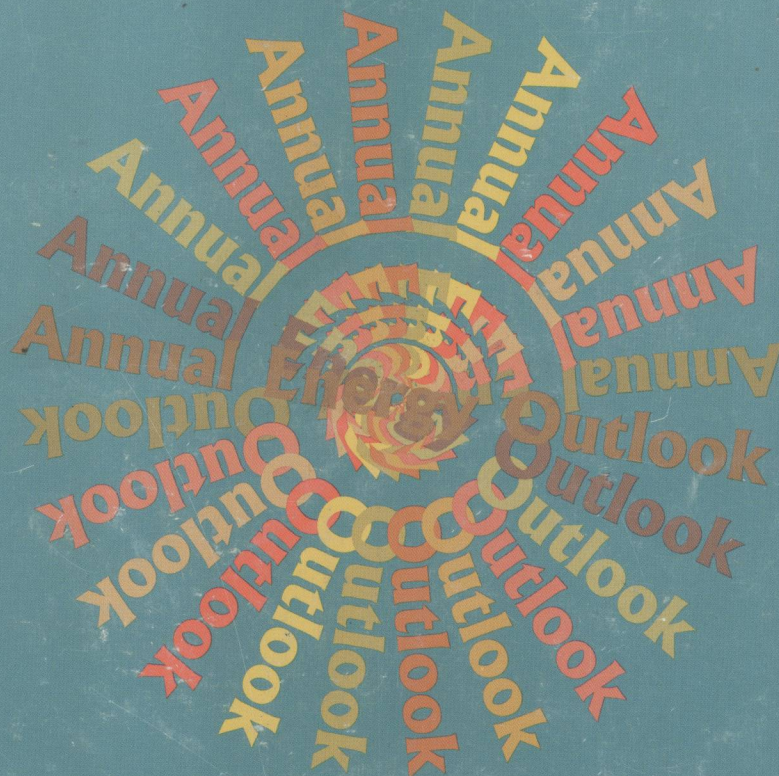


Annual Energy Outlook 1999

With Projections to 2020



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1999

Annual Energy Outlook 1999

With Projections to 2020

December 1998



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



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For Further Information . . .

The *Annual Energy Outlook 1999 (AEO99)* was prepared by the Energy Information Administration (EIA), Office of Integrated Analysis and Forecasting, under the direction of Mary J. Hutzler (mhutzler@eia.doe.gov, 202/586-2222). General questions may be addressed to Arthur T. Andersen (aanderse@eia.doe.gov, 202/586-1441), Director of the International, Economic, and Greenhouse Gas Division; Susan H. Holte (sholte@eia.doe.gov, 202/586-4838), Director of the Demand and Integration Division; James M. Kendell (jkendell@eia.doe.gov, 202/586-9646), Director of the Oil and Gas Division; Scott Sitzler (ssitzer@eia.doe.gov, 202/586-2308), Director of the Coal and Electric Power Division; or Andy S. Kydes (akydes@eia.doe.gov, 202/586-2222), Senior Modeling Analyst. Detailed questions about the forecasts and related model components may be addressed to the following analysts:

Overview, Carbon Emissions	Susan H. Holte (sholte@eia.doe.gov, 202/586-4838)
Economic Activity	Ronald Earley (rearley@eia.doe.gov, 202/586-1398)
International Oil Markets	G. Daniel Butler (gbutler@eia.doe.gov, 202/586-9503)
Residential Demand	John Cymbalsky (jcymbals@eia.doe.gov, 202/586-4815)
Commercial Demand	Erin Boedecker (eboedeck@eia.doe.gov, 202/586-4791)
Industrial Demand	T. Crawford Honeycutt (choneycu@eia.doe.gov, 202/586-1420)
Transportation Demand	David Chien (dchien@eia.doe.gov, 202/586-3994)
Electricity Generation, Restructuring, Renewable Portfolio Standards	J. Alan Beamon (jbeamon@eia.doe.gov, 202/586-2025)
Electricity Prices	Peter Whitman (pwhitman@eia.doe.gov, 202/586-1940)
Nuclear Energy	Laura Church (lchurch@eia.doe.gov, 202/586-1494)
Renewable Energy	Thomas Petersik (tpetersi@eia.doe.gov, 202/586-6582)
Oil and Gas Production	Ted McCallister (tmccalli@eia.doe.gov, 202/586-4820)
Natural Gas Markets	Phyllis Martin (pmartin@eia.doe.gov, 202/586-9592)
Oil Refining and Markets	Stacy MacIntyre (smacinty@eia.doe.gov, 202/586-9795)
Coal Supply and Prices	Richard Newcombe (rnewcomb@eia.doe.gov, 202/586-2415)

AEO99 will be available on the EIA Home Page (<http://www.eia.doe.gov/oiaf/aeo99/homepage.html>) by December 1998, including text, forecast tables, and graphics. Assumptions underlying the projections and tables of regional and other detailed results will also be available on the EIA Home Page by December 1998. *AEO99*, the assumptions, and the supplementary tables will be available on CD-ROM by February 1999.

Model documentation reports for the National Energy Modeling System (*NEMS*) are also available on CD-ROM and on the EIA Home Page. Projections of energy supply and demand for 1998 and 1999 are available in the *Annual Energy Outlook 1999* (AEO99). For ordering information and questions on other EIA products, contact EIA's National Energy Information Center. Address and phone numbers follow:

National Energy Information Center
Energy Information Administration
Forrestal Building
Washington, DC 20585

Telephone: 202/586-8800
FAX: 202/586-0727
TTY: 202/586-1181
9 a.m. to 5 p.m., eastern time, M-F

E-mail: neic@eia.doe.gov
World Wide Web: <http://www.eia.doe.gov>
FTP Site: <ftp://ftp.eia.doe.gov>

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Preface

The *Annual Energy Outlook 1999* (AEO99) presents midterm forecasts of energy supply, demand, and prices through 2020 prepared by the Energy Information Administration (EIA). The projections are based on results from EIA's National Energy Modeling System (NEMS).

The report begins with an "Overview" summarizing the AEO99 reference case. The next section, "Legislation and Regulations," describes the assumptions made with regard to laws that affect energy markets and discusses evolving legislative and regulatory issues. "Issues in Focus" discusses current energy issues—the economic decline in East Asia, growth in demand for natural gas, vehicle emissions standards, competitive electricity pricing, renewable portfolio standards, and carbon emissions. It is followed by the analysis of energy market trends.

The analysis in AEO99 focuses primarily on a reference case and four other cases that assume higher and lower economic growth and higher and lower world oil prices than in the reference case. Forecast tables for these cases are provided in Appendixes A through C. Appendixes D and E present a summary of the reference case forecasts in units of oil equivalence and household energy expenditures. Other cases explore the impacts of varying key assumptions in NEMS—generally, technology penetration. The major results are shown in Appendix F. Appendix G briefly describes NEMS and the AEO99

assumptions, with a summary table of the cases. Appendix H provides tables of energy and metric conversion factors. AEO99, the detailed assumptions, and supplementary tables will be available on the EIA Home Page and on CD-ROM.

The AEO99 projections are based on Federal, State, and local laws and regulations in effect on July 1, 1998. Pending legislation and sections of existing legislation for which funds have not been appropriated are not reflected in the forecasts. Historical data used for the AEO99 projections were the most current available as of July 31, 1998, when most 1997 data but only partial 1998 data were available. Historical data are presented in this report for comparative purposes; documents referenced in the source notes should be consulted for official values. The AEO99 projections for 1998 and 1999 incorporate the short-term projections from the September update of EIA's *Short-Term Energy Outlook* (STEO), Third Quarter 1998.

The AEO99 projections are used by Federal, State, and local governments, trade associations, and other planners and decisionmakers in the public and private sectors. They are published in accordance with Section 205c of the Department of Energy Organization Act of 1977 (Public Law 95 91), which requires the Administrator of EIA to prepare an annual report that contains trends and projections of energy consumption and supply.

The projections in AEO99 are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Thus, they provide a policy-neutral reference case that can be used to analyze policy initiatives. EIA does not propose, advocate, or speculate on future legislative and regulatory changes. All laws are assumed to remain as currently enacted; however, the impacts of emerging regulatory changes, when defined, are reflected.

Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures,

and assumptions used in their development. Behavioral characteristics are indicative of real-world tendencies rather than representations of specific outcomes.

Energy market projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Many key uncertainties in the AEO99 projections are addressed through alternative cases.

EIA has endeavored to make these projections as objective, reliable, and useful as possible; however, they should serve as an adjunct to, not a substitute for, analytical processes in the examination of policy initiatives.

Administrator's Message

As we present the projections in the *Annual Energy Outlook 1999 (AEO99)*, it is important to clarify what these projections represent. While the reference case projections do not hypothesize radical changes in energy markets and energy-using and producing technologies, they do assume continuing market changes and improvements in energy technologies, derived from past trends.

The Energy Information Administration (EIA) endeavors to represent current energy market conditions, both domestic and worldwide, and their impacts on future energy trends. An important example of such transitory issues is the ongoing economic crisis in East Asia, which currently is depressing world oil demand and prices and domestic oil production. Another is the continuing restructuring of the U.S. electricity industry and the movement to competitive pricing of electricity. Both of these topics are featured in *AEO99*, and they are included in the reference case projections.

In addition to the longer-term impacts of current market transitions, the reference case projections also include the impacts of a number of potential changes in energy markets—most notably, technology. Substantial productivity improvements and other technological advances are assumed for the fossil fuel supply sectors, in accordance with recent historical trends, accounting in part for the decline of coal prices and the relatively modest increases in oil and natural gas prices in the projections. The projections also incorporate all new and advanced energy-consuming and generating technologies that are assumed with a reasonable degree of confidence to be available by 2020. As a result, energy intensity—the amount of energy used for each dollar of output in the economy—declines by an average of 1 percent a year through 2020. In contrast, from 1986 to 1996, energy intensity was essentially flat.

Because the future cannot be known with certainty, it is possible that any of the assumptions, including the availability and characteristics of technology,

may be too optimistic or pessimistic. For that reason, *AEO99* includes a wide range of alternative cases examining the effects of variations in many key assumptions.

As a policy-neutral organization, EIA does not incorporate future changes in energy-related legislation, regulation, or policy into its projections. Because of this neutrality and the “most likely” nature of the energy trends, the reference case projections provide a solid baseline against which a variety of alternative policies and assumptions can be analyzed and evaluated. One example of the analytical work performed by EIA relative to its reference projections over the past several years is the recent report, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*, prepared at the request of the U.S. House of Representatives Committee on Science. Other recent work includes:

- *Analysis of S. 687, the Electric System Public Benefits Protection Act of 1997*, at the request of Senator James M. Jeffords
- *An Analysis of FERC's Final Environmental Impact Statement for Electricity Open Access and Recovery of Stranded Costs*, also at the request of Senator Jeffords
- *The Impacts on U.S. Energy Markets and the Economy of Reducing Oil Imports*, for the U.S. General Accounting Office
- *Analysis of Carbon Stabilization Cases*, for the U.S. Department of Energy, Office of Policy and International Affairs
- *The Impacts of Increased Diesel Penetration in the Transportation Sector*, for the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

Jay E. Hakes
Administrator
Energy Information Administration

The Energy Information Administration
National Energy Modeling System/Annual Energy Outlook Conference
Crystal Gateway Marriott, Arlington, VA *March 22, 1999*

Morning Program

- 8:15 a.m. **Opening Remarks - Jay E. Hakes, Administrator, Energy Information Administration**
8:30 a.m. - 9:00 **Overview of the *Annual Energy Outlook 1999* - Mary J. Hutzler, Director, Office of Integrated Analysis and Forecasting, Energy Information Administration**
9:00 a.m. - 9:45 **Keynote Address: Carbon Mitigation Topic - Speaker to be announced**

10:00 a.m. - 12:00 **Meeting U.S. Carbon Targets**

Afternoon Program

- 1:15 p.m. - 3:00 **Concurrent Sessions A**
 1. Impact of Asian Economic Crises on Oil Markets and the Economy
 2. Electricity Restructuring: A State Update
 3. Emerging Transportation Technologies
3:15 p.m. - 5:00 **Concurrent Sessions B**
 1. Electricity Transmission Issues in a Competitive Environment
 2. Natural Gas Pipeline and Production Availability
 3. Renewables in a Carbon-Constrained World
-

Hotel

The conference will be held at the *Crystal Gateway Marriott*, not to be confused with the Crystal City Marriott. The *Crystal Gateway Marriott* is located near the Crystal City Metro subway station at 1700 Jefferson Davis Highway, Arlington, VA 22202.

For room reservations, contact the *Crystal Gateway Marriott* directly by telephone: (703) 920-3230.

A block of rooms has been reserved in the name of the NEMS conference and will be held until March 1, 1999.

Information

For information, contact Susan H. Holte, Energy Information Administration, at (202) 586-4838, susan.holte@eia.doe.gov or Peggy Wells, Energy Information Administration, at (202) 586-0109, peggy.wells@eia.doe.gov.

Conference Registration

Conference registration is free, but space is limited. Please register by March 10, 1999.

To register, mail or fax this form to:

Peggy Wells
Energy Information Administration, EI-84
1000 Independence Avenue, SW
Washington, DC 20585
Phone: (202) 586-0109
Fax: (202) 586-3045

Or register by e-mail to peggy.wells@eia.doe.gov.

Please provide the information requested below:

Name: _____
Title: _____
Organization: _____
Address: _____
Phone: _____
Fax: _____

Please indicate which sessions you will be attending:

Morning Program

- ☐ Opening Remarks/Overview/Keynote Address/
Meeting U.S. Carbon Targets

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The Seventh Annual

**National Energy Modeling System/
Annual Energy Outlook Conference**

March 22, 1999

**Crystal Gateway Marriott
Arlington, Virginia**

**See Previous Page for Information and
Registration Form**

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Overview



Overview

Key Issues

A major issue in energy markets today is carbon emissions. Because the Kyoto Protocol has not been ratified by the United States and no specific policies for carbon reduction have been enacted, such policies are not included in the *Annual Energy Outlook 1999* (AEO99), although the Protocol and EIA's recent analysis of its potential impacts are discussed.

Economic developments in Asia over the past 18 months have weakened worldwide oil demand and lowered world oil prices—a trend that is likely to continue for several years and, therefore, is included in the AEO99 analysis of oil markets and prices.

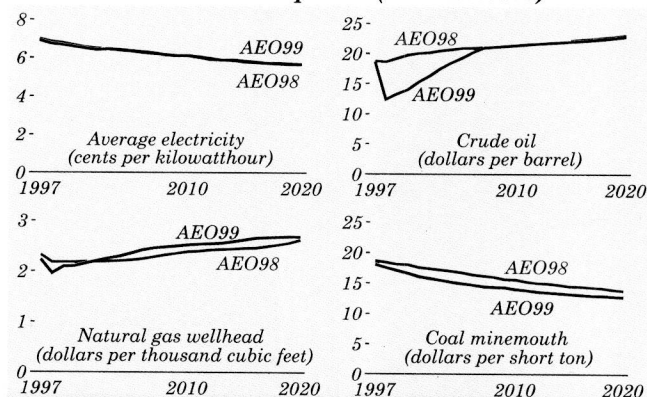
As in AEO98, the projections in AEO99 reflect ongoing changes in the financial structure of the U.S. electricity industry and cost reductions that are becoming evident with increased competition. A transition to retail competitive pricing is assumed in five regions—California, New York, New England, the Mid-Atlantic Area Council (Pennsylvania, Delaware, New Jersey, and Maryland), and the Mid-America Interconnected Network (Illinois and parts of Wisconsin and Missouri). Provisions of the California legislation on stranded cost recovery and price caps are also included. In the other regions, stranded cost recovery is assumed to be phased out by 2008. No national renewable portfolio standard has been passed, but State standards and other programs intended to encourage renewables are included as enacted. The new standards for control of nitrogen oxide (NO_x) emissions by electricity generators are also incorporated.

Prices

Although average world crude oil prices in AEO99 are similar to those in AEO98 by 2020, the projected prices over the next several years are much lower (Figure 1). In 2020, the average crude oil price is projected to be \$22.73 a barrel (in 1997 dollars), compared with \$22.78 a barrel in AEO98. With the economic downturn in many Asian nations and lower expected growth in world oil demand, world oil prices are expected to remain low over the next several years—as much as about \$5.50 a barrel lower than last year's projections in 2000.

After the start of the next decade, world oil demand is expected to rebound. Worldwide demand for oil is

Figure 1. Fuel price projections, 1997-2020: AEO98 and AEO99 compared (1997 dollars)



projected to reach 114.7 million barrels a day in 2020, only slightly lower than the AEO98 projection of 116.6 million barrels a day.

Through 2020, the relatively low growth of prices even as the demand for oil increases reflects continued optimism about the potential growth of production in both the Organization of Petroleum Exporting Countries (OPEC) and the non-OPEC nations. Although not increasing as rapidly as in AEO98, OPEC oil production is expected to reach 58.8 million barrels a day in 2020, nearly double the 29.9 million barrels a day in 1997, assuming sufficient capital to expand production capacity. Once sanctions are lifted, Iraqi oil production is expected to reach 2.5 million barrels a day within 2 years and about 5 million barrels a day within a decade. Outside the Persian Gulf, expansion of production in the offshore regions of Nigeria and Algeria and in Venezuela should make a significant contribution to OPEC production.

Non-OPEC oil production is expected to increase more rapidly in AEO99, reaching 55.6 million barrels a day in 2020, compared with 50.4 million barrels a day in AEO98. Contributing to the growth are a near doubling of production in the former Soviet Union by 2020 (primarily in the Caspian Sea oil fields), new fields in the North Sea, and increases in the offshore regions of West Africa. Mexican oil production will continue to expand, and the rest of Latin America is projected to increase production by more than 50 percent, particularly in Brazil and Colombia. Lower OPEC production and higher non-OPEC production than in AEO98 mean that OPEC does not dominate the world oil market until later in

the forecast and reaches a market share of only 51 percent, compared with 57 percent in *AEO98*.

The average wellhead price of natural gas is projected to increase from \$2.23 per thousand cubic feet in 1997 to \$2.68 per thousand cubic feet in 2020, an average annual growth rate of 0.8 percent. Continued technological improvements in the exploration and production of natural gas moderate the price increase even as demand grows rapidly. In 2020, the price is higher than the \$2.59 projected in *AEO98*, primarily because of a lower assessment of the recoverable resource base. Average delivered prices decline between 1997 and 2020 as a result of efficiency improvements in transmission and distribution; however, margins are as much as \$0.20 to \$0.30 per thousand cubic feet higher in *AEO99* than in *AEO98* in the 2000 to 2010 period, because recent data indicate fewer pipeline and distribution cost reductions than previously assumed.

In *AEO99*, the average minemouth price of coal is projected to decline from \$18.14 per ton in 1997 to \$12.74 per ton in 2020, as a result of increasing productivity in the industry, more production from lower-cost western mines, and competitive pressures on labor costs. Slightly lower production and higher productivity, as noted in recent data, lead to a price that is lower than the \$13.55 in *AEO98*.

Average electricity prices decline from 6.9 cents per kilowatthour in 1997 to 5.6 cents per kilowatthour in 2020, the same as in *AEO98*. The restructuring of the electricity industry contributes to declining prices throughout the Nation through lower operating and maintenance costs, lower administrative costs, and other cost reductions. Federal Energy Regulatory Commission actions on open access and other regulatory initiatives for competitive markets enacted by some State public utility commissions are included in the projections, as are renewable portfolio standards and other mandates that have been passed in some States. Legislative actions affecting the electricity industry are discussed in the "Legislation and Regulations" section of this report (page 14), and electricity pricing is discussed in "Issues in Focus" (page 24).

Consumption

Total U.S. energy consumption is projected to increase from 94.0 to 119.9 quadrillion British

thermal units (Btu) between 1997 and 2020, an average annual increase of 1.1 percent. In 2020, consumption is slightly higher than the 118.6 quadrillion Btu projected in *AEO98*, with higher commercial, industrial, and transportation demand partially offset by lower residential demand.

Consumption in the residential and commercial sectors is projected to increase at average rates of 0.8 and 0.7 percent a year, respectively, led by growth for a variety of equipment—telecommunications, computers, and other appliances. Residential demand is lower than in *AEO98*—22.9 quadrillion Btu in 2020, compared with 23.2 quadrillion Btu, because more efficient building shells in new construction offset higher growth in the housing stock. In the commercial sector, data from the *Commercial Buildings Energy Consumption Survey 1995* indicate less floorspace but higher energy intensities for some end uses. Commercial demand is projected to be 18.1 quadrillion Btu in 2020, 0.6 quadrillion Btu higher than in *AEO98*, primarily because of higher demand for natural gas and electricity.

Demand in the industrial sector increases at an average of 0.8 percent a year and is about 0.6 quadrillion Btu higher in 2020 than in *AEO98*. More rapid efficiency improvement in some manufacturing sectors is offset by higher energy intensity indicated by the *Manufacturing Energy Consumption Survey 1994*. Because the economic downturn in Asia affects the market for U.S. exports, manufacturing output and industrial demand are significantly lower than in *AEO98* over the next 10 years, rebounding later in the projections.

Transportation demand grows on average by 1.7 percent a year and is 0.4 quadrillion Btu higher in 2020 than in *AEO98*. The introduction of direct-injection engines and other advanced automotive technologies improves the efficiency of light-duty vehicles, but the improvement is more than offset by higher travel, resulting from higher projected personal income. Recent data indicate higher load factors and efficiency for aircraft, which are offset by more air travel. Freight requirements for both rail and trucks are also higher, primarily because of the higher economic growth projected in *AEO99*.

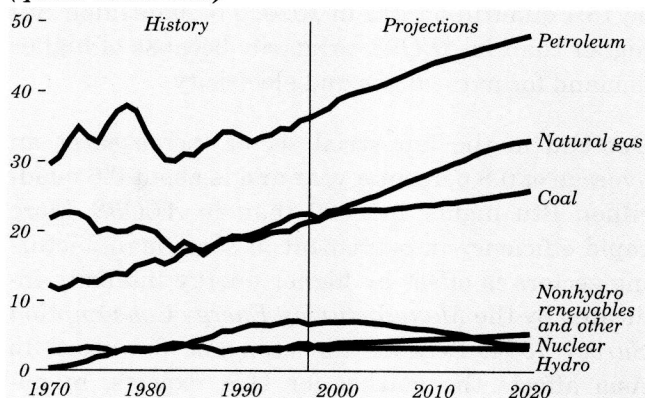
AEO99, like earlier AEOs, incorporates efficiency standards for new energy-using equipment in

Overview

buildings and for motors mandated by the National Appliance Energy Conservation Act of 1987 and the Energy Policy Act of 1992. Several alternative cases examine the impact of technology on the projections by assuming more and less rapid improvement of energy-efficient technologies in the end-use sectors relative to that projected in the reference case.

Natural gas consumption increases by an average of 1.7 percent a year (Figure 2). Demand increases in all sectors, but the most rapid growth is for electricity generation, which is projected to increase from 3.3 to 9.2 trillion cubic feet between 1997 to 2020, excluding cogenerators. Total gas consumption is only 0.1 trillion cubic feet higher than in *AEO98* in 2020, with higher demand in the commercial and industrial sectors offset by lower demand in the residential and electricity generation sectors.

Figure 2. Energy consumption by fuel, 1970-2020 (quadrillion Btu)



Coal consumption increases from 1,030 to 1,275 million tons between 1997 and 2020, an average annual increase of 0.9 percent. About 90 percent of the coal use is for electricity generation, and coal remains the primary fuel for generation, although its share of generation declines by 2020. Coal demand in 2020 is 18 million tons higher than in *AEO98* because of higher projected demand for electricity generation.

Petroleum demand is projected to grow at an average rate of 1.2 percent a year through 2020, led by continued growth for transportation, which accounts for about 70 percent of petroleum use in 2020. Increases in travel more than offset efficiency increases, and higher economic growth increases freight and shipping, and thus petroleum use, through 2020. Compared with *AEO98*, total transportation energy demand is slightly higher, with

higher projected efficiencies for new automobiles and aircraft more than offset by higher travel and freight requirements.

Renewable fuel consumption, including ethanol used for blending in gasoline, increases at an average rate of 0.8 percent a year through 2020. About 60 percent of renewables are used for electricity generation and the rest for dispersed heating and cooling, industrial uses, and fuel blending. In 2020, renewables are 0.7 quadrillion Btu higher than in *AEO98*, with higher demand for electricity generation, industrial uses, and ethanol blending.

Electricity demand is projected to grow by 1.4 percent a year through 2020. Efficiency gains in the use of electricity partially offset the growth of new electricity-using equipment. Electricity demand is only slightly higher than in *AEO98*, because an increase in commercial demand, resulting from more rapid growth of office equipment, computers, and other appliances is offset by a decrease in industrial demand from efficiency improvements in some manufacturing industries.

Energy Intensity

Energy intensity, measured as energy use per dollar of gross domestic product (GDP), has declined since 1970, particularly when energy prices have risen rapidly (Figure 3). Between 1970 and 1986, energy intensity declined at an average rate of 2.3 percent a year as the economy shifted to less energy-intensive industries and more efficient technologies. With moderate price increases and the growth of more energy-intensive industries, intensity improvements were flat between 1986 and 1996. From 1997

Figure 3. Energy use per capita and per dollar of gross domestic product, 1970-2020 (index, 1970 = 1)

