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Impacts of Modeled Recommendations of the National Commission on Energy Policy

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Preface

On December 17, 2004, Senator Jeff Bingaman, ranking Minority Member of the U.S. Senate Committee on Energy and Natural Resources, requested that the Energy Information Administration (EIA) assess the impacts of the recommendations made by the National Commission on Energy Policy (NCEP), a nongovernmental privately funded entity, in its December 2004 report entitled *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*. This report provides EIA's analysis of those NCEP recommendations on energy supply, demand, and imports that could be simulated using the National Energy Modeling System (NEMS). The impacts of the NCEP recommendations analyzed are compared with results published by EIA in the *Annual Energy Outlook 2005* (*AEO2005*).

The legislation that established EIA in 1977 vested the organization with an element of statutory independence. EIA does not take positions on policy questions. It is the responsibility of EIA to provide timely, high-quality information and to perform objective, credible analyses in support of the deliberations of both public and private decisionmakers. This report does not represent the official position of the U.S. Department of Energy or the Administration.

The model projections in this report are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The reference case 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 starting point 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 scheduled regulatory changes, when defined, are reflected.

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Background

This report was prepared in response to a December 17, 2004, letter from Senator Jeff Bingaman requesting that the Energy Information Administration (EIA) analyze the energy supply, demand, and fuel import impacts that would result from the recommendations proposed in the December 2004 report, entitled *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*, by the National Commission on Energy Policy (NCEP), a nongovernmental privately-funded entity. In order to provide a timely response to Senator Bingaman, only those energy-related recommendations that could be directly modeled using EIA's National Energy Modeling System (NEMS) and were thought to have significant potential to affect energy consumption, supply, and prices were analyzed. In some cases, where the NCEP recommendations were general and required further elaboration, Senator Bingaman's staff provided additional information regarding assumptions to be used.

The recommendations analyzed include:

- A program to reduce greenhouse gas (GHG) emissions intensity through an emissions cap-and-trade mechanism with a safety-valve permit price rising from $6.10 per metric ton of carbon dioxide (CO_2) in 2010 to $8.50 per metric ton in 2025 (2003 dollars). The emissions included in the proposed cap are energy-related CO_2, methane from coal mines, nitrous oxide emissions from nitric acid and adipic acid production, and emissions of the high global warming potential gases, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.
- A 36-percent increase (10 miles per gallon for cars, 8 miles per gallon for light trucks) in the corporate average fuel economy (CAFE) standards for light-duty vehicles (LDVs). The increases are phased in over the 2010 to 2015 period.
- A $3-billion tax incentives program to promote the adoption of hybrid and advanced diesel vehicles.
- A $3.25-per-million-Btu minimum price guarantee at the Alberta Hub for natural gas produced from Alaska's North Slope, to encourage earlier construction of an Alaska natural gas pipeline.
- New building codes and appliance efficiency standards for residential and commercial buildings.
- A $4-billion program to stimulate the deployment of coal-fired integrated gasification combined-cycle (IGCC) plants.
- A $3-billion program to stimulate carbon capture and sequestration technologies.
- A $2-billion program to promote the deployment of an advanced nuclear power plant.
- A $4-billion production tax credit (PTC) program for non-GHG-emitting power generation capacity added between 2006 and 2009.
- Increased research, development, and deployment incentives for renewable transportation fuels.

Summary Impacts of the Modeled NCEP Recommendations

The GHG emissions intensity reduction program, the 36-percent increase in CAFE standards for cars and light trucks, and the new building and appliance efficiency standards are projected to have the largest impacts on energy production, consumption, prices, and fuel imports. The other policies generally affect specific fuels or technologies but do not have large overall energy market impacts. The impacts of the modeled NCEP recommendations, taken together, on energy supply, demand, imports, prices, and GHG emissions, relative to the *Annual Energy Outlook 2005 (AEO2005)* reference case, are as follows:

- Primary energy consumption is 2.26 quadrillion Btu (1.9 percent) lower in 2015 and 6.73 quadrillion Btu (5 percent) lower in 2025 as the combination of efficiency programs and new CAFE standards reduces energy demand.
- Fossil fuel energy consumption is 2.5 quadrillion Btu (2.4 percent) lower in 2015 and 8.1 quadrillion Btu (6.9 percent) lower in 2025. In absolute terms, the use of all fossil fuels is projected to grow from 2003 levels through 2025.
- Oil consumption is 0.83 million barrels per day (3.4 percent) lower in 2015 and 2.1 million barrels per day (7.4 percent) lower in 2025. The import share of petroleum product supplied declines from 62.4 percent to 61.3 percent in 2015 and from 68.4 percent to 66.8 percent in 2025.
- Natural gas consumption is slightly lower (0.45 quadrillion Btu or 1. 6 percent) in 2015 and 1.1 quadrillion Btu (3.6 percent) lower in 2025, due mainly to lower electricity demand from the building standards recommendation and the incentives provided to renewable, IGCC, and nuclear deployments that further reduce the size of the generation market.
- Coal consumption is also slightly lower (0.46 quadrillion Btu or 1.8 percent) in 2015 and 3.0 quadrillion Btu (9.8 percent) in 2025, due mainly to the lower electricity demand and the fuel use shifts that are caused by the GHG cap-and-trade program.
- Covered GHG emissions are 393 million metric tons CO_2 equivalent (5.2 percent) lower in 2015 and 964 million metric tons CO_2 equivalent (11 percent) lower in 2025. Covered GHG emissions intensity decreases by 5.1 percent in 2015 and by 10.6 percent in 2025. The absolute level of covered GHG emissions is projected to grow at an annual average rate of 1.1 percent over the 2003 to 2025 period, compared to annual average growth of 1.5 percent in the reference case.
- Reductions in emissions of non-CO_2 GHGs, which are not represented in a detailed fashion in NEMS, account for 63 percent of the covered GHG emissions reductions in 2010 and 35 percent of the covered GHG emissions reductions in 2025. Estimates for non-CO_2 GHG emissions were developed using emissions baselines and abatement cost curves based on engineering cost estimates that were supplied by the Environmental Protection Agency (EPA). Real-world factors affecting the behavior of decisionmakers and the use of incomplete cost information may result in an overstatement of the actual level of non-CO_2 abatement achieved at each level of the permit price.
- Because of the safety-valve price mechanism in the cap-and-trade program for GHGs, the GHG intensity targets specified by the NCEP are not reached; total emission reductions fall short by 557 million metric tons CO_2 equivalent in 2025.

- The average petroleum price to all users (including the price of emissions permits) is 2.2 percent higher in 2015 and 1.4 percent higher in 2025 than in the reference case, with the permit prices more than offsetting the lower crude oil prices resulting from the new CAFE standard.
- The average delivered natural gas price is $0.17 per thousand cubic feet (2.7 percent) lower in 2015, with the wellhead cost reduction partially offset by the increased GHG permit price, and $0.52 per thousand cubic feet (7.6 percent) higher in 2025, largely because of the permit price which is added to the delivered fuel costs.
- When the costs of emissions permits are included, the average delivered coal price is $0.54 per million Btu (43 percent) higher in 2015 and $0.74 per million Btu (56 percent) higher in 2025 than in the reference case because of the high carbon content of coal.
- The average delivered electricity price is unchanged in 2015 but is 0.4 cents per kilowatthour (5.8 percent) higher in 2025 because of the mandatory cap-and-trade program.
- In 2025, because of the early deployment incentives and the GHG cap-and-trade proposal, IGCC capacity more than doubles, and renewable generation increases by 23 percent relative to the reference case.
- Government expenditures for the recommended tax incentives, research and development, demonstration, and deployment policies occur before significant revenues are recouped from permit sales. However, because expenditures for the incentive programs eventually end and the revenues from permit sales continue to grow over time, cumulative discounted revenues are projected to exceed cumulative discounted expenditures by 2022, using a 4-percent discount rate.
- Both potential and actual real gross domestic product (GDP) are projected to be reduced slightly. By 2025, potential and actual real GDP are, respectively, about 0.26 percent and 0.4 percent below their reference case levels. These changes do not materially affect average economic growth rates for the 2003 to 2025 period. Real consumption is also reduced over the 2010 to 2025 period, with the impact reaching almost $470 per household (0.5 percent) in terms of year 2000 dollars in 2025.

Other Key Findings

GHG Cap-and-Trade Program. The GHG cap-and-trade program causes significant reductions in emissions of GHGs other than CO_2 and in emissions of CO_2 from the electric power sector. The cap-and-trade system also contributes to higher fossil fuel and electricity prices. *When considered alone without other policies,* the GHG cap-and-trade program:

- Achieves total reductions in covered GHG emissions of 281 million metric tons CO_2 equivalent (3.7 percent) in 2015 and 621 million metric tons CO_2 equivalent (7.1 percent) in 2025—roughly two-thirds to three-quarters the amount achieved when all the modeled NCEP recommendations are taken together. Non-CO_2 GHGs account for a preponderant share of these reductions.
- Reduces total fossil fuel consumption by 1 quadrillion Btu (1 percent) in 2015 and 3.1 quadrillion Btu (2.7 percent) in 2025—roughly one-half the reduction achieved when all the modeled NCEP recommendations are taken together. Oil use is reduced only minimally.

- Raises effective delivered fuel prices as a result of the permit fee, depending on the carbon content of the fuel. Relative to the reference case, average delivered coal prices to all consumers are 57.3 percent higher in 2025, average delivered petroleum prices are 5 percent higher, average delivered natural gas prices are 8.3 percent higher, and electricity prices are 4.8 percent higher.

CAFE. The 36-percent increase in CAFE standards for LDVs mainly affects petroleum use and imports, vehicle miles traveled, and vehicle cost. *When considered alone without other policies*, the key impacts of the increase in the CAFE standard include:

- A reduction in petroleum consumption of 0.61 million barrels per day (2.5 percent) in 2015 and 1.61 million barrels per day (5.8 percent) in 2025. The import share of petroleum product supplied falls from 62.4 percent to 61.6 percent in 2015 and from 68.4 percent to 67.1 percent in 2025.
- An increase in the average fuel efficiency of new LDVs of 6.8 miles per gallon (26.2 percent) in 2015 and 6.3 miles per gallon (23.4 percent) in 2025. The increases in measured fuel economy are smaller than the increases in the CAFE standard, because new LDVs are projected to exceed the existing CAFE standard in the reference case.
- An increase in the average price of new LDVs of about $1,400 in 2015 and $1,200 in 2025 (2003 dollars).
- A reduction in CO_2 emissions of 79 million metric tons (1.1 percent) in 2015 and 242 million metric tons (2.8 percent) in 2025.

Building Standards. The new building and appliance efficiency standards mainly lower consumer electricity use, which leads to lower coal and natural gas use by power plants. *When considered alone without other policies*, the key impacts of the change in building and appliance efficiency standards include:

- Reductions in electricity sales of 77 billion kilowatthours (2 percent) in 2015 and 163 billion kilowatthours (3 percent) in 2025.
- Reductions in natural gas and coal use: natural gas consumption is reduced by 0.5 quadrillion Btu (1.6 percent) in 2015 and 0.6 quadrillion Btu (1.8 percent) in 2025, while coal use declines by 4 million tons (0.3 percent) in 2015 and 43 million tons (2.9 percent) in 2025.
- Reductions in CO_2 emissions of 34 million metric tons (0.5 percent) in 2015 and 115 million metric tons (1.4 percent) in 2025.

Tax and Deployment Incentives. Some of the tax and deployment incentive programs stimulate increased or earlier development of particular technologies. For example, relative to the reference case, *when evaluated without other policies*:

- The natural gas price guarantee stimulates the construction of an Alaska natural gas pipeline 2 years earlier and results in a lower natural gas wellhead price path, which delays some of the investments that would have been made with higher natural gas prices—e.g., investments in liquefied natural gas (LNG) import facilities.

- The $4-billion program to stimulate investment in IGCC plants increases their construction by 44 gigawatts from a reference case level of 16 gigawatts by 2025.
- The $4-billion capped PTC proposal for non-GHG technologies leads to the construction of 4.4 gigawatts of additional renewable generation capacity by 2015 and 7.1 gigawatts of additional renewable capacity by 2025.
- The $3-billion tax incentive to promote the adoption of hybrid and advanced turbo diesel LDVs does not lead to additional vehicle sales, because the projected sales without the incentive would exhaust the credits available.

High Technology Sensitivities. While the EIA reference case incorporates significant improvements in technology cost and performance over time, it may either overstate or understate the actual future pace of improvement, since the rate at which the characteristics of energy-using and producing technologies will change is highly uncertain. Relative to the reference case, EIA's high technology case generally assumes earlier availability, lower costs, and higher efficiencies for end-use technologies and new fossil-fired, nuclear, and nonhydropower renewable generating technologies. Although the NCEP recommends increases in the funding for research and development, EIA, consistent with its established practice in other recent studies, did not attempt to estimate how increased government spending might specifically impact technology development. Instead, to illustrate the importance of technology characteristics in assessing the impacts of the NCEP recommendations, EIA prepared a set of NCEP policy cases using its high technology assumptions. Relative to the *AEO2005* high technology case, *the high technology case combined with the NCEP recommendations*:

- Reduces fossil fuel use by 1.46 quadrillion Btu (1.5 percent) in 2015 and 4.48 quadrillion Btu (4.1 percent) in 2025.
- Reduces petroleum consumption by 0.64 million barrels per day in 2015 and 1.48 million barrels per day in 2025 and reduces the import share of petroleum product supplied from 61.6 percent to 60.6 percent in 2015 and from 66.9 percent to 66.1 percent in 2025.
- Meets the NCEP's greenhouse gas intensity goals, reducing covered GHG emissions intensity from 480 to 463 metric tons CO_2 equivalent per million dollars of GDP in 2015 (3.5 percent) and from 405 to 373 metric tons CO_2 equivalent per million dollars in 2025 (7.9 percent). Attainment of the emissions intensity goal depends heavily on estimated reductions of non-CO_2 GHG emissions that were developed using information and methodologies that may result in an overstatement of the actual level of abatement achieved at each level of the permit price. Attainment of the goal also relies on the use of banked GHG emissions permits that are exhausted in 2025, at the end of the forecast horizon for this analysis.

1. Background and Scope of the Analysis

This service report was prepared by the Energy Information Administration (EIA), Office of Integrated Analysis and Forecasting (OIAF), in response to a December 17, 2004, letter from Senator Jeff Bingaman (see Appendix A). The letter requested an analysis of the energy production, consumption, price, and fuel import impacts that would result from the recommendations in a December 2004 report, entitled *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*, by the National Commission on Energy Policy (NCEP), a nongovernmental, privately-funded group.[1]

In order to provide a timely response, EIA focused its analysis on only those NCEP recommendations that could be directly modeled using its National Energy Modeling System (NEMS)[2] and that were thought to have significant potential to affect U.S. energy consumption, supply, and prices. The analysis of NCEP's energy-related proposals is based on cases contained in EIA's *Annual Energy Outlook 2005* (*AEO2005*), published in February 2005.[3] Limited analysis of non-carbon dioxide (CO_2) greenhouse gas (GHG) emissions baselines and abatement opportunities was based on information supplied by the Environmental Protection Agency (EPA).

This report, like other EIA analyses of energy and environmental policy proposals, focuses on the impacts of those proposals on energy choices made by consumers in all sectors and the implications of those decisions for the economy. This focus is consistent with EIA's statutory mission and expertise. The study does not quantify, or place any value on, possible health and environmental benefits of curtailing GHG emissions.

NCEP Recommendations Analyzed

The NCEP recommendations analyzed by EIA are summarized briefly below. In some cases, the NCEP recommendations did not provide sufficient information for analysis. As necessary, Senator Bingaman's staff provided additional guidance.[4]

Implement a GHG emissions intensity target with a cap-and-trade program. The NCEP recommended a mandatory, market-based, tradable emissions allowance/credit program to reduce U.S. GHG intensity by 2.4 percent per year between 2010 and 2019 and by 2.8 percent per year between 2020 and 2025 relative to the reference case, where GHG intensity is defined

[1]National Commission on Energy Policy, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges* (Washington, DC, December 2004), web site www.energycommission.org/ewebeditpro/items/O82F4682.pdf. The National Commission on Energy Policy is a nongovernmental organization funded by the William and Flora Hewlett Foundation and its partners—The Pew Charitable Trusts, the John D. and Catherine T. MacArthur Foundation, the David and Lucile Packard Foundation, and the Energy Foundation.
[2]Energy Information Administration, *The National Energy Modeling System: An Overview 2003*, DOE/EIA-0581(2003) (Washington, DC, March 2003), web site www.eia.doe.gov/oiaf/aeo/overview/index.html.
[3]Energy Information Administration, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005) (Washington, DC, February 2005), web site www.eia.doe.gov/oiaf/aeo/index.html.
[4]With the exception of the greenhouse gas policy case, Senate Energy and Natural Resources Committee staff member, Jennifer Michael, provided the specific assumptions and guidelines for this analysis. See Appendix A for details of the assumptions and the cases requested for analysis and subsequent minor changes.

as GHG emissions per real dollar of gross domestic product. The proposal would, in effect, set a cap on annual emissions that is a function of anticipated gross domestic product. Emission permits would be allocated to emission sources primarily on the basis of past GHG emissions. Most of the permits (95 percent initially, gradually declining to 90 percent between 2013 and 2022) would be allocated at no cost; the Federal Government would auction the remainder. GHG emission permits would be bankable; i.e., they could be used in the year they are issued or in any year thereafter.

To control the potential cost of the mandatory emissions cap policy, the NCEP recommended that a maximum price, or safety valve, for emissions permits be established, at which price the Federal Government would sell permits on demand. The recommended safety-valve price starts at $7 per metric ton CO_2 equivalent in 2010 (nominal dollars) and increases by 5 percent annually up to $14.55 in 2025. In 2003 dollars, the safety-valve permit price would be $6.10 per metric ton CO_2 equivalent in 2010 and $8.50 in 2025.

GHG emissions included in the proposed cap are energy-related CO_2 emissions, methane emissions from coal mines, nitrous oxide emissions from nitric acid and adipic acid production, and emissions of the high global warming potential gases, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Implement new corporate average fuel economy standards. The NCEP recommended that the National Highway Traffic Safety Administration (NHTSA) strengthen vehicle efficiency standards starting no later than 2010 and phase in stricter standards over 5 years. A target value was not specified, but it was recommended that the process of setting new standards should consider vehicle performance, safety, job impacts, and vehicle efficiency. Based on guidance provided, a 36-percent increase in the corporate average fuel economy (CAFE) standard for new cars and light trucks by 2015 is assumed in this analysis. For cars, this represents an increase of 10 miles per gallon over existing CAFE standards, and for light trucks it represents an increase of 8 miles per gallon.[5]

Provide $3 billion in tax incentives over 10 years to promote domestic manufacturer conversion and consumer adoption of hybrid and advanced diesel vehicles. The incentives would be divided evenly between reducing conversion costs for domestic manufacturers and reducing vehicle costs for consumers.

Provide a price guarantee for natural gas from Alaska's North Slope. To ensure that North Slope natural gas is brought to U.S. markets at the earliest date possible, the NCEP believes additional incentives are necessary for the construction of an Alaska natural gas pipeline system beyond the recently enacted loan guarantees, accelerated depreciation, and treatment plant tax credits. By assumption,[6] a floor price, or minimum price guarantee, of $3.25 per million Btu in 2003 dollars was set for natural gas delivered to Alberta. Senator Bingaman's committee staff

[5]The original request by Senator Bingaman's staff was for an increase of 10 miles per gallon in the CAFE standards for both cars and light trucks; however, light trucks could not reasonably meet this increase by 2015. In its place EIA substituted the percentage increase in CAFE standards for cars, 36 percent.
[6]Assumptions were generally provided by Senator Bingaman's Energy and Natural Resources Committee staff.

also suggested a program requiring payments to the Federal Treasury if the market price of the natural gas delivered to Alberta exceeded $4.80 per million Btu.

Implement new efficiency standards in the building sectors. The NCEP recommended that new efficiency standards be developed for the residential and commercial sectors but did not provide specific requirements. Based on guidance from Senator Bingaman's committee staff, this analysis uses the standards referenced in the NCEP report's Technical Appendix.[7] The standards provide for significant changes to residential and commercial building codes and efficiency standards for equipment purchases. Residential policies include increased efficiency standards in 2010 for natural gas furnaces, room air conditioners, electric water heaters, dishwashers, refrigerator/freezers, torchiere lighting, pool pumps, ceiling fans, and standby power in miscellaneous electric products. In addition, residential building codes are tightened in 2010 and again in 2020. Policies specific to the commercial sector include increased equipment efficiency standards in 2010 for natural gas boilers, packaged and central air conditioners, heat pumps, gas water heaters, ventilation, fluorescent and high intensity discharge (HID) lighting, commercial refrigerator/freezers, ice and vending machines, and standby power in personal computers and other office equipment. The assumptions call for a second increase in efficiency standards for air conditioning and lighting equipment in 2020. In addition, commercial building codes are tightened for the building envelope in 2010 and for lighting power density in 2015.

Double research and development investments for the next 10 years. While increased expenditures for research and development (R&D) are expected to lead to some technology improvements, a statistically reliable relationship between the level of R&D spending for specific technologies and the impacts of those expenditures has not been developed. Furthermore, the impact of Federal R&D is also difficult to assess, because the levels of private sector R&D expenditures usually are unknown and often far exceed R&D spending by the Federal Government. Thus, EIA could not provide an estimate of the impact on technological change of a doubling of Federal R&D spending over a 10-year period.

At the request of Senator Bingaman's committee staff, this analysis includes several cases using the technology assumptions from the high technology cases in EIA's *AEO2005*. These cases are provided for illustrative purposes and should not be seen as representing EIA's estimate of the potential impact of doubling Federal R&D investments. The integrated high technology case for this study is a combination of the *AEO2005* high technology assumptions for the residential, commercial, transportation, industrial, and power generation sectors. In each of these cases, advanced technologies are assumed to be available sooner, at lower cost, and often with better performance characteristics. The high supply technology case for this study is the *AEO2005* oil and natural gas rapid technology case, where the cost, finding rate, and success rate parameters for exploration and development are adjusted to reflect 50 percent more rapid improvement than in the *AEO2005* reference case.[8]

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[7]Building equipment standards and code policy specifications were taken from Greg Rosenquist, Michael McNeil, Maithili Iyer, Steve Meyers, and Jim McMahon, *Energy Efficiency Standards and Codes for Residential/Commercial Equipment and Buildings: Additional Opportunities*, LBID-2533 (Berkeley, CA: Lawrence Berkeley National Laboratory, July 2004), reproduced in *NCEP Technical Appendix*, "Chapter 3: Improving Energy Efficiency," pp. 103-193, web site http://64.70.252.93/O82F4696.pdf.
[8]Detailed assumptions for the *AEO2005* cases, including the high technology cases, are described on EIA's web site at www.eia.doe.gov/oiaf/aeo/assumption/index.html.

Provide $4 billion in incentives for deployment of sequestration-ready integrated gasification combined-cycle (IGCC) generating capacity. The NCEP report does not define a “sequestration-ready” IGCC technology. Because the chemical process is similar but different in some important ways, the costs and performance characteristics are unknown. This analysis assumes that the cost and performance of such units will be similar to the standard IGCC units. In that case, the $4-billion program is sufficient to stimulate the development of 10 gigawatts of sequestration-ready coal IGCC capacity between 2009 and 2015.[9]

Provide $3 billion in deployment incentives for carbon capture and sequestration. This analysis assumes that the $3-billion investment will lead to the development of 4 gigawatts of new IGCC plants with carbon capture and sequestration equipment.[10]

Provide up to $2 billion to promote advanced nuclear development. This analysis assumes that the nuclear incentives will defray some development, licensing, regulatory, and R&D costs and will provide sufficient funds to deploy one advanced nuclear power plant.

Expand and extend the production tax credit (PTC) for new non-GHG-emitting generation capacity added between 2006 and 2009, with a cumulative payment limit of $4 billion. A uniform investment tax credit of 1.8 cents per kilowatthour for the first 10 years of production is assumed for all qualifying, non-carbon-emitting generation technologies on a first-come, first-paid basis until the $4-billion credit limit is expended.[11] In theory, new nuclear generation would qualify, but the leadtime required would preclude its participation in this program.

Provide $1.5 billion for research, development, and deployment of non-petroleum renewable transportation fuels. The NCEP recommended an expenditure of $1.5 billion over 10 years, evenly divided between R&D on renewable transportation fuels and incentives to promote the use of non-petroleum renewable transportation fuels. At the suggestion of Senate staff, the R&D and other incentives are assumed to reduce the capital costs and improve the efficiency of ethanol production from cellulosic biomass significantly. Using the model provided by the NCEP’s contractors, yields of ethanol from switchgrass are assumed to grow from the current 75 gallons per ton to 105.4 gallons per ton by 2015, reaching 90 percent of estimated maximum yield. Plant capital costs are assumed to fall from today’s $5 per annual gallon to $2.15 per annual gallon by 2015 (in 2003 dollars). Because biodiesel plants already achieve 98 percent of their maximum yield, no further improvements in biodiesel yields are assumed.

NCEP Recommendations Not Included in This Analysis

The NCEP’s recommendations that are not analyzed in this study generally fall into four categories:

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[9]A number of different sequestration-ready designs are being contemplated, each with its own cost and performance characteristics. Because the new technology will use higher concentrations of hydrogen and probably burn hotter, nitrogen oxide (NO_x) controls may be necessary. Technology experts have not reached consensus on a standardized design. The NCEP incentives are adequate to deploy 10 gigawatts of IGCC capacity starting in 2009.

[10]$3 billion for 4 gigawatts of sequestration capacity implies that the incremental cost of sequestration is about $750 per kilowatt. EIA estimates that this incentive will be adequate to stimulate the construction of 4 gigawatts of sequestration technology when IGCC plants are built.

[11]The NCEP did not specify the PTC level. Senator Bingaman’s Energy Committee staff provided guidance that excluded biomass co-firing in existing coal plants, which would quickly use up the incentive funds in the first 2 years and crowd out other longer-lasting investments in renewable generation technologies.

1. Recommendations that cannot be directly assessed using NEMS. For example, NEMS assumes that the Nation’s electric system will be operated reliably. Therefore, it cannot be used to quantify the benefits of adopting mandatory reliability rules. Other recommendations of this type include:
   - Encourage transmission investments and deployment of new technologies to enhance reliability and availability of the grid
   - Protect critical infrastructure from accidental failure
   - Manage treatment of nuclear threats, proliferation, or waste
   - Expand international cooperation on strategic petroleum reserves and oil production
   - Protect critical energy infrastructure from terrorist threats[12]
   - Provide additional or new funding for R&D (e.g, hydrates[13]and renewable generation)
   - Create voluntary programs and relationships
   - Link future U.S. actions to future international responses.

2. Recommendations that provide authority to set standards or establish specific targets at some future date, without providing specific values. EIA has no basis for speculating on what levels will ultimately be set. An example is promoting international agreements to expand foreign petroleum and natural gas production. Recommendations of this type include:
   - Expand collaboration with States or international organizations (GHG-limiting actions)
   - Enhance consumer protections in the electricity sector and establish an integrated, multi-pollutant program to reduce power plant emissions
   - Support Department of Energy and Federal Energy Regulatory Commission actions
   - Pursue cost-effective efficiency improvements in the industrial sector

3. Recommendations whose impacts are not directly quantifiable or are not expected to significantly affect energy markets. Recommendations of this type include:
   - Streamline Federal land permitting practices
   - Support a variety of generation resources—including both large-scale power plants, small-scale “distributed” and/or renewable generation—and demand reduction (for both electricity and natural gas) to ensure affordable and reliable energy service for consumers
   - Improve coordination among relevant Federal agencies
   - Provide expedited environmental and judicial reviews
   - Participate in meetings (e.g., international partnerships)
   - Provide encouragement and support from the Department of Energy for increases in private-sector R&D
   - Share unspecified risks

[12]Terrorist threats to critical infrastructure cannot be modeled in NEMS. The impacts of such protection would have to be specified as exogenous assumptions.
[13]The impact of research on methane hydrates is not expected to yield cost-effective natural gas supply through 2025. As with the treatment of other R&D, no one can accurately estimate the impact of specific R&D investments on specific successes, and EIA does not assess the impact of such investments.

- Increase incentives for private-sector R&D
- Encourage synergistic relationships with private industry to expand R&D.
- Expand investment in cooperative international energy research, development, demonstration, and early deployment initiatives

4. Recommendations that are already incorporated or assumed in the NEMS reference case, or recommendations whose assumed impacts are already projected to be achieved in the reference case. Recommendations of this type include:
   - Reduce barriers for expansion of liquefied natural gas (LNG) imports; NEMS assumes a permissive environment for LNG expansion
   - Remove barriers to adoption of advanced nuclear capacity expansion; NEMS assumes no non-market barriers for nuclear capacity expansion
   - Fulfill existing Federal commitments (including nuclear waste management); NEMS assumes fulfillment of current Federal policy
   - Provide financial incentives for technology adoption; in some cases, current laws and regulations already provide such incentives, e.g., the proposed hybrid vehicle incentive
   - Protect critical infrastructure; NEMS implicitly assumes that critical infrastructure is protected.

Cases Analyzed

Senator Bingaman's staff specifically identified eight policy cases for study. To these, EIA added two additional policy cases. The NCEP case represents all the modeled NCEP recommendations in combination under reference case technology assumptions. The ICE case, which modeled all the non-GHG polices, was considered important because it might reveal the incremental impact of the GHG cap-and-trade policy in the NCEP case. Three baseline cases (Reference, HiTech, and RTP) provide a basis for comparisons with the policy cases (Table 1).

Scope of the Report

While the results of all the model runs for the cases identified in Table 1 are available for download and review from EIA's web site, this report focuses on the main integrated NCEP case, discussed in Chapter 2, which includes the GHG policy, the tax and deployment incentives, the building codes and efficiency standards, and the new CAFE standards for light-duty vehicles. Subsets of the modeled recommendations are considered, where applicable, to provide supplementary information. EIA could not model the impact of doubling Federal R&D. However, to assess the impact of more rapid technological progress on the analyses of the NCEP policies, Chapter 3 discusses the incremental energy and GHG impacts of the NCEP recommendations under high technology assumptions relative to the *AEO2005* high technology cases.

Table 1. Study Cases and Descriptions

Case Name	Description
Reference Case Technology	
Reference[a]	*AEO2005* reference case
NCEP	Reference case plus the tax incentives and deployments, CAFE standards, buildings efficiency standards, and Commission's GHG policy
Cap-Trade	Reference case plus the Commission's GHG Cap and Trade policy
No-Safety	Reference case plus the Commission's GHG policy with no safety-valve price
CAFE	Reference case plus the higher CAFE standard, a 10-miles-per-gallon increase for cars with an equivalent percentage increase for light trucks
Bldg-Std	Reference case plus the buildings efficiency standards
Incent	Reference case plus the tax incentives and deployments, including incentives to construct the Alaska natural gas pipeline
ICE	Reference case plus the tax incentives and deployments, CAFE standards, and buildings efficiency standards
High Technology for End-Use Demand and PowerGeneration	
HiTech[a]	*AEO2005* high integrated technology case for demand and power generation
NCEP-HiTech	NCEP plus *AEO2005* high integrated technology case for demand and power generation
HiTech-IC	HiTech plus the tax incentives and deployments and CAFE standards
Rapid Oil and Gas Supply Technology Progress	
RTP[a]	*AEO2005* rapid oil and gas supply technology progress case
RTP-IC-ETH	RTP plus the tax incentives and deployments, CAFE standards, and ethanol R&D

[a]These cases appeared in EIA's *Annual Energy Outlook 2005*.
Notes: Italicized cases represent analysis of specific policies or groups of policies but do not simulate the combined impacts of all the NCEP recommendations. Summary results of key cases are provided in Appendix B. Detailed spreadsheet tables for each of the runs will be available on EIA's web site.

Methodology and Uncertainties

The analysis of energy sector and energy-related economic impacts of the NCEP recommendations addressed in this report is based on results from NEMS. NEMS, like all models, is a simplified representation of reality. Projections are dependent on the data, methodologies, model structure, and assumptions used to develop them. Because many of the events that shape energy markets are random and cannot be anticipated (including severe weather, technological breakthroughs, and geopolitical developments), energy market projections are subject to uncertainty. Furthermore, future developments in technologies, demographics, and resources cannot be foreseen with certainty. Nevertheless, well-formulated models are useful in analyzing complex policies, because they ensure consistency in accounting and represent key interrelationships, albeit imperfectly, but often well enough to provide insights.

EIA's projections are not statements of what will happen but what might happen, given technological and demographic trends and current policies and regulations. EIA's reference case is based on current laws and regulations. Thus, it provides a policy-neutral starting point that can be used to analyze energy policy initiatives. EIA does not propose, advocate, or speculate on future legislative or regulatory changes within its reference case. Laws and regulations are generally assumed to remain as currently enacted or in force (including sunset or expiration provisions); however, the impacts of scheduled regulatory changes, when clearly defined, are reflected.

Finally, the limited analysis of non-CO_2 GHG emissions provided in this report was conducted using baselines and abatement curves supplied by the EPA. Because the abatement curves are based on engineering cost estimates, they do not capture real-world factors that may affect the behavior of decisionmakers. As a result they may overstate the non-CO_2 GHG emission reductions that would actually be attained under a cap-and-trade program.

2. Impacts of the NCEP Recommendations

This chapter contains an analysis of results from NEMS simulations representing recommendations of the NCEP.[14] The analysis compares results from cases representing NCEP recommendations with results from EIA's *AEO2005* reference case. The cases examined include: two GHG cap-and-trade policy cases (Cap-Trade and No-Safety); a residential and commercial standards case (Bldg-Std); a new corporate average fuel economy standard case (CAFE); a tax incentives and deployment proposals case (Incent), which also includes the recommended natural gas price guarantee for the construction of an Alaska natural gas pipeline; and a case that combines all the policies (NCEP). Additional high technology sensitivity analyses are described in Chapter 3.

All sections provide comparative results that include the NCEP and Cap-Trade cases. In addition, the emissions section discusses the other cases with the NCEP's GHG intensity reduction program. The oil and gas supply section discusses the CAFE case, the residential and commercial section focuses on the Bldg-Std case, the transportation section focuses on the CAFE case, the electricity section focuses on the Incent and Bldg-Std cases, and the macroeconomic section focuses on the CAFE case.

Emissions Impacts

Representing the NCEP's Greenhouse Gas Emissions Cap-and-Trade Program

To represent the NCEP's GHG emissions reduction program, the energy, energy-related CO_2, and economic projections from the *AEO2005* reference case together with emission projections for other covered GHGs (methane from coal mining, nitrous oxide from adipic acid and nitric acid manufacturing, and high global warming potential gases) were used to develop a covered GHG emissions reference trend. Projections for the other GHG emissions, including the covered non-CO_2 gases, were based on the U.S. EPA Business-as-Usual (BAU) case cited in the White House Greenhouse Gas Policy Book Addendum[15] released with the Climate Change Initiative.

In the emissions cap-and-trade cases, NEMS endogenously calculated changes in energy-related CO_2 emissions and used abatement cost curves to simulate the emissions changes expected for other covered GHGs. The emissions reduction opportunities for GHGs other than CO_2 are embodied in marginal abatement cost (MAC) relationships that indicate the quantity of emission reductions that would be expected to occur given the value of an emissions permit. While emissions of the non-CO_2 covered gases are a relatively small share of total U.S. GHGs

[14]Ms. Jennifer Michael, Senate Committee on Energy and Natural Resources minority staff, provided specific assumptions (see Appendix A).

[15]See "Addendum to the Global Climate Change Policy Book" at web site www.whitehouse.gov/news/releases/2002/02/addendum.pdf. The business-as-usual (BAU) projections cited in the Addendum are somewhat higher than a "Policies and Measures" case EPA developed for the *U.S. Climate Action Report 2002*. EIA has adjusted the addendum projections to reflect the most recent 2002 and 2003 data on these gases as published by EIA, as well as to estimate the intervening years of the projections, since the projections were only provided for every 5 years. In addition, EIA extrapolated the projections to estimate emissions for 2025.

(3.5 percent in 2003), EPA believes that there is a substantial potential for reductions at relatively low permit prices (Table 2). The methodology for representing the opportunities for reducing the emissions of other GHGs is discussed in more detail in EIA's analysis of the Climate Stewardship Act of 2003.[16]

MACs[17,18,19] for other gases, which were developed by the EPA based on engineering and economic analysis, are used in this analysis because they are the only consistent and relatively complete source for such emissions estimates.[20] EIA adjusted the original MACs so that the reductions that are assumed to be economical at zero or "negative" permit prices are instead priced at $1 per ton carbon ($0.30 per ton CO_2 equivalent). Because the MACs are engineering cost estimates, they do not reflect real-world factors that may affect the behavior of decisionmakers. As a result, the MACs summarized in Table 2 may overestimate the non-CO_2 emissions reductions that would actually be attained at each specified permit price level.

Table 2. Assumed Emissions Abatement Opportunities for Non-CO_2 Covered Greenhouse Gases by Permit Price and Year

Permit Price (2003 Dollars per Metric Ton Carbon Dioxide Equivalent)	Emission Reductions (Million Metric Tons Carbon Dioxide Equivalent)			
	2010	2015	2020	2025
0.3	45	54	66	78
2.9	112	138	174	222
5.8	159	199	257	337
8.7	165	203	260	340
11.6	180	224	289	381
14.5	187	233	300	395
21.7	196	244	316	416
28.9	196	245	316	417
36.1	199	248	321	423
43.4	204	256	331	438
50.6	210	263	341	451
57.8	210	263	341	451

Source: Calculated using EPA sources. See footnotes 17-19.

[16]Energy Information Administration, *Analysis of S. 139, the Climate Stewardship Act of 2003*, SR/OIAF/2003-02 (Washington, DC, June 2003), web site www.eia.doe.gov/oiaf/servicerpt/ml/pdf/sroiaf_(2003)02.pdf. See also Energy Information Administration, *Analysis of Senate Amendment 2028, the Climate Stewardship Act of 2003* (Washington, DC, June 2004), web site www.eia.doe.gov/oiaf/analysispaper/sacsa/pdf/s139amend_analysis.pdf.

[17]U.S. Environmental Protection Agency, *U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions*, EPA 30-R-99-013 (Washington, DC, September 1999), web site www.epa.gov/ghginfo/pdfs/07-complete.pdf; and *Addendum to the U.S. Methane Emissions 1990-2020: Update for Inventories, Projections, and Opportunities for Reductions* (Washington, DC, December 2001), web site www.epa.gov/ghginfo/pdfs/final_addendum2.pdf.

[18]U.S. Environmental Protection Agency, *U.S. High GWP Gas Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions*, EPA 000-F-97-000 (Washington, DC, June 2001), web site http://www.epa.gov/ghginfo/pdfs/gwp_gas_emissions_6_01.pdf.

[19]U.S. Environmental Protection Agency, *U.S. Adipic Acid and Nitric Acid N_2O Emissions 1990-2020: Inventories, Projections and Opportunities for Reductions* (Washington, DC, December 2001), web site www.epa.gov/ghginfo/pdfs/adipic.pdf.

[20]The curves are based on an EPA-funded evaluation of reduction opportunities available across a range of emission allowance prices and are consistent with EPA's BAU case. The BAU case has somewhat higher emissions than the policies and measures case published in EPA's *Climate Action Report 2002*. The BAU and the associated MACs generally (with one exception, methane emissions from gas production) assume that technological improvement does not occur and that trends in improved management practices to reduce emissions do not continue into the future. Such an approach overestimates both the BAU emissions and the economic reductions possible.

The simulation of the emissions cap-and-trade policy in NEMS was used to estimate the price of GHG permits over time. The cost of using each fossil fuel was adjusted to include the cost of the GHG permits needed to cover the emissions produced and released into the atmosphere when the fuel is consumed, in addition to the market price of the fuel. These adjustments influence energy demand and energy-related CO_2 emissions. The GHG permit price also determines the reductions in the emissions of other GHGs. With emission permit banking, NEMS solves for the time path of permit prices such that cumulative emissions match the cumulative target, provided the permit price remains below the safety-valve permit price. Once the safety-valve permit price is attained and the previously banked permits are exhausted, annual GHG emissions exceed the target.[21]

Emissions, Greenhouse Gas Permit Prices, and Banking

This section focuses on the results of the following three policy cases to illustrate the GHG emissions-related effects of the NCEP programs:

- The NCEP case simulates all the NCEP policies that were modeled using NEMS.
- The Cap-Trade case simulates the emissions cap-and-trade policy by itself without the other NCEP-recommended policies.
- The No-Safety sensitivity case also simulates an emissions cap-and-trade policy by itself, but it omits the safety-valve permit price provision to show an unconstrained market-based solution that meets the emissions targets. This case is included for illustrative purposes and does not reflect a recommendation by the NCEP.

The cases with the GHG cap-and-trade program differ in terms of the degree to which, and the time frame over which, the emissions target is achieved, whether the safety-valve permit price is binding, and the patterns of permit banking. Fully meeting the GHG intensity target would require a cumulative reduction of 10.5 billion metric tons CO_2 equivalent from 2010 to 2025, or about 8 percent of total reference case covered emissions over that time frame. However, the policy's emissions reductions are phased in gradually, with a 1-percent reduction in covered emissions required to meet the 2010 target and a 17-percent reduction required to meet the 2025 target. As a result, the target is relatively easy to meet initially but becomes increasingly stringent over time.

Figure 1 illustrates the level of GHG emissions achieved in the reference, NCEP, Cap-Trade, and No-Safety cases. In the NCEP case, GHG emissions are reduced by 964 million metric tons CO_2 equivalent below the reference case but are 557 million metric tons CO_2 equivalent higher than the implied NCEP target level.

[21]In the No-Safety case, the permit price is free to rise by as much as 8.5 percent per year, and permits can be banked as long as it is economical to do so. Because the NEMS forecast horizon is limited to 2025, it is assumed that the banks will be depleted by 2025. It appears that it would have been economical to bank permits for 1 to 2 more years beyond 2025 before starting to draw down the bank. The impact would have been higher starting and ending permit prices over the forecast horizon.

The projected permit prices in the NCEP case are initially lower than in the Cap-Trade case (Figure 2), as the efficiency programs and other policies in the NCEP case result in emissions reductions independent of the permit-based incentives. The permit price is not projected to reach the safety-valve price until 2019, compared with 2016 in the Cap-Trade case. The emissions intensity targets for the first phase of the GHG policy (2010-2019) are achieved on a cumulative basis. Under the second phase (2020-2025), with more stringent emissions targets, and the projected cumulative emissions remain above the target. While the CAFE and building codes and standards in the NCEP case make significant contributions toward meeting the emissions intensity target, the permit price needed to bring covered emissions to the target level would need to be between the safety-valve price and $35 per metric ton CO_2 equivalent. The permit price would need to be even higher to meet the emissions target if the assumed supply of non-CO_2 reductions proved to be too optimistic.

In the Cap-Trade case, the permit price reaches the safety-valve permit price in 2016 (Figure 2). The annual emissions are projected to be below the target from 2010 to 2012, and a small balance of banked permits is projected to accrue (Figure 3). The banked permits are depleted from 2013 to 2015 as annual emissions rise above target. Beginning in 2016, permits are priced at the safety-valve permit price level, and the emissions remain above the target (bank balance shown as negative).

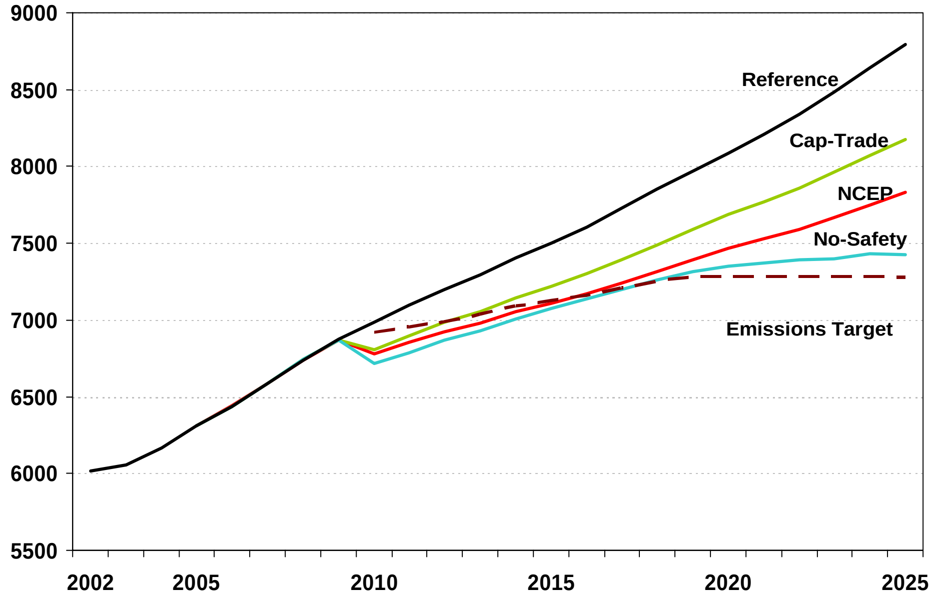
Cumulative emissions reductions in the Cap-Trade case are projected to meet the targets from 2010 through 2015, while the permit price remains below the safety-valve permit price. However, without the additional policies recommended by the NCEP or a higher safety-valve permit price, the emissions targets would not be achieved over much of the projection period (2016-2025). Substantial low-cost emissions reductions would occur, however, slowing the overall growth of emissions through 2025.

In the No-Safety sensitivity case, cumulative emissions from 2010 to 2025 meet the cumulative emissions targets through a cap-and-trade program with no limit on the emissions permit price. Permit prices are projected to be two to four times higher than the NCEP's safety-valve permit price. With permit banking, emissions are projected to be below the yearly targets through 2018, as a balance of banked permits accumulates. From 2019 to 2025, the projected emissions are above the target, and the bank balance of permits is gradually depleted to meet the difference.

Composition of Emissions Reductions

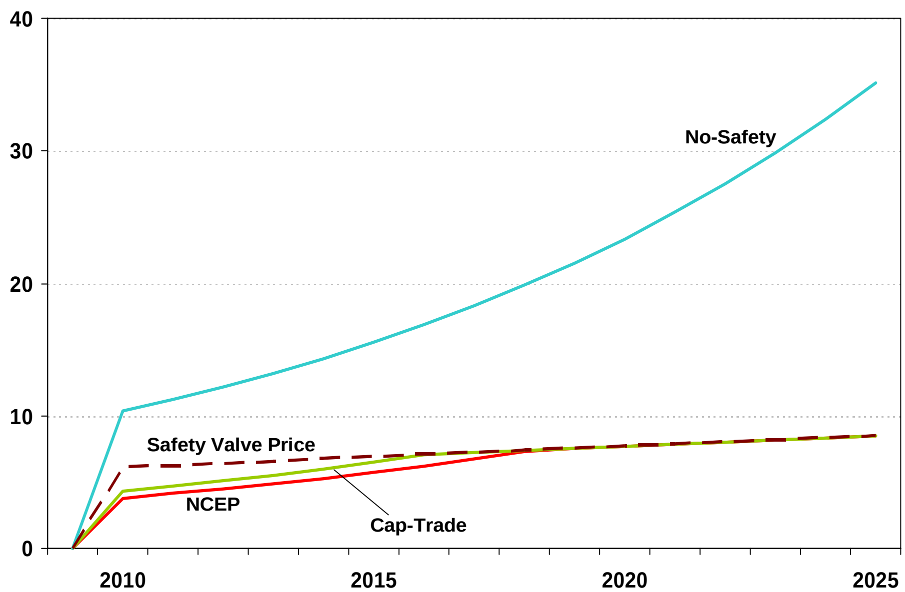
While the NCEP's energy-related policies reduce energy-related CO_2 emissions, a large share of the emissions reductions is projected to be from other GHGs (Figure 4). In the NCEP case, 43 percent of the cumulative emissions reductions projected from 2010 to 2025 are from other GHGs, with the share decreasing from 50 percent in 2015 to 35 percent in 2025. As shown in Table 2 above, significant reductions of other GHGs are assumed to be economical at permit prices below the safety-valve permit price. As permit prices increase, the share of reductions from energy-related CO_2 increases. In the Cap-Trade case, where all the emissions reductions are driven by the emissions permit program, the share of cumulative reductions from other GHGs is higher (64 percent, compared to 43 percent in the NCEP case). In the No-Safety case, the permit prices are two to four times higher than in the Cap-Trade case, inducing larger reductions in

Figure 1. Covered Greenhouse Gas Emissions in Four Cases, 2002-2025
(Million Metric Tons Carbon Dioxide Equivalent)



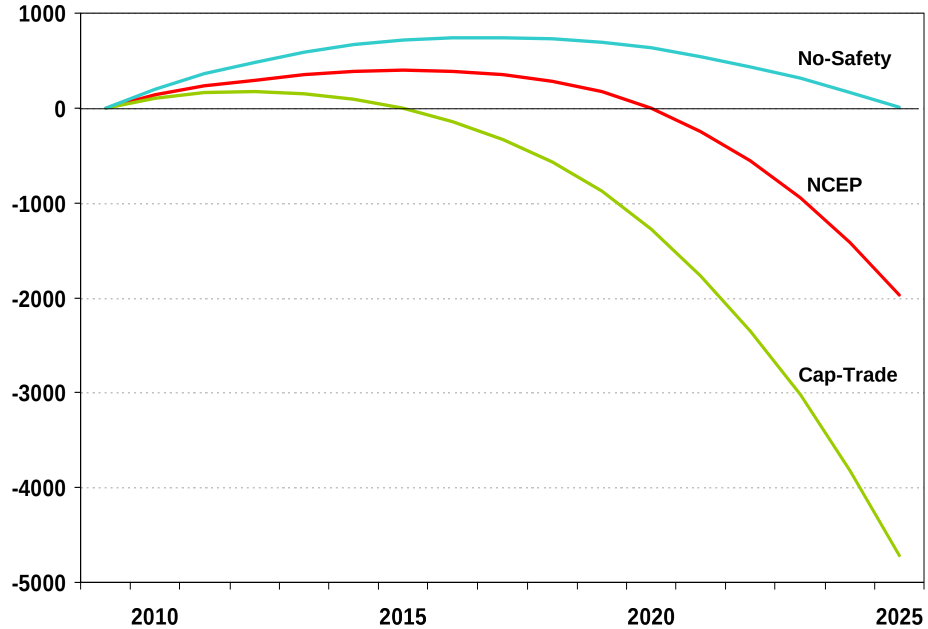
Source: National Energy Modeling System runs AEO2005.D102004A, BING_CAP.D021005A, BING_ICE_CAP.D021005C, and BING_NOCAP.D020805A.

Figure 2. Projected Permit Prices in the NCEP, Cap-Trade, and No-Safety Cases, 2010-2025
(2003 Dollars per Metric Ton Carbon Dioxide Equivalent)



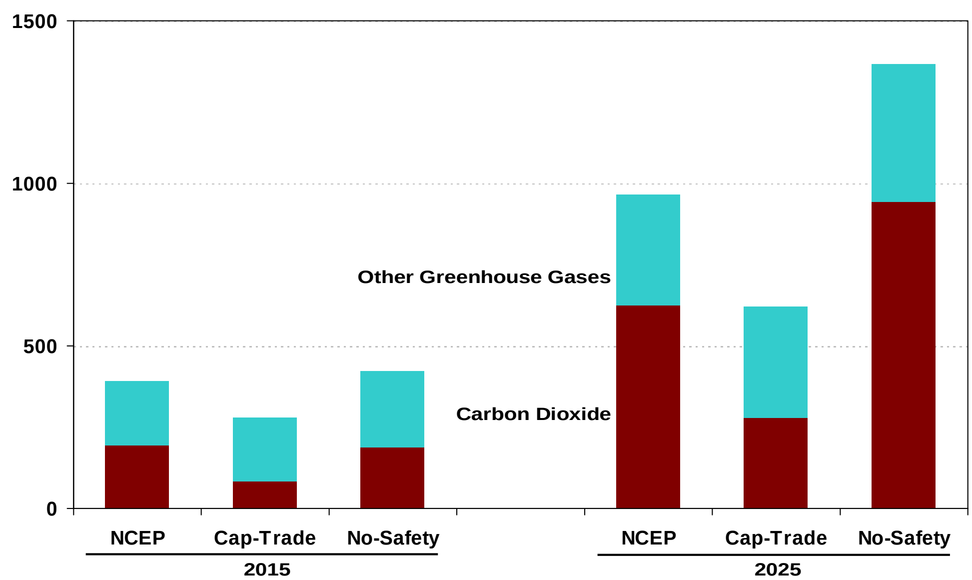
Source: National Energy Modeling System, runs BING_CAP.D021005A, BING_NOCAP.D020805A, and BING_ICE_CAP.D021005c

Figure 3. Permit Bank Balance in the NCEP, Cap-Trade, and No-Safety Cases, 2010-2025
(Million Metric Tons Carbon Dioxide Equivalent)



Source: National Energy Modeling System, runs BING_CAP.D021005A, BING_NOCAP.D020805A, and BING_ICE_CAP.D021005c.

Figure 4. Projected Emission Reductions from Carbon Dioxide and Other Greenhouse Gases, 2010-2025
(Million Metric Tons Carbon Dioxide Equivalent)



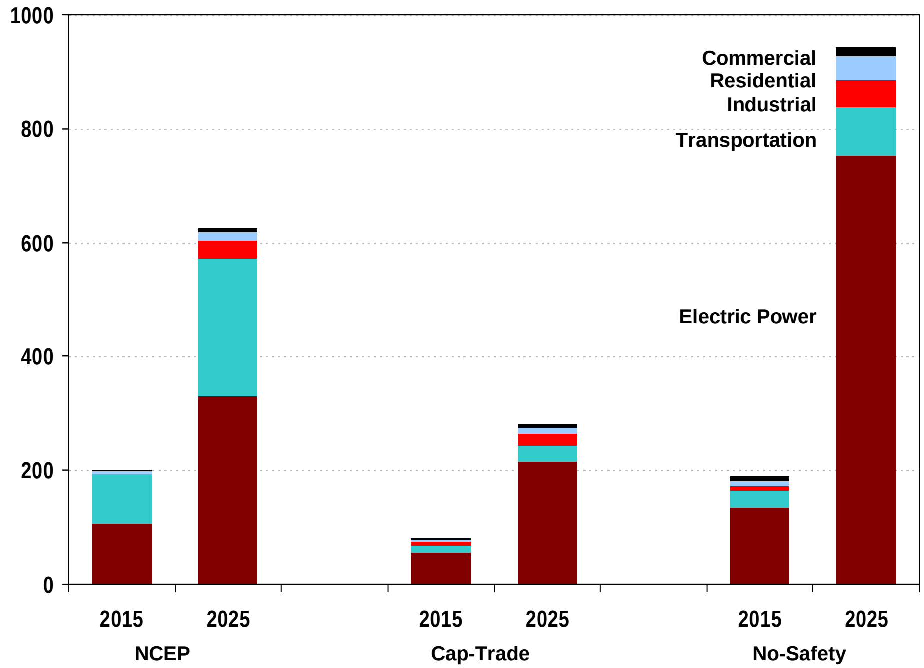
Source: National Energy Modeling System, runs BING_ICE_CAP.D021005C, BING_CAP.D021005A, and BING_NOCAP.D020805A.

energy-related CO_2 emissions while eventually exhausting the low-cost opportunities for reductions in other GHG emissions.

In all the GHG cap-and-trade policy cases, the greatest share of the reductions in energy-related CO_2 emissions occurs in the electric power sector (Figure 5). Compared to the other consuming sectors, more opportunities exist in the electric power sector to switch to fuels that emit less or no net CO_2 at relatively modest cost. These options include using less coal and more natural gas, renewable fuels, nuclear power, and sequestering CO_2. Reductions in electricity demand also contribute to the CO_2 reductions in the power sector, and many of the NCEP policy proposals promote more efficient electricity use. In the NCEP case, large reductions also occur in the transportation sector, which are attributable to the assumed increases in CAFE standards. Together, the GHG emissions reductions attributed to electricity and to other GHGs constitute 72 percent of the total projected reductions from 2010 to 2025 in the NCEP case (compared to the reference case), and transportation emission reductions account for 24 percent.

Figure 5. Carbon Dioxide Reductions by Sector in the NCEP, Cap-Trade, and No-Safety Cases, 2015 and 2025

(Million Metric Tons)



Source: National Energy Modeling System, runs BING_ICE_CAP.D021005C, BING_CAP.D021005A, and BING_NOCAP.D020805A.

Energy Use Patterns in the Cap-and-Trade Cases

The main discussion of energy use impacts is provided in the sections below that consider impacts in each of the main energy-using sectors; however, it is useful to highlight some of the differences between the GHG cap-and-trade policy cases (Table 3). Among the three GHG cap-and trade policy cases, primary energy consumption is lowest in the combined NCEP case, followed closely by the No-Safety sensitivity case. The lower energy consumption in the NCEP

Table 3. Summary of Greenhouse Gas Emission Scenarios, 2015 and 2025

Projection	2003	2015 Reference	2015 NCEP	2015 Cap-Trade	2015 No-Safety	2025 Reference	2025 NCEP	2025 Cap-Trade	2025 No-Safety
Net Petroleum Imports (Million Barrels per Day)	11.24	15.40	14.60	15.24	15.03	19.11	17.29	18.77	18.04
Net Natural Gas Imports (Trillion Cubic Feet)	3.24	7.02	5.92	6.99	6.86	8.66	8.53	9.25	8.19
Total Fossil Consumption (Quadrillion Btu)	**84.34**	**102.47**	**99.96**	**101.49**	**100.37**	**116.37**	**108.29**	**113.28**	**105.67**
Petroleum	39.09	48.07	46.46	47.78	47.42	54.42	50.44	53.70	52.25
Natural Gas	22.54	28.69	28.24	28.63	28.81	31.47	30.34	31.84	30.71
Coal	22.71	25.71	25.25	25.08	24.14	30.48	27.51	27.74	22.72
Average Electricity Price (2003 Dollars per Kilowatthour)	7.4	6.9	6.9	7.1	7.3	7.3	7.7	7.6	8.1
Wellhead Gas Price (2003 Dollars per Thousand Cubic Feet)	4.98	4.16	3.66	4.13	4.02	4.79	4.86	4.90	4.54
Covered GHG Emissions (Million Metric Tons CO_2 Equivalent)	**6,032**	**7,501**	**7,108**	**7,220**	**7,077**	**8,794**	**7,829**	**8,172**	**7,428**
Energy-Related CO_2	5,789	7,052	6,733	6,971	6,864	8,062	7,438	7,781	7,119
GHG Emissions Price (2003 Dollars per Metric Ton CO_2 Equivalent)	0.00	0.00	5.72	6.50	15.55	0.00	8.50	8.50	35.15
Covered GHG Emissions Intensity	581.1	492.9	467.8	475.1	466.6	433.3	387.3	403.3	367.5
Total Electricity Generation (Billion Kilowatthours)	**3,852**	**4,890**	**4,786**	**4,860**	**4,827**	**5,770**	**5,507**	**5,706**	**5,624**
Coal	1,970	2,305	2,285	2,248	2,174	2,890	2,584	2,577	2,080
Natural Gas	632	1,173	1,075	1,189	1,215	1,406	1,325	1,542	1,449
Nuclear	764	826	834	826	826	830	838	830	944
Renewable	359	447	465	460	477	489	603	608	1,023
Primary Energy Consumption (Quadrillion Btu)	**98.22**	**118.29**	**116.03**	**117.63**	**116.71**	**133.18**	**126.45**	**131.57**	**129.40**
Buildings	38.78	46.76	45.63	46.44	45.86	53.36	50.89	52.72	51.78
Total Transportation	27.24	34.96	33.72	34.78	34.63	40.28	36.80	39.89	39.16
Industrial	32.21	36.58	36.67	36.41	36.22	39.53	38.75	38.96	38.46

Source: National Energy Modeling System, runs AEO2005.D10204, BING_CAP.D021005A, BING_NOCAP.D020805A, and BING_ICE_CAP.D021005C.

case reflects the lower end-use petroleum and electricity consumption resulting from the CAFE and buildings efficiency policies and the additional broader reductions resulting from the GHG cap-and-trade policy. The No-Safety case achieves the GHG policy by increasing GHG penalties until the delivered fuel prices are high enough to cause fuel switching from fuels with high carbon content to fuels with lower or no carbon content, as well as some reductions in end-use consumption.

Primary energy consumption in the NCEP case is 2.26 quadrillion Btu lower than in the reference case in 2015, compared to reductions of 1.58 quadrillion Btu in the No-Safety case and 0.66 quadrillion Btu in the Cap-Trade case. In 2025, primary consumption in the NCEP case is 6.73 quadrillion Btu lower than in the reference case, compared to 3.78 quadrillion lower in the No-Safety case and 1.61 quadrillion Btu lower in the Cap-Trade case. While primary consumption is lowest in the NCEP case, fossil fuel consumption is lowest in the No-Safety case because of the unrestricted permit price and its emphasis on reducing the use of fuels with high carbon content.

Coal use is reduced the most in the No-Safety case (7.8 quadrillion Btu in 2025, compared to 3.0 quadrillion Btu in the NCEP case and 2.7 in the Cap-Trade case). Most of the reductions occur in the electricity generation area where, for example, coal-fired generation is reduced by 810 billion kilowatthours in 2025 in the No-Safety case and is displaced by 114 billion kilowatthours of additional nuclear, 534 billion kilowatthours of additional renewable, and about 43 billion kilowatthours of additional natural-gas-fired generation. In contrast to the No-Safety case, the lower safety-valve price in the Cap-Trade and NCEP cases reduces coal-fired generation by about the same levels, slightly over 300 billion kilowatthours in 2025.

Impacts on Primary Energy Supply

This section focuses on the results of the following policy cases to illustrate the supply-related effects of the NCEP policy recommendations:

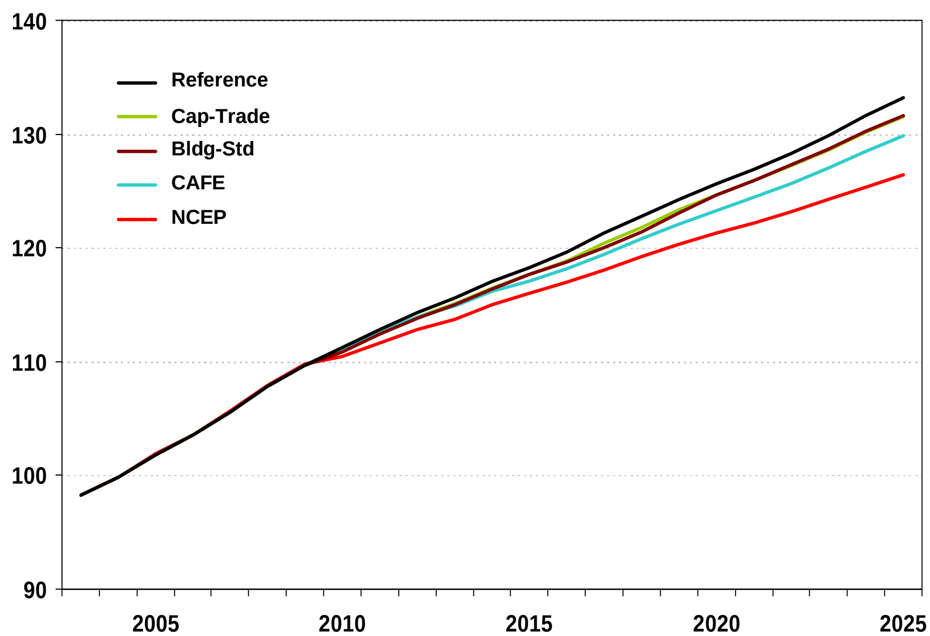
- The NCEP case simulates all the NCEP policies that were possible to model using NEMS.
- The CAFE case simulates the impacts of a 36-percent increase in the CAFE standard for light-duty vehicles (LDVs).
- The Incent case simulates the impact of the tax and deployment incentives on energy supply. This case combines the proposed extension and changes of the production tax credit, the $4 billion in incentives to deploy up to 10 gigawatts of IGCC, $3 billion to build and deploy 4 gigawatts of carbon capture and sequestration, $2 billion to support the development and construction of 1 gigawatt of advanced nuclear capacity, and a price guarantee for construction of an Alaska natural gas pipeline for natural gas produced on the North Slope of Alaska.
- The Bldg-Std case simulates the impact of new building codes and efficiency standards.

With respect to domestic oil production and consumption and oil imports, the recommended increase in CAFE standards is the most important policy. The other non-GHG policies modeled in NEMS do not significantly affect petroleum consumption beyond the changes seen in the CAFE case. The most important policies for natural gas are the Bldg-Std and Incent cases. The Bldg-Std case primarily reduces electricity demand in the residential and commercial markets and hence natural gas demand for generation, while the tax and deployment incentives policy in the Incent case encourages all generation technologies except natural-gas-fired technologies.

Total Primary Consumption Patterns

The impacts of individual NCEP policies on total primary energy consumption (Figure 6) are nearly additive. For example, in 2015, primary energy consumption in the Cap-Trade case is 0.7 quadrillion Btu lower than in the reference case; the Bldg-Std case reduces primary energy consumption by 0.7 quadrillion Btu relative to the reference case; the CAFE case reduces primary energy consumption by 1.2 quadrillion Btu relative to the reference case; and in the Incent case, primary energy consumption is 0.6 quadrillion Btu higher than in the reference case, because the increased use of IGCC generating capacity increases coal use by 0.3 quadrillion Btu, and the PTC increases renewable generation. When the results for the individual cases are added together, the total difference from the reference case projection of primary energy consumption in 2015 is a reduction of 2.0 quadrillion Btu, as compared with a reduction of 2.3 quadrillion Btu in the NCEP case. In 2025, the difference between the combined results of the individual cases and the NCEP case projection is only 0.1 quadrillion Btu. The CAFE case has the single biggest impact on primary energy consumption.

Figure 6. Primary Energy Use in Five Cases, 2005-2025
(Quadrillion Btu)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_EFF.D020905A, BING_CAFE.D021005A, BING_CAP.D021005A.

Petroleum

Compared to the reference case, the NCEP case results in a 3.4-percent reduction in total petroleum demand (830,000 barrels per day) in 2015 and 7.4 percent (2.1 million barrels per day) in 2025. Petroleum imports are reduced by about 0.8 million barrels per day in 2015 and 1.8 million barrels per day in 2025. As a result, the import share of total petroleum supplied in 2025 decreases from 68.4 percent in the reference case to 66.8 percent in the NCEP case (Table 4).

Table 4. Comparison of Oil, Natural Gas, and Ethanol Results for Selected Cases, 2015 and 2025

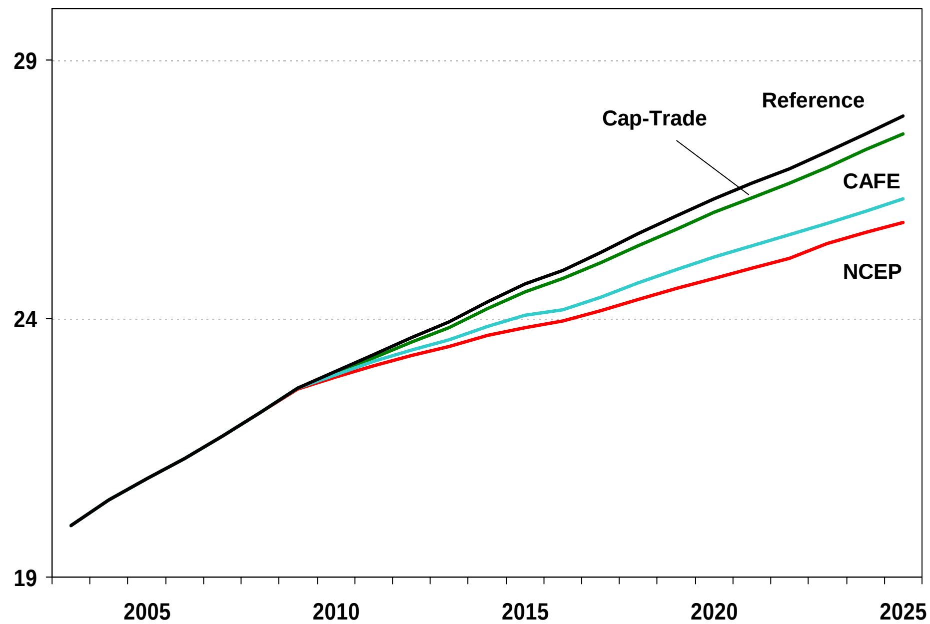
Projection	2003	2015					2025				
		Refer-ence	NCEP	Bldg-Std	CAFE	Incent	Refer-ence	NCEP	Bldg-Std	CAFE	Incent
Domestic Oil Production (Million Barrels per Day)	5.68	5.49	5.49	5.49	5.49	5.49	4.73	4.69	4.71	4.71	4.70
Domestic Dry Natural Gas Production (Trillion Cubic Feet)	19.07	20.77	21.44	20.69	20.74	21.49	21.83	20.85	21.72	21.71	21.07
Net Petroleum Imports (Million Barrels per Day)	11.24	15.40	14.60	15.39	14.82	15.38	19.11	17.29	19.07	17.65	19.15
Net Natural Gas Imports (Trillion Cubic Feet)	**3.24**	**7.02**	**5.92**	**6.64**	**7.00**	**6.43**	**8.66**	**8.53**	**8.23**	**8.65**	**8.72**
Liquefied Natural Gas	0.44	4.33	3.72	4.11	4.32	4.08	6.37	6.36	6.12	6.38	6.48
Canadian Pipeline Gas	3.13	2.98	2.51	2.83	2.98	2.66	2.55	2.55	2.45	2.52	2.53
Exports to Mexico	-0.33	-0.29	-0.32	-0.30	-0.29	-0.31	-0.26	-0.37	-0.34	-0.26	-0.29
Oil Import Dependence (Percent)	56.2	62.4	61.3	62.4	61.6	62.4	68.4	66.8	68.4	67.1	68.6
Natural Gas Import Dependence (Percent)	14.7	25.1	21.5	24.1	25.1	22.9	28.2	28.9	27.3	28.3	29.1
Fossil Fuel Consumption (Quadrillion Btu)	**84.34**	**102.47**	**99.96**	**101.90**	**101.28**	**102.88**	**116.37**	**108.29**	**114.88**	**112.88**	**115.61**
Petroleum	39.09	48.07	46.46	48.04	46.93	48.01	54.42	50.44	54.31	51.34	54.34
Natural Gas	22.54	28.69	28.24	28.22	28.64	28.83	31.47	30.34	30.92	31.34	30.76
Coal	22.71	25.71	25.25	25.65	25.71	26.04	30.48	27.51	29.65	30.20	30.51
Ethanol Consumption (Quadrillion Btu)	0.24	0.33	0.33	0.33	0.31	0.33	0.38	0.34	0.38	0.33	0.38
Average Electricity Price (2003 Dollars per Kilowatthour)	7.4	6.9	6.9	6.8	6.9	6.7	7.3	7.7	7.3	7.3	7.2
Wellhead Natural Gas Price (2003 Dollars per Thousand Cubic Feet)	4.98	4.16	3.66	4.01	4.14	3.78	4.79	4.86	4.79	4.84	4.82
Motor Gasoline Delivered Price (2003 Dollars per Gallon)	1.60	1.51	1.54	1.51	1.50	1.51	1.58	1.62	1.58	1.55	1.58
Ethanol (E-85) Delivered Price (2003 Dollars per Gallon)	1.52	1.63	1.59	1.63	1.59	1.61	1.70	1.70	1.70	1.69	1.71
Total Emissions of Covered Greenhouse Gases (Million Metric Tons Carbon Dioxide Equivalent)	**6,032**	**7,501**	**7,108**	**7,467**	**7,421**	**7,516**	**8,794**	**7,829**	**8,678**	**8,552**	**8,735**
Energy-Related Carbon Dioxide	5,789	7,052	6,857	7,018	6,973	7,068	8,062	7,438	7,947	7,820	8,004
Alaska Natural Gas Pipeline Online Date	—	2016	2014	2016	2016	2014	2016	2014	2016	2016	2014

Note: Totals may not equal sum of components due to independent rounding.
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_EFF.D020905A, BING_CAFE.D021005A, and BING_INCENT.D020805A.

About 80 percent of the petroleum demand reduction in 2025 in the NCEP case relative to the reference case is attributable to the increases in CAFE standards for LDVs—10 miles per gallon (mpg) for cars and 8 mpg for light trucks (Figure 7). The NCEP recommendation on the GHG cap-and-trade policy (Cap-Trade case) has much less impact on overall petroleum supply than the CAFE requirement. In addition, the GHG policy more evenly affects petroleum demand across all sectors than does the CAFE requirement, which affects only the transportation sector.

The impact of increased CAFE standards on gasoline demand has minor implications for ethanol as well. Essentially, ethanol consumption declines with the decline in overall fuel consumption

Figure 7. Oil Consumption in Four Cases, 2003-2025
(Million Barrels per Day)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAFE.D021005A, and BING_CAP.D021005A.

by LDVs. The economic competitiveness of ethanol production improves under the NCEP's GHG policy; nevertheless, assuming reference case costs for ethanol production, the variation in production of ethanol is small under any combination of NCEP recommendations.

Natural Gas

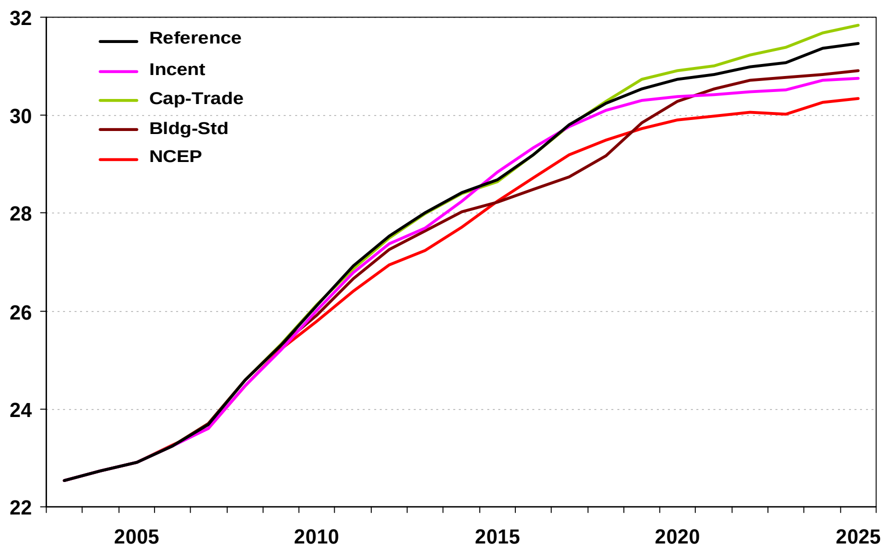
The only NCEP-recommended natural gas supply incentive is the price guarantee for construction of an Alaska natural gas pipeline for natural gas produced on the North Slope of Alaska. Other NCEP programs, however, such as the GHG cap-and-trade, increased CAFE, buildings efficiency, and the various deployment programs, also lead to changes in demand for natural gas, with corresponding impacts on supply markets.

In the NCEP case, the 2015 average lower-48 natural gas wellhead price (in 2003 dollars) is lower than the reference case price by $0.50 per thousand cubic feet. The difference narrows considerably toward the end of the forecast and by 2025 the price in the NCEP case exceeds that in the reference case, even with reduced consumption levels, as lower prices in the middle years of the forecast result in less exploration and production activity and, therefore, less capacity to produce in the later years of the forecast. The capacity to import liquefied natural gas (LNG) is also lower, as projects that might have come on earlier with higher prices are delayed.

GHG emission restrictions in the NCEP case raise natural gas consumption by electricity generators as they move away from fuels with higher GHG emissions levels. Consumers with less fuel flexibility respond to the higher natural gas prices (with permit costs included) by reducing their natural gas consumption, but without fuel substitutes the response is limited. Total natural gas consumption, and therefore supply, in the NCEP case are slightly lower than in the reference case, by about 0.45 trillion cubic feet in 2015 and about 1.13 trillion cubic feet in 2025. While both domestic production and imports are reduced or increased in accordance with the consumption change, the impact on natural gas imports is significantly greater. On a cumulative basis across the forecast, about 80 percent of the change in natural gas consumption in the emissions cases versus the reference case is reflected in a change in import levels. When prices fall in response to demand reductions, some LNG import facilities are not built that would have been built otherwise.

Policy combinations that include tax incentives and deployments and improved building efficiencies reduce levels of total natural gas consumption (Figure 8). In general, the combinations of policies examined that reduce consumption have a combined impact somewhat less than the sum of the impacts of the measures taken individually. In addition, the increase in natural gas consumption by electricity generators due to imposing emissions restrictions is less when implemented in combination with the other policies that lower demand for electricity, resulting in a reduction rather than an increase in total natural gas consumption.

Figure 8. Natural Gas Consumption in Six Cases, 2005-2025
(Quadrillion Btu)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_EFF.D020905A, BING_CAFE.D021005A, BING_INCENT.D020805A, and BING_CAP.D021005A.

The natural gas consumption response to building efficiency improvements is seen largely in the electric power and residential sectors, and it is insignificant in the commercial and industrial sectors. Total natural gas consumption is reduced in the Bldg-Std case relative to the reference case by nearly 0.5 trillion cubic feet per year on average from 2010 to 2025. Under the tax incentive and deployment (Incent) case, natural gas consumption by electricity generators is steadily reduced across the forecast relative to the reference case values, whereas the other primary sectors show slightly increased consumption around 2015 to 2020.

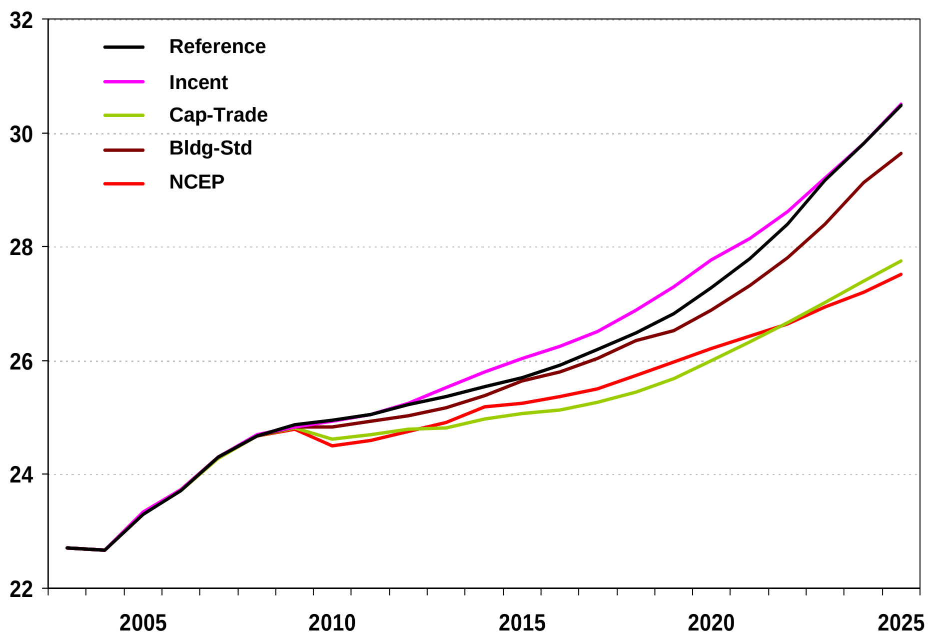
The impact on imports versus domestic production is varied across the assortment of cases, which include tax incentives and deployment and building efficiency measures, partially because of the relative role that an Alaska natural gas pipeline plays in the supply picture. The timing of the completion of the pipeline has a noticeable impact on the resulting natural gas wellhead price path, as well as on natural gas imports and domestic production levels. In the reference case, the pipeline is completed in 2016. In cases incorporating a tax incentive for North Slope natural gas, an Alaska natural gas pipeline is expected to be constructed as soon as possible, or 2014. As a result, the average natural gas wellhead price in these cases, which is already reduced in response to a demand reduction due to other tax incentives and deployments, is further reduced in 2014 and 2015 with the earlier introduction of the Alaska natural gas pipeline.

Coal

Coal consumption is reduced the most in cases that incorporate the mandatory GHG cap-and-trade program, e.g., the Cap-Trade case and the NCEP case. Coal consumption is relatively unaffected by the new CAFE standard alone (Figure 9). In 2025, coal consumption in the Cap-Trade case is 2.74 quadrillion Btu below the reference case projection, and in the NCEP case it is 2.97 quadrillion Btu below the reference case level. In each of these cases, the principal policy factor that drives the reduction is the cap-and-trade program. The addition of the policy on increased building codes and efficiency standards further reduces the demand for electricity, which results in even less coal-fired generating capacity being built or used for generation.

Figure 9. Coal Consumption in Five Cases, 2005-2025

(Quadrillion Btu)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_EFF.D020905A, BING_CAFE.D021005A, BING_INCENT.D020805A, and BING_CAP.D021005A.

Energy Consumption Impacts of NCEP Policies by End-Use Sector

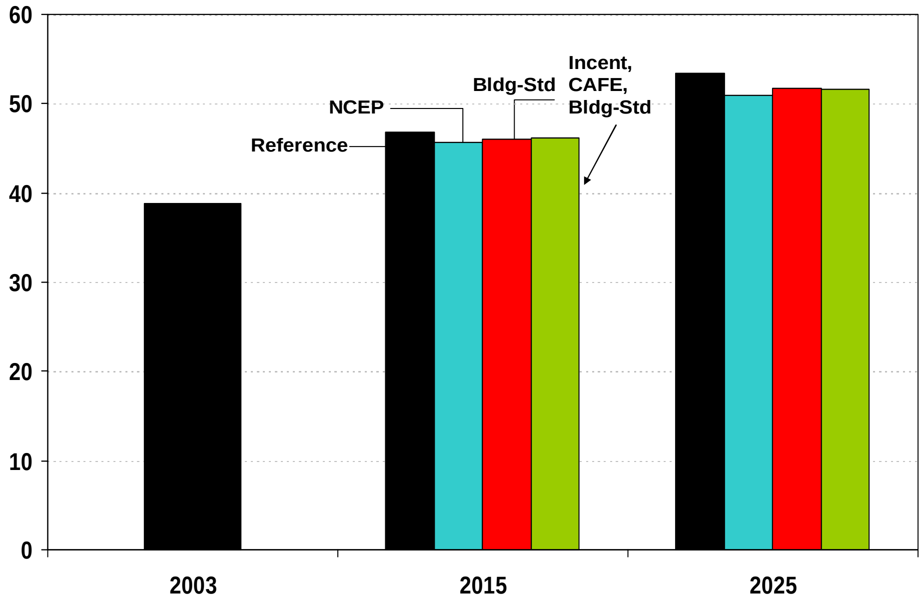
Residential and Commercial Sector Impacts

The assumed building codes and efficiency standards are effective in significantly reducing residential and commercial energy demand, because they eliminate the opportunity to purchase less efficient equipment available in the reference case.[22]

When the CAFE policy is combined with the building efficiency standards, tax incentives and deployments, and GHG policy, i.e., the NCEP case, total residential energy demand is projected to be about 3 percent (0.7 quadrillion Btu) lower than the reference case level in 2015 and 5 percent (1.5 quadrillion Btu) lower in 2025 (Figure10 and Table 5). Projected total commercial energy use shows comparable reductions in the NCEP case, decreasing by about 2 percent (0.4 quadrillion Btu) in 2015 and 4 percent (1.0 quadrillion Btu) in 2025.

Figure 10. Buildings Sector Total Energy Use in Four Cases, 2003, 2015, and 2025

(Quadrillion Btu)



Sources: 2003 consumption based on Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). Projections: National Energy Modeling System, runs AEO2005.D102004A, BING_EFF.D020905A, BING_ICE.D020905A, and BING_ICE_CAP.D021005C.

[22]Although the NCEP did not make specific policy recommendations for the buildings sector, Senate staff requested the use of efficiency standards for both equipment and building shells as defined by an appendix to the NCEP study: Greg Rosenquist, Michael McNeil, Maithili Iyer, Steve Meyers, and Jim McMahon, Lawrence Berkeley National Laboratory, "Energy Efficiency Standards and Codes for Residential/Commercial Equipment and Buildings: Additional Opportunities," LBID-2533, in *NCEP Technical Appendix* (Washington, DC: National Commission on Energy Policy, 2004). Residential policies include increased efficiency standards in 2010 for gas furnaces, room air conditioners, electric water heaters, dishwashers, refrigerator/freezers, torchiere lighting, pool pumps, ceiling fans, and standby power in miscellaneous electric products. In addition, residential building codes are tightened in 2010 and again in 2020. Policies specific to the commercial sector include increased equipment efficiency standards in 2010 for gas boilers, packaged and central air conditioners, heat pumps, gas water heaters, ventilation, fluorescent and high intensity discharge (HID) lighting, commercial refrigerator/freezers, ice and vending machines, and standby power in personal computers and other office equipment. Policy assumptions call for a second increase in commercial efficiency standards for air conditioning and lighting equipment in 2020. In addition, commercial building codes for the building envelope are tightened in 2010 and for lighting power density in 2015.

Table 5. Buildings Energy Consumption by Sector and Source in the Reference and NCEP Cases, 2015 and 2025

(Quadrillion Btu)

Sector and Source	2003	Projections 2015 Reference	2015 NCEP	2025 Reference	2025 NCEP
Residential					
Petroleum	1.58	1.58	1.56	1.53	1.49
Natural Gas	5.25	5.90	5.86	6.17	5.94
Electricity	4.37	5.10	5.21	6.18	5.75
Other[a]	0.41	0.40	0.40	0.39	0.38
Delivered Energy	**11.61**	**13.29**	**13.03**	**14.26**	**13.56**
Electricity Related Losses	9.71	11.29	10.84	12.35	11.60
Total	**21.31**	**24.58**	**23.88**	**26.62**	**25.16**
Commercial					
Petroleum	0.75	0.91	0.89	1.02	0.98
Natural Gas	3.22	3.69	3.69	4.17	4.09
Electricity	4.13	5.63	5.51	7.12	6.79
Other[b]	0.18	0.18	0.18	0.18	0.18
Delivered Energy	**8.29**	**10.41**	**10.28**	**12.49**	**12.04**
Electricity Related Losses	9.18	11.77	11.48	14.25	13.69
Total	**17.46**	**22.18**	**21.75**	**26.74**	**25.73**

[a]Includes coal and wood used for residential heating. Does not include estimates of nonmarketed renewable energy consumption for geothermal heat pumps, solar thermal hot water heating, and solar photovoltaic electricity generation.
[b]Includes commercial sector consumption of coal, wood and wood waste, landfill gas, municipal solid waste, and other biomass for combined heat and power. Does not include estimates of nonmarketed renewable energy consumption for solar thermal hot water heating and solar photovoltaic electricity generation.
Notes: Totals may not equal sum of components due to independent rounding. Data for 2003 are model results and may differ slightly from official EIA data reports.
Sources: 2003 consumption based on Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). Projections: National Energy Modeling System, runs AEO2005.D102004A and BING_ICE_CAP.D021005C.

Electricity use decreases more than the use of any other fuel in the NCEP case. Electricity delivered to the buildings sector in 2025 is 6 percent (0.8 quadrillion Btu or 224 billion kilowatthours) lower than the reference case projection. Projected buildings sector natural gas demand decreases by about 3 percent (0.3 quadrillion Btu), and buildings petroleum use is reduced by 3 percent (0.1 quadrillion Btu) in 2025 compared to the reference case. Projected delivered electricity and natural gas prices to the buildings sector are about 6 percent higher in 2025 than in the reference case, due primarily to the permit price that results from the GHG policy in the NCEP case. The higher natural gas and electricity prices combine with new efficiency standards to further decrease energy demand. Despite higher projected natural gas and electric prices, annual per-household non-transportation energy expenditures in 2025 fall slightly (by about $6) relative to the reference case as a result of demand reductions. Projected price increases outweigh demand reductions in the commercial sector in the NCEP case, causing projected commercial energy expenditures in 2025 to increase by 2 percent ($3.1 billion) relative to the reference case.

When measured on a delivered basis, space heating is the largest single use of energy in the residential sector. This use declines the most in both 2015 and 2025 in the NCEP case, as efficiency standards, building codes, and price increases spur reductions in demand relative to the reference case (Table 6). Taking into account the fuels used to generate electricity, water heating and miscellaneous electricity use account for the biggest residential energy reductions in 2025, as aggressive standards for electric water heaters and standby power reduce total residential demand for these uses by 12 percent and 8 percent, respectively. Residential electric water heater stock efficiency increases by 40 percent in 2025, relative to the reference case, as standards requiring heat pump technology instead of the less efficient resistance technology are mandated in 2010.

Commercial energy use for lighting is projected to decline the most in absolute terms in the NCEP case, relative to the reference case (Table 7). In the NCEP case, equipment efficacy standards and building codes are projected to reduce total primary energy demand for commercial lighting by about 3 percent (0.1 quadrillion Btu) in 2015 and 11 percent (0.5 quadrillion Btu) in 2025 relative to the reference case.

For commercial end uses, 2010 efficiency standards for refrigeration equipment provide the greatest percentage increase in efficiency in the NCEP case, with average stock efficiency improving by 9 percent in 2015 and 16 percent in 2025, relative to the reference case. Stringent standards are proposed for all types of commercial refrigeration equipment, ranging from the refrigeration systems found in grocery stores to walk-in coolers to ice machines and refrigerated vending machines.

The combination of proposed energy- and emissions-related policies in the NCEP case decrease projected CO_2 emissions attributable to residential energy demand by 4 percent in 2015 and 10 percent in 2025, relative to the reference case. Emissions related to residential electricity use account for 94 percent of the 57-million-metric-ton reduction in 2015 and 90 percent of the 153-million-metric-ton reduction in 2025. CO_2 emissions attributable to commercial energy demand in the NCEP case are decreased by 3 percent (42 million metric tons) in 2015 and 9 percent (139 million metric tons) in 2025, relative to the reference case projections. Reductions in projected emissions related to electricity use are responsible for 97 percent of the decrease in 2015 and 95 percent of the decrease in 2025. Figure 11 summarizes CO_2 emissions in 3 policy cases.

When only the building codes and efficiency standards are implemented (the Bldg-Std case), projected commercial total lighting energy use declines by about 2 percent (0.1 quadrillion Btu) in 2015 and 6 percent (0.3 quadrillion Btu) in 2025, relative to the reference case. Although proposed efficiency standards target most commercial end uses, commercial energy use for lighting is projected to decline the most in absolute terms, primarily because proposed building codes affect commercial lighting in addition to lighting efficacy standards that take effect in 2010 and 2020. The proposed commercial building codes include a limit on lighting power density[23] in 2015 that may affect the amount of light provided as well as the amount of power used for lighting. Lower electricity demand resulting from all the proposed building codes and standards contributes to slightly lower electricity prices (by less than 1 mill per kilowatthour).

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[23]The lighting power density limitation of the proposed commercial building codes sets a maximum number of watts that lighting systems can use per square foot of floor space.

Table 6. Residential Sector Energy Consumption by End Use in the Reference and NCEP Cases, 2015 and 2025
(Quadrillion Btu)

Key Indicators and Consumption	2003	Projections 2015 Reference	Projections 2015 NCEP	Projections 2025 Reference	Projections 2025 NCEP
Delivered Energy Consumption by End Use					
Space Heating	5.72	6.19	6.12	6.29	6.02
Space Cooling	0.65	0.73	0.73	0.80	0.77
Water Heating	1.71	1.83	1.83	1.85	1.72
Refrigeration	0.40	0.35	0.35	0.36	0.35
Cooking	0.34	0.39	0.39	0.44	0.44
Clothes Dryers	0.31	0.37	0.36	0.40	0.40
Freezers	0.13	0.12	0.12	0.13	0.13
Lighting	0.78	0.99	0.93	1.13	1.04
Clothes Washers	0.03	0.05	0.05	0.06	0.06
Dishwashers	0.02	0.03	0.03	0.03	0.03
Color Televisions	0.13	0.23	0.23	0.28	0.28
Personal Computers	0.07	0.12	0.12	0.15	0.15
Furnace Fans	0.08	0.10	0.10	0.12	0.12
Other Uses[a]	1.22	1.79	1.68	2.23	2.06
Total Delivered Energy Consumption	**11.61**	**13.29**	**13.03**	**14.26**	**13.56**
Electricity-Related Losses	**9.71**	**11.29**	**10.84**	**12.35**	**11.60**
Total Energy Consumption by End Use					
Space Heating	6.61	7.13	7.04	7.22	6.92
Space Cooling	2.11	2.27	2.24	2.41	2.33
Water Heating	2.53	2.63	2.63	2.60	2.28
Refrigeration	1.30	1.08	1.07	1.08	1.06
Cooking	0.57	0.64	0.64	0.70	0.70
Clothes Dryers	0.85	0.92	0.91	0.97	0.96
Freezers	0.42	0.37	0.37	0.38	0.38
Lighting	2.51	3.07	2.87	3.39	3.14
Clothes Washers	0.10	0.15	0.15	0.19	0.20
Dishwashers	0.08	0.09	0.08	0.09	0.08
Color Televisions	0.43	0.70	0.70	0.85	0.84
Personal Computers	0.23	0.37	0.36	0.45	0.45
Furnace Fans	0.27	0.32	0.32	0.35	0.35
Other Uses[a]	3.32	4.83	4.50	5.93	5.47
Total Energy Consumption	**21.31**	**24.58**	**23.88**	**26.62**	**25.16**

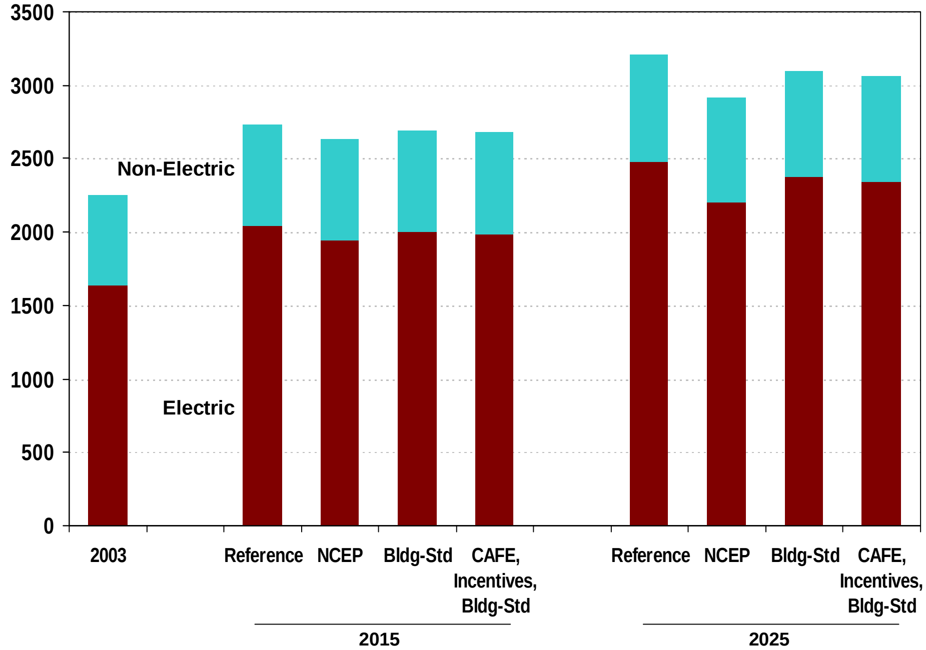
[a]Includes small electric devices, heating elements, and motors not listed above and such appliances as swimming pool and spa heaters, outdoor grills, and outdoor lighting (natural gas).
Notes: Totals may not equal sum of components due to independent rounding. Data for 2003 are model results and may differ slightly from official EIA data reports.
Sources: 2003 consumption based on Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). Projections: National Energy Modeling System, runs AEO2005.D102004A and BING_ICE_CAP.D021005C.

Table 7. Commercial Sector Energy Consumption by End Use in the Reference and NCEP Cases, 2015 and 2025
(Quadrillion Btu)

Key Indicators and Consumption	2003	Projections 2015 Reference	2015 NCEP	2025 Reference	2025 NCEP
Delivered Energy Consumption by End Use					
Space Heating[a]	1.73	2.00	1.98	2.20	2.13
Space Cooling[a]	0.43	0.49	0.47	0.57	0.51
Water Heating[a]	0.78	0.94	0.94	1.09	1.06
Ventilation	0.16	0.18	0.18	0.20	0.19
Cooking	0.29	0.37	0.37	0.43	0.42
Lighting	1.10	1.37	1.33	1.52	1.35
Refrigeration	0.20	0.24	0.22	0.28	0.24
Office Equipment (PC)	0.14	0.29	0.29	0.36	0.36
Office Equipment (non-PC)	0.31	0.57	0.54	0.87	0.84
Other Uses[b]	3.15	3.96	3.95	4.98	4.94
Total Delivered Energy Consumption	**8.29**	**10.41**	**10.28**	**12.49**	**12.04**
Electricity Related Losses	**9.18**	**11.77**	**11.48**	**14.25**	**13.69**
Total Energy Consumption by End Use					
Space Heating[a]	2.06	2.32	2.31	2.52	2.44
Space Cooling[a]	1.37	1.49	1.42	1.66	1.48
Water Heating[a]	1.08	1.26	1.26	1.41	1.38
Ventilation	0.52	0.55	0.55	0.59	0.58
Cooking	0.36	0.43	0.43	0.49	0.48
Lighting	3.55	4.23	4.09	4.56	4.07
Refrigeration	0.65	0.75	0.69	0.85	0.73
Office Equipment (PC)	0.44	0.90	0.89	1.08	1.07
Office Equipment (non-PC)	1.00	1.75	1.68	2.61	2.54
Other Uses[b]	6.44	8.49	8.44	10.98	10.95
Total Energy Consumption	**17.46**	**22.18**	**21.75**	**26.74**	**25.73**

[a]Includes fuel consumption for district services.
[b]Includes miscellaneous uses, such as service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, emergency electric generators, combined heat and power in commercial buildings, manufacturing performed in commercial buildings, and cooking (distillate), plus residual fuel oil, liquefied petroleum gas, coal, motor gasoline, and kerosene.
PC = Personal computer.
Notes: Totals may not equal sum of components due to independent rounding. Data for 2003 are model results and may differ slightly from official EIA data reports.
Sources: 2003 based on Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). Projections: National Energy Modeling System, runs AEO2005.D102004A and BING_ICE_CAP.D021005C.

Figure 11. Buildings Sector Carbon Dioxide Emissions in Four Cases, 2003, 2015, and 2025
(Million Metric Tons)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_EFF.D020905A, BING_ICE.D020905A, and BING_ICE_CAP.D021005C.

When the incentive and deployment proposals in the Incent case (that is, the price guarantee for an Alaska natural gas pipeline, tax incentives for nuclear power, IGCC, and sequestration, and the PTC extension) are combined with the new building code and efficiency standards in the Bldg-Std case, the price of electricity falls by about 2.5 mills per kilowatthour in 2015 and about 1 mill per kilowatthour in 2025, relative to the reference case. The net impact of adding the additional tax incentives and deployments proposal is to slightly decrease the price of electricity (increased IGCC reduces natural gas consumption and prices for power generation) and slightly increase electricity demand above what it would have been without the incentives and deployment proposal. For commercial lighting, this means that projected total electricity demand declines by about 1 percent in 2015 and 5.5 percent in 2025 in the combined NCEP case relative to the reference case.

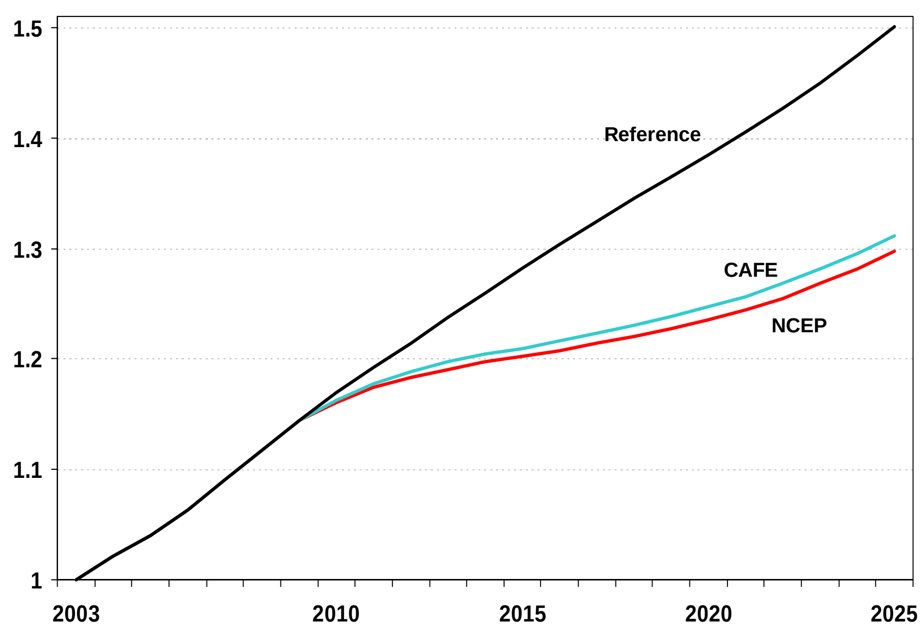
Transportation Sector Impacts

The Commission did not provide a specific recommendation for a revised CAFE standard. Instead, it recommended that the National Highway Transportation Safety Administration (NHTSA) study the matter and determine a plausible increase in CAFE. The CAFE standard used in this study was based on guidance provided by Senator Bingaman’s committee staff. This proposal simulates a 36-percent increase in the CAFE standard for cars and light trucks by 2015, corresponding closely to an increase of 10 mpg for automobiles, with an equivalent percentage improvement for light-duty trucks, amounting to about 8 mpg. The CAFE case does not include any other NCEP-recommended policies, but it does assume that all LDV manufacturers adhere to the new CAFE standards, which forces an increase in the sale of hybrid vehicles.

The NCEP and the CAFE cases have similar impacts on petroleum consumption and imports, because the other NCEP technology policies have little impact on petroleum consumption, as previously noted. Further, the NCEP and CAFE cases share other similarities—the LDV efficiencies achieved and the incremental costs of new LDVs are virtually identical in the two cases (see Table B-2 in Appendix B). Relative to the CAFE case, total vehicle miles traveled are slightly lower in the NCEP case because of the increased cost of driving that results from higher fuel costs due to the permit price on the fuel. The NCEP case, because of its higher fuel prices, reduces fuel consumption beyond the reductions induced by the new CAFE policy alone (Figure 12). The impact of the CAFE proposal on net petroleum imports, transportation consumption, and vehicle efficiency is largely additive when combined with the other NCEP policies modeled in NEMS. Consequently, the analysis in this section focuses on the CAFE and NCEP cases.

Figure 12. Index of Light-Duty Vehicle Energy Use, 2003-2025

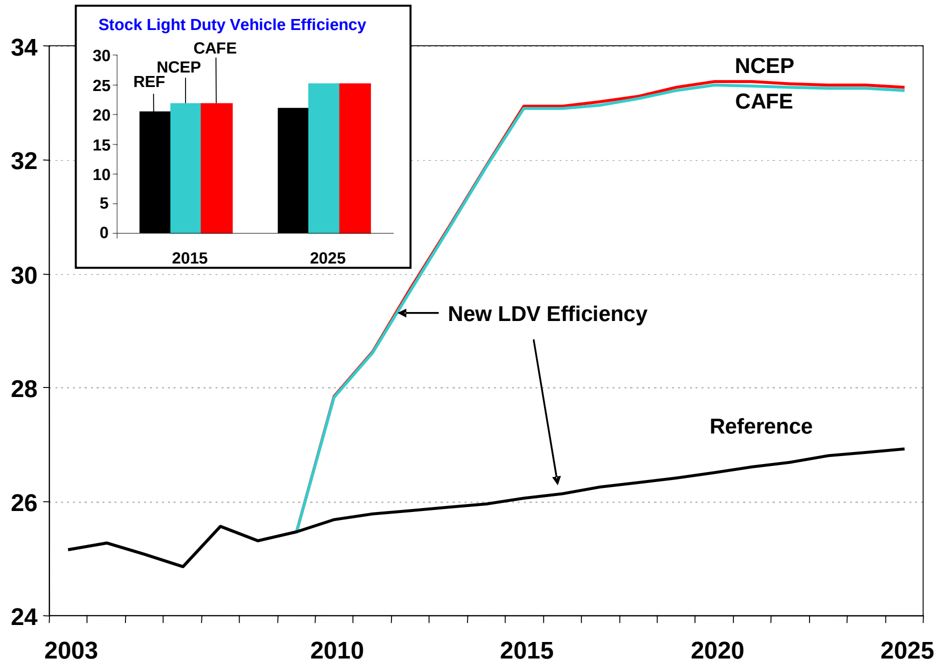
(Index, 2003=1.0)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_CAFE.D021005A, and BING_ICE_CAP.D021005C.

The 36-percent increase in the CAFE standard for cars and light trucks by 2015 has a significant impact on LDV fuel consumption. The reduction in LDV energy demand is directly attributable to the increased fuel economy of new LDVs in the CAFE case relative to the reference case. In the CAFE case, LDV fuel consumption is reduced by 6 percent (1.2 quadrillion Btu) in 2015 and 13 percent (3.0 quadrillion Btu) in 2025, relative to the reference case (Figure13). The NCEP case, which combines the CAFE standards with other proposed efficiency standards, tax incentives, and GHG emission target with a safety-valve price, reduces LDV energy consumption by an additional 1 percent (0.2 quadrillion Btu) in 2025.

Figure 13. New and Stock Light-Duty Vehicle Fuel Efficiency
(Miles per Gallon)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_CAFE.D020905A, and BING_ICE_CAP.D021005C.

The current CAFE standard is 27.5 mpg for cars and 21.0 mpg for light trucks. In the reference case, the CAFE standard for light trucks increases to 22.2 mpg by 2007. The NCEP CAFE proposal, at 36 percent higher than today's standard, results in efficiency levels of 37.5 mpg for cars and 30.3 mpg for light trucks by 2015. The CAFE proposal has a significant impact on increasing LDV fuel economy over the reference case. However, projected new LDV fuel economy is substantially higher than the projected average fuel economy of the LDV stock. Average LDV stock fuel economy is lower due to continued use of older vehicles not effected by the new CAFE standards (stock turnover) and the fact that on-road fuel economy performance is typically 20 percent lower than the fuel economy achieved in the EPA fuel economy tests. In the CAFE case, new LDV fuel efficiency is 26 percent (6.8 mpg) higher in 2015 and 23 percent (6.3 mpg) higher in 2025, relative to the reference case (Figure 13). Combining this with the slow stock turnover and fuel economy degradation factors causes average stock fuel efficiency to increase by only 7 percent (1.4 mpg) in 2015 and 19.5 percent (4.1 mpg) in 2025, relative to the reference case. Compared to the CAFE case, the NCEP case produces no further change in LDV fuel efficiency.

The CAFE proposal plus the increase in sales of hybrids have an impact on the average price of new LDVs. It costs more to produce these higher fuel economy vehicles, resulting in higher average prices for LDVs. In the CAFE case, the average price of a new LDV increases by 5 percent ($1,400 in 2003 dollars) in 2015 and by 4 percent ($1,200) in 2025, relative to the reference case.

The CAFE proposal and resulting increases in the vehicle price has an impact on LDV sales. In both the NCEP and CAFE cases, LDV sales are lower relative to the reference case, with the sales impact approximately the same. In the CAFE case, new LDV sales decline by 5 percent (910,000 vehicles) in 2015 and by 4 percent (896,000 vehicles) in 2025 relative to the reference case.

For the CAFE case, increased sales of hybrid light trucks, which displace sales of conventionally powered light trucks, enable manufacturers to meet the CAFE standard. In the CAFE case, new hybrid vehicle sales increase by 327 percent (1.3 million vehicles) in 2015 and by 255 percent (1.3 million vehicles) in 2025 relative to the reference case. On the other hand, sales of new conventionally powered vehicles decline by 21 percent (1.6 million vehicles) in 2015 and 17 percent (1.5 million vehicles) in 2025 relative to the reference case.

The CAFE proposal results in a slight increase in vehicle miles traveled, due to the decrease in the cost of driving associated with the increase in the average LDV stock fuel economy. In the CAFE case, the real cost of driving is 7 percent (0.5 cents per mile) lower in 2015 and 18 percent (1.3 cents per mile) lower in 2025 relative the reference case. In the CAFE case, total LDV miles traveled are 1 percent (38 billion miles) higher in 2015 and 4 percent (172 billion miles) higher in 2025 relative to the reference case. CO_2 emission reductions from the imposition of the new CAFE standard are significant. In the CAFE case, transportation CO_2 emissions are reduced by 3 percent (82 million metric tons) in 2015 and 8 percent (215 million metric tons) in 2025 relative to the reference case.

The CAFE and NCEP cases have a slight impact on freight truck fuel use, efficiency, and vehicle miles traveled. In both the NCEP and CAFE cases, changes in freight travel are due to changes in economic activity—specifically, industrial output. The slight reduction in heavy vehicle fuel economy in these cases relative to the reference case is based on the reduction in fuel price. The new CAFE standard for LDVs does not appreciably change economic activity or fuel prices and therefore negligibly changes consumption and prices. Industrial output reductions in the NCEP case are slightly more significant than in the CAFE case. The delivered fuel prices to freight transportation, which include the GHG permit price, are higher than in the CAFE case. Change in heavy vehicle fuel economy between these cases is based on variation in fuel price among cases.

The current version of NEMS does not represent the product mixes of each vehicle manufacturer. Therefore our analysis does not address the potential of major CAFE changes to affect the competitive position and profitability of each manufacturer in a non-uniform manner.

Industrial Sector Impacts

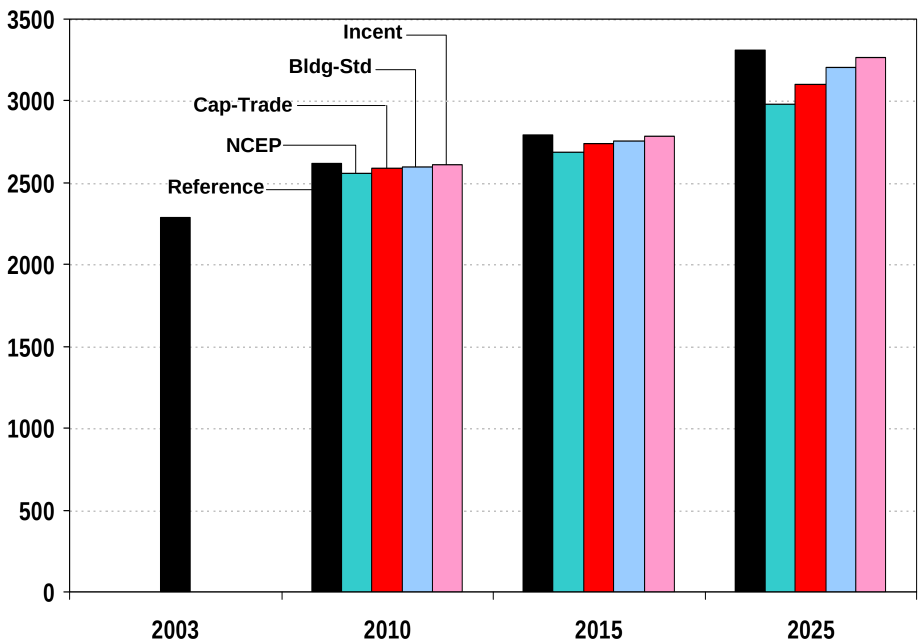
There are no special policies directed toward the industrial sector in the NCEP recommendations; however, the industrial sector is affected by the limitations on CO_2 emissions and is indirectly affected by the price and macroeconomic effects of policies targeted to other sectors. Because of the limitations on GHG emissions and the macroeconomic impacts of the recommendations, energy consumption in the industrial sector is reduced by up to 0.8 quadrillion Btu in the NCEP case relative to the reference case, most of which is coal use in boiler applications and purchased electricity.

Electricity Generation and Fuel Use

The NCEP recommendations have significant impacts on power sector CO_2 emissions, generation by fuel, generating technology selection, electricity sales, and electricity prices. A shift in the fuels used to generate electricity and a reduction in the overall demand for electricity contribute to a 108-million-metric-ton (3.9-percent) reduction in power sector CO_2 emissions in 2015 and a 331-million-metric-ton (10.0-percent) reduction in 2025 in the NCEP case (Figure 14). The key policy recommendations driving these reductions are the proposed GHG cap-and-trade program and the revised buildings sector efficiency standards. The recommended increase in CAFE standards and the various technology deployment programs do not have a significant impact on power sector CO_2 emissions.

Figure 14. Power Sector Carbon Dioxide Emissions in Five Cases

(Million Metric Tons CO_2)

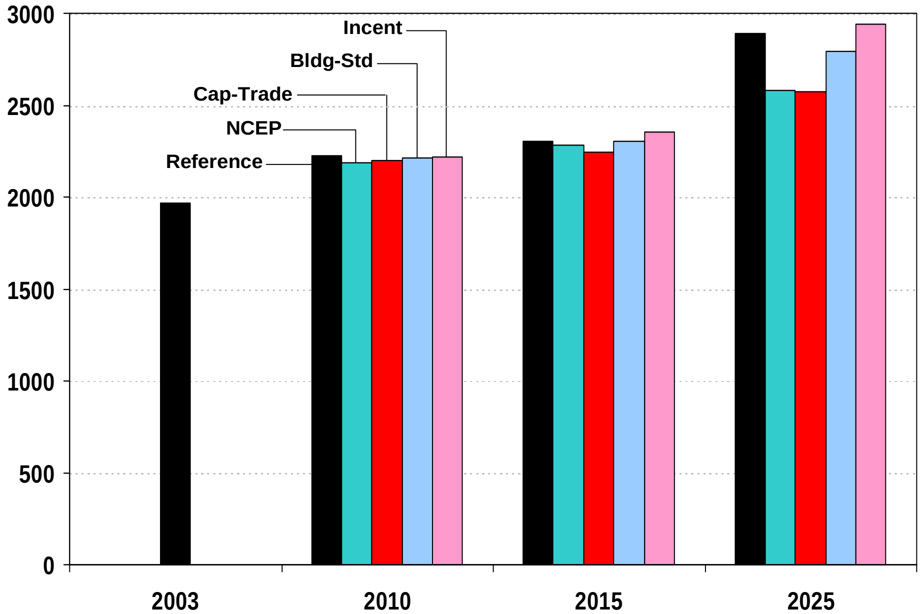


Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

Reduced use of coal and natural gas and increased use of renewable fuels are key factors in the reduced power sector CO_2 emissions. Relative to the reference case, coal-fired generation is 20 billion kilowatthours (0.9 percent) lower in 2015 and 306 billion kilowatthours (10.6 percent) lower in 2025 in the NCEP case (Figure 15). Even with these changes, however, total coal-fired generation in 2025 is 614 billion kilowatthours (31.1 percent) higher than in 2003 in the NCEP case. The NCEP recommendations slow the expected growth in coal use but do not eliminate it.

The key recommendations leading to lower coal use are the GHG cap-and-trade program and the revised buildings sector efficiency standards. The revised buildings sector standards lower consumer electricity needs, while the GHG cap-and-trade program makes it more expensive to

Figure 15. Coal-Fired Electricity Generation in Five Cases
(Billion Kilowatthours)



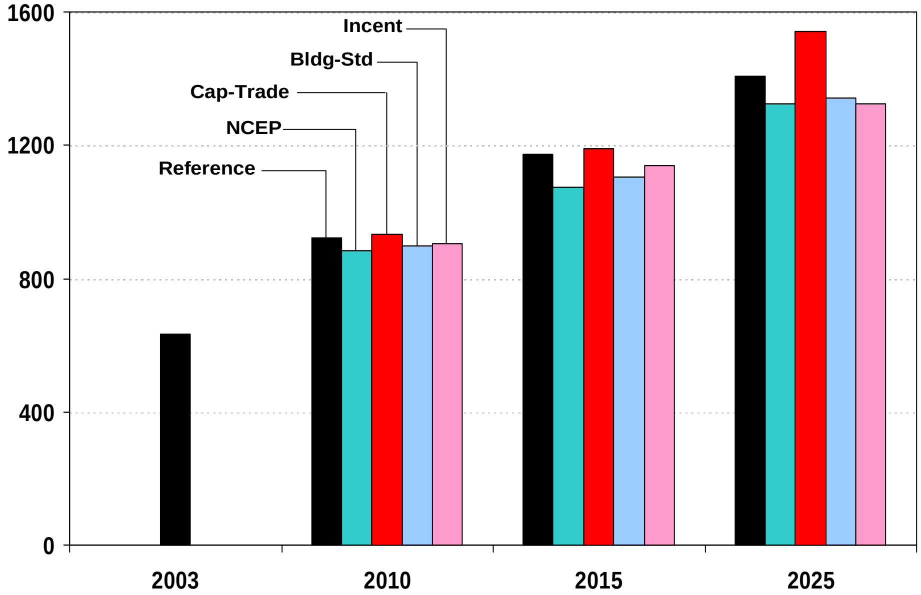
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

use coal. In the NCEP case, the effective price of using coal (the price of coal plus the cost of emissions permits) delivered to power plants is $0.54 per million Btu (43.4 percent) higher in 2015 and $0.74 per million Btu (56.4 percent) higher in 2025 than in the reference case.

The projected effects of the NCEP recommendations on natural-gas-fired generation are similar to the effects on coal-fired generation. Relative to the reference case, gas-fired generation is 113 billion kilowatthours (9.5 percent) lower in 2015 and 138 billion kilowatthours (9.0 percent) lower in 2025 in the NCEP case than in the reference case (Figure 16). However, the various NCEP recommendations influence gas-fired generation in opposite directions. By itself, the GHG cap-and-trade program would lead to an increase in gas-fired generation, because it makes it more economical to use natural gas rather than coal. Conversely, the revised buildings sector efficiency standards and the various deployment incentives, including the PTC for renewables and the $4-billion program for advanced coal technologies, both lead to lower gas-fired generation. Again, as was the case for coal, the NCEP recommendations are expected to slow the growth of natural-gas-fired generation but not eliminate it. In 2025, gas-fired generation is 694 billion kilowatthours (109.8 percent) higher than in 2003 in the NCEP case.

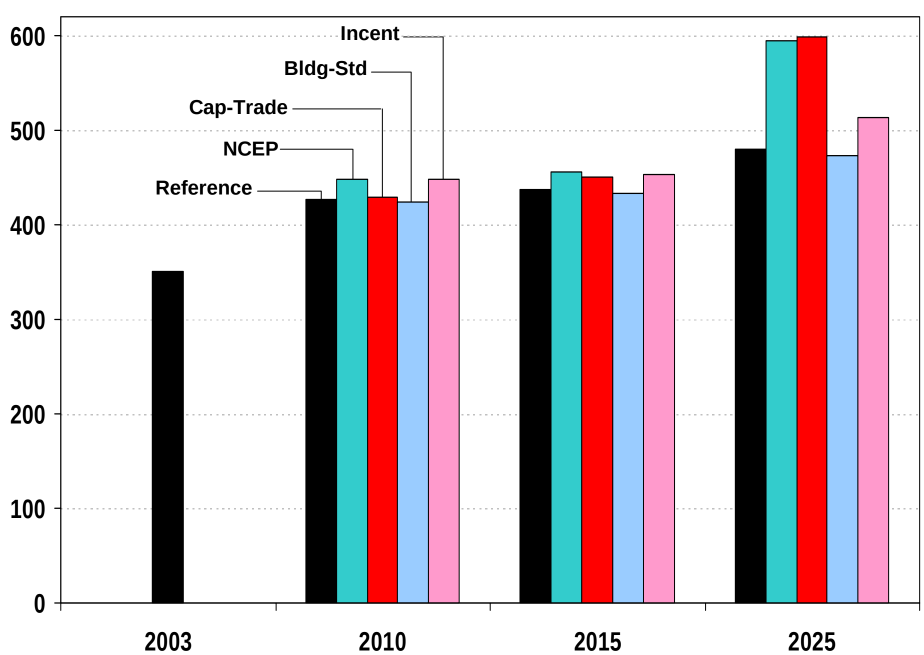
In contrast to coal and natural gas, renewable fuel use for power generation is stimulated by the NCEP recommendations. Relative to the reference case, renewable generation is 18 billion kilowatthours (4.1 percent) higher in 2015 and 114 billion kilowatthours (23.3 percent) higher in 2025 in the NCEP case (Figure 17). The GHG cap-and-trade and the extended PTC for

Figure 16. Natural-Gas-Fired Electricity Generation in Five Cases
(Billion Kilowatthours)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

Figure 17. Renewable Electricity Generation in Five Cases
(Billion Kilowatthours)



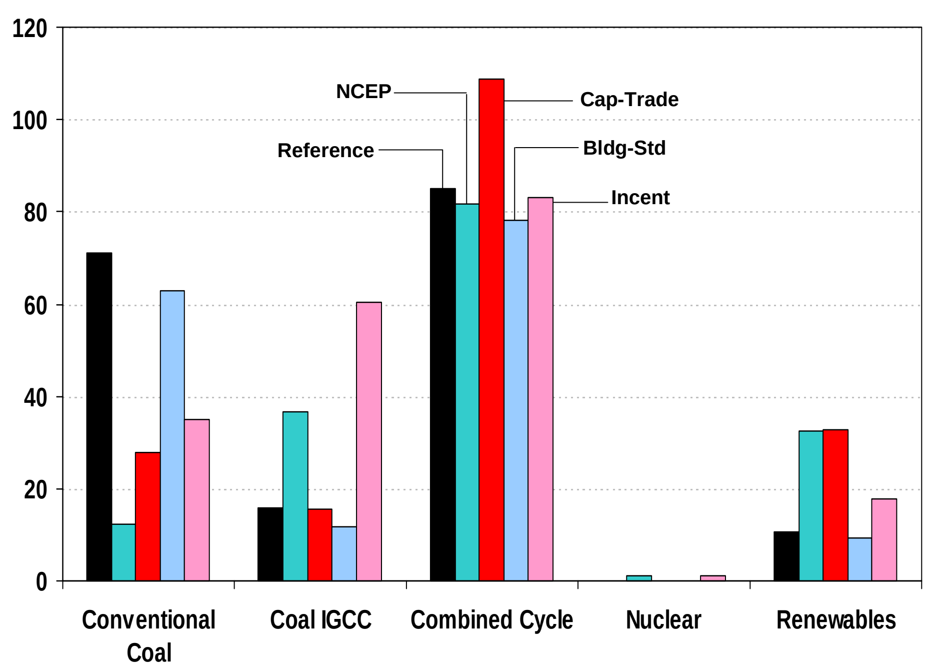
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

non-GHG-emitting technologies (included in the Incent case) stimulate increased electricity production from renewables. Among renewable generation options, increased generation from dedicated biomass plants, which can operate as baseload plants, is expected to show the largest change. Smaller increases are expected for geothermal and landfill gas generation, because they have a limited number of available economical sites. Wind-powered generation is also expected to increase, but because it is not a baseload technology, it cannot displace coal-fired generation as effectively as biomass can.

Consistent with the expected changes in generation by fuel, the NCEP policies also influence the types of generation capacity added to meet growing electricity demand. In the NCEP case, overall coal capacity additions are lower than in the reference case, but the additions of advanced coal IGCC plants are expected to be larger. In the NCEP case, 37 gigawatts of IGCC capacity are added, 21 gigawatts more than are added in the reference case (Figure 18). The shift toward IGCC is stimulated by the $4-billion deployment program to develop 10 gigawatts of IGCC capacity over 10 years. The early deployment of 10 gigawatts of IGCC capacity stimulates cost reductions that lead to further capacity additions in later years. Of these, 4 gigawatts (as called for in the deployment program) also have carbon capture equipment. As shown in the Incent case, the impact of this program would be larger if it were implemented without the GHG cap-and-trade program, which dampens overall additions of coal-fired capacity.

Renewable capacity additions are stimulated by both the GHG cap-and-trade and non-GHG-emitting technology PTC recommendations. In the NCEP case, renewable capacity additions are

Figure 18. Power Generation Capacity Additions by Type in Five Cases
(Gigawatts)



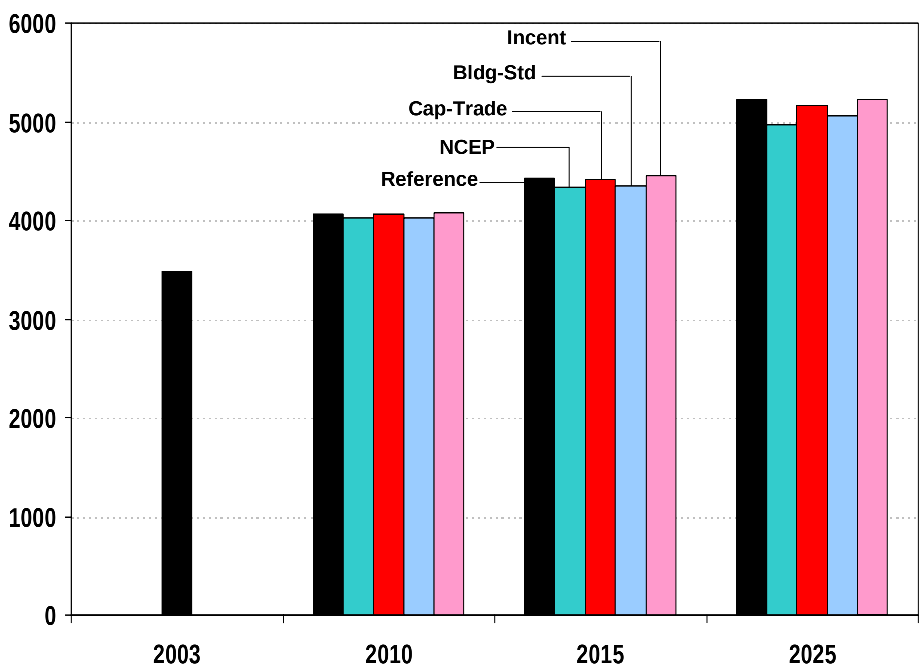
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

expected to increase to nearly 33 gigawatts, almost 3 times the level seen in the reference case, in 2025. In contrast, the early deployment of a 1-gigawatt nuclear unit is not expected to bring the costs of future units down enough to stimulate further development, and no additional plants are projected.

In addition to shifting fuel use, lower electricity demand resulting from the NCEP policies is also a significant contributor to lower power sector CO_2 emissions. Relative to the reference case, electricity sales are 92 billion kilowatthours (2.1 percent) lower in 2015 and 249 billion kilowatthours (4.8 percent) lower in 2025 in the NCEP case (Figure 19). The revised buildings sector efficiency standards are the key recommendation affecting electricity sales. The new standards force many consumers to choose more efficient appliances and improve the shell efficiency of their buildings beyond the levels seen in the reference case. Consumers are also expected to reduce their electricity consumption in response to higher electricity prices caused by the GHG cap-and-trade program.

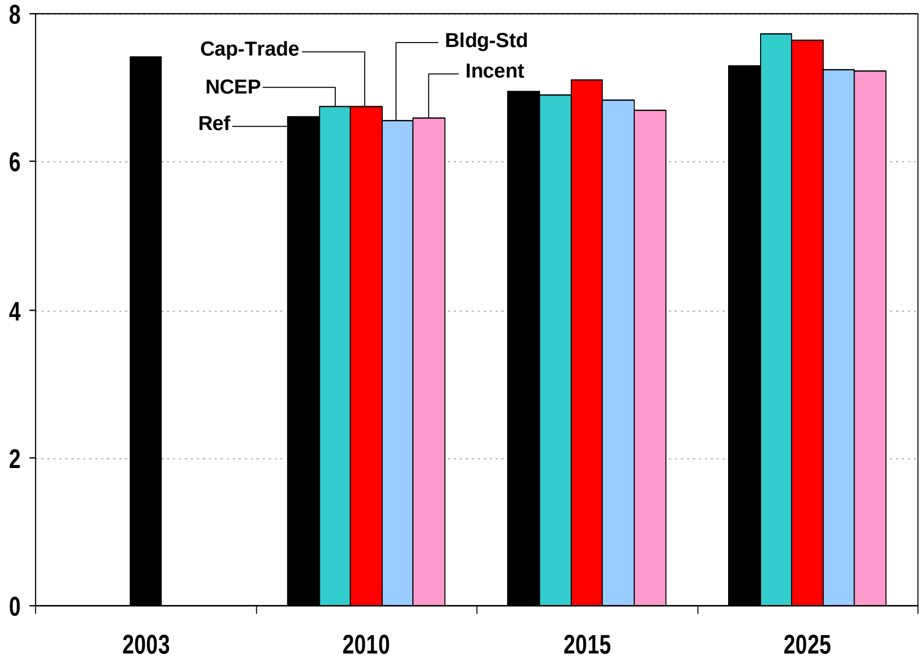
In the NCEP case, electricity prices in 2015 are virtually unchanged from those in the reference case, but in 2025 they are 0.4 cents per kilowatthour (5.8 percent) higher than in the reference case (Figure 20). The revised buildings sector efficiency standards and the various technology deployment and tax incentive programs tend to cause electricity prices to be slightly below reference case levels, but their impact is offset by the GHG cap-and-trade program, which causes power companies to turn to more expensive generation sources and pass on the costs of holding emissions allowances to their customers.

Figure 19. Electricity Sales in Five Cases
(Billion Kilowatthours)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

Figure 20. Electricity Prices in Five Cases
(Billion Kilowatthours)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.D021005A, BING_CAFE.D021005A, BING_EFF.D020905A, and BING_INCENT.D020805A.

Revenue Implications and Macroeconomic Impacts

The NCEP policies, which include a tradable emissions permit system with a safety valve on the emissions price, create additional costs that are reflected first in the wholesale and retail prices of energy and, in turn, in the consumer price index. This price impact is reflected in the Cap-Trade case. The Government retains from 5 to 10 percent of the GHG emissions credits, depending on the year, and auctions them off. It also provides additional permits at the safety-valve permit price as needed. In the Cap-Trade case, all proceeds from Government emissions permit sales go to the U.S. Treasury as additional revenue.

The NCEP case, which includes the NCEP's GHG policy as well as other policy proposals including financial incentives, price guarantees, and CAFE and efficiency standards, introduces increased Federal expenditures into the picture. Here, one question centers on the degree to which those expenditures are balanced by the additional revenue collected. Another question centers on how to reflect the additional economic consequences of a set of non-price policies, such as CAFE standards.

The discussion of the macroeconomic consequences of the NCEP policies flows from their impacts on Federal revenue and expenditures, together with their impacts on the consumer price for energy. The relationship between energy use and the full-employment long-run potential output path for the economy is first explored, followed by a discussion of the impacts of the policies on the aggregate economy throughout the entire forecast period from 2005 through 2025.

Revenue and Expenditures

In the Cap-Trade case, the emissions permit system generates revenue for the Government from the auctioned permits and from additional permits sold at the safety-valve permit price. Projected annual permit revenue ranges from $1.5 billion in 2010 to $13.8 billion in 2025 (2003 dollars). Revenue growth occurs in part because the auctioned share increases from 5 percent in 2010 to 10 percent in 2022. More significantly, revenue from safety-valve permit sales is projected to grow rapidly after 2016, eventually exceeding the auction revenue. The projected cumulative undiscounted permit revenue from 2010 to 2025 is $101.5 billion, or 0.04 percent of real GDP over the same period. On a 2003 present value basis (discounting at 4 percent, the same rate used in the NCEP analysis), the permit revenue in the Cap-Trade case is $51.9 billion, with no offsetting expenditures for other policies represented.

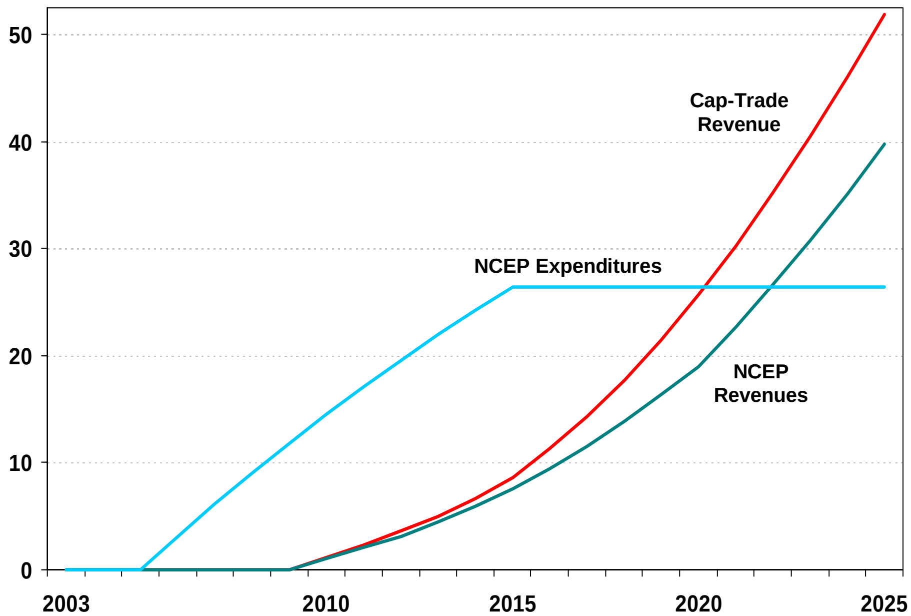
Projected permit prices and auction revenue in the NCEP case are somewhat lower than in the Cap-Trade case through 2019, when the safety-valve permit price is reached. The energy efficiency and deployment programs in the NCEP case reduce emissions independently of the permit program, the sole source of CO_2 emissions reductions in the Cap-Trade case. As a result, the auction price is below the safety-valve price through 2018, and fewer permits are sold at the safety-valve permit price after 2018 in the NCEP case. The delay in permit prices reaching the safety-valve price reduces projected undiscounted revenue in the NCEP case. Projected cumulative undiscounted revenue is $77.6 billion in the NCEP case, compared with $101.5 billion in the Cap-Trade case. The present value of the revenue is $39.7 billion in the NCEP case, compared with $51.9 billion in the Cap-Trade case. The NCEP's estimated policy expenditures from 2006 to 2015 total $35.3 billion in 2003 dollars, or $26.4 billion on a present-value basis.[24] This suggests that the NCEP's goal to recoup the policies' expenditures through permit sales would be more than realized through 2025, with revenue uncertainty depending on the level of the safety-valve permit sales. Accumulating discounted revenue and expenditures over time reveals the time frame necessary for the programs to achieve fiscal neutrality (Figure 21). In the NCEP case, the projected cumulative discounted revenue equates with cumulative expenditures in 2022.

Prices

In 2010, when the tradable permit system is put in place in the Cap-Trade case, the producer price index (PPI) for fuels and related products and power is projected to increase by 3.5 percent; the consumer price index for energy (CPI-Energy) rises by 2 percent; and the overall consumer price index (CPI) rises by 0.2 percent relative to their values in the reference case. Over the following 15 years, all these price indices are projected to diverge continuously from the reference case. In 2025, the PPI for fuels and related products and power is 7.2 percent above the reference level, the CPI-Energy is 5 percent above the reference level, and the CPI is 0.5 percent

[24]This is equivalent to $36 billion in 2004 dollars and covers the entire set of programs recommended by the NCEP, as described in the summary of the NCEP report.

Figure 21. Cumulative Sum of Discounted Forecast Revenue and Expenditures
(Billion 2003 Dollars)

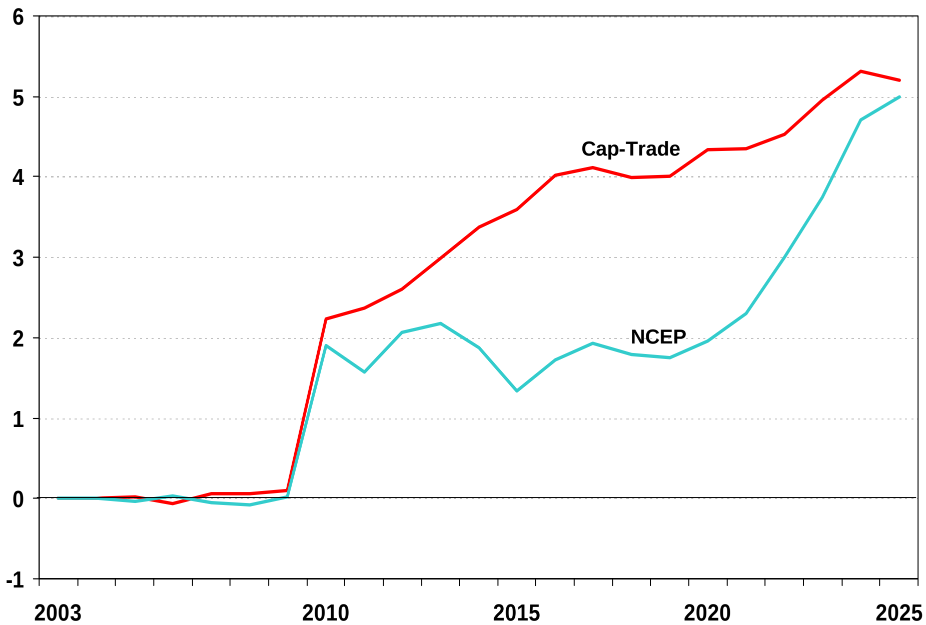


Source: National Energy Modeling System, runs BING_ICE_CAP.D021005C and BING_CAP.D021005A.

above the reference level. However, the average annual inflation rate, as measured by the average annual growth rate of the CPI, remains essentially unchanged for the 2010-2025 period.

With the addition of the financial incentives, CAFE regulations, and building efficiency standards in the NCEP case, the demand for natural gas and electricity is moderated starting in 2010. In addition, the price guarantee for natural gas delivered through an Alaska natural gas pipeline is projected to bring it online by 2014, displacing some more expensive domestic natural gas supplies and natural gas imports. Consequently, the natural gas wellhead price is relatively stable between 2010 and 2018, with some minor variations, which are reflected in electricity prices. The PPI for fuels and related products and power is expected to drop very slightly from the reference case level before 2010, rise to 2.7 percent above the reference case level in 2010 when the emissions permit system is introduced, fall back to the reference case level by 2015, and rise to 7.0 percent above the reference case level in 2025. The sharp increase in the last 10 years of the forecast is due mainly to the forecast of a sharp rise in electricity and natural gas prices. The CPI-Energy (Figure 22) follows a similar profile, first diverging from the Cap-Trade result, and then rising in the later years to about the same level as the Cap-Trade case. However, throughout most of the period, the CPI-Energy in the NCEP case is below that in the Cap-Trade case. Again, there is virtually no impact on the average annual inflation rate over the period from 2005 to 2025.

Figure 22. Impacts on the Consumer Price Index for Energy
(Percent Change from Reference Case)



Sources: National Energy Modeling System, runs BING_ICE_CAP.D021005C and BING_CAP.D021005A.

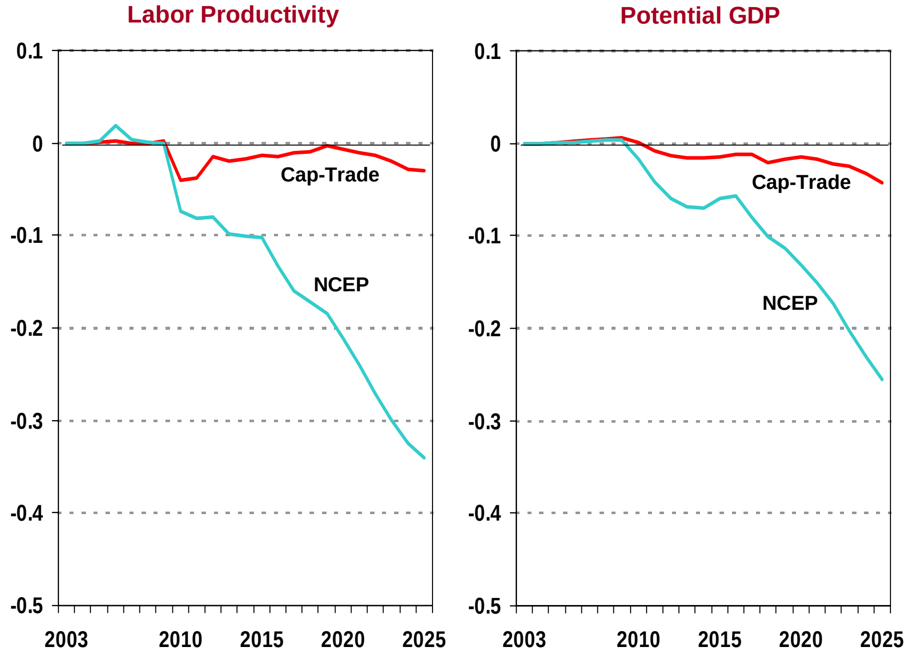
Energy Use and Potential GDP

The aggregate supply potential of the economy is embodied in a concept identified as "potential GDP." The estimate of this concept relies on a production function view of the economy that combines factor input growth and improvements in total factor productivity. Factor inputs equal a weighted average of labor, business fixed capital, public infrastructure, and energy.[25] The concept of potential GDP reflects the trajectory of the long-term growth potential of the economy at full employment, unlike the concept of real GDP (sometimes referred to as actual GDP), which reflects the trajectory of the actual economy as it adjusts to the long-run path. The impacts of these policies on real GDP can be expected to be, on average, considerably higher than on potential GDP until the adjustment process plays out over time.

In the Cap-Trade case, higher energy costs reduce the amount of energy used. Although this reflects a more efficient use of energy, it tends to lower slightly the productivity of other factors in the production process. As shown in Figure 23, there is a decline in labor productivity resulting from the imposition of the permit price mechanism, and there is a long-run loss in the "potential" output of the economy. The combination of price (permit fee) and non-price (including standards) policies leads to a further reduction in energy use and an even greater loss in potential GDP. In 2025, potential GDP is projected to be 0.04 percent lower than the reference

[25]Based on each factor's historical share of input costs, the elasticity of potential output with respect to labor is 0.64 (i.e., a 1-percent increase in the labor supply increases potential GDP by 0.64 percent); the business capital elasticity is 0.26; the infrastructure elasticity is 0.02; and the energy elasticity is 0.07.

Figure 23. Impacts on Labor Productivity and Potential GDP
(Percent Change from Reference Case)



Sources: National Energy Modeling System, runs BING_ICE_CAP.D021005C and BING_CAP.D021005A.

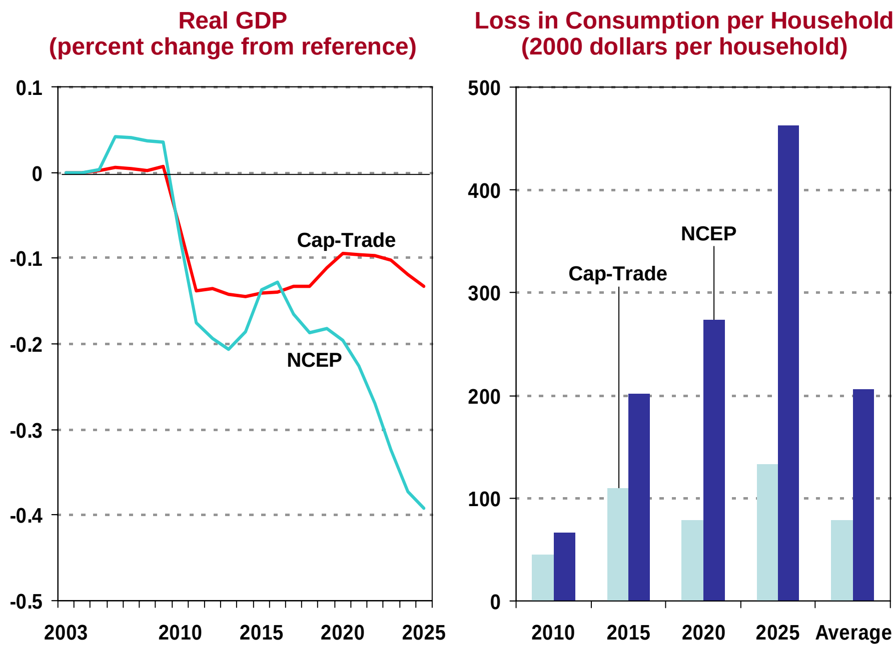
case level in the Cap-Trade case and 0.26 percent lower than the reference case level in the NCEP case.

The Aggregate Economy

In the Cap-Trade case, with GHG credit prices added to the production cost of fuels, delivered energy prices are higher than in the reference case, and real income of households is lower. This not only reduces energy consumption but also indirectly reduces real spending (due to lower purchasing power) for other goods and services. Lower aggregate demand for goods and services results in lower real GDP relative to the reference case (Figure 24). On the production side of the economy, higher energy costs imply a movement toward energy-saving production techniques that entail dislocations and unemployment of resources in the short to medium term as the economy moves toward a different optimal use of capital, labor, and energy.

The economy is immediately affected in the first 2 years of the emissions policy implementation. Real GDP is reduced by $19 billion in 2000 dollars (0.14 percent) in 2011. The negative impact on real GDP is expected to remain around 0.10 to 0.15 percent throughout the remainder of the forecast period. In 2025, real GDP in the economy is approximately $27 billion (0.13 percent) less than in the reference case; however, the overall annual growth rate of the economy between 2003 and 2025, in terms of both real GDP and potential GDP, is not materially altered. The average loss in consumption per household over the period from 2006 to 2025 is $78, expressed in 2000 annual dollars.

Figure 24. Impacts on Real GDP and Consumption per Household
(Percent Change from Reference Case)



Source: National Energy Modeling System, runs BING_ICE_CAP.D021005C and BING_CAP.D021005A.

In addition to the GHG cap-and-trade program, the NCEP case includes increases in Government expenditures to fund selected energy programs. The increase in Government expenditures leads to a slight rise in real GDP in the near term. As the economy responds to the other policies and energy price fluctuations, real GDP is expected to be 0.1 percent ($10 billion) lower in 2010 and 0.4 percent ($79 billion) lower in 2025 relative to the reference case. The loss in consumption per household averages $205 per year (2000 dollars) for the entire period in the NCEP case compared to the Cap-Trade case because of the combination of new CAFE standards, efficiency standards, and the GHG emissions permit prices; however, the overall annual growth rate of the economy between 2003 and 2025, in terms of both real GDP and potential GDP, is not materially altered. Peak consumption losses per household occur in 2025, at $132 per household in the Cap-Trade case (a loss of 0.1 percent relative to the reference case) and $465 per household in the NCEP case (a loss of 0.5 percent relative to the reference case).

Comparison with Analyses by the National Commission on Energy Policy

Because the Commission's technical appendices[26] reported analyses of the impacts of its proposed policies individually (or in combinations that were not requested for EIA's analysis in this report), direct comparisons could not be made, with the exception of the GHG cap-and-trade program. However, since the NCEP technical appendixes used the *AEO2004* reference case as the starting point for the analyses, the following conclusions can be drawn:

[26]National Commission on Energy Policy, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges: Economic Analysis of Commission Proposals* (Washington, DC, December 2004), web site http://64.70.252.93/O82F4693.pdf.

- The differences between the two reference cases appear to account for most of the differences in impacts on energy and GHG emissions between the two analyses of modeled NCEP policies.

- When the assumptions used were comparable, as in the building codes and efficiency standards and the CAFE cases, the savings were also comparable.

- Differences in the impacts of the cap-and-trade cases are directly attributable to the differences in the two reference cases. *AEO2005* has a higher GDP and lower GHG emissions, thus making it slightly easier to meet the NCEP target than the studies in the NCEP's technical appendixes.

- In the CAFE case, EIA's assumptions differed by 2 miles per gallon for light trucks, because with the menu of technologies available in *AEO2005*, sufficiently advanced technologies were not available to meet the CAFE target for light trucks of 10 miles per gallon by 2015. The NCEP used a slightly different menu of light truck technologies to achieve the standard.

- Other differences in the price paths for oil and natural gas between the two cases also influenced the projections for primary energy consumption.

Macroeconomic Assessment of Higher CAFE Standards

One of the key policy elements that differentiates the NCEP case from the Cap-Trade case is the raising of CAFE standards. In the CAFE case, the CAFE standards are raised by 10 mpg for cars and by an equivalent percentage for light trucks relative to the reference case. It is assumed that the new standards for cars and light trucks are phased in between 2010 and 2015.

To meet the new CAFE standards, additional resources are employed for new technologies, retooling, and design by the auto manufacturers to produce the more fuel-efficient LDVs. It is assumed that the additional manufacturing and resource costs for these new LDVs are fully added to the average price of new LDVs in the reference case. As these additional costs represent product improvements (more fuel-efficient vehicles), the incremental price of new LDVs is not considered inflationary.[27]

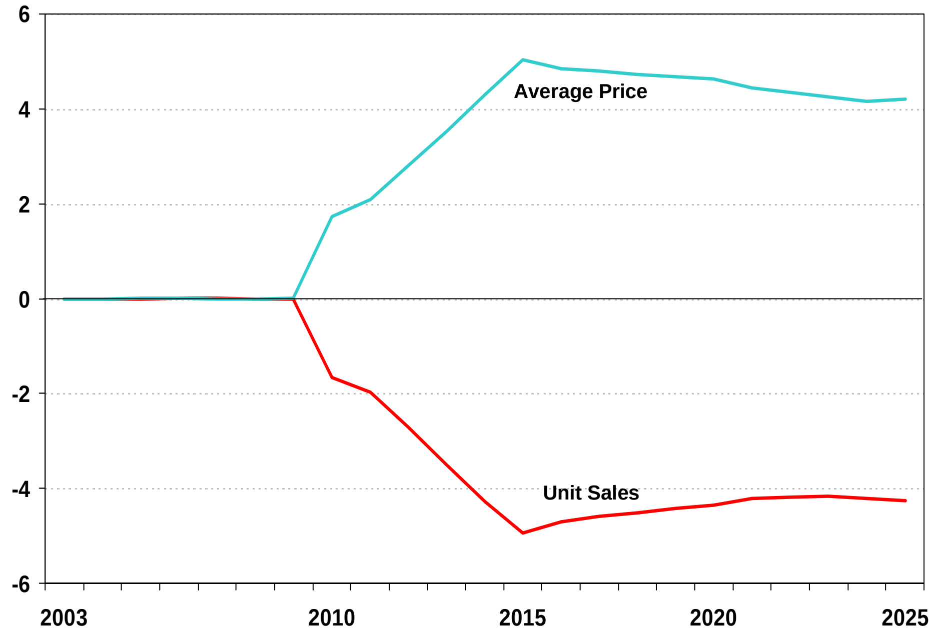
This macroeconomic analysis assesses the change in LDV sales in the aggregate, but it cannot assess shifts between cars and light trucks within the macroeconomic framework. The transportation model in NEMS estimates the shares of car and light truck sales, and there are minor shifts in light truck sales shares between the various cases (the most extreme difference is about 0.5 percentage points). The average LDV incremental cost calculation includes the price impact associated with the shift in light truck market share. Because the new CAFE standards raise the average new LDV costs relative to the reference case, fewer LDVs are sold in the CAFE case (Figure 25). Between 2010 and 2015, the average nominal price of LDVs increases steadily to $1,740 (approximately 5 percent) above the reference case price as standards are met. After 2015, new LDV efficiency is no longer required to increase, moderating further increases in vehicle prices.

In 2025, the average price of new LDVs is approximately 4.2 percent above the reference case projection, a slightly lower impact than in 2015 due to technological progress and the ability to use more conventional vehicle technologies to meet the CAFE standard. Sales of LDVs fall in proportion to the price increases, and in 2015 there are 910,000 fewer units sold (approximately 5 percent below the reference case level). Between 2016 and 2025, the decrease in LDV sales is commensurate with the increase in vehicle prices. In 2025, sales of new LDVs are approximately 4.3 percent below the reference case level. Nominal and real expenditures on new LDVs are not expected to change significantly.

At the aggregate level, there are benefits and costs to the economy because of the new CAFE standards. On the benefit side, with more fuel-efficient LDVs sold, petroleum consumption and expenditures for LDV transportation are lower than in the reference case. The decline in energy use reduces petroleum imports. As a result of a decrease in energy demand, energy prices decline slightly relative to the reference case. The relative decline in energy prices sets into motion deflationary forces that in turn stimulate aggregate demand for all goods and services, including energy.

[27]The deflator for sales of new LDVs is quality adjusted by the Bureau of Economic Analysis to reflect the imputed value of the added fuel-saving technology. Hence, the deflator would not rise.

Figure 25. Change in Average Price and Unit Sales of New Light-Duty Vehicles
(Percent Change from Reference Case)



Source: National Energy Modeling System, runs AEO2005.D102004A and BING_CAFE.D021005A.

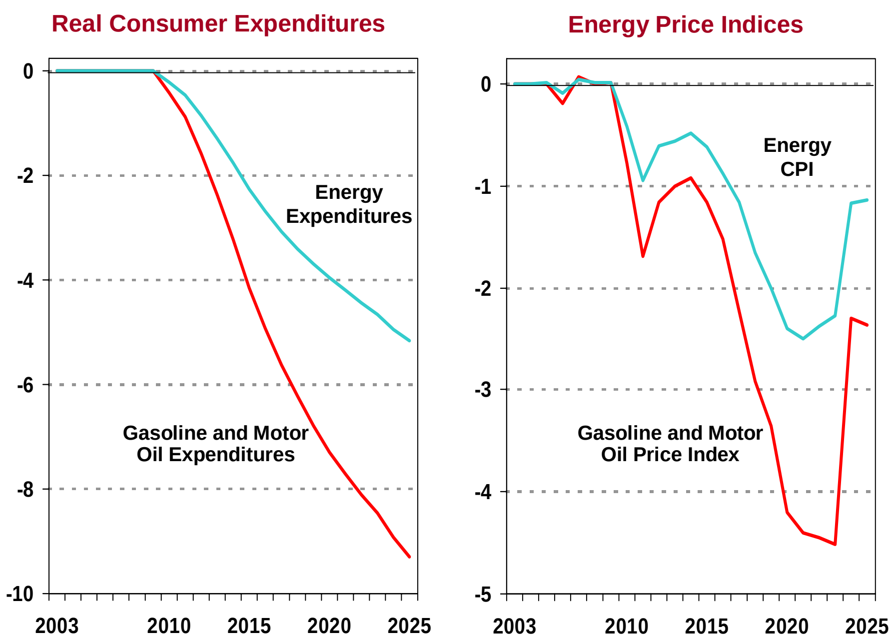
Figure 26 shows the percentage change in real consumer expenditures on gasoline and motor oil and aggregate consumer expenditures on energy relative to the reference case. It shows a continuing decrease in these real concepts, relative to the reference case, as the total LDV stock becomes more fuel efficient. In 2025, consumer expenditures on gasoline and motor oil are 9 percent lower, and aggregate real consumer expenditures on energy are 5 percent lower, than in the reference case. Figure 26 also shows the result of lower energy demand on prices. In 2025, the chained price index for consumer gasoline and oil is 2.4 percent below the reference case level, and the aggregate consumer price index for energy is 1.1 percent below the reference case level.

The costs to the economy of raising CAFE standards involve transition costs as the product mix in the economy changes and resources move toward the production of more expensive, higher-fuel-economy LDVs and away from less expensive, lower-fuel-economy vehicles. This shift forces a change in the optimal mix of factor inputs of capital, labor, and energy. Moving to this new factor input mix involves dislocations, idling of the old capital stock, employment changes, and the accumulation of new capital stock with the requisite technologies. This is reflected in the decline in potential output, relative to the reference case, with the existing resources and state of technology. Reduced energy demand in the short run is reflected in a reduction in real GDP (aggregate demand). As energy prices decrease, real demand for all goods and services increases, and real GDP temporarily goes above potential output; however, this position cannot be sustained given that potential output has not completely adjusted to providing the goods and services that are demanded. Over time, both concepts adjust and move toward each other. In 2025, both concepts are down by 0.1 percent relative to the reference case.

In 2025, both real GDP and potential GDP are approximately $26 billion (0.1 percent) less in the CAFE case than in the reference case; however, the loss to the economy does not significantly alter the overall average annual growth rate of the economy between 2003 and 2025 in terms of either real GDP or potential GDP.

Figure 26. Change in Real Consumer Expenditures, Gasoline and Oil and Aggregate Spending on Energy and Energy Price Indices

(Percent Change from Reference Case)



Source: National Energy Modeling System, runs AEO2005.D102004A and BING_CAFE.D021005A.

3. Impacts of Alternative Technology and Resource Assumptions

Introduction

This chapter focuses on the NCEP recommendations, considered in the context of the *AEO2005* high technology sensitivity cases. Each sensitivity case starts from one of the two high technology cases developed in *AEO2005*, either the integrated high technology case or the oil and natural gas rapid technology case, and incorporates additional NCEP assumptions that simulate the impacts of various policies.

EIA is acutely aware that the rate at which the future cost and performance characteristics of energy-using and producing technologies change is highly uncertain. While the EIA reference case incorporates significant improvements in technology cost and performance over time, it may either overstate or understate the actual pace of improvement.

The two *AEO2005* high technology cases are sensitivity cases that reflect assumptions of faster technological progress than is assumed in the reference case. Neither case is based on a specific level of investment in R&D. The integrated high technology case, designated here as the high demand technology case (HiTech), is a combination of the high technology assumptions for the residential, commercial, transportation, industrial, and power generation sectors. In each of these sectors, advanced technologies are assumed to be available sooner, at lower cost, and often with better performance characteristics. The oil and gas rapid technology case, designated as the high supply technology case (RTP), assumes that the effect of technological improvement on the costs, finding rates, and success rates for the exploration and production of crude oil and natural gas is 50 percent greater than in the reference case.[28]

Pursuant to the initial service report request and subsequent elaboration (see Appendix A), the EIA's analysis focused on three policy cases:

- The NCEP-HiTech case incorporates NCEP's GHG cap-and-trade policy using HiTech assumptions coupled with tax and deployment incentives and the new light duty vehicle CAFE standards.

- The RTP-IC-ETH case combines the RTP case with the tax and deployment incentives, the new CAFE standards, and assumptions on more rapid ethanol cost reductions.

- The HiTech-IC case incorporates HiTech assumptions coupled with tax and deployment incentives[29] and the new light-duty vehicle CAFE standards.

[28]Detailed assumptions for the *AEO2005* cases, including the high technology cases, are described on the EIA web site at www.eia.doe.gov/oiaf/aeo/assumption/index.html.
[29]The tax and deployment incentives include an expansion of the PTC to all new non-CO_2-emitting generation technologies and extension of the PTC to the end of 2009 with a total PTC value of $4 billion over 10 years, a price guarantee for the Alaska Natural Gas Transportation System (ANGTS), deployment incentives for one advanced nuclear plant, deployment of 10 gigawatts of sequestration-ready IGCC generating capacity, and 4 gigawatts of sequestration technologies.

The discussion below focuses on the first two of these policy cases. The impact of the third case is reflected in the results of the first.

Basis for Comparisons

Two alternative comparisons can be used to gauge the effects of the NCEP policy suite under high technology assumptions. The first, which focuses on the change in energy and economic performance between the HiTech and NCEP-HiTech cases, implicitly assumes that the enactment of the NCEP policy suite does not affect the set of available technologies, only what and how much is chosen from that set. The second compares the NCEP-HiTech case against the standard reference case. This comparison implicitly assumes that the NCEP policies are directly responsible for creating technologies with the cost and performance characteristics of EIA's high technology suite, which would not be available in their absence.

Analytical judgment and recognition of inherent modeling limitations are needed to assess which approach is most likely to more closely reflect the actual effect of "high technology" on the impact of the NCEP's policy proposals. While the imposition of more stringent efficiency standards for appliances, buildings, and vehicles included in the NCEP policy recommendations could spur targeted R&D activity in selected sectors, the limited impact of the NCEP's policy suite on delivered energy prices suggests that there would be only a modest across-the-board incentive through the price mechanism to stimulate R&D on new technologies to increase energy efficiency or reduce GHG intensity. The NCEP's policy recommendations also include a doubling of Federal funding for energy R&D; however, the relationship between increased Federal authorizations for R&D and actual technology outcomes is not well-defined, for reasons discussed in the text box below.

Caveats in Assessing the Impacts of R&D and Other NCEP Recommendations

Two types of uncertainty characterize proposed Federal R&D investments. First, while Congress often authorizes R&D, the timing and level of the actual R&D appropriations often are different from the authorization. Moreover, appropriation bills may also contain language that direct funding to specific activities or projects without regard to merit-based criteria. Second, a statistically reliable relationship between the level of R&D spending on specific technologies and the outcome of that R&D spending has not been developed. Even if both of these uncertainties were resolved, the analysis still would be complicated, because the levels of private-sector R&D spending usually are unknown and often exceed Federal R&D spending. Moreover, the relationship between private and Federal spending is unclear. Consequently, EIA cannot estimate the impact on technological change of a doubling of Federal R&D spending. EIA can, however, provide the results of the sensitivity cases specifically requested for this report, using the two *AEO2005* high technology cases as starting points.

Provided that the NCEP recommendations do not have a large impact on the set of technologies available before 2025, the implications of having a "better" technology menu on the estimated effects of the modeled elements of the NCEP proposals are best assessed by comparisons that use same technology menu for both the reference and policy cases. To the extent that the NCEP proposals are actually responsible for improving the menu as well as influencing technology choices, comparisons of this type would understate the impacts of the policy package.

The other available approach (comparing the high technology case with NCEP policies to the standard reference case) will tend to overstate impacts of the NCEP recommendations. This would be true even under the extreme assumption of an exclusive causal link between the NCEP policies and the availability of the high technology menu, given that NEMS does not capture the costs of technology development. Moreover, NEMS does not explicitly represent the role of non-energy-related R&D activities in supporting the baseline economic growth in its macroeconomic component. Therefore, NEMS cannot represent the macroeconomic impact of diverting R&D effort away from other sectors toward energy-related technologies. Such shifts in R&D effort would erode baseline growth to the extent that scarce R&D resources and technological progress in other areas of the economy were reduced.

The analysis of these effects continues to be an active area of academic research. Based on a reading of the available literature, EIA believes that the first approach is most likely to provide estimates of economic impacts that are closest to the actual economic effects under a high technology scenario and has therefore focused on such comparisons in recent service reports that estimate the impacts of policies under such a scenario.[30] The presentation below generally follows that practice, while also providing information that can be used to make the alternative comparison.

Additional Issues Regarding Technology Scenarios

Two additional issues related to technology assumptions also merit attention here. One is the possibility that one or more technologies superior to those identified in the high technology case could become available within the time frame of this analysis. While the high technology case assumptions are optimistic by design, there is always a potential for undiscovered or unanticipated technological developments to occur. The contribution of such technologies within the time frame of this analysis is likely to be limited by delays that often arise in the market penetration of new energy technologies, particularly when the new technologies are not readily compatible with existing infrastructure.

The other important issue is the global nature of technology. Because technologies can diffuse globally, technologies available in the high technology cases that penetrate the market in the United States are also likely to be applied in other national markets, with possibly important effects on world energy supplies and prices. Because NEMS does not have the capability to consider the impacts of technological spillover beyond the U.S. economy, such effects are not considered in this report.

[30]Energy Information Administration, *Analysis of S. 139, the Climate Stewardship Act of 2003*, SR/OIAF/2003-02 (Washington, DC, June 2003), web site www.eia.doe.gov/oiaf/servicerpt/ml/pdf/sroiaf_(2003)02.pdf. See also Energy Information Administration, *Analysis of Senate Amendment 2028, the Climate Stewardship Act of 2003* (Washington, DC, June 2004), web site www.eia.doe.gov/oiaf/analysispaper/sacsa/pdf/s139amend_analysis.pdf, and Energy Information Administration, *Summary Provisions of the 2003 Conference Energy Bill*, SR/OIAF/2004-02 (Washington, DC, February 2004), web site www.eia.doe.gov/oiaf/servicerpt/ml/pdf/sroiaf_(2004)02.pdf.

Greenhouse Gas Emissions Comparison

Technological progress affecting energy-using equipment usually increases energy efficiency and, all else being equal, lowers energy consumption and the resulting CO_2 emissions. By 2025, covered GHG emissions in the HiTech case are 591 million metric tons CO_2 equivalent (7 percent) lower than in the reference case (Table 8), illustrating the importance of the assumptions about technological progress. The HiTech case provides about 39 percent of the GHG reductions needed to meet the NCEP's GHG intensity target without any additional policies. In the HiTech scenario, there is less to be done to achieve the NCEP intensity target. Figure 27 illustrates the GHG emissions for key policy proposal combination. Relative to the HiTech case, the NCEP-HiTech case reduces GHG emissions by 254 million metric tons CO_2 equivalent (3.4 percent) in 2015 and 639 million metric tons (7.8 percent) in 2025.

Projected prices for emissions permits in the NCEP-HiTech case are lower than in the NCEP case, as expected given the greater efficiency improvement and more optimistic patterns of technological adoption assumed. Permit prices in the NCEP-HiTech are projected to remain below the safety-valve price throughout the projection period, and the GHG emissions targets from 2010 to 2025 are met on a cumulative basis (i.e., with the use of permit banking), because there is less to be done to achieve the intensity target (Figures 28 and 29). The NCEP-HiTech case accumulates a balance of permits during the less stringent, early phase of the program and then depletes them gradually through 2025.

As Figures 30 and 31 illustrate, a large portion of the accumulated bank of permits is from non-CO_2 GHG gases. The non-CO_2 share of emissions reductions in the NCEP-HiTech case relative to the HiTech case is 66 percent in 2010, declining to about 52 percent in 2015 and 2025. In contrast, the non-CO_2 share of emissions reductions in the NCEP case relative to the reference case is 63 percent in 2010, declining to 50 percent in 2015 and 37.5 percent in 2025. Given that non-CO_2 GHGs account for a significant share of overall GHG reductions under the NCEP-recommended cap-and-trade program, the results regarding permit prices and other effects depend heavily on the baselines and abatement cost curves for non-CO_2 GHGs supplied by the EPA for use in this analysis. Therefore, the caveats raised in earlier chapters regarding the representation of non-CO_2 GHG abatement should be kept in mind when considering these results.

Composition of Emissions Reductions

Reductions are projected for both energy-related CO_2 emissions and emissions of other covered GHGs (Figure 30). In all the cap-and-trade cases, large shares of the projected emissions reductions are made up by other GHGs, especially when permit prices are relatively low. As indicated in Table 2 in Chapter 2, significant reductions in emissions of other GHGs are assumed to be economical at permit prices below the safety-valve price. As a result, reductions of other GHGs are projected to occur starting in the first year of the policy. As permit prices increase, the share of reductions from energy-related CO_2 emissions increases.

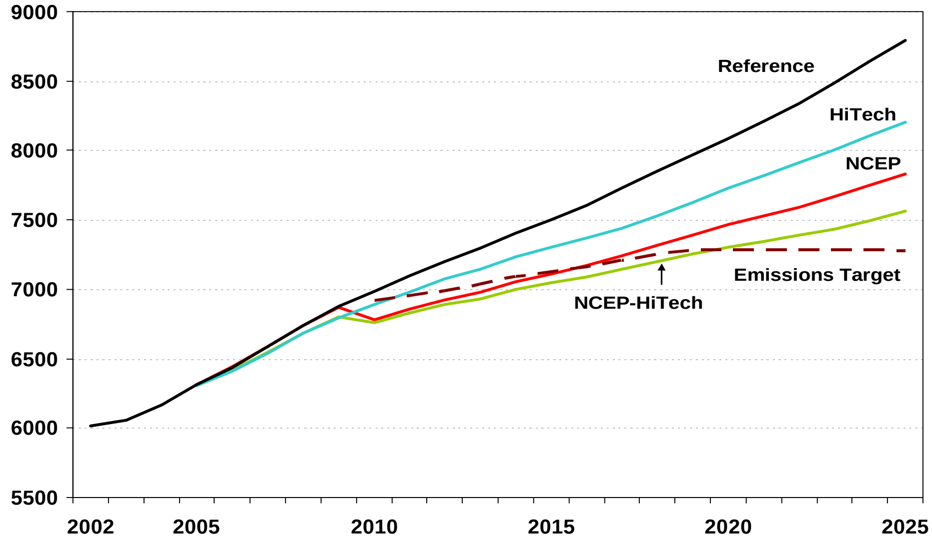
In all the cap-and-trade policy cases, the greatest share of reductions in energy-related CO_2 emissions occurs in the electric power sector, because opportunities exist in that sector to switch

Table 8. Summary Comparisons for Reference, NCEP, HiTech, and NCEP-HiTech Cases

Projection	2003	2015 Reference	2015 NCEP	2015 HiTech	2015 NCEP-HiTech	2025 Reference	2025 NCEP	2025 HiTech	2025 NCEP-HiTech
Domestic Oil Production (Million Barrels per Day)	5.68	5.49	5.49	5.50	5.49	4.73	4.69	4.72	4.65
Domestic Dry Gas Production (Trillion Cubic Feet)	19.07	20.77	21.44	20.45	21.21	21.83	20.85	21.65	20.35
Net Petroleum Imports (Million Barrels per Day)	11.24	15.40	14.60	14.79	14.18	19.11	17.29	17.66	16.48
Oil Import Dependence (Percent)	56.2	62.4	61.3	61.6	60.6	68.4	66.8	66.9	66.1
Total Fossil Fuel Consumption (Quadrillion Btu)	**84.34**	**102.47**	**99.96**	**99.39**	**97.93**	**116.37**	**108.29**	**108.60**	**104.12**
Petroleum	39.09	48.07	46.46	46.79	45.56	54.42	50.44	51.42	48.55
Natural Gas	22.54	28.69	28.24	27.56	27.42	31.47	30.34	30.50	28.90
Coal	22.71	25.71	25.25	25.04	24.95	30.48	27.51	26.68	26.67
Average Electricity Price (2003 Dollars per Kilowatthour)	7.4	6.9	6.9	6.7	6.5	7.3	7.7	7.0	7.0
Wellhead Natural Gas Price (2003 Dollars per Thousand Cubic Feet)	4.98	4.16	3.66	3.93	3.54	4.79	4.86	4.66	4.60
Delivered Price of Motor Gasoline (2003 Dollars per Gallon)	1.60	1.51	1.54	1.51	1.48	1.58	1.62	1.59	1.57
Household Energy Expenditures (2003 Dollars per Household)	1,582	1,496	1,459	1,436	1,392	1,571	1,565	1,479	1,455
Covered GHG Emissions (Million Metric Tons CO_2 Equivalent)	6,032	7,501	7,108	7,302	7,048	8,794	7,829	8,203	7,564
Energy-related CO_2 Emissions	5,789	7,052	6,857	6,854	6,733	7,820	7,438	7,471	7,171
GHG Emission Price (2003 Dollars per Metric Ton CO_2 Equivalent)	0.00	0.00	5.72	0.00	2.77	0.00	8.50	0.00	6.27
Covered GHG Emissions Intensity (Metric Tons CO_2 Equivalent per Million 2000 Dollars of GDP)	581.1	492.9	467.8	480.0	462.7	433.3	387.3	404.8	373.5
Total Electricity Generation (Billion Kilowatthours)	**3,852**	**4,890**	**4,786**	**4,783**	**4,748**	**5,770**	**5,507**	**5,558**	**5,422**
Coal	1,970	2,305	2,285	2,256	2,273	2,890	2,584	2,494	2,527
Natural Gas	632	1,173	1,075	1,120	1,048	1,406	1,325	1,577	1,364
Nuclear	764	826	834	826	834	830	838	834	846
Renewable	359	447	465	447	466	489	603	511	546
Delivered Energy Consumption by Sector (Quadrillion Btu)	**98.22**	**118.29**	**116.03**	**115.27**	**114.09**	**133.18**	**126.45**	**126.16**	**122.24**
Buildings	19.89	23.70	23.31	23.35	23.24	26.75	25.60	25.88	25.32
Total Transportation	27.07	34.75	33.52	34.03	33.04	40.04	36.56	38.20	35.50
Light-Duty Vehicles	16.33	20.93	19.63	20.35	19.45	24.51	21.15	23.27	20.86
Industrial	24.86	28.27	28.39	27.25	27.45	30.76	30.07	28.79	28.45
Fossil Fuels for Electricity Generation	26.68	33.52	32.21	32.35	31.67	39.59	35.96	36.23	34.91
Light-Duty Vehicle Sales (Thousands)	**15,902**	**17,658**	**16,788**	**17,655**	**17,290**	**20,157**	**19,201**	**20,104**	**19,690**
Hybrids Plus Advanced Diesel	392	1,634	2,798	1,555	1,395	2,099	3,200	1,988	1,780
Average New Car Miles per Gallon	29.5	30.3	37.9	32.1	39.0	31.0	38.0	33.4	39.8
Average New Light Truck Miles per Gallon	21.8	23.4	29.7	24.3	29.9	24.6	30.6	26.3	31.2

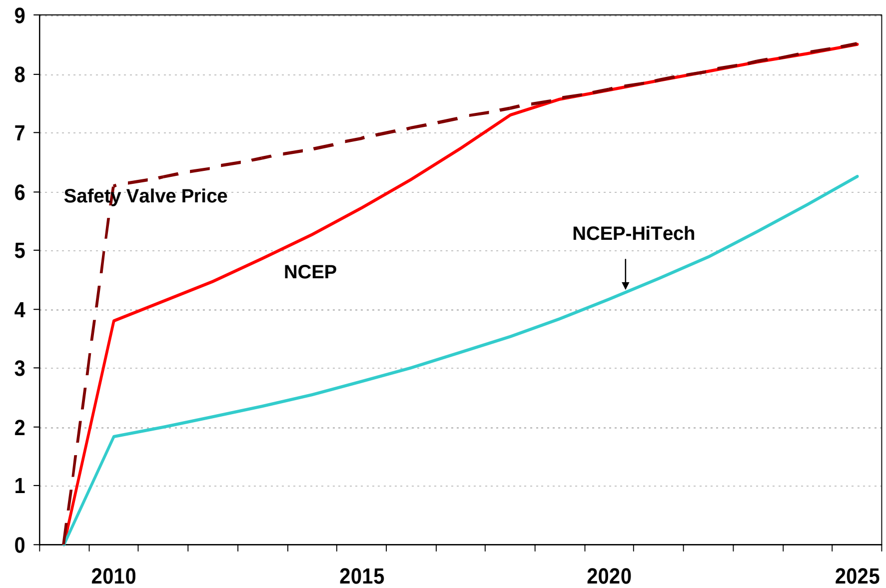
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

Figure 27. Covered Greenhouse Gas Emissions in the Reference, HiTech, NCEP, and NCEP-HiTech Cases, Compared to the Intensity Target, 2002-2025
(Million Metric Tons Carbon Dioxide Equivalent)



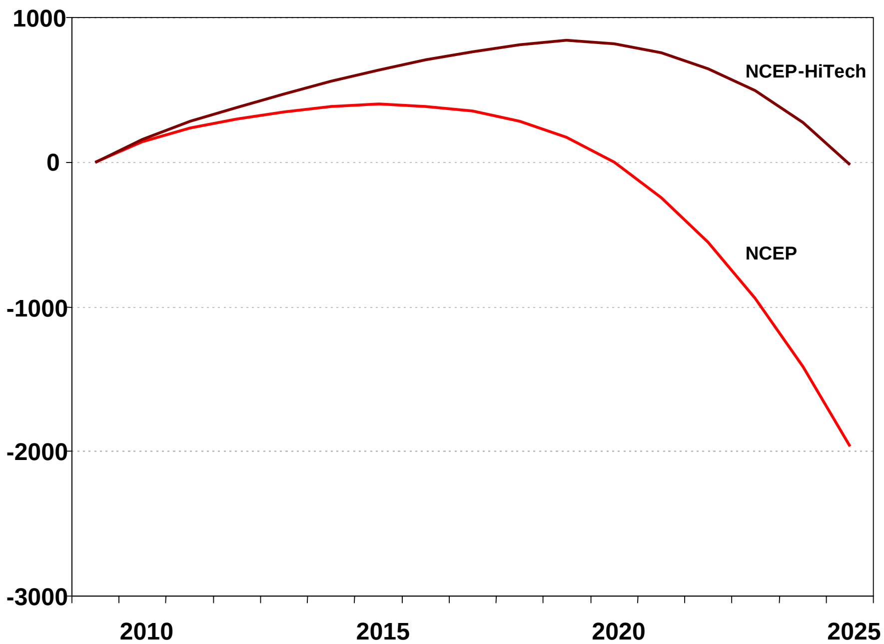
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

Figure 28. Greenhouse Gas Emissions Permit Prices Compared to the Safety-Valve Price
(2003 Dollars per Metric Ton Carbon Dioxide Equivalent)



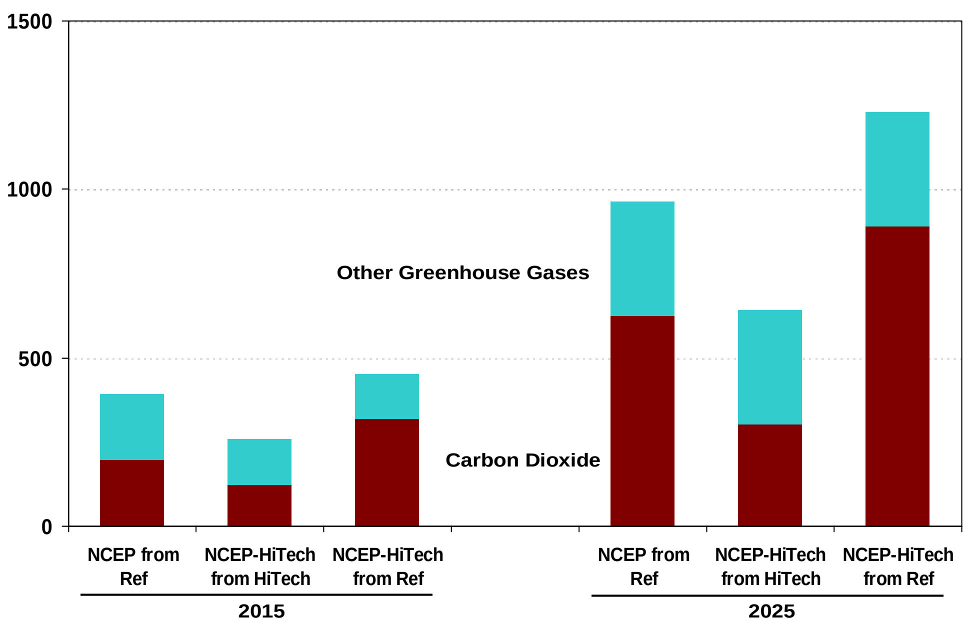
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_CAP.DO21005A, and BING_HDTICECAP.D021005A.

Figure 29. Emissions Permit Bank Balance in the NCEP and NCEP-HiTech Cases, 2002-2025
(Million Metric Tons Carbon Dioxide Equivalent)



Source: National Energy Modeling System, runs BING_ICE_CAP.D021005C and BING_HDTICECAP.D020905A.

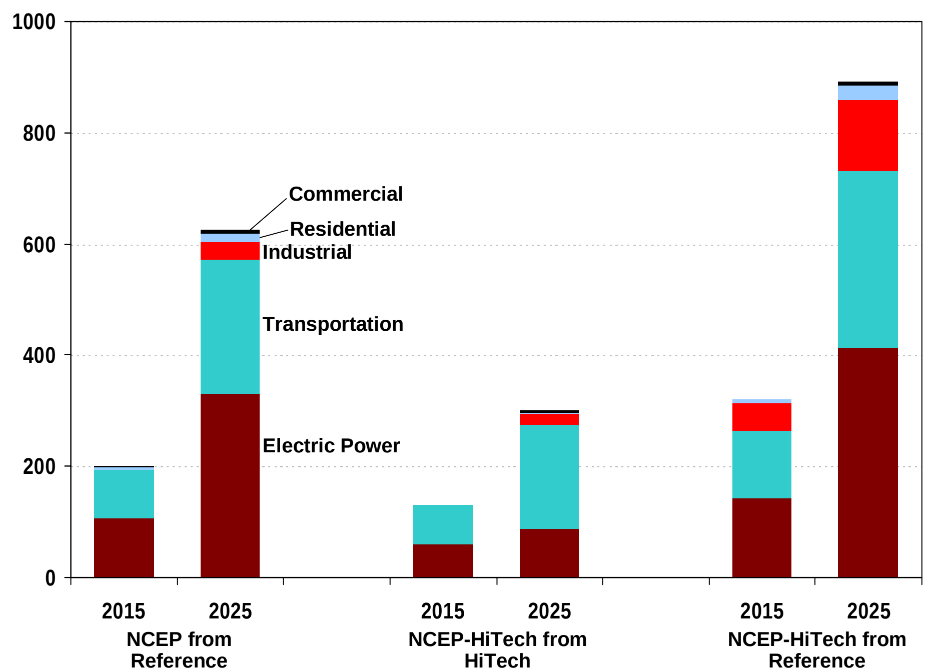
Figure 30. Mix of Greenhouse Gas Emissions Reductions, 2015 and 2025
(Million Metric Tons Carbon Dioxide Equivalent)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_HDTICECAP.D020905A, and HRTKITEN.D111604A.

to fuels that emit less or no net CO_2 at a lower cost than in other sectors (Figure 31). These options include sequestering CO_2 and using less coal and more natural gas, renewable fuels, and nuclear power. Reductions in electricity demand also contribute to the CO_2 emissions reductions in the power sector, and many of the NCEP policies would promote more efficient use of electricity. In the NCEP and NCEP-HiTech cases, large emissions reductions occur in the transportation sector as a result of the assumed increases in the CAFE standards. Together, the reductions in total GHG emissions attributable to changes in energy consumption for electricity generation and to reductions in other GHG emissions account for 70 percent of the total GHG emissions reductions in the NCEP-HiTech case relative to the HiTech case from 2010 to 2025 as compared with 72 percent of the total GHG emissions reductions projected to occur from 2010 to 2025 in the NCEP case relative to the reference case. Figure 32 shows the cumulative emission reduction shares for CO_2 and non-CO_2 gases from 2010 to 2025 in the NCEP-HiTech relative to the HiTech case and in the NCEP case relative to the reference case. In the NCEP-HiTech case, about 52 percent of the cumulative reductions are reductions in emissions of non-CO_2 GHGs.

Figure 31. Carbon Dioxide Emissions Reductions by Sector in Three Cases, 2015 and 2025
(Million Metric Tons)



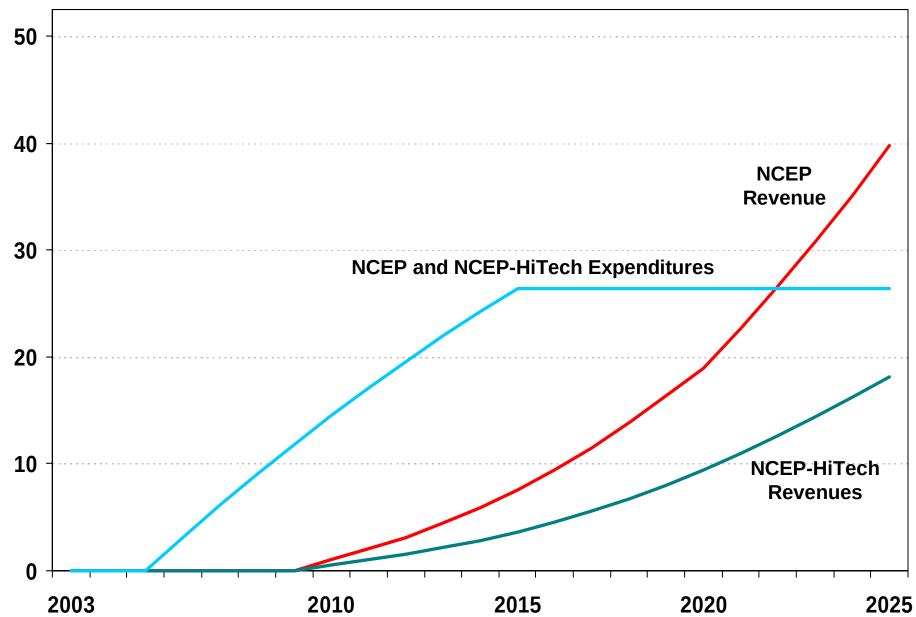
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, BING_HDTICECAP.D020905A, and HRTKITEN.D111604A.

Revenue Implications

The NCEP-HiTech case represents the same set of policies as the NCEP case but with the assumption of more rapid technological progress in all end-use sectors and the power generation sector. The GHG intensity goal is achieved in the NCEP-HiTech with less adverse impact on the economy than in the NCEP case. Any incremental costs associated with achieving the assumed rates of technological progress are not addressed in this study.[31]

With the use of high technology and efficiency assumptions in the NCEP-HiTech case, the emissions permit price never reaches the safety-valve level within the forecast horizon (Figure 28). Revenue collected from the tradable permit system is expected to increase from $0.6 billion in 2010 to $4.6 billion in 2025. The cumulative revenues through 2025 are $35.1 billion and their present value is $18.2 billion. By 2025, the permit revenue collection is not sufficient to cover the expenditures of the full program (Figure 32).

Figure 32. Cumulative Sum of Projected Revenues and Expenditures, Discounted to 2003 Value
(Billion 2003 Dollars)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, and BING_HDTICECAP.D020905A.

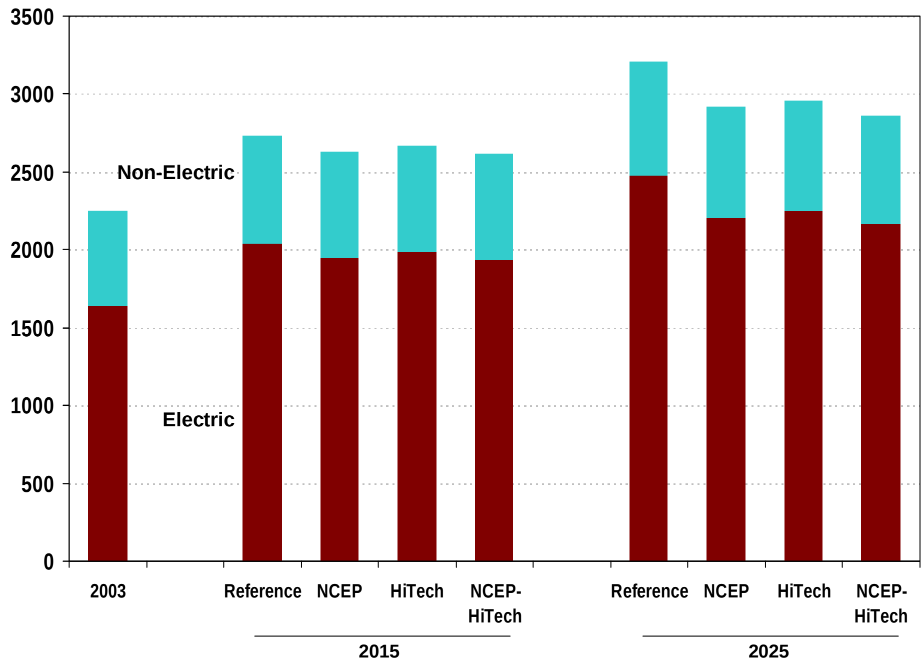
Buildings Sector Impacts

The impacts of the NCEP-HiTech case are similar to but more pronounced than the impacts of the NCEP case. That is, the advanced technologies become economical and are adopted sooner, which leads to greater reductions in energy use and CO_2 emissions than in the NCEP case (Figure 33 and Table 9). It should be noted that buildings energy consumption and CO_2 emissions in the HiTech case are roughly comparable to, although slightly higher than, those in the NCEP case in both 2015 and 2025.

[31]The costs to the economy associated with developing lower costs and higher efficiencies are unknown and beyond the scope of this analysis.

The addition of the NCEP's policies in the NCEP-HiTech case leads to slightly greater reductions in projected CO_2 emissions in the buildings sector when compared with the HiTech case. Projected CO_2 emissions attributable to the residential sector in the NCEP-HiTech case are 2 percent (27 million metric tons) lower in 2015 and 3 percent (51 million metric tons) lower in 2025 than projected in the HiTech case. Projected CO_2 emissions attributable to the commercial sector in the NCEP-HiTech case are 2 percent (26 million metric tons) lower in 2015 and 3 percent (42 million metric tons) lower in 2025 than projected in the HiTech case.

Figure 33. Buildings Sector Carbon Dioxide Emissions in Selected Cases, 2003, 2015, and 2025
(Million Metric Tons Carbon Dioxide)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

Transportation Sector Impacts

Petroleum consumption in the NCEP-HiTech case is lower than in the NCEP case (Figure 34). The incremental cost of new vehicles is also much lower in the NCEP-HiTech case due to fuel economy improvements resulting from the increased penetration of advanced conventional technologies, allowing the fuel economy standards proposed by the NCEP to be met without increasing sales of diesel or hybrid vehicles (as occurs in the NCEP case). As a percent of new vehicles sold, hybrid and diesel vehicle sales decrease slightly in the NCEP-HiTech case compared to the HiTech case, because the improved fuel economy of conventional vehicles reduces the competitive advantage of hybrid and diesel vehicles in the market.

By improving conventional technologies, the HiTech case reduces LDV fuel demand by 3 percent (0.6 quadrillion Btu) in 2015 and 5 percent (1.2 quadrillion Btu) in 2025, relative to the reference case. With the new CAFE proposal in the NCEP-HiTech case, LDV fuel consumption declines by another 4 percent (0.9 quadrillion Btu) in 2015 and 10 percent (2.4 quadrillion Btu)

Table 9. Buildings Energy Consumption by Sector and Source
(Quadrillion Btu per Year, Unless Otherwise Noted)

Sector and Source	2003	Projections			
		2015		2025	
		HiTech	NCEP-HiTech	HiTech	NCEP-HiTech
Residential					
Petroleum	1.58	1.56	1.56	1.47	1.47
Natural Gas	5.25	5.78	5.81	5.80	5.76
Electricity	4.37	5.30	5.22	6.02	5.77
Other[a]	0.41	0.39	0.40	0.37	0.37
Delivered Energy	**11.61**	**13.03**	**12.98**	**13.66**	**13.37**
Electricity-Related Losses	9.71	11.02	10.83	11.70	11.39
Total	**21.31**	**24.05**	**23.81**	**25.36**	**24.76**
Commercial					
Petroleum[b]	0.75	0.89	0.89	0.99	0.97
Natural Gas	3.22	3.71	3.72	4.18	4.10
Electricity	4.13	5.53	5.46	6.87	6.69
Other[c]	0.18	0.18	0.18	0.18	0.18
Delivered Energy	**8.29**	**10.32**	**10.26**	**12.22**	**11.95**
Electricity-Related Losses	9.18	11.49	11.34	13.36	13.21
Total	**17.46**	**21.80**	**21.60**	**25.58**	**25.16**

[a]Includes coal and wood used for residential heating. Does not include estimates of nonmarketed renewable energy consumption for geothermal heat pumps, solar thermal hot water heating, and solar photovoltaic electricity generation.

[b]Includes ethanol (blends of 10 percent or less) and ethers blended into gasoline.

[c]Includes commercial sector consumption of coal, wood and wood waste, landfill gas, municipal solid waste, and other biomass for combined heat and power. Does not include estimates of nonmarketed renewable energy consumption for solar thermal hot water heating and solar photovoltaic electricity generation.

Notes: Totals may not equal sum of components due to independent rounding. Data for 2003 are model results and may differ slightly from official EIA data reports.

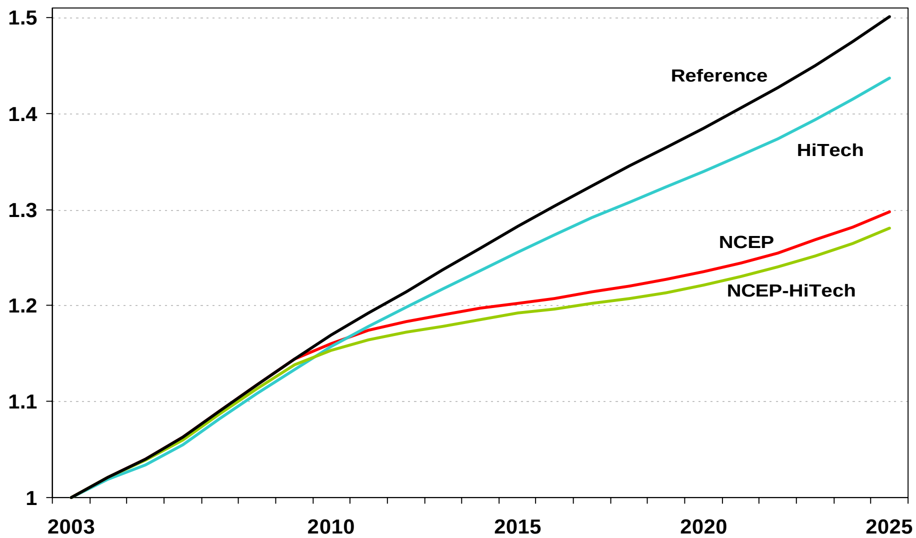
Sources: **2003 consumption:** Based on Energy Information Administration, *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004). **Projections:** National Energy Modeling System, runs HTRKITEN.D111604A and BING_HDTICECAP.D020905A.

in 2025 relative to the HiTech case. Nearly all of the reduction in transportation petroleum demand achieved in the NCEP-HiTech case can be attributed to improved LDV fuel economy.

As a result of reduced transportation energy demand, projected GHG emissions are also lower in the HiTech and NCEP-HiTech cases than in the reference case. GHG emissions in the HiTech case are 2 percent (50 million metric tons CO_2 equivalent) lower in 2015 and 5 percent (130 million metric tons CO_2 equivalent) lower in 2025 than in the reference case. GHG emissions in the NCEP-Hitech case are 3 percent (74 million metric tons CO_2 equivalent) lower than in the HiTech case in 2015 and 7 percent (184 million metric tons CO_2 equivalent) lower in 2025.

In the NCEP-HiTech case, new LDV fuel economy increases by 22 percent (6.1 miles per gallon) in 2015 and 19 percent (5.5 miles per gallon) in 2025, relative to the HiTech case (Figure 35). The fuel economy of the LDV stock increases by only 7 percent (1.4 miles per gallon) in 2015 and 17 percent (3.7 miles per gallon) in 2025 relative to the HiTech case, because of slow stock turnover. As a result of the higher fuel economy of the LDV stock in the NCEP-HiTech

Figure 34. Projected Trends in Light-Duty Vehicle Petroleum Consumption, 2003-2025
(Index, 2003=1)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

case, the cost of driving is reduced, which induces greater travel demand. Compared to the HiTech case, LDV travel in the NCEP-HiTech case is 1 percent (41 billion miles) higher in 2015 and 3 percent (141 billion miles) higher in 2025.

The changes in average LDV prices, sales, and vehicle miles traveled in the NCEP-HiTech case and HiTech case are smaller than those in the CAFE case. The average price of a new LDV is projected to increase by $800 (3 percent) in 2015 and $600 (2003 dollars) (2 percent) in 2025 in the NCEP-HiTech case, compared with increases of $1,400 in 2015 and $1,200 in 2025 in the CAFE case, because the NCEP-HiTech case makes use of lower cost, more efficient conventional technologies in the HiTech case to meet the CAFE standard. New LDV sales in the NCEP-HiTech case, as compared with the HiTech case, decline by 365,000 vehicles (2 percent) in 2015 and 414,000 vehicles (2 percent) in 2025, because the new CAFE standard in the NCEP-HiTech case increases the cost of new LDVs. Because of the lower technology costs, however, the uptake of advanced LDV technologies increases the new and stock average fuel efficiencies relative to those in the NCEP case.

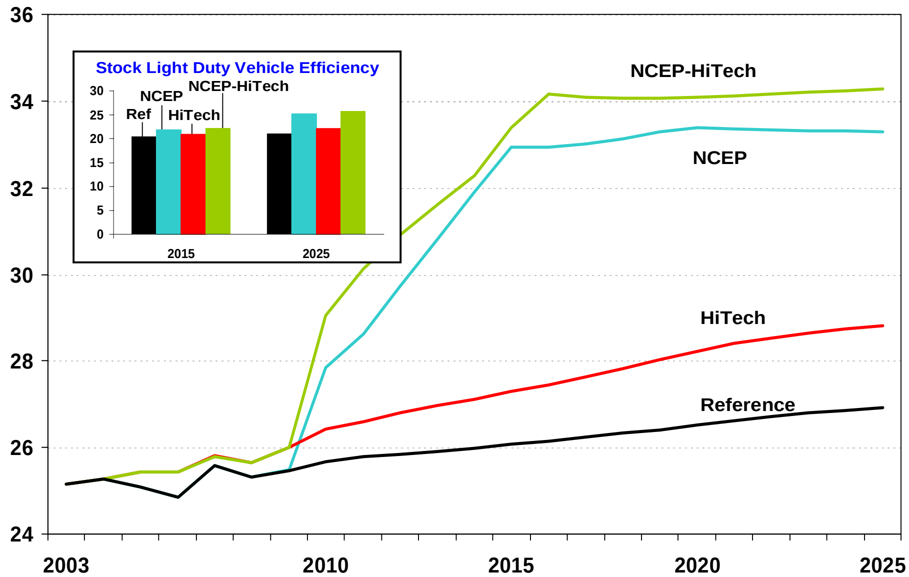
Primary Energy Use Patterns

Total Primary Energy Use

Total energy consumption in 2025 in the HiTech case is 126.2 quadrillion Btu, 7.0 quadrillion Btu less than in the reference case (Table 8 and Figure 36). Primary energy consumption in the HiTech case is slightly lower than the NCEP case projection of 126.5 quadrillion Btu in 2025, illustrating the importance of the technological change assumptions on the impact of potential

Figure 35. New and Stock Fuel Economy for Light-Duty Vehicles in the Reference, NCEP, HiTech, and NCEP-HiTech Cases

(Miles per Gallon)



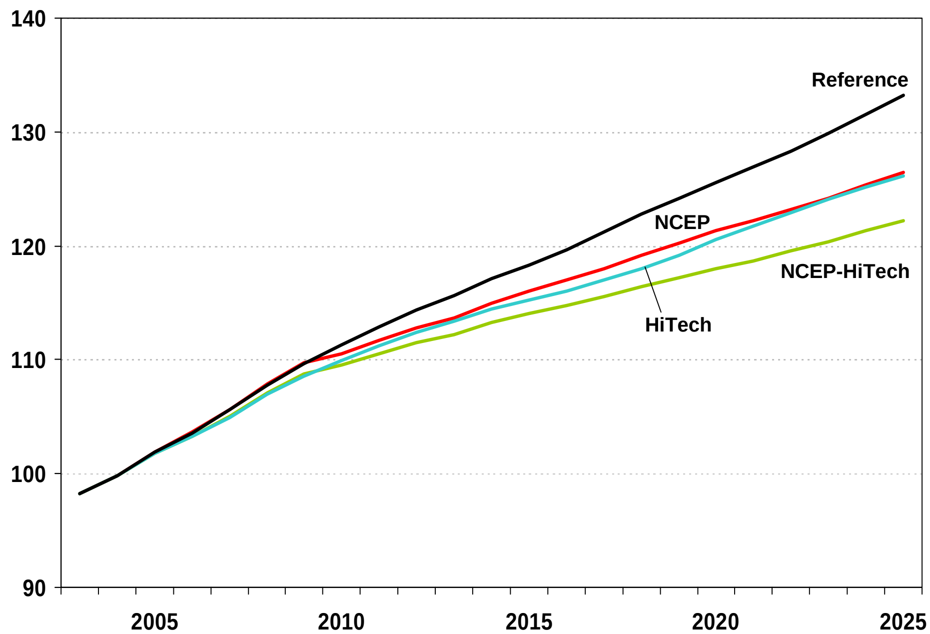
Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

policies. The high technology assumptions combined with the NCEP modeled policies lower primary energy consumption by another 3.9 quadrillion Btu from the HiTech case.

Although the projections for primary energy consumption in the NCEP and HiTech cases are comparable, the mix of fuels is different in the two cases. The new CAFE standards and the new building and efficiency standards in the NCEP case, relative to the HiTech case, cause lower petroleum and electricity consumption. The mandatory GHG cap-and-trade program of the NCEP increases renewable fuel use and reduces emissions of GHGs other than CO_2 and thus reduces the pressure for fuel switching away from coal in the power generation sector. As a result, coal use is higher in the NCEP case than in the HiTech case. However, CO_2 emissions in the HiTech case are slightly higher than in the NCEP case, and with no emissions cap-and-trade policy, total GHG emissions are much higher in the HiTech case than in the NCEP case (by 374 million metric tons CO_2 equivalent).

In the NCEP-HiTech case, all delivered energy prices except the price of coal are lower than those in the HiTech case in 2015. The price guarantee for the Alaska natural gas pipeline reduces natural gas wellhead prices in the period following its construction in 2014. The new CAFE standard reduces petroleum consumption and slightly lowers world oil prices. In 2015, the minemouth and wellhead fuel price reductions are greater than the increases caused by the addition of the permit price to the delivered fuel cost. By 2025, however, only delivered petroleum products are below the Hitech delivered prices, as increases in the permit prices generally overtake the reductions in natural gas wellhead prices and minemouth coal prices.

Figure 36. Total Primary Energy Consumption in Four Cases, 2003-2025
(Quadrillion Btu)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

Petroleum

The NCEP-HiTech case results in a significant reduction in petroleum consumption relative to the HiTech and reference cases; however, the reduction in petroleum consumption in the NCEP case relative to the reference case is larger than the corresponding reduction in the NCEP-Hitech case relative to the HiTech case. For example, petroleum consumption in the NCEP case is 1.61 quadrillion Btu lower than in the reference case in 2015, whereas in the NCEP-HiTech case it is 1.23 quadrillion Btu lower than in the HiTech case in 2015. The differences are greater in 2025: petroleum consumption in the NCEP case is 3.98 quadrillion Btu lower than in the reference case, and in the NCEP-HiTech case it is 2.87 quadrillion Btu lower than in the HiTech case. The differences result primarily from the higher-efficiency and lower-cost transportation technologies assumed in the HiTech case, which boost new car fuel economy by 2.4 mpg above the reference case level in 2025, and from the lower permit price projected in the NCEP-HiTech case compared to the NCEP case. Consequently, the improvement in LDV fuel economy between the HiTech and NCEP-HiTech cases is smaller than the improvement between the NCEP and reference cases. The CAFE policy by itself reduces petroleum consumption in 2025 by 3.08 quadrillion Btu. The smaller efficiency difference, combined with the lower permit price in the NCEP-HiTech case, narrows the difference in consumption between the NCEP-HiTech and HiTech cases compared to the difference between the NCEP and reference cases.

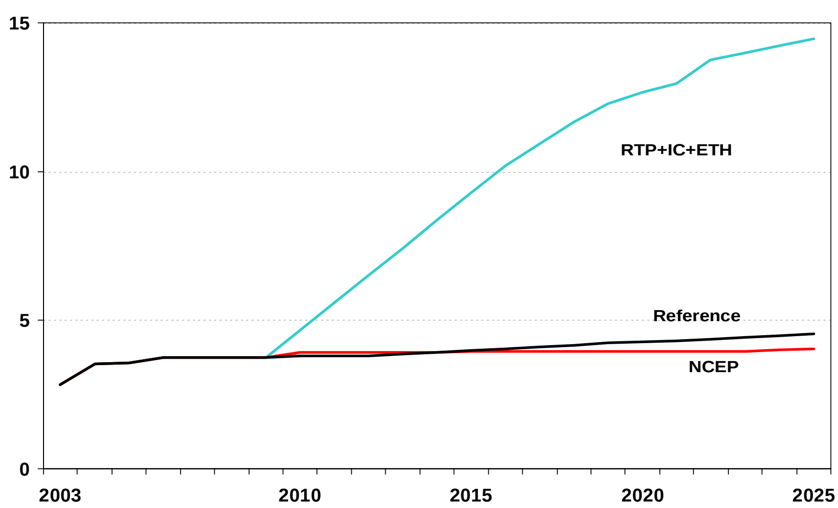
Changes in net petroleum imports are almost linearly related to the changes in petroleum consumption between the cases, because petroleum imports are the marginal source of supply for U.S. energy markets. A decrease in U.S. petroleum consumption of 1 barrel relative to the reference case is projected to lead to a reduction in oil imports of approximately 0.94 barrel.

Ethanol

If the HiTech case were combined with only the NCEP's proposed CAFE standards for LDVs, motor gasoline consumption by LDVs (and consequently demand for ethanol for fuel blending) would be reduced. However, under the assumptions provided by Senator Bingaman's committee staff for crop yield improvements and manufacturing cost declines, cellulose ethanol production increases to well over 10.7 billion gallons in 2025 in the RTP-IC-ETH case—10.3 billion gallons higher than in the reference case.

The RTP-IC-ETH case includes tax and deployment incentives, the new CAFE standard for LDVs, and an ethanol R&D program, which is assumed to substantially reduce the cost of ethanol from cellulose relative to the reference case. The assumed cost reductions and yield improvements for cellulosic ethanol more than offset the effects of the new CAFE standards, resulting in large increases in ethanol production from cellulose compared with the reference case. Some growth in corn ethanol production that would have happened in the reference case is displaced by cellulosic ethanol in the RTP-IC-ETH case. The net result is a large overall increase in transportation ethanol use, from 4.5 billion gallons in the reference case to 14.5 billion gallons in the RTP-IC-ETH case (Figure 37).

Figure 37. Ethanol Use for Transportation in the Reference, NCEP, and RTP+IC+ETH Cases
(Billion Gallons)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, and BING_HST_IC.D021105A.

Natural Gas

In general, the high technology assumptions result in lower natural gas prices and more natural gas consumption than in the reference case. In the RTP case, the assumed impact of technological improvement for oil and natural gas exploration and production is 50 percent greater than in the reference case, resulting in total natural gas consumption that is 2.4 trillion cubic feet (7.8 percent) higher in 2025 than in the reference case and average delivered natural gas prices that are about $0.50 per thousand cubic feet (in 2003 dollars) lower than in the reference case.

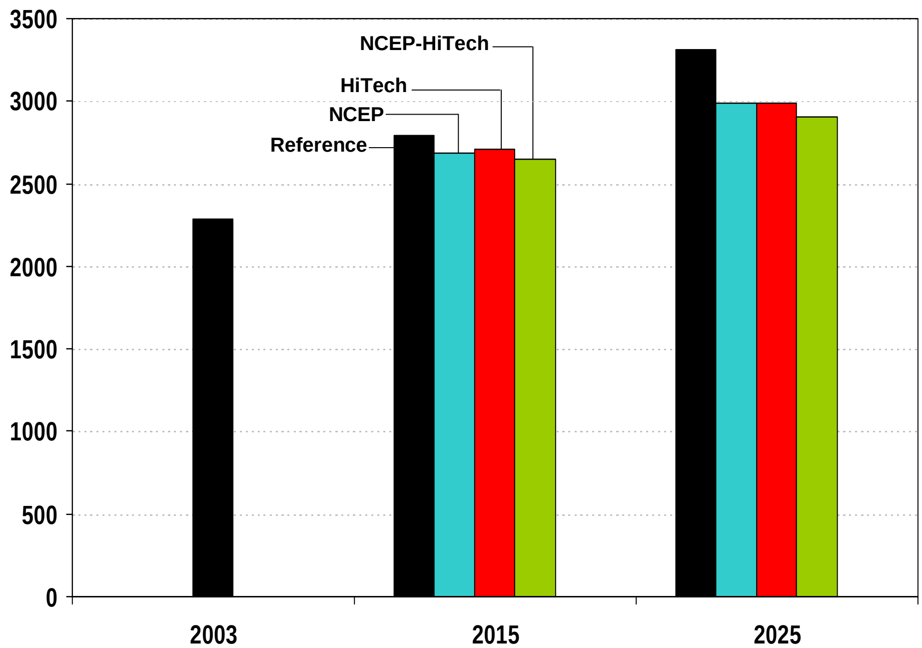
In the RTP-IC-ETH case, which combines the same higher rates of technology improvement with the NCEP's proposed tax incentive and deployment and CAFE policies, the impact of lower natural gas prices far outweighs the lower level of consumption that would result from the NCEP's proposed policies. In comparing the RTP-IC-ETH case and the Incent case, the greatest difference in consumption can be seen in 2025, when the average delivered natural gas price is $0.50 per thousand cubic feet lower in the RTP-IC-ETH case than in the Incent case, and natural gas consumption is 1.9 trillion cubic feet higher. Compared with the reference case, natural gas consumption in the RTP-IC-ETH case is 1.2 trillion cubic feet higher in 2025, largely because of the lower average delivered price of natural gas ($0.46 per thousand cubic feet). Across all the cases examined in this study, the average lower-48 natural gas wellhead price is lowest in the RTP-IC-ETH case. In addition, the RTP-IC-ETH case consistently results in more domestic natural gas production than is projected in the reference case (8 percent or 1.7 trillion cubic feet higher in 2025) and lower net import levels (6 percent or 0.5 trillion cubic feet lower in 2025).

Power Generation Sector Impacts

The high technology assumptions in the consuming sectors of the economy in the HiTech and NCEP-HiTech cases lead to much lower electricity demand (Figure 38) and petroleum consumption, as discussed previously. Some of the impacts of the NCEP's proposed policies in the NCEP-HiTech case are similar to the results in the NCEP case. Coal-fired generation in the NCEP-HiTech case is lower and renewable generation is higher, but much of the difference in emissions results from the high technology assumptions in the NCEP-HiTech case rather than from the proposed policies. As an example, the NCEP case reduces electricity generation by 105 billion kilowatthours in 2015 relative to the reference case while generation in the NCEP-HiTech case is 35 billion kilowatthours lower than the HiTech case. In 2025, generation in the NCEP case is 263 billion kilowatthours lower than the reference while the NCEP-HiTech is 135 billion kilowatthours lower than the HiTech case. The lower level of energy demand in the NCEP-HiTech case also leads to lower natural gas prices than in the reference case. The combination of lower electricity demand, which reduces the need for new power plants, and lower natural gas prices, which make new natural-gas-fired plants more attractive, leads to much lower coal use in the NCEP-HiTech case.

The lower demand for electricity, petroleum, natural gas, and coal in the NCEP-HiTech case makes it easier to meet the GHG intensity target recommended by the Commission. For example, CO_2 emissions in the NCEP case are 107 million metric tons lower than in the reference case in 2015 and 330 million metric tons lower in 2025. The NCEP-HiTech case CO_2 emissions are 60 million metric tons lower than the HiTech case in 2015 and 88 million metric tons lower in 2025. In fact, power-sector CO_2 emissions in the HiTech case are approximately equal to the level of CO_2 emissions reached in the NCEP case (within 5 million metric tons) in 2025. The reduction in total energy-related CO_2 emissions between the HiTech and reference cases (591 million metric tons CO2) is about 39 percent of the total GHG reduction needed (1,522 million metric tons CO_2 equivalent) to meet the NCEP's GHG intensity target in 2025. As a result, the GHG emissions permit price required to achieve the NCEP's target in the HiTech case is below the safety-valve permit price.[32]

Figure 38. Electricity Sales in the Reference and High Technology Cases, 2015 and 2025
(Billion Kilowatthours)



Source: National Energy Modeling System, runs AEO2005.D102004A, BING_ICE_CAP.D021005C, HTRKITEN.D111604A, and BING_HDTICECAP.D020905A.

[32]Because the time horizon of NEMS ends in 2025, the bank of allowances was required to end in 2025. It is likely that the permit safety-valve price would be achieved if the NEMS time horizon extended to 2030, resulting in more banked allowances in the early years and a longer period of time in which to use them.

Appendix A. Letters of Request for Analysis

- Letter from Senator Jeff Bingaman to Guy Caruso, EIA Administrator (December 17, 2004)
- Letter from Jennifer Michael, Minority staff, Senate Committee on Energy and Natural Resources, to Guy Caruso, Administrator (January 26, 2005)[33]

[33]Additional clarifications of two scenarios were made through telephone calls or email.

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510–6150

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December 17, 2004

Mr. Guy F. Caruso
Administrator
Energy Information Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Caruso:

On December 8, 2004, the National Commission on Energy Policy (NCEP), a bipartisan group of top energy experts from industry, government, labor, academia, and environmental and consumer groups, released a report to address major long-term U.S. energy challenges. The report, "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges," contains a set of 28 key energy policy recommendations for addressing oil security, climate change, natural gas supply, the future of nuclear energy, and other long-term challenges. I would like to receive information on the impacts of the 28 key recommendations contained in the NCEP's report, and how these measure up to the current status quo, or base case scenario which EIA has forecast for the coming decades.

By means of this letter, I would ask that you and your staff provide a comprehensive analysis with estimates of the impacts of the NCEP Study compared to EIA's 2005 Annual Energy Outlook (AEO) Reference Case to be released in January 2005. This analysis should include supply estimates (by fuel), demand estimates (by sector) and import estimates (by fuel type) for the provisions of the Report that can be addressed using the National Energy Modeling System (NEMS) model. I recognize that some of the NCEP recommendations are only characterized in general terms. My staff will provide specific policy assumptions if necessary for modeling purposes.

Given the information from past EIA studies which outlines the constraints of EIA's NEMS model, I do recognize the fact that not all provisions may lend themselves to a precise modeling result in NEMS. I would appreciate your thoughts on how provisions that cannot be modeled in NEMS directly might otherwise be estimated.

I would like to make this analysis available to all Energy Committee members as we consider a path for US energy policy in the new 109th Congress, be it a comprehensive energy package such as the Commission outlines, or a set of individual provisions. This would dictate that a high priority be given to the study, such that its release may be realized as soon as possible. I would appreciate receiving your estimates by February 21, 2004, and look forward to hearing from you in this regard.

Please do not hesitate to contact Jennifer Michael, Energy Committee Staff, (202)-224-7143, if you have any questions regarding this request.

Sincerely,

Jeff Bingaman
Ranking Minority Member

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510–6150

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January 26, 2005

Mr. Guy F. Caruso
Administrator
Energy Information Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Caruso:

In a letter dated December 17, 2004, Senator Bingaman requested that the Energy Information Administration (EIA) analyze the recommendations contained in the newly released report by the National Commission on Energy Policy (the "Commission"), "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges."

In response to our letter request, we have been asked by EIA staff to provide guidance on specific aspects of the analysis. To be clear, it is our understanding that in order for EIA analysts to complete our request, some additional guidance is required in order to formulate assumptions for input into the NEMS model. In accordance with your staff's request, we are submitting this letter. As regards specific assumptions, we would suggest that the following guidance be employed in the analysis:

In General:

1. All costs and incentives should be stated in constant $ 2004 dollars unless otherwise stated.

2. Macro-economic feedback should be employed in all integrated policy analysis.

3. For the purpose of illustrating the impact of accelerated technological progress (for example, that which might be stimulated by increased research and development funding) use of the technology assumptions in the AEO2005 high technology case is suggested.

4. Please identify Commission recommendations which were not included in the modeling analysis. We would appreciate your thoughts on how provisions that cannot be modeled in NEMS directly might otherwise be estimated.

Enhancing Oil Security:

Fuel Economy: A CAFÉ standard increase of 10 mpg for both cars and light trucks. A 10 mpg increase represents a 36 percent increase for automobiles. A second analysis may be performed, time and resources permitting, using a 15 mpg increase in the CAFÉ standards for both cars and light trucks (which translates to a 54 percent increase in the current standard for cars). Consideration should also be given to the $3 billion in incentives to be provided to manufacturers and consumers for domestic production and purchase of efficient vehicles.

Reducing Risks from Climate Change:

The greenhouse gas (GHG) policy scenario, as we understand, may be input into NEMS, exactly as described in the Commission report. In terms of scenario cases, (as outlined below), the GHG trading policy both with and without the proposed safety valve are requested.

Increasing Energy Efficiency:

While specific recommendations were not specified in the report, we would suggest that an efficiency standards case be constructed using the LBNL study ("Energy Efficiency Standards and Codes for Residential/Commercial Equipment and Buildings: Additional Opportunities") provided in the technical appendix of the Commission's report, in combination with EIA's AEO high technology case.

Natural Gas:

Inputs for the Alaska Natural Gas Pipeline System should follow those put forth in the legislation introduced in the previous Congress. This includes a price guarantee of $3.25 per million Btu (mmBtu) for delivered gas to Alberta and a ceiling price of $4.80/mmBtu.

Advanced Coal Technologies:

1. To represent the $4 billion program to stimulate the development of coal IGCC facilities, staff has suggested that the funds be programmed to be used to build 10 gigawatts of capacity over the 2009 to 2015 timeframe. We are in agreement.

2. The report outlines a $3 billion program to stimulate carbon capture and sequestration technology. Again, staff has suggested that the funds be used to

sequester carbon from 4 gigawatts of the 10 gigawatts of new IGCC built as a result of the $4 billion program. Carbon capture and sequestration technology would be added beginning in 2010 and are added a rate of 1 gigawatt per year. We are in agreement.

Nuclear Energy:

To represent the $2 billion program to stimulate new nuclear facilities, the model may be programmed such that the funds are used to build one nuclear facility beginning in the first year that they are available.

Renewable Energy Sources:

1. The report indicates that the expanded production tax credit program (PTC) will be available to all non carbon-emitting technologies added between 2006 and 2009. A uniform investment tax credit of 1.8 cents per kilowatt-hour for all qualifying technologies is suggested. In modeling the $ 4 billion overall credit limit, a first come first served basis should be used until it is expended.

2. To represent the program to stimulate non-petroleum renewable transportation fuels, the funds of $750 million for R&D and the $750 million in early deployment incentives are though to jointly bring about an increase in cellulose ethanol yields and reductions in capital cost. For modeling, staff has suggested that the yield increase from the current 75 gallons per ton of biomass to 105.4 gallons per ton of biomass by 2015, reaching 90 percent of its estimated maximum using switch grass; and that capital cost falls from today's $5 per annual gallon to $2.15 per annual gallon by 2015. Biodiesel plants already achieve 98 percent of their maximum yield, hence no improvement in biodiesel yields going forward should be considered.

Energy Technologies for the Future:

To represent a doubling of the R&D funding for energy research and development, use of the AEO2005 high technology cases should illustrate the advances that might be stimulated by the additional R&D funding when analyzing the remaining Commission policies.

Selected Scenarios:

EIA Staff has also asked for specific feedback on the types of scenarios and policy combinations to be run in NEMS. We understand that the Base case will be the AEO2005 Reference Case. Additionally, we would suggest that the following eight scenarios be run initially.

1. Tax incentives and deployment policies
2. GHG - Cap and trade base case

3. GHG - with safety valve
4. Vehicle Efficiency max (CAFÉ/efficiency vehicle measures)
5. Energy Efficiency
6. Hitechdem plus all defined and implementable tax incentives and deployments plus 1 CAFÉ case for new light duty vehicle CAFÉ standard.
7. Hitechsup plus all defined and implementable tax incentives and deployments plus 1 CAFÉ case for new light duty vehicle CAFÉ standard.
8. GHG policy on Hitechdem plus all defined and implementable tax incentives and deployments plus 1 CAFÉ case for new light duty vehicle CAFÉ standard.

Please do not hesitate to contact us should you have questions regarding any of the above. I can be reached at 202-224-7143.

Sincerely,

Jennifer Michael

Appendix B. Summary Tables of Findings

Table B1. Comparison of Individual Policies

		2015						2025					
	2003	Reference	Bldg-Std	CAFE	Incent	Cap-Trade	No-Safety	Reference	Bldg-Std	CAFE	Incent	Cap-Trade	No-Safety
Domestic Oil Production (Million B/d)	5.68	5.49	5.49	5.49	5.49	5.49	5.49	4.73	4.71	4.71	4.70	4.73	4.70
Domestic Dry Gas Production (Tcf)	19.07	20.77	20.69	20.74	21.49	20.74	21.05	21.83	21.72	21.71	21.07	21.60	21.56
Net Petroleum Imports (Million B/d)	11.24	15.40	15.39	14.82	15.38	15.24	15.03	19.11	19.07	17.65	19.15	18.77	18.04
Net Natural Gas Imports (Tcf)	3.24	7.02	6.64	7.00	6.43	6.99	6.86	8.66	8.23	8.65	8.72	9.25	8.19
Percent Oil Import Dependence	56.2%	62.4%	62.4%	61.6%	62.4%	62.2%	61.8%	68.4%	68.4%	67.1%	68.6%	68.1%	67.2%
Percent Gas Import Dependence	14.7%	25.1%	24.1%	25.1%	22.9%	25.1%	24.4%	28.2%	27.3%	28.3%	29.1%	29.8%	27.4%
Total Fossil Consumption (Quads)	84.34	102.47	101.90	101.28	102.88	101.49	100.37	116.37	114.88	112.88	115.61	113.28	105.67
Petroleum	39.09	48.07	48.04	46.93	48.01	47.78	47.42	54.42	54.31	51.34	54.34	53.70	52.25
Natural Gas	22.54	28.69	28.22	28.64	28.83	28.63	28.81	31.47	30.92	31.34	30.76	31.84	30.71
Coal	22.71	25.71	25.65	25.71	26.04	25.08	24.14	30.48	29.65	30.20	30.51	27.74	22.72
Average Electricity Price ($2003/kwh)	7.4	6.9	6.8	6.9	6.7	7.1	7.3	7.3	7.2	7.3	7.2	7.6	8.1
Wellhead Gas Price ($2003/mcf)	4.98	4.16	4.01	4.14	3.78	4.13	4.02	4.79	4.79	4.84	4.82	4.90	4.54
Average Delivered Coal Price (2003$/million Btu)	1.30	1.25	1.25	1.25	1.26	1.87	2.72	1.32	1.30	1.32	1.33	2.08	4.53
Average Delivered Natural Gas Price (2003$/mcf)	6.86	5.92	5.78	5.91	5.58	6.24	6.61	6.59	6.57	6.64	6.63	7.13	8.18
Average Delivered Petroleum Price[1]	10.51	10.00	10.01	9.83	10.04	10.42	10.94	10.66	10.66	10.28	10.66	11.19	12.83
Avg Household Energy Expend ($2003/house)	1582	1496	1449	1494	1460	1526	1556	1571	1509	1573	1564	1618	1688
Covered Emissions (million metric tons CO2 eq)	6032	7501	7467	7421	7516	7220	7077	8794	8678	8552	8735	8172	7428
Energy-related CO2 emissions (MMT CO2)	5789	7052	7018	6973	7068	6971	6864	8062	7947	7820	8004	7781	7119
GHG Covered Emission Target	6142	7113	7113	7113	7113	7125	7125	7883	7883	7883	7883	7272	7272
GHG emission price ($2003/ton CO2 EQ)	0.00	0.00	0.00	0.00	0.00	6.50	15.55	0.00	0.00	0.00	0.00	8.50	35.15
GHG Covered Emm Intensity	581.1	492.9	490.7	488.1	493.4	475.1	466.6	433.3	427.9	422.0	430.8	403.3	367.5
Primary Energy Intensity	9.46	7.77	7.73	7.70	7.81	7.74	7.69	6.56	6.49	6.41	6.55	6.49	6.40
Generation Cap Additions After 2003 (GW)	N/A	88.6	81.9	88.1	101.7	86.6	91.4	281.1	251.3	280.9	288.6	274.7	301.2
NGCC without Seq	N/A	14.8	10.6	14.8	16.9	18.8	21.3	55.1	48.4	61.1	53.7	79.6	62.5
NGCC with Seq	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conventional Coal	N/A	8.3	9.0	7.9	6.4	3.5	1.9	70.9	62.9	61.7	34.9	27.7	1.9
IGCC without Seq	N/A	0.0	0.0	0.0	6.0	0.0	0.0	16.0	11.9	20.4	56.4	15.5	0.0
IGCC with Seq	N/A	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	5.6
Wind	N/A	2.7	2.6	2.7	6.3	3.4	6.1	4.7	4.2	4.7	8.4	10.4	44.2
Dedicated Biomas	N/A	1.8	1.6	1.7	2.2	2.5	5.0	5.4	4.5	6.2	8.1	19.7	60.4
Geothermal	N/A	0.5	0.3	0.5	0.5	1.3	1.4	2.4	2.3	2.8	2.9	4.2	5.8
Other Renewables	N/A	1.2	1.1	1.2	1.5	1.3	1.4	2.8	2.8	2.8	3.0	3.2	4.5

Table B1. Comparison of Individual Policies

		2015						2025					
	2003	**Reference**	**Bldg-Std**	**CAFE**	**Incent**	**Cap-Trade**	**No-Safety**	**Reference**	**Bldg-Std**	**CAFE**	**Incent**	**Cap-Trade**	**No-Safety**
Domestic Oil Production (Million B/d)	5.68	5.49	5.49	5.49	5.49	5.49	5.49	4.73	4.71	4.71	4.70	4.73	4.70
Domestic Dry Gas Production (Tcf)	19.07	20.77	20.69	20.74	21.49	20.74	21.05	21.83	21.72	21.71	21.07	21.60	21.56
Net Petroleum Imports (Million B/d)	11.24	15.40	15.39	14.82	15.38	15.24	15.03	19.11	19.07	17.65	19.15	18.77	18.04
Net Natural Gas Imports (Tcf)	3.24	7.02	6.64	7.00	6.43	6.99	6.86	8.66	8.23	8.65	8.72	9.25	8.19
Percent Oil Import Dependence	56.2%	62.4%	62.4%	61.6%	62.4%	62.2%	61.8%	68.4%	68.4%	67.1%	68.6%	68.1%	67.2%
Percent Gas Import Dependence	14.7%	25.1%	24.1%	25.1%	22.9%	25.1%	24.4%	28.2%	27.3%	28.3%	29.1%	29.8%	27.4%
Total Fossil Consumption (Quads)	84.34	102.47	101.90	101.28	102.88	101.49	100.37	116.37	114.88	112.88	115.61	113.28	105.67
Petroleum	39.09	48.07	48.04	46.93	48.01	47.78	47.42	54.42	54.31	51.34	54.34	53.70	52.25
Natural Gas	22.54	28.69	28.22	28.64	28.83	28.63	28.81	31.47	30.92	31.34	30.76	31.84	30.71
Coal	22.71	25.71	25.65	25.71	26.04	25.08	24.14	30.48	29.65	30.20	30.51	27.74	22.72
Average Electricity Price ($2003/kwh)	7.4	6.9	6.8	6.9	6.7	7.1	7.3	7.3	7.2	7.3	7.2	7.6	8.1
Wellhead Gas Price ($2003/mcf)	4.98	4.16	4.01	4.14	3.78	4.13	4.02	4.79	4.79	4.84	4.82	4.90	4.54
Average Delivered Coal Price (2003$/million Btu)	1.30	1.25	1.25	1.25	1.26	1.87	2.72	1.32	1.30	1.32	1.33	2.08	4.53
Average Delivered Natural Gas Price (2003$/mcf)	6.86	5.92	5.78	5.91	5.58	6.24	6.61	6.59	6.57	6.64	6.63	7.13	8.18
Average Delivered Petroleum Price[1]	10.51	10.00	10.01	9.83	10.04	10.42	10.94	10.66	10.66	10.28	10.66	11.19	12.83
Avg Household Energy Expend ($2003/house)	1582	1496	1449	1494	1460	1526	1556	1571	1509	1573	1564	1618	1688
Covered Emissions (million metric tons CO2 eq)	6032	7501	7467	7421	7516	7220	7077	8794	8678	8552	8735	8172	7428
Energy-related CO2 emissions (MMT CO2)	5789	7052	7018	6973	7068	6971	6864	8062	7947	7820	8004	7781	7119
GHG Covered Emission Target	6142	7113	7113	7113	7113	7125	7125	7883	7883	7883	7883	7272	7272
GHG emission price ($2003/ton CO2 EQ)	0.00	0.00	0.00	0.00	0.00	6.50	15.55	0.00	0.00	0.00	0.00	8.50	35.15
GHG Covered Emm Intensity	581.1	492.9	490.7	488.1	493.4	475.1	466.6	433.3	427.9	422.0	430.8	403.3	367.5
Primary Energy Intensity	9.46	7.77	7.73	7.70	7.81	7.74	7.69	6.56	6.49	6.41	6.55	6.49	6.40
Generation Cap Additions After 2003 (GW)	N/A	88.6	81.9	88.1	101.7	86.6	91.4	281.1	251.3	280.9	288.6	274.7	301.2
NGCC without Seq	N/A	14.8	10.6	14.8	16.9	18.8	21.3	55.1	48.4	61.1	53.7	79.6	62.5
NGCC with Seq	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conventional Coal	N/A	8.3	9.0	7.9	6.4	3.5	1.9	70.9	62.9	61.7	34.9	27.7	1.9
IGCC without Seq	N/A	0.0	0.0	0.0	6.0	0.0	0.0	16.0	11.9	20.4	56.4	15.5	0.0
IGCC with Seq	N/A	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	5.6
Wind	N/A	2.7	2.6	2.7	6.3	3.4	6.1	4.7	4.2	4.7	8.4	10.4	44.2
Dedicated Biomas	N/A	1.8	1.6	1.7	2.2	2.5	5.0	5.4	4.5	6.2	8.1	19.7	60.4
Geothermal	N/A	0.5	0.3	0.5	0.5	1.3	1.4	2.4	2.3	2.8	2.9	4.2	5.8
Other Renewables	N/A	1.2	1.1	1.2	1.5	1.3	1.4	2.8	2.8	2.8	3.0	3.2	4.5

Table B-2: Comparison of Individual Cases with the NCEP Case

		2015					2025				
Projection	**2003**	**Reference**	**NCEP**	**Bldg-Std**	**CAFE**	**Incent**	**Reference**	**NCEP**	**Bldg-Std**	**CAFE**	**Incent**
Domestic Oil Production (Million B/d)	5.68	5.49	5.49	5.49	5.49	5.49	4.73	4.69	4.71	4.71	4.70
Domestic Dry Gas Production (Tcf)	19.07	20.77	21.44	20.69	20.74	21.49	21.83	20.85	21.72	21.71	21.07
Net Petroleum Imports (Million B/d)	11.24	15.40	14.60	15.39	14.82	15.38	19.11	17.29	19.07	17.65	19.15
Net Natural Gas Imports (Tcf)	3.24	7.02	5.92	6.64	7.00	6.43	8.66	8.53	8.23	8.65	8.72
Percent Oil Import Dependence	0.56	0.62	0.61	0.62	0.62	0.62	0.68	0.67	0.68	0.67	0.69
Percent Gas Import Dependence	0.15	0.25	0.21	0.24	0.25	0.23	0.28	0.29	0.27	0.28	0.29
Total Fossil Consumption (Quads)	84.34	102.47	99.96	101.90	101.28	102.88	116.37	108.29	114.88	112.88	115.61
Petroleum	39.09	48.07	46.46	48.04	46.93	48.01	54.42	50.44	54.31	51.34	54.34
Natural Gas	22.54	28.69	28.24	28.22	28.64	28.83	31.47	30.34	30.92	31.34	30.76
Coal	22.71	25.71	25.25	25.65	25.71	26.04	30.48	27.51	29.65	30.20	30.51
Average Electricity Price ($2003/kwh)	7.42	6.94	6.91	6.82	6.94	6.69	7.30	7.72	7.25	7.31	7.22
Wellhead Gas Price ($2003/mcf)	4.98	4.16	3.66	4.01	4.14	3.78	4.79	4.86	4.79	4.84	4.82
Average Delivered Coal Price (2003$/million Btu)	1.30	1.25	1.79	1.25	1.25	1.26	1.32	2.06	1.30	1.32	1.33
Average Delivered Natural Gas Price (2003$/mcf)	6.86	5.92	5.76	5.78	5.91	5.58	6.59	7.09	6.57	6.63	6.63
Average Delivered Petroleum Price[1]	10.51	10.00	10.22	10.01	9.83	10.04	10.66	10.81	10.66	10.28	10.66
Avg Household Energy Expend ($2003/househld)	1582	1496	1459	1449	1494	1460	1571	1565	1509	1573	1564
Covered Emissions (million metric tons CO2 eq)	6032	7501	7108	7467	7421	7516	8794	7829	8678	8552	8735
GHG Covered Emission Target	6142	7113	7125	7113	7113	7113	7883	7272	7883	7883	7883
GHG emission price ($2003/ton CO2 EQ)	0	0	6	0	0	0	0	9	0	0	0
GHG Covered Emmissions Intensity	581	493	468	491	488	493	433	387	428	422	431
Primary Energy Intensity	9	8	8	8	8	8	7	6	6	6	7
Gen Cap Additions After 2003 (GW)	N/A	88.6	91.6	81.9	88.1	101.7	281.1	250.6	251.3	280.9	288.6
NGCC	N/A	14.8	10.0	10.6	14.8	16.9	55.1	53.1	48.4	61.1	53.7
Conventional Coal	N/A	8.3	4.4	9.0	7.9	6.4	70.9	12.3	62.9	61.7	34.9
Total IGCC	N/A	0.0	10.0	0.0	0.0	10.0	16.0	36.7	11.9	20.4	60.4
Non-Hydro Renewables	N/A	6.2	11.4	5.5	6.0	10.5	15.3	37.3	13.8	16.5	22.3
Nuclear	N/A	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0

[1] 2003$ per million Btu; delivered prices include any applicable GHG permit prices.

Definitions: b/d = barrels per day. Quads = quadrillion Btu. Mpg = miles per gallon. MMT = million metric tons. Bkwh = billion killowatthour. GW = gigawatt. Tcf = trillion cubic feet. Mcf = thousand cubic feet. GHG intensity = metric tons CO2 equivalent per million 2000 dollars.

Table B-2: Comparison of Individual Cases with the NCEP Case - Continued

		2015					2025				
	2003	**Reference**	**NCEP**	**Bldg-Std**	**CAFE**	**Incent**	**Reference**	**NCEP**	**Bldg-Std**	**CAFE**	**Incent**
Total Electricity Generation (Bkwh)	3852	4890	4786	4810	4890	4919	5770	5507	5596	5769	5777
Coal	1970	2305	2285	2301	2306	2354	2890	2584	2791	2862	2944
Natural Gas	632	1173	1075	1105	1166	1137	1406	1325	1343	1396	1324
Nuclear	764	826	834	826	826	834	830	838	830	830	838
Renewable	359	447	465	442	446	462	489	603	482	497	522
Hydro	275	306	306	306	306	306	307	307	307	307	307
Dedicated Biomass	10	17	25	16	17	21	34	123	28	39	52
Biomass Co-firing	4	18	14	18	18	15	10	0	12	10	6
Wind	11	27	40	27	27	39	35	57	33	35	47
Other	59	77	80	75	77	80	104	116	102	106	110
Delivered Energy By Sector (Quads)	98.22	118.29	116.03	117.64	117.10	118.94	133.18	126.45	131.59	129.82	132.89
Buildings	19.89	23.70	23.31	23.40	23.71	23.84	26.75	25.60	26.03	26.76	26.76
Total Transportation	27.07	34.75	33.52	34.76	33.56	34.87	40.04	36.56	40.02	36.94	40.01
Cars	8.92	9.14	8.68	9.14	8.71	9.14	9.58	8.60	9.58	8.65	9.58
Light Trucks	7.41	11.79	10.95	11.79	11.03	11.80	14.94	12.55	14.94	12.73	14.94
Industrial	24.86	28.27	28.39	28.33	28.23	28.54	30.76	30.07	30.75	30.53	30.65
Power Gen Fossil	26.68	33.52	32.21	32.94	33.56	33.51	39.59	35.96	38.29	39.42	38.99
Primary Energy By Sector (Quads)	98.22	118.29	116.03	117.64	117.10	118.94	133.18	126.45	131.59	129.82	132.89
Buildings	38.78	46.76	45.63	45.98	46.80	46.98	53.36	50.89	51.71	53.34	53.26
Total Transportation	27.24	34.96	33.72	34.96	33.77	35.07	40.28	36.80	40.26	37.18	40.25
Cars	8.92	9.15	8.68	9.15	8.72	9.15	9.59	8.61	9.59	8.66	9.59
Light Trucks	7.41	11.80	10.96	11.80	11.03	11.81	14.95	12.56	14.95	12.75	14.95
Industrial	32.21	36.58	36.67	36.70	36.54	36.88	39.53	38.75	39.61	39.30	39.38
Power Gen Fossil	26.68	33.52	32.21	32.94	33.56	33.51	39.59	35.96	38.29	39.42	38.99
Light Duty Vehicle Sales (thousands)	15902	17658	16788	17669	16787	17728	20157	19201	20124	19297	20142
Hybrid	41	885	2155	885	2182	888	1106	2356	1104	2382	1105
Advanced turbo diesel	351	749	643	746	645	748	993	844	994	840	996
Avg New Car Efficiency (mpg)	29.50	30.25	37.92	30.25	37.90	30.25	31.0	37.98	31.00	37.93	31.00
Avg New Light Truck Efficiency (mpg)	21.80	23.42	29.72	23.42	29.71	23.42	24.6	30.60	24.65	30.55	24.65

[1] 2003$ per million Btu; delivered prices include any applicable GHG permit prices.

Definitions: b/d = barrels per day. Quads = quadrillion Btu. Mpg = miles per gallon. MMT = million metric tons. Bkwh = billion killowatthour. GW = gigawatt. Tcf = trillion cubic feet. Mcf = thousand cubic feet. GHG intensity = metric tons CO2 equivalent per million 2000 dollars.

Sources: AEO2005 Reference Case, aeo2005.d013105a; Bldg-Std: bing_eff.d020905a; CAFE: bing_cafe.d021005a; Incent: bing_incent.d020805a; bing-ice-cap.d02.d021005c

Table B-3. Comparison of 6 Cases, 2015 and 2025

Projection	2003	2015 Reference	2015 NCEP	2015 HiTech	2015 NCEP-HiTech	2015 RTP	2015 RTP-IC-ETH	2025 Reference	2025 NCEP	2025 HiTech	2025 NCEP-HiTech	2025 RTP	2025 RTP-IC-ETH
Domestic Oil Production (Million B/d)	5.68	5.49	5.49	5.50	5.49	5.64	5.63	4.73	4.69	4.72	4.65	5.11	5.08
Domestic Dry Gas Production (Tcf)	19.07	20.77	21.44	20.45	21.21	22.08	22.87	21.83	20.85	21.65	20.35	24.71	23.51
Net Petroleum Imports (Million B/d)	11.24	15.40	14.60	14.79	14.18	15.18	14.22	19.11	17.29	17.66	16.48	18.52	16.50
Net Natural Gas Imports (Tcf)	3.24	7.02	5.92	6.23	5.34	6.43	5.69	8.66	8.53	7.90	7.62	8.17	8.17
Percent Oil Import Dependence	56.2%	62.4%	61.3%	61.6%	60.6%	61.5%	59.2%	68.4%	66.8%	66.9%	66.1%	66.3%	62.9%
Percent Gas Import Dependence	14.7%	25.1%	21.5%	23.2%	20.0%	22.4%	19.8%	28.2%	28.9%	26.6%	27.1%	24.7%	25.6%
Total Fossil Consumption (Quads)	84.34	102.47	99.96	99.39	97.93	102.96	102.27	116.37	108.29	108.60	104.12	116.84	113.27
Petroleum	39.09	48.07	46.46	46.79	45.56	48.09	46.84	54.42	50.44	51.42	48.55	54.39	51.11
Natural Gas	22.54	28.69	28.24	27.56	27.42	29.43	29.48	31.47	30.34	30.50	28.90	33.92	32.69
Coal	22.71	25.71	25.25	25.04	24.95	25.44	25.95	30.48	27.51	26.68	26.67	28.54	29.47
Ethanol Production (quadrillion Btu)	0.24	0.33	0.33	0.33	0.33	0.33	0.77	0.38	0.34	0.38	0.34	0.3	1.21
Average Electricity Price ($2003/kwh)	7.4	6.9	6.9	6.7	6.5	6.8	6.6	7.3	7.7	7.0	7.0	7.1	7.1
Wellhead Gas Price ($2003/mcf)	4.98	4.16	3.66	3.93	3.54	3.81	3.48	4.79	4.86	4.66	4.60	4.35	4.36
Average Delivered Petroleum Price [1]	10.51	10.00	10.22	10.03	9.87	10.00	9.73	10.66	10.81	10.70	10.58	10.67	10.12
Average Delivered Natural Gas Price [1]	6.86	5.92	5.76	5.72	5.51	5.58	5.27	6.59	7.09	6.46	6.76	6.11	6.14
Average Delivered Coal Price [1]	1.30	1.25	1.79	1.24	1.50	1.25	1.25	1.32	2.06	1.23	1.82	1.27	1.31
Delivered Mogas Price ($2003/gal)	1.60	1.51	1.54	1.51	1.48	1.51	1.46	1.58	1.62	1.59	1.57	1.58	1.50
Avg Household Energy Expend ($2003/house)	1582	1496	1459	1436	1392	1473	1438	1571	1565	1479	1455	1543	1532
GHG Covered Emissions (million metric tons CO_2 eq)	6032	7501	7108	7302	7048	7515	7429	8794	7829	8203	7564	8735	8458
Energy-Related CO_2 Emissions (MMT)	5789	7052	6857	6854	6733	7067	6980	8062	7438	7471	7171	8004	7726
GHG Covered Emission Target	6142	7113	7125	7113	7125	7113	7113	7883	7272	7883	7272	7883	7883
GHG emission price ($2003/ton CO_2 EQ)	0.00	0.00	5.72	0.00	2.77	0.00	0.00	0.00	8.50	0.00	6.27	0.00	0.00
GHG Covered Emmission Intensity	581.1	492.9	467.8	480.0	462.7	493.4	487.3	433.3	387.3	404.8	373.5	429.9	417.0
Primary Energy Intensity	9.46	7.77	7.64	7.58	7.49	7.80	7.75	6.56	6.26	6.23	6.04	6.58	6.41
Gen Capacity Additions After 2003	N/A	88.6	91.6	82.9	92.9	89.6	103.9	281.1	250.6	257.6	251.9	282.9	292.1
NGCC	N/A	14.8	10.0	21.4	19.3	19.0	18.5	55.1	53.1	120.0	99.1	86.4	67.8
Conventional Coal	N/A	8.3	4.4	3.7	2.7	4.6	4.1	70.9	12.3	12.2	5.5	39.1	16.4
IGCC without Sequestration	N/A	0.0	6.0	0.0	6.0	0.0	6.0	16.0	32.7	20.2	31.6	14.9	55.7
IGCC with Sequestration	N/A	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0
Wind	N/A	2.7	6.5	2.5	6.3	2.5	6.3	4.7	11.2	3.7	10.1	3.9	7.5
Dedicated Biomas	N/A	1.8	2.9	2.6	3.1	1.5	2.1	5.4	19.1	7.0	9.2	5.2	5.2
Geothermal	N/A	0.5	0.3	0.2	0.2	0.4	0.3	2.4	3.5	3.8	4.2	2.4	2.0
Other Renewables	N/A	1.2	1.6	1.1	1.5	1.1	1.5	2.8	3.4	2.6	2.9	2.7	2.9

Table B-3. Comparison of 6 Cases, 2015 and 2025 (Page 2 Continued)

		2015						2025					
Projection	2003	Reference	NCEP	HiTech	NCEP-HiTech	RTP	RTP-IC-ETH	Reference	NCEP	HiTech	NCEP-HiTech	RTP	RTP-IC-ETH
Total Electricity Generation (Bkwh)	3852	4890	4786	4783	4748	4911	4938	5770	5507	5558	5422	5800	5805
Coal	1970	2305	2285	2256	2273	2275	2341	2890	2584	2494	2527	2659	2817
Natural Gas	632	1173	1075	1120	1048	1230	1180	1406	1325	1577	1364	1681	1514
Nuclear	764	826	834	826	834	826	834	830	838	834	846	830	838
Renewable	359	447	465	447	466	444	453	489	603	511	546	487	491
Hydro	275	306	306	306	306	306	306	307	307	307	307	307	307
Dedicated Biomass	10	17	25	17	21	16	20	34	123	29	42	33	34
Biomass Co-firing	4	18	14	18	17	19	8	10	0	15	8	12	4
Wind	11	27	40	27	39	27	39	35	57	31	54	32	43
Other	59	77	80	79	83	76	79	104	116	129	135	103	103
Delivered Energy By Sector (Quads)	98.22	118.29	116.03	115.27	114.09	118.75	118.21	133.18	126.45	126.16	122.24	133.63	130.12
Buildings	19.89	23.70	23.31	23.35	23.24	23.86	24.01	26.75	25.60	25.88	25.32	27.00	27.02
Total Transportation	27.07	34.75	33.52	34.03	33.04	34.83	33.82	40.04	36.56	38.20	35.50	40.20	37.19
Cars	8.92	9.14	8.68	8.80	8.51	9.14	8.74	9.58	8.60	9.05	8.27	9.58	8.70
Light Trucks	7.41	11.79	10.95	11.55	10.94	11.81	11.09	14.94	12.55	14.23	12.58	14.96	12.86
Industrial	24.86	28.27	28.39	27.25	27.45	28.51	28.68	30.76	30.07	28.79	28.45	31.22	30.73
Power Gen Fossil	26.68	33.52	32.21	32.35	31.67	33.61	33.69	39.59	35.96	36.23	34.91	39.29	39.20
Primary Energy By Sector (Quads)	98.22	118.29	116.03	115.27	114.09	118.75	118.21	133.18	126.45	126.16	122.24	133.63	130.12
Buildings	38.78	46.76	45.63	45.85	45.42	46.90	47.15	53.36	50.89	50.94	49.92	53.30	53.32
Total Transportation	27.24	34.96	33.72	34.24	33.25	35.03	34.03	40.28	36.80	38.47	35.77	40.44	37.43
Cars	8.92	9.15	8.68	8.81	8.52	9.15	8.75	9.59	8.61	9.06	8.28	9.59	8.70
Light Trucks	7.41	11.80	10.96	11.55	10.95	11.81	11.10	14.95	12.56	14.24	12.60	14.97	12.87
Industrial	32.21	36.58	36.67	35.17	35.41	36.82	37.03	39.53	38.75	36.75	36.54	39.89	39.37
Power Gen Fossil	26.68	33.52	32.21	32.35	31.67	33.61	33.69	39.59	35.96	36.23	34.91	39.29	39.20
Light Duty Vehicle Sales (thousands)	15902	17658	16788	17655	17290	17684	16896	20157	19201	20104	19690	20193	19327
Hybrid	41	885	2155	856	822	886	2208	1106	2356	1061	1017	1108	2403
Advanced turbo diesel	351	749	643	699	572	749	640	993	844	927	763	1001	821
Avg New Car Efficiency (mpg)	29.5	30.3	37.9	32.1	39.0	30.3	37.9	31.0	38.0	33.4	39.8	31.0	37.9
Avg New Light Truck Efficiency (mpg)	21.8	23.4	29.7	24.3	29.9	23.4	29.7	24.6	30.6	26.3	31.2	24.6	30.7

[1] Average Price delivered to all consumers. Units = 2003$ per million Btu. Prices include any applicable GHG permit prices.

Source Runs. Reference: aeo2005.d102004a. NCEP: bing_ice_cap.d021005c. HiTech: htrkiten.d111604a. NCEP-HiTech: bing_hdticecap.d020905a. RTP: oghtec05.d102704a.
RTP-IC-ETH: bing_hst_ic.d021105a

Definitions: b/d = barrels per day. Quads = quadrillion Btu. Mpg = miles per gallon. MMT = million metric tons. Bkwh = billion killowatthour. GW = gigawatt.
Tcf = trillion cubic feet. Mcf = thousand cubic feet. GHG intensity = metric tons CO2 equivalent per million 2000 dollars.