Text Notes

Legislation and Regulations

[*1*] The tax of 4.3 cents per gallon is in nominal terms.

[*2*] Federal Energy Regulatory Commission, Order 2000, "Regional Transmission Organizations," Docket No. RM99-2-000 (December 20, 1999).

[*3*] Federal Energy Regulatory Commission, Order 2000, "Regional Transmission Organizations," Docket No. RM99-2-000 (December 20, 1999), p. 3.

[*4*] R. Wiser, K. Porter, and M. Bolinger, *Comparing State Portfolio Standards and Systems-Benefits Charges Under Restructuring* (Berkeley, CA: Lawrence Berkeley National Laboratory, August 2000).

[*5*] *Federal Register*, Vol. 65, No. 51 (March 15, 2000), p. 14074.

[*6*] U.S. Environmental Protection Agency, *Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Control Requirements*, 40 CFR Parts 80, 85, and 86 (Washington, DC, February 10, 2000).

[*7*] U.S. Environmental Protection Agency, web site www.epa.gov/oms/regs/hd-hwy/2000frm/f00026.htm.

[*8*] U.S. Environmental Protection Agency, web site www.epa.gov/oms/regs/hd-hwy/2000frm/2004frm.pdf.

[*9*] U.S. Environmental Protection Agency, "Proposed Rules," *Federal Register*, Vol. 65, No. 107, p. 35546 (June 2, 2000).

[*10*] U.S. Environmental Protection Agency, *Proposal for Cleaner Heavy-Duty Trucks and Buses and Cleaner Diesel Fuel: Fact Sheet* (Washington, DC, May 17, 2000).

[*11*] EIA will be conducting a study of the proposed diesel fuel standards at the request of the Committee on Science of the U.S. House of Representatives. The study is expected to be released in spring 2001.

[*12*] Figure quoted by Dr. James R. Katzer, ExxonMobil Research & Engineering Company, at the Hart 2000 World Fuels Conference (Washington, DC, September 21, 2000).

[*13*] "RFG Watch: With No Minimum Oxygen Standard, Ethanol in RFG Widens," *Octane Week* (August 14, 2000).

[*14*] U.S. Environmental Protection Agency, *Regulatory Announcement: Control of Emissions of Hazardous Air Pollutants from Mobile Sources*, EPA-420-F-00-025 (Washington, DC, July 2000).

[*15*] State of California Air Resources Board, *Staff Report: Proposed Regulations for Low Emission Vehicles and Clean Fuels* (Sacramento, CA, August 13, 1990).

[*16*] State of California Air Resources Board, Mobile Source Control Division, *Staff Report: Initial Statement of Reasons, Proposed Amendments to California Exhaust and Evaporative Emissions Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles—"LEV II" and Proposed Amendments to California Motor Vehicle Certification, Assembly-Line and In-Use Test Requirements—"CAP 2000"* (El Monte, CA, September 18, 1998).

Issues in Focus

[*17*] See web site www.bea.doc.gov/bea/dn1.htm for a listing and access to BEA national accounts.

[*18*] J.S. Landefeld and R.P. Parker, "BEA's Chain Indexes, Time Series, and Measures of Long-Term Economic Growth," *Survey of Current Business* (May 1997), pp. 58-68, web site www.bea.doc.gov/bea/an1.htm.

[*19*] The fixed-weighed, or Laspeyres, measure of real GDP specified a single base-period set of prices and then value the output in all periods in those prices. As explained in the May 1997 BEA article, this resulted in significant changes in perceived growth rates when the base year was periodically updated. Chain-weighted, or Fisher, indexes overcome this problem by using weights of adjacent years. The annual changes are "chained" together to form a time series that allows for the effects of changes in relative prices and in the composition of output over time.

[*20*] E.P. Seskin, "Improved Estimates of the National Income and Product Accounts for 1959-98: Results of the Comprehensive Revision," *Survey of Current Business* (December 1999), pp. 15-43, web site www.bea.doc.gov/bea/an1.htm.

[*21*] As part of any comprehensive revision of the NIPA's, BEA will designate a more recent year as a benchmark year to express the real value of the output of the economy. The update presented in the December BEA article changed the base year from 1992 to 1996. However, as explained in the previous note, this revaluation does not affect historical growth rates because of the chain-weighting procedure introduced by BEA (BEA, May 1997).

[*22*] D. Wyss, "Rewriting History," in *The U.S. Economy* (Standard & Poor's DRI, November 1999).

[*23*] D. Wyss, "Growing Faster," in *The U.S. Economy* (Standard & Poor's DRI, April 2000); and A. Hodge, "Productivity and the New Age Economy," *U.S. Macro Special Study* (May 8, 2000). For a summary of the debate about recent productivity trends, see "United States: Adjusting the Lens," *The Economist* (November, 20, 1999), pp. 29-30; "Productivity on Stilts," *The Economist* (June 10, 2000), p. 86; and "Performing Miracles," *The Economist* (June 17, 2000), p. 78. The latter two articles highlight the work of Robert Gordon of Northwestern University (web site http://faculty-web.at.northwestern.edu/economics/gordon/351_text.pdf); Stephen Oliner and Daniel Sichel of the Federal Reserve Board in Washington, DC (web site www.federalreserve.gov/pubs/feds/2000/200020/200020pap.pdf); and Dale Jorgenson of Harvard University and Kevin Stiroh of the Federal Reserve Bank of New York (web site www.economics.harvard.edu/faculty/jorgenson/papers/dj_ks5.pdf).

[*24*] A 21-year period was selected to match the 21-year forecast period (from 1999 to 2020) for *AEO2001*.

[*25*] U.S. Geological Survey, *Worldwide Petroleum Assessment 2000* (Reston, VA, June 2000).

[*26*] Energy Information Administration, Office of Oil and Gas.

[27] "Upstream Digging Its Way Back, But Production Hole a Deep One," *Natural Gas Week*, Vol. 16, No. 29 (July 17, 2000), p. 1.

[28] U.S. Department of Energy, Office of Fossil Energy, *Natural Gas Imports and Exports, Fourth Quarter Report 1999*, DOE/FE-0414 (Washington, DC, 1999), p. xi.

[29] T.A. Stokes and M.R. Rodriguez, "44th Annual Reed Rig Census," *World Oil* (October 1996).

[30] "Simmons: Offshore Rig Shortage Looms," *Oil and Gas Journal* (April 27, 1998), p. 24.

[31] Adjustments were made to unconventional resources with data from Advanced Resources International and to offshore resources with data from the National Petroleum Council.

[32] 3-D seismic technology provides data to create a multidimensional picture of the subsurface by bouncing acoustic or electrical vibrations off subsurface structures, enabling the oil and gas deposits to be better targeted. 4-D seismic technology goes one step further by allowing the scientist to see the flow pattern of hydrocarbon changes in the formation over time.

[33] As of November 13, 2000, the Alliance Pipeline was scheduled to open on December 1, 2000.

[34] U.S. Environmental Protection Agency, *Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline*, EPA-420-R-99-021 (Washington, DC, September 15, 1999).

[35] States that have passed legislation limiting MTBE are Arizona, California, Connecticut, Maine, Minnesota, Nebraska, New York, and South Dakota.

[36] At least one bill banning MTBE—S. 2962, as amended—would also put new limits on high-octane aromatics, which would make octane replacement even more difficult for refiners.

[37] J. Vaiutrain, "California Refiners Anticipate Broad Effects of Possible State MTBE Ban," *Oil and Gas Journal* (January 18, 1999).

[38] S. Shaffer, "Ethanol Sulfur: Not a Serious Concern", *Oxy-Fuel News* (June 5, 2000).

[39] Downstream Alternatives, Inc., *The Use of Ethanol in California Clean Burning Gasoline: Ethanol Supply and Demand* (Bremen, IN, February 5, 1999).

[40] Remote applications are not addressed in this analysis.

[41] This includes a generic representation of microturbines, frame type combustion turbines operating on natural gas, and three types of reciprocating engines. The cost of the generic technology is the sum of an assumed share of each of the technologies mentioned above multiplied by its respective costs. The lowest costs are for the diesel cycle/compression ignition engines operated with natural gas. This technology represents 40 percent of the generic technology for peaking distributed generators.

[42] The technologies in the generic include heavy-duty microturbines, combustion turbines, compression ignition engines, and fuel cells. The cost of the base-load generic is calculated in the same fashion as is done for the peaking generic. Combustion turbines and engines make up about one-half of the generic for baseload distributed generators.

[43] For further information on DOE's Million Solar Roofs program see the program web site at www.eren.doe.gov/millionroofs/background.html. For the Department of Defense fuel cell demonstration program see http://energy.nfesc.navy.mil/enews/96b/fuelcell.htm.

[44] For photovoltaic and fuel cell technologies, a doubling of cumulative shipments yields an assumed 13 percent reduction in installed capital costs. For microturbines, a doubling results in an assumed 7 percent reduction in costs.

[45] For a more detailed discussion of modeling distributed generation and several sensitivity cases see E. Boedecker, J. Cymbalsky, and S. Wade, "Modeling Distributed Electricity Generation in the NEMS Buildings Models," Energy Information Administration, web site www.eia.doe.gov/oiaf/analysispaper/electricity_generation.html.

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

[47] Arkansas, Arizona, California, Illinois, Maine, Maryland, Nevada, New Hampshire, New York, and Pennsylvania allow some form of competitive metering and/or billing services. Delaware, Massachusetts, Michigan, Montana , New Jersey, Ohio, Oregon, Rhode Island, Virginia, and West Virginia are studying or have not made final determinations on whether or not to allow competitive metering and/or billing services. Louisiana is considering allowing these services to be competitive as part of a restructuring package.

[48] Arizona, Arkansas, California, Connecticut, Delaware, District of Columbia, Illinois, Maine, Maryland, Massachusetts, Michigan, Montana, Nevada, New Hampshire, New Jersey, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Virginia, and West Virginia have legislation mandating competition of electricity supply. New York passed a comprehensive regulatory order mandating electric restructuring which is considered legally binding.

[49] R.T. Eynon, T.J. Leckey, and D.R. Hale, "The Electric Transmission Network: A Multi-Region Analysis," Energy Information Administration, web site www.eia.doe.gov/oiaf/analysispaper/transmiss.html.

[50] U.S. Department of Energy, *Report of the U.S. Department of Energy's Power Outage Study Team: Findings and Recommendations to Enhance Reliability From the Summer of 1999*, Final Report, March 2000, web site www.policy.energy.gov/electricity/postfinal.pdf.

[51] Office of the Chief Accountant, Office of Economic Policy, Office of Electric Power Regulation, Office of the General Counsel, *Staff Report to the Federal Energy Regulatory Commission on the Causes of Wholesale Electric Pricing Abnormalities in the Midwest During June 1998* (Washington, DC, September 22, 1998), pp. 4-15 to 4-17, web site www.ferc.fed.us/electric/mastback.pdf. Immediately after the June 1998 Midwest price spikes, wholesale market participants told the staff investigating team that they were actively reviewing the creditworthiness of their counterparts and asking for increased assurances of performance in

appropriate cases. The team also found some evidence that power purchasers had, immediately after the June price spikes, begun to change their short-term buying strategy to anticipate large price swings without disrupting service to native load retail customers.

[52] *Power Markets Week* (September 6, 1999).

[53] "ISO New England Files to Eliminate ICAP Market in June," ISO New England Press Advisory (May 8, 2000), web site www.iso-ne.com/iso_news/newsnews.html; M. Kahn and L. Lynch, *California's Electricity Options and Challenges: Report to Governor Gray Davis* (August 2, 2000).

[54] Gaming the system is when traders or generators use their knowledge of market procedures and regulations to buy up or withhold large amounts of power, bid up the price, then dump the power in the spot market at a much higher rate.

[55] "ISO New England Files to Eliminate ICAP Market in June," ISO New England Press Advisory (May 8, 2000), web site www.iso-ne.com/iso_news/newsnews.html.

[56] M. Kahn and L. Lynch, *California's Electricity Options and Challenges: Report to Governor Gray Davis* (August 2, 2000).

[57] "Governor Davis Presses FERC for Action on Wholesale Power Rates: Calls on Federal Regulators To Reduce Prices, Issue Refunds," Office of the Governor press release (September 12, 2000).

[58] A. de Rouffignac, "Supply vs. Demand: The Gas Industry's Catch-22," *Financial Times Energy* (September 14, 2000). Can be accessed by registering with Energy Insight Today at web site www.einsight.com.

[59] Based on the most recently completed survey of electricity sales data from the 1998 Form EIA-861, "Annual Electric Utility Report."

[60] Some of the regulations mandating price freezes and reductions have a fuel clause allowing prices to increase or further decrease within a certain range with a substantial increase or decrease in fuel costs.

[61] **Buildings:** Energy Information Administration (EIA), *Technology Forecast Updates—Residential and Commercial Building Technologies—Advanced Adoption Case* (Arthur D. Little, Inc., September 1998). **Industrial:** EIA, *Aggressive Technology Strategy for the NEMS Model* (Arthur D. Little, Inc., September 1998). **Transportation:** U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, ORNL/CON-444 (Washington, DC, September 1997); Office of Energy Efficiency and Renewable Energy, Office of Transportation Technologies, *OTT Program Analysis Methodology: Quality Metrics 2000* (November 1998); J. DeCicco and M. Ross, *An Updated Assessment of the Near-Term Potential for Improving Automotive Fuel Economy* (Washington, DC: American Council for an Energy-Efficient Economy, November 1993); and F. Stodolsky, A. Vyas, and R. Cuenca, *Heavy and Medium Duty Truck Fuel Economy and Market Penetration Analysis*, Draft Report (Chicago, IL: Argonne National Laboratory, August 1999). **Fossil-fired generating technologies:** U.S. Department of Energy, Office of Fossil Energy. **Renewable Generating Technologies:** U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, and Electric Power Research Institute, *Renewable Energy Technology Characterizations*, EPRI-TR-109496 (Washington, DC, December 1997).

[62] President William J. Clinton and Vice President Albert Gore, Jr., *The Climate Change Action Plan* (Washington, DC, October 1993).

[63] Carbon dioxide is absorbed by growing vegetation and soils. Defining the total impacts of CCAP as net reductions accounts for the increased sequestration of carbon dioxide as a result of the forestry and land-use actions in the program.

[64] Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland, and United States of America. Turkey and Belarus are Annex I nations that have not ratified the Framework Convention and did not commit to quantifiable emissions targets.

[65] Antigua and Barbuda, Azerbaijan, Bahamas, Barbados, Bolivia, Cyprus, Ecuador, El Salvador, Equatorial Guinea, Fiji, Georgia, Guatemala, Guinea, Honduras, Jamaica, Kiribati, Lesotho, the Maldives, Mexico, Micronesia, Mongolia, Nicaragua, Niue, Palau, Panama, Paraguay, Trinidad and Tobago, Turkmenistan, Tuvalu, and Uzbekistan.

[66] Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000), web site www.eia.doe.gov/oiaf/1605/ggrpt/.

[67] Hydrofluorocarbons are a non-ozone-depleting substitute for CFCs; perfluorocarbons are byproducts of aluminum production and are also used in semiconductor manufacturing; and sulfur hexafluoride is used as an insulator in electrical equipment and in semiconductor manufacturing.

[68] Web site www.state.gov/www/global/global_issues/climate/fs-9911_bonn_climate_conf.html.

[69] Web site www.state.gov/www/global/global_issues/climate/fs-000801_unfccc1_subm.html.

[70] Web site http://cop6.unfccc.int/media/press.html.

[71] Energy Information Administration, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*, SR/OIAF/98-03 (Washington, DC, October 1998), web site www.eia.doe.gov/oiaf/kyoto/kyotorpt.html.

[72] Energy Information Administration, *What Does the Kyoto Protocol Mean to U.S. Energy Markets and the U.S. Economy?*, SR/OIAF/98-03(S) (Washington, DC, October 1998), web site www.eia.doe.gov/oiaf/kyoto/kyotobrf.html.

[73] Energy Information Administration, *Analysis of the Impacts of an Early Start for Compliance with the Kyoto Protocol*, SR/OIAF/99-02 (Washington, DC, July 1999), web site www.eia.doe.gov/oiaf/kyoto3/kyoto3rpt.html.

[*74*] Energy Information Administration (EIA), *Analysis of the Climate Change Technology Initiative*, SR/OIAF/99-01 (Washington, DC, April 1999), web site www.eia.doe.gov/oiaf/climate99/climaterpt.html, and EIA, *Analysis of the Climate Change Technology Initiative: Fiscal Year 2001*, SR/OIAF/2000-01 (Washington, DC, April 2000), web site www.eia.doe.gov/oiaf/climate/index.html.

Market Trends

[*75*] Standard & Poor's DRI, Simulation T250200 (February 2000).

[*76*] I. Ismail, "Future Growth in OPEC Oil Production Capacity and the Impact of Environmental Measures," presented to the Sixth Meeting of the International Energy Workshop (Vienna, Austria, June 1993).

[*77*] The transportation sector has been left out of these calculations because levels of transportation sector electricity use have historically been far less than 1 percent of delivered electricity. In the transportation sector, the difference between total and delivered energy consumption is also less than 1 percent.

[*78*] The high and low macroeconomic growth cases are linked to higher and lower population growth, respectively, which affects energy use in all sectors.

[*79*] The definition of the commercial sector for *AEO2001* is based on data from the 1995 Commercial Buildings Energy Consumption Survey (CBECS). See Energy Information Administration, 1995 CBECS Micro-Data Files (February 17, 1998), web site www.eia.doe.gov/emeu/cbecs/. Nonsampling and sampling errors (found in any statistical sample survey) and a change in the target building population resulted in a lower commercial floorspace estimate than found with the previous CBECS. In addition, 1995 CBECS energy intensities for specific end uses varied from earlier estimates, providing a different composition of end-use consumption. These factors contribute to the pattern of commercial energy use projected for *AEO2001*. Further discussion is provided in Appendix G.

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

[*81*] Estimated as consumption of alternative transportation fuels in crude oil Btu equivalence.

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

[*83*] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, ORNL/CON-444 (Washington, DC, September 1997); Office of Energy Efficiency and Renewable Energy, Office of Transportation Technologies, *OTT Program Analysis Methodology: Quality Metrics 2000* (November 1998); J. DeCicco and M. Ross, *An Updated Assessment of the Near-Term Potential for Improving Automotive Fuel Economy* (Washington, DC: American Council for an Energy-Efficient Economy, November 1993); and F. Stodolsky, A. Vyas, and R. Cuenca, *Heavy-Duty and Medium-Duty Truck Fuel Economy and Market Penetration Analysis*, Draft Report (Chicago, IL: Argonne National Laboratory, August 1999).

[*84*] Values for incremental investments and energy expenditure savings are discounted back to 2000 at a 7-percent real discount rate.

[*85*] Unless otherwise noted, the term "capacity" in the discussion of electricity generation indicates utility, nonutility, and cogenerator capacity.

[*86*] D. Stellfox, "Colvin Tells UI That U.S. Utility May Order New Unit Before 2006," *Nucleonics Week*, Vol. 41, No. 36 (September 7, 2000).

[*87*] For example, according to the latest USGS estimates, the size of the Nation's technically recoverable undiscovered conventional crude oil resources (in onshore areas and State waters) is most likely to be 30.3 billion barrels—with a 19 in 20 chance of being at least 23.5 billion barrels and a 1 in 20 chance of being at least 39.6 billion barrels. The corresponding USGS estimate for the Nation's natural gas resources is 258.7 trillion cubic feet—with a 19 in 20 chance of being at least 207.1 trillion cubic feet and a 1 in 20 chance of being at least 329.1 trillion cubic feet. *AEO2001* does not examine the implications of geological resource uncertainty. The figures cited above are taken from U.S. Geological Survey, National Oil and Gas Resource Assessment Team, *1995 National Assessment of United States Oil and Gas Resources*, U.S. Geological Survey Circular 1118 (Washington, DC, 1995), p. 2. The cited numbers exclude natural gas liquids resources, for which the corresponding USGS estimates are 7.2, 5.8, and 8.9 billion barrels.

[*88*] Currently, all production in Alaska is either consumed in the State, reinjected, or exported to Japan as liquefied natural gas (LNG). Projected Alaskan natural gas production does not include gas from the North Slope, which primarily is being reinjected to support oil production. In the future, North Slope gas may be transported to the lower 48 market through a pipeline, converted into LNG and marketed to the Pacific Rim, and/or converted into synthetic petroleum products and marketed to California.

[*89*] Greater technological advances can markedly increase the quantity of economically recoverable resources by driving down costs, increasing success rates, and increasing recovery from producing wells. Expected production rate declines could be slowed or

even reversed within the forecast period if faster implementation of advanced technologies is realized.

[*90*] Enhanced oil recovery (EOR) is the extraction of the oil that can be economically produced from a petroleum reservoir greater than that which can be economically recovered by conventional primary and secondary methods. EOR methods usually involve injecting heated fluids, pressurized gases, or special chemicals into an oil reservoir in order to produce additional oil.

[*91*] Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000).

[*92*] Total labor costs are estimated by multiplying the average hourly earnings of coal mine production workers by total annual labor hours worked. Average hourly earnings do not represent total labor costs per hour for the employer, because they exclude retroactive payments and irregular bonuses, employee benefits, and the employer's share of payroll taxes. Labor hours of office workers are excluded from the calculation.

[*93*] Variations in mining costs are not necessarily limited to changes in labor productivity and wage rates. Other factors that affect mining costs and, subsequently, the price of coal include such items as severance taxes, royalties, fuel costs, and the costs of parts and supplies.

[*94*] U.S. Environmental Protection Agency, web site www.epa.gov/acidrain/overview.html (September 1997).

Forecast Comparisons

[*95*] In April 2000, the Gas Research Institute and the Institute of Gas Technology combined to form the Gas Technology Institute.

[*96*] The source used is a forecast prepared for GRI by Hill & Associates, Inc., containing coal projection detail that is comparable with the other forecasts reviewed.

Table Notes

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

Table 1. Summary of results for five cases: Tables A1, A19, A20, B1, B19, B20, C1, C19, and C20.

Table 2. Summer season NO_x emissions budgets for 2003 and beyond: U.S. Environmental Protection Agency, *Federal Register*, Vol. 65, No. 207 (October 27, 1998).

Table 3. Effective dates of appliance efficiency standards, 1988-2005: U.S. Department of Energy, Office of Codes and Standards; and Electric Power Research Institute, "Energy Conservation Standards for Consumer Products."

Table 4. Historical revisions to growth rates of GDP and its major components, 1959-1998: E.P. Seskin, "Improved Estimates of the National Income and Product Accounts for 1959-98: Results of the Comprehensive Revision," *Survey of Current Business* (December 1999), pp. 15-43, web site www.bea.doc.gov/bea/an1.htm.

Table 5. Revisions to nominal GDP, 1959-1998: E.P. Seskin, "Improved Estimates of the National Income and Product Accounts for 1959-98: Results of the Comprehensive Revision," *Survey of Current Business* (December 1999), pp. 15-43, web site www.bea.doc.gov/bea/an1.htm.

Table 6. Revisions to nominal GDP for 1998: E.P. Seskin, "Improved Estimates of the National Income and Product Accounts for 1959-98: Results of the Comprehensive Revision," *Survey of Current Business* (December 1999), pp. 15-43, web site www.bea.doc.gov/bea/an1.htm.

Table 7. Historical growth in GDP, the labor force, productivity and energy intensity: Real GDP: Data from BEA web site www.bea.doc.gov/bea/dn1.htm. **Labor force:** Data from BLS web site stats.bls.gov/datahome.htm. **Productivity:** Calculated as real GDP growth minus labor force growth. **Energy intensity:** Calculated with energy data from Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000).

Table 8. Forecast comparison of key macroeconomic variables: National Energy Modeling System, runs AEO2K.D100199A and AEO2001.D101600A.

Table 9. Cost and performance of generic distributed generators: Distributed Utility Associates, *Assessing Market Acceptance and Penetration for Distributed Generation in the United States*, June 7, 1999.

Table 10. Projected installed costs and electrical conversion efficiencies for distributed generation technologies by year of introduction and technology, 2000-2020: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy and Electric Power Research Institute, *Renewable Energy Technology Characterizations,* EPRI-TR-109496 (Washington, DC, December 1997); and ONSITE SYCOM Energy Corporation, *The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector* (Washington, DC, January 2000).

Table 11. Costs of industrial cogeneration systems, 1999 and 2020: ONSITE SYCOM Energy Corporation, *The Market and Technical Potential for Combined Heat and Power in the Industrial Sector* (Washington, DC, January 2000).

Table 12. New car and light truck horsepower ratings and market shares, 1990-2020: History: U.S. Department of Transportation, National Highway Traffic Safety Administration. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Table 13. Costs of producing electricity from new plants, 2005 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Table 14. Technically recoverable U.S. oil and gas resources as of January 1, 1999: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Table 15. Natural gas and crude oil drilling in three cases, 1999-2020: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LW2001. D101600A, and HW2001.D101600A.

Table 16. Transmission and distribution revenues and margins, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-

0384(99) (Washington, DC, July 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A. End-use consumption is net of pipeline and lease and plant fuels.

Table 17. Components of residential and commercial natural gas end-use prices, 1985-2020: History: Energy Information Administration, *Annual Energy Review 1987*, DOE/EIA-0384(87) (Washington, DC, July 1988). **1999 and projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A. **Note:** End-use prices may not equal the sum of citygate prices and LDC margins due to independent rounding.

Table 18. Petroleum consumption and net imports in five cases, 1999 and 2020: 1999: Energy Information Administration, *Petroleum Supply Annual 1999*, Vol. 1, DOE/EIA-0340(99)/1 (Washington, DC, June 2000). **Projections:** Tables A11, B11, and C11.

Table 19. Forecasts of economic growth, 1999-2020: AEO2001: Table B20. **DRI:** Standard and Poor's DRI, *The U.S. Economy 25-Year Outlook*, Winter 2000. **WEFA:** The WEFA Group, *U.S. Long Term Economic Outlook*, Second Quarter 2000.

Table 20. Forecasts of world oil prices, 2000-2020: AEO2001: Tables A1 and C1. **DRI:** Standard and Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **IEA:** International Energy Agency, *World Energy Outlook 1998*. **PEL:** Petroleum Economics, Ltd., *Oil and Energy Outlook to 2015* (February 2000). **PIRA:** PIRA Energy Group, "Retainer Client Seminar" (October 2000). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **NRCan:** Natural Resources Canada, *Canada's Energy Outlook 1996-2020* (April 1997). **DBAB:** Deutsche Banc Alex. Brown, World Oil Supply and Demand Estimates (June 2000).

Table 21. Forecasts of average annual growth rates for energy consumption: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **AEO2001:** Table A2. **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000). **Note:** Delivered energy includes petroleum, natural gas, coal, and electricity (excluding generation and transmission losses) consumed in the residential, commercial, industrial, and transportation sectors.

Table 22. Forecasts of average annual growth in residential and commercial energy demand: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **AEO2001:** Table A2. **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000).

Table 23. Forecasts of average annual growth in industrial energy demand: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **AEO2001:** Table A2. **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000).

Table 24. Forecasts of average annual growth in transportation energy demand: History: Energy Information Administration (EIA), *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999); EIA, *State Energy Price and Expenditures Report 1997*, DOE/EIA-0376(97) (Washington, DC, July 2000); Federal Highway Administration, *Highway Statistics*, various issues, Table VM-1; U.S. Department of Energy, Oak Ridge National Laboratory, *Transportation Energy Data Book #19*, ORNL-6958 (Oak Ridge, TN, September 1999); and National Highway Transportation Safety Administration, *Summary of Fuel Economy Performance* (Washington, DC, February 2000). **AEO2001:** Table A2. **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000).

Table 25. Comparison of electricity forecasts: AEO2001: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LM2001.D101600A, and HM2001.D101600A. **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000).

Table 26. Comparison of natural gas forecasts: AEO2001: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LM2001.D101600A, and HM2001.D101600A. **WEFA:** The WEFA Group, *Natural Gas Outlook* (2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **AGA:** American Gas Association, *1999 AGA-TERA Base Case* (December 1999). **NPC:** National Petroleum Council, *Meeting the Challenges of the Nation's Growing Natural Gas Demand* (December 1999).

Table 27. Comparison of petroleum forecasts: AEO2001: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LW2001.D101600A, and HW2001.D101600A. **WEFA:** The WEFA Group, *U.S. Energy Outlook* (2000). **GRI:** Gas Research Institute, *GRI Baseline Projection of U.S. Energy Supply and Demand*, 2000 Edition (January 2000). **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000). **IPAA:** Independent Petroleum Association of America, *IPAA Supply and Demand Committee Long-Run Report* (April 2000).

Table 28. Comparison of coal forecasts: AEO2001: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LM2001.D101600A, and HM2001.D101600A. **WEFA**: The WEFA Group, *U.S. Energy Outlook* (2000). **GRI/Hill**: Gas Research Institute, Final Report, *Coal Outlook and Price Projection*, Vol. I, GRI-00/0019.1, and Vol. II, GRI/0019.2 (April 2000). **DRI:** Standard & Poor's DRI, *U.S. Energy Outlook* (Spring/Summer 2000).

Figure Notes

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

Figure 1. Fuel price projections, 1999-2020: *AEO2000* and *AEO2001* compared: *AEO2000* projections: Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999). ***AEO2001* projections:** Table A1.

Figure 2. Energy consumption by fuel, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A1 and A18.

Figure 3. Energy use per capita and per dollar of gross domestic product, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A20.

Figure 4. Electricity generation by fuel, 1970-2020: History: Energy Information Administration (EIA), Form EIA-860B, "Annual Electric Generator Report - Nonutility;" EIA, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000); and Edison Electric Institute. **Projections:** Table A8.

Figure 5. Energy production by fuel, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A1 and A18.

Figure 6. Net energy imports by fuel, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A1.

Figure 7. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 8. Index of energy use per dollar of gross domestic product, 1960-1998: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, July 2000) and U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 9. Annual growth in real gross domestic product: 21-year moving average, 1980-2020: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 10. Projected average annual growth in sectoral output, 1999-2020: National Energy Modeling System, runs AEO2K.D100199A and AEO2001.D101600A.

Figure 11. Projected commercial delivered energy intensity by fuel, 1999-2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 12. Projected industrial energy intensity by fuel, 1999-2020: Table A6.

Figure 13. Projected new light-duty vehicle and on-road stock fuel efficiency, 1999-2020: Table A7.

Figure 14. Refiner acquisition cost of imported crude oil, 1997-2000: 1997 and 1998: Energy Information Administration (EIA), *Monthly Energy Review December 1999*, DOE/EIA-0035(99/12) (Washington, DC, December 1999). **1999 and 2000:** EIA, *Weekly Petroleum Status Report October 6, 2000*, DOE/EIA-0208(2000/40) (Washington, DC, October 2000).

Figure 15. World oil supply and demand forecast in the *AEO2001* reference case, 1995-2020: History: Energy Information Administration, *International Petroleum Monthly*, DOE/EIA-0520(2000/09) (Washington, DC, September 2000). **Projections:** Table A21.

Figure 16. Net U.S. imports of natural gas, 1970-2020: History: 1970-1998: Energy Information Administration (EIA), *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **1999:** EIA, *Natural Gas Monthly*, DOE/EIA-0130(2000/06) (Washington, DC, June 2000). **Projections:** Table A13.

Figure 17. Lower 48 natural gas wells drilled, 1970-2020: History: 1970-1994: Energy Information Administration (EIA), computations based on well reports submitted to the American Petroleum Institute. **1995-1999:** EIA, computations based on well reports submitted to the Information Handling Services Energy Group, Inc. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 18. Technically recoverable U.S. natural gas resources as of January 1, 1999: Onshore conventional: U.S. Geological Survey. **Offshore:** Minerals Management Service and National Petroleum Council. **Unconventional:** Advanced Resources International. **Proved:** Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(98) (Washington, DC, December 1999).

Figure 19. Lower 48 end-of-year natural gas reserves, 1990-2020: History: Total onshore and offshore: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(98) (Washington, DC, December 1999). **Unconventional:** Advanced Resources International. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 20. Lower 48 natural gas production in three resource cases, 2000-2020: Table F13.

Figure 21. Average lower 48 natural gas wellhead prices in three resource cases, 2000-2020: Table F13.

Figure 22. Lower 48 natural gas production in three technology cases, 1970-2020: History: 1970-1998: Energy Information Administration (EIA), *Natural Gas Annual 1998*, DOE/EIA-0131(98) (Washington, DC, October 1999). **1999:** EIA, *Natural Gas Monthly*, DOE/EIA-0130 (2000/06) (Washington, DC, June 2000). **Projections:** AEO2001 National Energy Modeling System, runs AEO2001.D101600A, OGLTEC.D101600A, and OGHTEC.D101600A.

Figure 23. Major new U.S. natural gas pipeline systems, 1990-2000: Energy Information Administration, EIAGIS-NG Geographic Information System: Natural Gas Pipeline State Border Capacity Database, September 2000; Natural Gas Proposed Pipeline Construction Database, September 2000; various industry news sources.

Figure 24. Projected buildings sector electricity generation by selected distributed resources in the reference case, 2000-2020: AEO2001 National Energy

Modeling System, run AEO2001.D101600A. **Note:** Other technologies includes coal, petroleum, hydropower, and biomass-based technologies.

Figure 25. Cogeneration capacity by type and fuel, 1999 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 26. Average annual electricity prices for competitive and noncompetitive regions, 1995-2020: History: FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others." **Projections:** AEO2001 National Energy Modeling System, run AEO2001. D101600A.

Figure 27. Projected average regional electricity prices, 2000 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 28. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 29. U.S. carbon dioxide emissions per capita, 1990-2020: History: Energy Information Administration (EIA), *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000); EIA, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 30. U.S. carbon dioxide emissions per unit of gross domestic product, 1990-2020: History: Energy Information Administration (EIA), *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000); EIA, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Tables A19 and A20.

Figure 31. Projected U.S. energy consumption in three economic growth cases, 1990-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, July 2000). **Projections:** Table B1.

Figure 32. Projected U.S. carbon dioxide emissions in three economic growth cases, 1990-2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table B19.

Figure 33. Projected U.S. energy intensity in three economic growth cases, 1990-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, July 2000). **Projections:** Table B20.

Figure 34. Projected U.S. energy intensity in three technology cases, 1990-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, July 2000). **Projections:** Table F5.

Figure 35. Projected U.S. energy consumption in three technology cases, 1990-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, July 2000). **Projections:** Table F5.

Figure 36. Projected U.S. carbon dioxide emissions in three technology cases, 1990-2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table F5.

Figure 37. Projected average annual real growth rates of economic factors, 1999-2020: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 38. Projected sectoral composition of GDP growth, 1999-2020: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 39. Projected average annual real growth rates of economic factors in three cases, 1999-2020: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2001 National Energy Modeling System, runs AEO2001.D101600A, HM2001.D101600A, and LM2001.D101600A.

Figure 40. Annual GDP growth rate for the preceding 21 years, 1970-2020: History: U.S. Department of Commerce, Bureau of Economic Analysis. **Projections:** AEO2001 National Energy Modeling System, runs AEO2001.D101600A, HM2001.D101600A, and LM2001. D101600A.

Figure 41. World oil prices in three cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A1 and C1.

Figure 42. OPEC oil production in three cases, 1970-2020: History: Energy Information Administration, *International Petroleum Monthly*, DOE/EIA-0520 (2000/09) (Washington, DC, September 2000). **Projections:** Tables A21 and C21.

Figure 43. Non-OPEC oil production in three cases, 1970-2020: History: Energy Information Administration, *International Petroleum Monthly*, DOE/EIA-0520 (2000/09) (Washington, DC, September 2000). **Projections:** Tables A21 and C21.

Figure 44. Persian Gulf share of worldwide oil exports in three cases, 1965-2020: History: Energy Information Administration, *International Petroleum Monthly*, DOE/EIA-0520(2000/09) (Washington, DC, September 2000). **Projections:** AEO2001 National Energy Modeling System, runs AEO2001.D101600A, HW2001.D101600A, and LW2001.D101600A.

Figure 45. Projected U.S. gross petroleum imports by source, 1999-2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A; and World Oil, Refining, Logistics, and Demand (WORLD) Model, run AEO01B.

Figure 46. Projected worldwide refining capacity by region, 1999 and 2020: History: *Oil and Gas Journal*, Energy Database (January 1999). **Projections:** AEO2001 National Energy Modeling System, run AEO2001. D101600A; and World Oil, Refining, Logistics, and Demand (WORLD) Model, run AEO01B.

Figure 47. Primary and delivered energy consumption, excluding transportation use, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A2.

Figure 48. Energy use per capita and per dollar of gross domestic product, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A2.

Figure 49. Delivered energy use by fossil fuel and primary energy use for electricity generation, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A2.

Figure 50. Primary energy use by sector, 1970-2020: History: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999), and preliminary 1998 and 1999 data. **Projections:** Table A2.

Figure 51. Residential primary energy consumption by fuel, 1970-2020: History: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999), and preliminary 1998 and 1999 data. **Projections:** Table A2.

Figure 52. Residential primary energy consumption by end use, 1990, 1997, 2010, and 2020: History: Energy Information Administration, *Residential Energy Consumption Survey 1997*. **Projections:** Table A4.

Figure 53. Efficiency indicators for selected residential appliances, 1999 and 2020: Arthur D. Little, Inc., "EIA Technology Forecast Updates," Reference No. 37125 (September 2, 1998), and AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 54. Commercial nonrenewable primary energy consumption by fuel, 1970-2020: History: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999), and preliminary 1998 and 1999 data. **Projections:** Table A2.

Figure 55. Commercial primary energy consumption by end use, 1999 and 2020: Table A5.

Figure 56. Industrial primary energy consumption by fuel, 1970-2020: History: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999), and preliminary 1998 and 1999 data. **Projections:** Table A2.

Figure 57. Industrial primary energy consumption by industry category, 1994-2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 58. Industrial delivered energy intensity by component, 1994-2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 59. Transportation energy consumption by fuel, 1975, 1999, and 2020: History: Energy Information Administration (EIA), *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999), and EIA, *Short-Term Energy Outlook September 2000*. **Projections:** Table A2.

Figure 60. Projected transportation stock fuel efficiency by mode, 1999-2020: Table A7.

Figure 61. Projected technology penetration by mode of travel, 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 62. Projected sales of advanced technology light-duty vehicles by fuel type, 2010 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 63. Projected variation from reference case primary energy use by sector in two alternative cases, 2010, 2015, and 2020: Tables A2, F1, F2, F3, and F4.

Figure 64. Projected variation from reference case primary residential energy use in three alternative cases, 2000-2020: Tables A2 and F1.

Figure 65. Projected cost and investment for selected residential appliances in the best available technology case, 2000-2020: AEO2001 National Energy Modeling System, runs RSRINV.D101800D and RSBINV.D101800A.

Figure 66. Present value of investment and savings for residential appliances in the best available technology case, 2000-2020: AEO2001 National Energy Modeling System, runs RSRINV.D101800D and RSBINV.D101800A.

Figure 67. Projected variation from reference case primary commercial energy use in three alternative cases, 2000-2020: Tables A2 and F2.

Figure 68. Projected industrial primary energy intensity in two alternative cases, 1994-2020: Tables A2 and F3.

Figure 69. Projected changes in key components of the transportation sector in two alternative cases, 2020: Table A2 and AEO2001 National Energy Modeling System, runs AEO2001.D101600A, FRZ.D101700A, and TEK.D101700A.

Figure 70. Population, gross domestic product, and electricity sales, 1965-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A8 and A20.

Figure 71. Annual electricity sales by sector, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A8.

Figure 72. Projected new generating capacity and retirements, 2000-2020: Table A9.

Figure 73. Projected electricity generation and capacity additions by fuel type, including cogeneration, 2000-2020: Table A9.

Figure 74. Fuel prices to electricity generators, 1990-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A3.

Figure 75. Average U.S. retail electricity prices, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A8.

Figure 76. Projected electricity generation costs, 2005 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 77. Projected electricity generation by fuel, 1999 and 2020: Table A8.

Figure 78. Nuclear power plant capacity factors, 1973-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 79. Projected operable nuclear capacity in three cases, 1995-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table F6.

Figure 80. Projected electricity generation costs by fuel type in two advanced nuclear cost cases, 2005 and 2020: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, ADVNUC1.D101700A, and ADVNUC2.D102000A.

Figure 81. Projected cumulative new generating capacity by type in two cases, 1999-2020: Tables A9 and F7.

Figure 82. Projected cumulative new generating capacity by technology type in three economic growth cases, 1999-2020: Tables A9 and B9.

Figure 83. Projected cumulative new generating capacity by technology type in three fossil fuel technology cases, 1999-2020: Table F8.

Figure 84. Grid-connected electricity generation from renewable energy sources, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A17. **Note:** Data for nonutility producers are not available before 1989.

Figure 85. Projected nonhydroelectric renewable electricity generation by energy source, 2010 and 2020: Table A17.

Figure 86. Projected nonhydroelectric renewable electricity generation in two cases, 2020: Table F9.

Figure 87. Wind-powered electricity generating capacity in two cases, 1985-2020: 1985-1988: California Energy Commission. **1989-1998:** Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table F9.

Figure 88. Lower 48 crude oil wellhead prices in three cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A15 and C15.

Figure 89. U.S. petroleum consumption in five cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A11, B11, and C11.

Figure 90. Lower 48 natural gas wellhead prices in three cases, 1970-2020: History: Energy Information Administration, *Natural Gas Annual*, DOE/EIA-0131(98) (Washington, DC, October 1999). **Projections:** Tables A1 and B1.

Figure 91. Successful new lower 48 natural gas and oil wells in three cases, 1970-2020: History: 1970-1994: Energy Information Administration (EIA), computations based on well reports submitted to the American Petroleum Institute. **1995-1999:** EIA, computations based on well reports submitted to the Information Handling Services Energy Group, Inc. **Projections:** AEO2001 National Energy Modeling System, runs AEO2001. D101600A, LW2001.D101600A, and HW2001. D101600A.

Figure 92. Lower 48 natural gas reserve additions in the reference case, 1970-2020: 1970-1976: Energy Information Administration (EIA), Office of Integrated Analysis and Forecasting, computations based on well reports submitted to the American Petroleum Institute. **1977-1998:** EIA, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(77-98). **1999 and projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 93. Lower 48 crude oil reserve additions in three cases, 1970-2020: 1970-1976: Energy Information Administration (EIA), Office of Integrated Analysis and Forecasting, computations based on well reports submitted to the American Petroleum Institute. **1977-1998:** EIA, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(77-98). **1999 and projections:** AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LW2001.D101600A, and HW2001. D101600A.

Figure 94. Natural gas production by source, 1990-2020: History: Total production and Alaska: Energy Information Administration (EIA), *Natural Gas Annual 1998*, DOE/EIA-0131(98) (Washington, DC, October 1999). **Offshore, associated-dissolved, and nonassociated:** EIA, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(90-98). **Unconventional:** EIA, Office of Integrated Analysis and Forecasting. **1999 and projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A. **Note:** Unconventional gas recovery consists principally of production from reservoirs with low permeability (tight sands) but also includes methane from coal seams and gas from shales.

Figure 95. Natural gas production, consumption, and imports, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A13. **Note:** Production includes supplemental supplies; consumption includes discrepancies and net storage additions.

Figure 96. Natural gas consumption by sector, 1990-2020: History: Electric utilities: Energy Information Administration (EIA), *Electric Power Annual 1999*, Vol. 1, DOE/EIA-0348(99)/1 (Washington, DC, August 2000). **Nonutilities:** EIA, Form EIA-867, "Annual Nonutility Power Producer Report, 1998." **Other:** EIA, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 2000). **Projections:** Table A13.

Figure 97. Projected pipeline capacity expansion by Census division, 1999-2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 98. Projected pipeline capacity utilization by Census division, 1999 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 99. Natural gas end-use prices by sector, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A14.

Figure 100. Wellhead share of natural gas end-use prices by sector, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 101. Lower 48 crude oil and natural gas end-of-year reserves in three technology cases, 1990-2020: History: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, DOE/EIA-0216(90-98). **Projections:** Tables F11 and F12.

Figure 102. Lower 48 natural gas wellhead prices in three technology cases, 1970-2020: History: Energy Information Administration, *Natural Gas Annual*, DOE/EIA-0131(98) (Washington, DC, October 1999). **Projections:** Table F11.

Figure 103. Lower 48 crude oil production in three technology cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table F12.

Figure 104. Lower 48 crude oil production in three oil and gas resource cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table F13.

Figure 105. Crude oil production by source, 1970-2020: History: Total production and Alaska: Energy Information Administration (EIA), *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Lower 48 offshore, 1970-1985:** U.S. Department of the Interior, *Federal Offshore Statistics: 1985*. **Lower 48 offshore, 1986-1999:** EIA, *Petroleum Supply Annual*, DOE/EIA-0340 (86-99). **Lower 48 onshore, conventional, and enhanced oil recovery:** EIA, Office of Integrated Analysis and Forecasting. **Projections:** Table A15.

Figure 106. Petroleum supply, consumption, and imports, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A11, B11, and C11. **Note:** Domestic supply includes domestic crude oil and natural gas plant liquids, other crude supply, other inputs, and refinery processing gain.

Figure 107. Share of U.S. petroleum consumption supplied by net imports in three oil price cases, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A11 and C11.

Figure 108. Domestic refining capacity in three cases, 1975-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Tables A11 and B11. **Note:** Beginning-of-year capacity data are used for previous year's end-of-year capacity.

Figure 109. Petroleum consumption by sector, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A11.

Figure 110. Consumption of petroleum products, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A11.

Figure 111. U.S. ethanol consumption, 1993-2020: History: Energy Information Administration, *Petroleum Supply Annual 1999*, Vol. 1, DOE/EIA-0340(99)/1 (Washington, DC, June 2000. **Projections:** Table A18.

Figure 112. Components of refined product costs, 1999 and 2020: Gasoline and diesel taxes: Federal Highway Administration, *Monthly Motor Fuels Report by State* (Washington, DC, March 1998). **Jet fuel taxes:** Energy Information Administration (EIA), Office of Oil and Gas. **1999:** Estimated from EIA, *Petroleum Marketing Monthly*, DOE/EIA-0380(2000/03) (Washington, DC, March 2000). **Projections:** Estimated from AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 113. Coal production by region, 1970-2020: History: Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** Table A16.

Figure 114. Average minemouth price of coal by region, 1990-2020: History: Energy Information Administration, *Coal Industry Annual 1998*, DOE/EIA-0584(98) (Washington, DC, June 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 115. Coal mining labor productivity by region, 1990-2020: History: Energy Information Administration, *Coal Industry Annual 1998*, DOE/EIA-0584(98) (Washington, DC, June 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 116. Labor cost component of minemouth coal prices, 1970-2020: History: U.S. Department of Labor, Bureau of Labor Statistics (2000), and Energy Information Administration, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 117. Average minemouth coal prices in three mining cost cases, 1990-2020: Tables A16 and F15.

Figure 118. Projected change in coal transportation costs in three cases, 1999-2020: AEO2001 National Energy Modeling System, runs AEO2001.D101600A, LW2001.D101600A, and HW2001.D101600A.

Figure 119. Projected variation from reference case projections of coal demand in two economic growth cases, 2020: Tables A16 and B16.

Figure 120. Electricity and other coal consumption, 1970-2020: History: Energy Information Administration (EIA), *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000) and EIA, *Short-Term Energy Outlook September 2000*. **Projections:** Table A16.

Figure 121. Projected coal consumption in the industrial and buildings sectors, 2010 and 2020: Table A16.

Figure 122. Projected U.S. coal exports by destination, 2010 and 2020: History: U.S. Department of Commerce, Bureau of the Census, "Monthly Report EM 545." **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 123. Projected coal production by sulfur content, 2010 and 2020: AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 124. Projected carbon dioxide emissions by sector, 2000, 2010, and 2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 125. Projected carbon dioxide emissions by fuel, 2000, 2010, and 2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 126. Projected carbon dioxide emissions from electricity generation by fuel, 2000, 2010, and 2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** Table A19.

Figure 127. Projected methane emissions from energy use, 2005-2020: History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(99) (Washington, DC, October 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 128. Projected sulfur dioxide emissions from electricity generation, 2000-2020: History: U.S. Environmental Protection Agency, *Acid Rain Program Emissions Scorecard 1999. SO_2, NO_x, Heat Input, and CO_2 Emissions Trends in the Electric Utility Industry*, EPA-430-R-98-020 (Washington, DC, June 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.

Figure 129. Projected nitrogen oxide emissions from electricity generation, 2000-2020: History: U.S. Environmental Protection Agency, *Acid Rain Program Emissions Scorecard 1999. SO_2, NO_x, Heat Input, and CO_2 Emissions Trends in the Electric Utility Industry*, EPA-430-R-98-020 (Washington, DC, June 2000). **Projections:** AEO2001 National Energy Modeling System, run AEO2001.D101600A.