from relatively high 2000 levels to 2015, with the most dramatic drop in the DRI-WEFA forecast, at 42 percent. The GRI margin is similar to those in the *AEO2002* cases in 2020, but the DRI-WEFA margin remains relatively low.

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**Table 23. Comparison of natural gas forecasts (trillion cubic feet, except where noted)**

Projection	2000	AEO2002			Other forecasts	
		Reference	Low economic growth	High economic growth	DRI-WEFA	GRI <sup>a</sup>
<b>2015</b>						
<b>Lower 48 wellhead price</b> (2000 dollars per thousand cubic feet)	<b>3.60</b>	<b>3.07</b>	<b>2.88</b>	<b>3.36</b>	<b>3.23</b>	<b>2.34</b>
<b>Dry gas production<sup>b</sup></b>	<b>19.08</b>	<b>26.32</b>	<b>25.28</b>	<b>26.92</b>	<b>24.29</b>	<b>25.55</b>
<b>Net imports</b>	<b>3.52</b>	<b>5.26</b>	<b>4.96</b>	<b>5.94</b>	<b>6.01</b>	<b>6.38</b>
<b>Consumption</b>	<b>22.83</b>	<b>31.34</b>	<b>30.02</b>	<b>32.63</b>	<b>30.05</b>	<b>33.78</b>
Residential	5.00	5.73	5.60	5.80	5.82	5.75
Commercial <sup>c</sup>	3.27	4.21	4.13	4.26	3.72 <sup>d</sup>	4.11
Industrial <sup>c</sup>	8.41	9.79	9.28	10.28	8.56 <sup>e</sup>	11.76
Electricity generators <sup>f</sup>	4.24	8.91	8.39	9.51	9.22 <sup>g</sup>	9.15
Other <sup>h</sup>	1.91	2.71	2.61	2.78	2.73	3.01
<b>End-use prices</b> (2000 dollars per thousand cubic feet)						
Residential	7.85	7.04	6.84	7.31	7.35	6.14
Commercial <sup>c</sup>	6.40	5.84	5.63	6.12	6.30	5.21
Industrial <sup>c</sup>	4.43	3.79	3.59	4.11	4.38 <sup>i</sup>	3.54 <sup>i</sup>
Electricity generators <sup>f</sup>	4.49	3.72	3.52	4.04	3.70	3.12
<b>2020</b>						
<b>Lower 48 wellhead price</b> (2000 dollars per thousand cubic feet)	<b>3.60</b>	<b>3.26</b>	<b>2.94</b>	<b>3.65</b>	<b>3.48</b>	<b>2.81</b>
<b>Dry gas production<sup>b</sup></b>	<b>19.08</b>	<b>28.48</b>	<b>27.25</b>	<b>28.93</b>	<b>25.64</b>	<b>25.60</b>
<b>Net imports</b>	<b>3.52</b>	<b>5.51</b>	<b>5.00</b>	<b>6.25</b>	<b>6.28</b>	<b>8.10</b>
<b>Consumption</b>	<b>22.83</b>	<b>33.78</b>	<b>32.03</b>	<b>34.99</b>	<b>31.64</b>	<b>35.57</b>
Residential	5.00	5.98	5.79	6.08	6.14	5.95
Commercial <sup>c</sup>	3.27	4.52	4.39	4.61	3.71 <sup>d</sup>	4.34
Industrial <sup>c</sup>	8.41	10.06	9.39	10.94	9.28 <sup>e</sup>	12.71
Electricity generators <sup>f</sup>	4.24	10.30	9.65	10.36	9.71 <sup>g</sup>	9.35
Other <sup>h</sup>	1.91	2.93	2.81	2.99	2.81	3.21
<b>End-use prices</b> (2000 dollars per thousand cubic feet)						
Residential	7.85	7.16	6.89	7.52	7.56	6.26
Commercial <sup>c</sup>	6.40	6.02	5.72	6.39	6.51	5.39
Industrial <sup>c</sup>	4.43	4.01	3.68	4.43	4.62 <sup>i</sup>	3.82 <sup>i</sup>
Electricity generators <sup>f</sup>	4.49	3.94	3.63	4.33	3.95	3.46

<sup>a</sup>The baseline projection includes a cyclical price trend based on exploration and production cycles; therefore, forecast values for an isolated year may be misleading. The conversion factor for natural gas is 1,030 Btu per cubic foot for all end-use sectors, net imports, production and consumption. A factor of 1.0227 was applied to convert prices in 1999 dollars to 2000 dollars.

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

<sup>c</sup>Includes natural gas consumed in cogeneration.

<sup>d</sup>Excludes natural gas used for cogenerators and other nonutility generation.

<sup>e</sup>Excludes cogenerators' energy attributed to generating electricity.

<sup>f</sup>Includes independent power producers and excludes cogenerators.

<sup>g</sup>Includes portion of cogeneration attributed to electricity generation.

<sup>h</sup>Includes lease, plant, and pipeline fuel and fuel consumed in natural gas vehicles.

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

Sources: **AEO2002:** AEO2002 National Energy Modeling System, runs AEO2002.D102001B (reference case), LM2002.D102001B (low economic growth case), and HM2002.D102001B (high economic growth case). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand to 2020*, 2001 Edition (March 2001). **DRI-WEFA:** DRI-WEFA, *U.S. Energy Outlook* (Spring/Summer 2001).

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### Petroleum

The *AEO2002* low world oil price and *AEO2002* high world oil price forecasts for 2015 and 2020 form intervals that bound the other forecasts (Table 24). The *AEO2002* reference case projects increasing world crude oil prices over the period 2003 to 2020, reaching \$24.00 per barrel in 2015 and \$24.68 per barrel in 2020. The *AEO2002* low world oil price case and high world oil price case and the DRI-WEFA projections also increase over some or all of their respective horizons. DRI-WEFA's crude oil price is \$2.45 per barrel below the *AEO2002* reference case projection in 2015 and \$1.82 per barrel below the *AEO2002* reference case in 2020. GRI forecasts a constant real crude oil price of \$18.70 per barrel.

The *AEO2002* reference case projects an increase in domestic crude oil production after 2010 to 5.6 million barrels per day by 2020. GRI projects increasing crude oil production until 2015. The GRI production forecast decreases after 2015 but is still higher in 2020 than the *AEO2002* reference case projection, by 0.5 million barrels per day. The DRI-WEFA projection for domestic crude oil is 0.5 million barrels per day below the *AEO2002* reference case projection. The Independent Petroleum Association of America (IPAA) projects much higher crude oil production for 2005 than any other forecast, at 6.6 million barrels per day, followed by decreasing production through 2015. The IPAA forecast for 2015 is the same as DRI-WEFA's and is below the *AEO2002* reference case projection by 0.2 million barrels per day.

The pattern of increasing production to 2015 followed by a decrease to 2020 is seen in GRI's projections for both crude oil and natural gas liquids (NGL). In the GRI forecast, NGL production in 2020 of 2.8 million barrels per day is similar to the *AEO2002* reference case and declines from 2.9 million barrels per day in 2015. NGL production is projected to increase steadily in the *AEO2002* reference case, to 2.8 million barrels per day in 2020. DRI-WEFA and IPAA also project increasing NGL production. GRI projects an increase in total domestic production of crude oil and NGL to 9.3 million barrels per day in 2015 and then a decline to 8.9 million barrels per day in 2020, higher than the *AEO2002* reference case projection for total domestic production of 8.5 million barrels per day in 2020.

DRI-WEFA and IPAA project total domestic production of 7.9 million barrels per day in 2020 and 7.7 million barrels per day in 2015, respectively. The *AEO2002* high world oil price case projects the highest world crude oil price and, not surprisingly, the highest domestic production of both crude oil and NGL in 2020.

Oil price forecasts may differ because of assumptions about world supply in each forecast. DRI-WEFA expects increased cooperation between the Organization of Petroleum Exporting Countries (OPEC), Norway, Mexico, and Russia on oil exports. Price forecasts may also differ because of assumptions about technology in energy consumption and production and assumptions about the availability of exploration and production rights. Advances in energy consumption are often summarized in the ratio of total energy consumption to GDP. Energy consumption per unit of GDP is generally expected to decline. GRI predicts a constant real crude oil price that is closer to that in the *AEO2002* low world oil price case than to the reference case yet also predicts fairly high domestic production.

Even the forecasts that project increases in domestic oil and NGL production expect domestic product demand to outpace the increased production. DRI-WEFA expects total product demand to reach 27.2 million barrels per day by 2020, and the GRI forecast is 22.3 million barrels per day. The *AEO2002* reference case projection is 26.7 million barrels per day. Total net imports and import share of product supplied increase in the *AEO2002* reference case and low world oil price cases and in the DRI-WEFA and IPAA forecasts. Only in the *AEO2002* high world oil price case does import share decrease slightly from 2015 to 2020. The *AEO2002* and DRI-WEFA forecasts show increasing motor gasoline demand to 2020. GRI's dissenting view is that gasoline demand growth will be reversed after 2010. By 2020, GRI's gasoline demand forecast is 3.6 million barrels per day lower than DRI-WEFA and 3.7 million barrels per day below the *AEO2002* reference case. All three *AEO2002* cases, GRI, DRI-WEFA, and IPAA project increasing distillate and jet fuel demand over their forecast periods. As might be expected, the *AEO2002* low world oil price case projects the largest total petroleum product demand in 2020.

## Forecast Comparisons

**Table 24. Comparison of petroleum forecasts (million barrels per day, except where noted)**

Projection	2000	AEO2002			Other forecasts		
		Reference	Low world oil price	High world oil price	DRI-WEFA	GRI	IPAA
<b>2015</b>							
<b>World oil price (2000 dollars per barrel)<sup>a</sup></b>	<b>27.72</b>	<b>24.00</b>	<b>17.64</b>	<b>30.44</b>	<b>21.55</b>	<b>18.70</b>	<b>NA</b>
<b>Crude oil and NGL production</b>	<b>7.73</b>	<b>8.20</b>	<b>7.51</b>	<b>8.76</b>	<b>8.01</b>	<b>9.34</b>	<b>7.73</b>
Crude oil	5.82	5.56	4.92	6.10	5.33 <sup>b</sup>	6.43	5.34
Natural gas liquids	1.91	2.64	2.59	2.66	2.48	2.91	2.40
<b>Total net imports</b>	<b>10.42</b>	<b>15.30</b>	<b>16.76</b>	<b>14.17</b>	<b>15.98</b>	<b>NA</b>	<b>13.72</b>
Crude oil	9.02	11.01	12.02	10.17	10.90	NA	11.45
Petroleum products	1.40	4.29	4.74	4.00	5.08	NA	2.27
<b>Petroleum demand</b>	<b>19.74</b>	<b>25.07</b>	<b>25.67</b>	<b>24.59</b>	<b>25.39</b>	<b>21.41</b>	<b>24.25</b>
Motor gasoline	8.50	11.13	11.27	10.92	10.99	8.32	10.63
Jet fuel	1.73	2.47	2.49	2.45	2.82	2.30	2.41
Distillate fuel	3.67	4.99	5.16	4.91	4.79	4.45	4.64
Residual fuel	1.05	0.73	0.94	0.66	0.89	0.59	0.77
Kerosene	0.07	0.06	0.06	0.06	0.08	0.07	NA
Liquefied petroleum gas	2.23	2.59	2.62	2.51	2.82	2.38	NA
Other	2.49	3.10	3.14	3.10	3.00	3.30	5.80
<b>Import share of product supplied (percent)</b>	<b>53.0</b>	<b>61.0</b>	<b>65.3</b>	<b>57.6</b>	<b>62.9</b>	<b>NA</b>	<b>56.6</b>
<b>2020</b>							
<b>World oil price (2000 dollars per barrel)<sup>a</sup></b>	<b>27.72</b>	<b>24.68</b>	<b>17.64</b>	<b>30.58</b>	<b>22.86</b>	<b>18.70</b>	<b>NA</b>
<b>Crude oil and NGL production</b>	<b>7.73</b>	<b>8.47</b>	<b>7.71</b>	<b>9.31</b>	<b>7.90</b>	<b>8.90</b>	<b>NA</b>
Crude oil	5.82	5.63	4.94	6.43	5.13 <sup>b</sup>	6.11	NA
Natural gas liquids	1.91	2.84	2.77	2.88	2.59	2.79	NA
<b>Total net imports</b>	<b>10.42</b>	<b>16.64</b>	<b>18.43</b>	<b>14.97</b>	<b>17.87</b>	<b>NA</b>	<b>NA</b>
Crude oil	9.02	11.20	12.37	10.08	11.22	NA	NA
Petroleum products	1.40	5.44	6.06	4.89	6.65	NA	NA
<b>Petroleum demand</b>	<b>19.74</b>	<b>26.66</b>	<b>27.52</b>	<b>26.12</b>	<b>27.22</b>	<b>22.25</b>	<b>NA</b>
Motor gasoline	8.50	11.81	12.00	11.54	11.69	8.10	NA
Jet fuel	1.73	2.81	2.83	2.79	3.33	2.50	NA
Distillate fuel	3.67	5.32	5.64	5.24	5.16	4.83	NA
Residual fuel	1.05	0.75	0.97	0.68	0.85	0.58	NA
Kerosene	0.07	0.06	0.06	0.06	0.08	0.07	NA
Liquefied petroleum gas	2.23	2.71	2.75	2.61	3.00	2.58	NA
Other	2.49	3.20	3.27	3.20	3.11	3.59	NA
<b>Import share of product supplied (percent)</b>	<b>53.0</b>	<b>62.4</b>	<b>67.0</b>	<b>57.3</b>	<b>65.7</b>	<b>NA</b>	<b>NA</b>

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

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

NA = Not available.

Notes: The GRI price, originally in 1999 dollars per barrel, was multiplied by 1.021126 to convert to 2000 dollars. IPAA includes jet fuel in demand for "aviation fuels." GRI and DRI-WEFA forecast aviation gasoline demand of 20 thousand barrels per day from 2005 to 2020.

Sources: **AEO2002**: AEO2002 National Energy Modeling System, runs AEO2002.D102001B (reference case), LW2002.D102001B (low world oil price case), and HW2002.D102001B (high world oil price case). **DRI-WEFA**: DRI-WEFA, *U.S. Energy Outlook* (Spring/Summer 2001). **IPAA**: Independent Petroleum Association of America, *IPAA Supply and Demand Committee Long-Run Report* (April 2001). **GRI**: Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand to 2020*, 2001 Edition (March 2001).

## Forecast Comparisons

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### Coal

The coal forecasts by DRI-WEFA and Hill & Associates, Inc. project lower production and overall consumption than does *AEO2002* (Table 25). The differences stem from differences in assumptions related to growth in electricity demand and whether the forecast includes the effects of emissions limits proposed by the U.S. Environmental Protection Agency, which could force the retirement of many older coal plants. *AEO2002* represents the provisions of the State implementation plan (SIP) call for 19 States where NO<sub>x</sub> caps were finalized but does not incorporate revised limits on emissions of particulate matter. In contrast, Hill & Associates includes revised limits on particulate matter beginning in 2008.

EIA projects growing domestic consumption over the forecast horizon in combination with shrinking real coal prices. Hill & Associates projects declines in coal consumption between 2015 and 2020. The DRI-WEFA forecast has the lowest coal consumption projection for the electricity generation sector. DRI-WEFA's coal consumption forecast shows virtually no growth (only 7 million tons) between 2015 and 2020. For the same period, the *AEO2002* reference case projects an increase of 71 million tons. Although DRI-WEFA projects 81 gigawatts of coal-fired capacity additions over the forecast period, most of those represent replacement capacity for retiring coal plants.

The differences among the forecasts for coal exports are significant. U.S. coal exports declined from 90 million tons in 1996 to 58 million tons in 2000, and net coal exports in 2000 (after adjustment for imports) were 46 million tons. EIA expects net exports to decline to 34 million tons in 2015 and

remain approximately at that level through 2020. Hill & Associates projects an even more dramatic decline in net exports to 18 million tons in 2015 and 16 million tons in 2020. The projections for a long-term decline in exports are based on expected strong price competition by other exporters and the loss of markets as Europe moves away from coal for environmental reasons. DRI-WEFA projects relative stability in U.S. net coal exports, at 44 million tons in 2015 and 42 million tons in 2020.

All the forecasts show declining real coal prices over the forecast horizon. The *AEO2002* and Hill & Associates price forecasts for national average minemouth coal prices (all shown in 2000 dollars) differ, however. The Hill & Associates minemouth price projections are somewhat lower than the *AEO2002* reference case projections, which include exported and metallurgical coal in the calculation. (Exported and metallurgical coal tend to be more expensive.) Hill & Associates shows lower delivered coal prices to electricity generators than are projected for 2015 and 2020 in the *AEO2002* reference case, whereas the DRI-WEFA price projections (per million Btu) are 24 percent higher in 2020.

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 coal fields 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.

## Forecast Comparisons

**Table 25. Comparison of coal forecasts (million short tons, except where noted)**

Projection	2000	AEO2002			Other forecasts	
		Reference	Low economic growth	High economic growth	DRI-WEFA	Hill & Associates
<b>2015</b>						
<b>Production</b>	1,084	1,325	1,298	1,366	1,202	1,172
<b>Consumption by sector</b>						
Electricity generation	965	1,183	1,156	1,218	1,048	1,075
Coking plants	29	22	22	22	26	18
Industrial/other	87	89	84	95	85	61
<b>Total</b>	1,081	1,294	1,262	1,335	1,159	1,154
<b>Net coal exports</b>	46	34	39	34	44	18
<b>Minemouth price</b>						
(2000 dollars per short ton)	16.45	13.44	13.17	13.51	NA	9.77 <sup>a</sup>
(2000 dollars per million Btu)	0.79	0.66	0.65	0.67	NA	0.46 <sup>a</sup>
<b>Average delivered price to electricity generators</b>						
(2000 dollars per short ton)	24.36	20.15	19.91	20.55	26.03	18.23
(2000 dollars per million Btu)	1.20	1.01	1.00	1.03	1.26	0.87
<b>2020</b>						
<b>Production</b>	1,084	1,397	1,335	1,493	1,208	1,160
<b>Consumption by sector</b>						
Electricity generation	965	1,254	1,198	1,341	1,054	1,071
Coking plants	29	20	20	20	24	15
Industrial/other	87	92	85	101	88	58
<b>Total</b>	1,081	1,365	1,303	1,462	1,166	1,144
<b>Net coal exports</b>	46	35	35	35	42	16
<b>Minemouth price</b>						
(2000 dollars per short ton)	16.45	12.79	12.56	13.23	NA	8.98 <sup>a</sup>
(2000 dollars per million Btu)	0.79	0.64	0.62	0.66	NA	0.42 <sup>a</sup>
<b>Average delivered price to electricity generators</b>						
(2000 dollars per short ton)	24.36	19.00	18.72	19.75	24.70	17.26
(2000 dollars per million Btu)	1.20	0.97	0.95	1.00	1.20	0.82

<sup>a</sup>In the Hill & Associates forecast, minemouth prices represent an average for domestic steam coal only. Exports and coking coal are not included in the average.

NA = Not available.

Btu = British thermal unit.

Sources: **AEO2002:** AEO2002 National Energy Modeling System, runs AEO2002.D102001B (reference case), LM2002.D102001B (low economic growth case), and HM2002.D102001B (high economic growth case). **Hill & Associates:** Hill & Associates, Inc., *The Outlook for U.S. Steam Coal: Long-Term Forecast to 2020* (March 2001). **DRI-WEFA:** DRI-WEFA, *U.S. Energy Outlook* (Spring/Summer 2001).