April 2007








National Commission on Energy Policy

Energy Policy Recommendations

To the President and 110th Congress

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Disclaimer

These recommendations are the product of a bipartisan Commission of 21 members of diverse expertise and affiliations, addressing many complex and contentious topics. It is inevitable that arriving at a consensus document in these circumstances entailed innumerable compromises. Accordingly, it should not be assumed that every member is entirely satisfied with every formulation in this document, or even that all of us would agree with any given recommendation if it were taken in isolation. Rather, we have reached consensus on these recommendations as a package, which taken as a whole offers a balanced and comprehensive approach to the economic, national security, and environmental challenges that the energy issue presents our nation.

Acknowledgements

The National Commission on Energy Policy would like to express its thanks for the strong support of its funders. The Commission was founded in 2002 by the William and Flora Hewlett Foundation and its partners.

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NCEP Commissioners

John P. Holdren
Co-Chair
Teresa and John Heinz Professor of Environmental Policy, Harvard University; Director of the Woods Hole Research Center

William K. Reilly
Co-Chair
Senior Advisor, TPG, Inc.; Former Administrator, U.S. Environmental Protection Agency

John W. Rowe
Co-Chair
Chairman and CEO, Exelon Corporation

Philip R. Sharp
Congressional Chair
President, Resources for the Future; Former U.S. Representative, IN

Marilyn Brown
Visiting Distinguished Scientist, Oak Ridge National Laboratory; Professor, School of Public Policy, Georgia Institute of Technology

John E. Bryson*
Chairman, President and Chief Executive Officer, Edison International; Chairman, Southern California Edison

Ralph Cavanagh
Senior Attorney and Co-Director, Energy Program, Natural Resources Defense Council

Erroll B. Davis*
Chancellor of the University System of Georgia

Rodney Ellis
State Senator, Texas

Leo W. Gerard
International President, United Steelworkers of America

Robert E. Grady*
Managing Partner, Carlyle Venture Partners, The Carlyle Group; Former Executive Associate Director of the OMB

F. Henry Habicht
Managing Partner of SAIL Venture Partners, LLC; Former Deputy Administrator of the U.S. Environmental Protection Agency

Frank Keating*
CEO of the American Council of Life Insurers; Former Governor of Oklahoma

Richard A. Meserve*
President of The Carnegie Institution; Former Chairman of the U.S. Nuclear Regulatory Commission (NRC)

Mario Molina
Professor, University of California, San Diego

Sharon L. Nelson
Chair, Board of Directors, Consumers Union; Former Chief, Consumer Protection Division, Washington Attorney General's Office

Richard L. Schmalensee*
Professor of Economics, MIT; John C. Head III Dean, MIT Sloan School of Management

Norm Szydlowski*
President and CEO, Colonial Pipeline Company

Susan Tierney
Managing Principal, The Analysis Group; Former Assistant Secretary of Energy

R. James Woolsey
Vice President, Booz Allen Hamilton; Former Director of Central Intelligence

Martin B. Zimmerman
Clinical Professor of Business, Ross School of Business, University of Michigan; Former Group Vice President, Corporate Affairs, Ford Motor Company

* Joined the Commission since the release of the December 2004 report, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges.*

Letter from NCEP Co-Chairs

August 2007

Dear Colleagues,

Since the National Commission on Energy Policy (NCEP) released its December 2004 report, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*, we have watched our nation's discourse on energy issues with a combination of optimism and concern. On the one hand, we have seen growing support — not only in Congress, but among business leaders and the general public — for decisive action to address serious, energy-related threats to the environment and to our national and economic security. As a result, prospects for progress on problems like global warming and U.S. oil dependence now seem more promising than they have in over a decade.

On the other hand, the experience of the last few years also underscores how difficult it is to reach political consensus on these issues. The Energy Policy Act of 2005 contained many useful provisions to expand the domestic biofuels industry, address urgent infrastructure needs, promote efficiency, and develop new energy supplies. And yet, it seemed clear to many that these measures did not go nearly far enough. As the Commission prepared to issue updated recommendations in April 2007, it appeared our nation was fast approaching the end of the decade without an adequate response to the central energy challenges we confront.

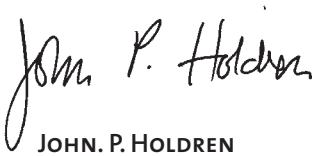
At the time of this writing, new opportunities to bridge that gap are again within reach. Detailed climate legislation, introduced in June 2007 by Senators Bingaman and Specter with bipartisan backing, is winning support from constituencies that had hitherto been opposed to mandatory action on greenhouse gas emissions — including prominent leaders from the labor and business communities. More recently, Senators Lieberman and Warner have introduced bipartisan legislation to limit greenhouse gas emissions, and Speaker Pelosi has established a select committee in the House of Representatives to address global warming and energy security. At the same time, energy bills recently passed by the House and Senate contain, between them, important provisions to boost renewable energy resources, appliance efficiency standards, automobile fuel economy, and the development of alternative fuels.

Which of these elements survives in final legislation is, of course, the key question. Likewise, whether-and in what form and timeframe — Congress will finally act to adopt a mandatory climate policy remains uncertain. In all of these areas, the politics of polarization and paralysis continue to exert a potent influence. They must not prevail. Over the last two-plus years, the Commission has continued working to identify critical policy gaps and explore options for bridging them. This document summarizes the results of these efforts, focusing on specific areas where additional interventions, or in some cases an expansion or extension of current commitments, are called for. We do not attempt here to review the full suite of topics and proposals included in our 2004 report, though all the needs identified in that document remain extremely important.

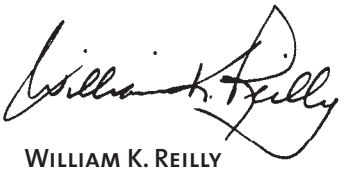
In closing, it is worth re-stating two core messages from our original report. The first is the ongoing need for comprehensive rather than piecemeal approaches. As before, our updated recommendations are designed to be mutually reinforcing and to function as a package. Thus, for example, the policy we propose for limiting U.S. greenhouse gas emissions generates the funds needed to support major new investments in climate-friendly technologies. Similarly, we believe a significant push to improve vehicle fuel economy is an essential complement to the nation's ongoing efforts to promote clean, domestic biofuels.

Second, we remain convinced that the path to solving our most difficult energy problems can only be found through bipartisan cooperation and principled compromise. Without cooperation and compromise, opportunities for progress on issues like climate change and oil dependence will continue to go unrealized for lack of public resources, political will, or both — even as mounting evidence of a warming planet and stubbornly high oil prices underscore the liabilities of further inaction and delay. Here and elsewhere, the Commission's central message remains the same: it is time — indeed it is past time — for the stalemate to end.

Sincerely,



John. P. Holdren



William K. Reilly

John W. Rowe

Summary of Recommendations

1. Oil Security

- Establish a national average new-vehicle fuel-economy improvement target of four percent per year, while retaining the full discretionary authority of the National Highway Traffic Safety Administration (NHTSA) to modify the presumptive target up or down if safety, technology, or economic considerations warrant.
- Encourage and empower NHTSA to implement reforms aimed at making the existing corporate average fuel economy (CAFE) program more cost-effective, market-oriented, and responsive to the jobs and competitiveness concerns of the automobile industry.
- Provide targeted consumer and manufacturer incentives to promote the domestic development, production, and deployment of advanced automotive technologies such as hybrids, plug-in hybrids, and advanced diesel vehicles.
- Pursue cost-effective opportunities to further reduce transportation energy use by improving heavy-truck fuel economy and by adopting efficiency standards for light-duty vehicle replacement tires.

2. Climate Change

- Adopt legislation this Congress to implement a mandatory, market-based program to limit economy-wide U.S. greenhouse gas emissions.
- Strengthen key parameters of the original NCEP climate proposal, including:
  - defining program targets to aim for stabilizing emissions at current (2006) levels by 2020 and reducing emissions 15 percent below current levels by 2030;
  - raising the starting price of the safety valve to $10 per ton of carbon-dioxide equivalent emissions; and
  - increasing the rate of escalation in the safety-valve price to 5 percent per year in real (rather than nominal) terms.
- Address other program design issues by (1) allocating emission allowances in a manner that effectively directs substantial resources to aid in the transition to a low-carbon economy and that fairly compensates major affected industries for short-term economic dislocations incurred as a result of the policy, while also avoiding the potential for significant windfall gains; (2) placing the compliance obligation (point of regulation) at or near primary energy suppliers; and (3) including a well-designed offsets provision.
- Create stronger incentives for comparable action on the part of key trading partners by providing technical and financial resources for the transfer of low-carbon technology, by signaling that the United States will work with other countries to forcefully address trade and competitiveness concerns in the event other major emitting nations fail to take action within a reasonable timeframe, and by linking future U.S. emission-reduction commitments to progress in the international arena.

3. Energy Efficiency

- Enhance and extend tax incentives for efficiency investments introduced under the Energy Policy Act of 2005 (EPAct05).
- Ensure that the Department of Energy (DOE) follows through on its recent commitment to issue efficiency standards for 22 categories of appliances and equipment that capture all cost-effective and technically feasible energy savings.

4. Natural Gas

- Continue to focus on assuring future supply adequacy by following through on EPAct05 commitments with respect to the Alaska pipeline, LNG infrastructure, market transparency, and permitting and leasing. The Commission reiterates its call for a comprehensive inventory of on- and off-shore resources to inform future policy decisions and urges Congress to address concerns about the adequacy of related provisions in EPAct05 (both in terms of the relatively short timeframe specified for completing the inventory and in terms of constraints on the use of federal resources to conduct inventory-related activities in certain areas).

5. Advanced Coal

- Direct greater resources toward accelerating the commercialization of carbon capture and storage (CCS) by providing substantial deployment incentives. Specifically, the Commission believes CCS projects should be eligible for bonus allowances under a greenhouse gas trading program that are at least equal in value to incentives provided under the renewable energy production tax credit.
- Condition eligibility for public funding or subsidies on the actual inclusion of CCS with any new integrated gasification combined cycle (IGCC) and other advanced coal projects going forward. CCS must be included from the outset in any taxpayer supported efforts to develop coal-to-liquids technology.
- Explore carbon capture options for non-IGCC plants.
- Ensure that the U.S. Environmental Protection Agency (EPA) completes a rigorous, formal public process to formulate effective regulatory protocols governing long-term carbon storage as soon as possible (recognizing that midcourse corrections will likely be needed as experience is gained).
- Ensure that new coal plants built without CCS are not "grandfathered" (i.e., awarded free allowances) in any future regulatory program to limit greenhouse gas emissions.

6. Nuclear Energy

- Take action to address the current impasse on nuclear waste disposal, while reaffirming the ultimate objective of siting and developing one or more secure geologic disposal facilities, by amending the Nuclear Waste Policy Act (NWPA) to:
  - Align its requirements with human engineering and scientific capabilities, while adequately protecting public health and safety and the environment.
  - Require DOE to site and operate consolidated national or regional interim storage options.
  - Undertake R&D to explore technological alternatives to the direct geologic disposal of waste from a once-through cycle that meet commercial requirements and nonproliferation objectives, reduce the challenge of waste disposal, ensure adequate protection of public health and safety, and extend fuel supply.
  - Codify that interim storage and federal responsibility for disposal of nuclear waste is sufficient to satisfy the Nuclear Regulatory Commission's waste confidence requirement.
  - Require the Secretary of Energy to take possession of and/or remove fuel from reactor sites that have been, or are in the process of being fully decommissioned.

7. Renewable Energy

- Continue to provide investment certainty by extending the eligibility period for federal production tax credits in five-year, rather than two- or one-year, increments.
- Adopt a federal renewable portfolio standard (RPS) that increases the share of electricity generated by renewable resources nationwide to at least 15 percent by 2020.

8. Biofuels

- Re-evaluate ethanol subsidies and tariffs in light of current fuel mandates and rationalize existing policies to direct a greater share of public resources to more promising options, such as cellulosic ethanol; biobutanol; and clean, high-quality diesel fuel from organic wastes.
- Address other hurdles to biofuels deployment, including hurdles related to the deployment of critical supporting infrastructures (including gathering systems, distribution systems, and refueling facilities) and compatible vehicle technologies.
- Take steps to ensure that policies aimed at reducing U.S. oil dependence do not promote environmentally unsustainable fuel alternatives. The Commission believes that California's recently introduced low-carbon fuel standard suggests a useful direction for future policy and deserves consideration at the national level.

9. Energy Technology Innovation

- Double annual direct federal expenditures on energy-technology research, development, and demonstration, corrected for inflation, with increases emphasizing public-private partnerships, international cooperation, and energy-technologies that offer high potential leverage against multiple challenges. Substantially increasing public investment in energy technology innovation is critical to the achievement of oil security and climate change objectives and can be funded using revenues generated by the proposed greenhouse-gas trading program.
- Triple federal funding specifically for cooperative international efforts in energy research, development, and deployment (where this proposed increase is within the overall expansion of federal expenditures recommended above).

Oil Security

In its 2004 report, the Commission emphasized the importance of a balanced approach to enhancing oil security. Thus, the Commission's recommendations included a number of supply-side measures — aimed at nurturing a greater diversity of foreign and domestic suppliers, promoting a more robust global network of strategic reserves, and developing long-term alternatives to petroleum, such as biofuels — while also stressing the importance of concerted efforts on the demand side. In particular, the Commission called on Congress to "significantly strengthen" and "simultaneously reform" the existing Corporate Average Fuel Economy (CAFE) program, while providing targeted manufacturer and consumer incentives to accelerate the deployment of advanced vehicle technologies and to address the competitiveness concerns of the U.S. auto industry.

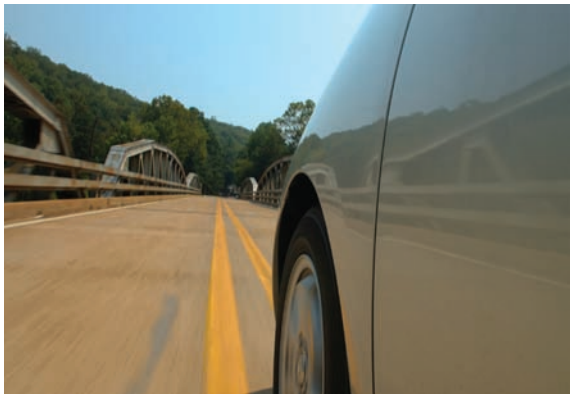
Two years later, despite promising advances on the technology front — including substantial progress in developing vehicles, such as hybrid electric and "plug-in" hybrids, that could radically reduce gasoline consumption per mile traveled — improving the efficiency of the nation's light-duty vehicle fleet remains the most important and as-yet-untapped area of policy opportunity for reducing oil dependence and making the nation more energy secure. The Commission therefore applauds President Bush's recent call for a significant improvement in average new-vehicle fuel economy and urges Congress to move quickly to adopt legislation that would:

- **Establish a four percent per year fuel-economy improvement target;**
- **Retain the full discretionary authority of the National Highway Traffic Safety Administration (NHTSA) to implement the CAFE program, including discretion to modify the presumptive annual average fuel-economy improvement target up or down upon demonstrating that safety, technology, or economic considerations warrant such modification;**
- **Encourage and empower NHTSA to implement reforms aimed at making the CAFE program more cost-effective, market-oriented, and responsive to the jobs and competitiveness concerns of the automobile industry (e.g., by adopting attribute- or size-based standards, allowing trading or averaging across manufacturers, establishing multi-year compliance periods, and rationalizing incentives within the CAFE program for alternative fuel vehicles);**
- **Promote the domestic production of advanced automotive technologies and boost consumer demand for more efficient vehicles by providing targeted consumer and manufacturer incentives, as recommended in the Commission's 2004 report. The Commission notes that a market-based program to limit greenhouse gas emissions (as discussed in the next section) could provide a secure revenue stream to support such incentives.**

The Commission believes that the approach outlined above will produce substantial fuel-economy improvement over time and greatly accelerate the adoption of transformative vehicle technologies. At the same time, the Commission recognizes that efforts toward this objective must be responsive to jobs and competitiveness concerns given the vulnerable state of the domestic auto industry. In our view, a well-designed package of CAFE program reforms and manufacturer and consumer incentives can mitigate these concerns. For example, an attribute- or size-based system could significantly address the disadvantages some automakers would otherwise face as a result of the mix of vehicles in their product line. With a thoughtful combination of policies, the Commission is confident that progress toward more efficient cars and a more robust and globally competitive U.S. auto industry are achievable at the same time.[1]

Here, as in other major policy areas, the importance of a comprehensive approach is worth emphasizing. Incentives for the production and sale of more efficient vehicles alone will not do the job: absent a change in standards, average fuel economy will continue to stagnate so long as gains from more efficient models can be offset by a larger market share for less efficient vehicles. And even though consumers' vehicle choices are affected by substantial changes in gasoline prices, the magnitude of the price signal generated by any politically viable, near-term program to regulate greenhouse gas emissions is unlikely — by itself — to be sufficient to effect a significant shift in driving patterns or consumer preferences for more efficient automobiles. Thus, as the Commission has argued in the climate context, a combination of regulation and incentives that generates a simultaneous market pull and market push for new technologies is likely to be more effective than either approach in isolation. By essentially "flipping" the regulatory presumption in favor of steady progress absent a finding to the contrary, we seek to alter the dynamic that has enabled fuel economy to stagnate for over twenty years, while retaining NHTSA's full authority to adjust the rate of improvement based on its expert judgment. Moreover, the Commission sees great merit in establishing a system that achieves constant, incremental, and relatively predictable improvement compared against the current system, which has produced long periods of inaction interrupted by erratic and potentially disruptive changes in fuel-economy requirements that occur only once every ten to twenty years.

"Improving the efficiency of the nation's light-duty vehicle fleet remains the most important and as-yet-untapped area of policy opportunity for reducing oil dependence and making the nation more energy secure."



[1] For example, in its 2004 report, the Commission encouraged policy makers to consider establishing cost certainty for the vehicle industry by incorporating a cost-containment mechanism in the CAFE program (the idea was first proposed in a 2002 National Academy of Sciences study of fuel-economy regulation). The Commission has not undertaken further analysis of specific cost-containment options, but continues to believe that this and other approaches to managing technology and cost uncertainty merit further exploration.

Climate Change

Among the most prominent and controversial recommendations put forward by the Commission in 2004 was a proposal that the United States adopt a mandatory, economy-wide program to limit future greenhouse gas emissions. Two years later, as the scientific case for action has grown steadily more compelling and more urgent, the Commission remains convinced that a combination of market signals and technology policies (including substantially increased R&D investments, enhanced deployment incentives, and well-designed mandates) provides the most promising and ultimately most effective path forward.

We therefore reiterate our call for a comprehensive approach that will generate the market signals and investment certainty needed to spur the development and deployment of lower-carbon technologies, recognizing that the market signal generated by any politically viable, near-term proposal is unlikely be adequate — on its own — to overcome existing deployment barriers for certain key technologies (such as carbon capture and storage), at least in the early years of program implementation. Thus, a critical element of the Commission's original approach was and remains the inclusion of a complementary package of technology policies and incentives (where the latter are funded by new revenues generated under a greenhouse gas trading program).

In sum, the Commission urges Congress to act without further delay to implement a comprehensive, mandatory, market-based program to limit emissions of greenhouse gases in a manner that does not significantly harm the U.S. economy and that encourages

comparable action by other major emitting nations. Core elements of the program architecture described in the Commission's 2004 report remain, in our view, central to crafting sound, politically viable legislation consistent with this objective. As momentum for a change in national policy has grown and as Congress has begun to consider a number of competing proposals, three program design issues — stringency of program targets, inclusion of a price cap or safety valve mechanism, and linkage to developing country participation — have provoked intense debate among stakeholders and extensive further deliberation within the Commission itself. Our current thinking in each of these areas is summarized below. In each case, the Commission has come to the view that its original recommendations should be strengthened while preserving the basic approach we proposed in 2004.

Program Targets

The Commission has long been convinced that the best hope for timely action on climate change lies in formulating a "first step" policy that establishes moderate near-term targets while also providing a robust basis for long-term progress. Our original ecommendations envisioned an initial ten-year implementation period during which program targets would first aim to slow the rate of growth in U.S. emissions before proceeding to "stop" and "reverse" phases in which emissions would stabilize and then begin to decline.

The Commission has always recognized, of course, that responsibly managing climate risks will eventually require substantial reductions in absolute emissions. The recent (Fourth) Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) indicates that limiting the projected increase in Earth's average surface temperature to 2–3 degrees Celsius could require absolute reductions in global carbon-dioxide emissions of as much as 30–85 percent below 2000 levels by mid-century (2050).[2] In contrast, the latest reference-scenario projection issued by the International Energy Agency shows the continuation of a business-as-usual trajectory leading to a 55 percent increase in global carbon dioxide emissions over just the next quarter century (that is, by 2030).[3] Given the rapid industrialization that is now occurring in many parts of the world and given the long-lived and capital-intensive nature of much of the world's energy infrastructure, the challenge of reversing global emissions trends to the extent needed to address climate concerns is clearly enormous.[4]

"The Commission urges Congress to act without further delay to implement a comprehensive, mandatory, market-based program to limit emissions of greenhouse gases."

At the same time, and notwithstanding the fact that many stakeholders now accept and expect that greenhouse gas emissions will eventually be regulated, the Commission is under no illusions about the continuing

[2] See Table SPM.5 (p. 23) of IPCC, 2007. Climate change 2007: Mitigation. Contribution of Working group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. The IPCC's Fourth Assessment Report also locates the onset of many of the most serious potential consequences of climate change in the range of a global average temperature increase of 2–3°C (for a fuller discussion of impacts, see IPCC, 2007. Climate change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working group II to the Fourth Assessment Report). All IPCC reports are available at http://www.ipcc.ch/.

[3] See <http://www.energybulletin.net/22042.html>. The reference-scenario projection is from the IEA's 2006 World Energy Outlook; it is intended to provide a baseline vision of how energy markets are likely to evolve absent new government measures to alter underlying trends. The U.S. Energy Information Administration's 2006 reference case projection is even more pessimistic, indicating a nearly 75 percent increase in global emissions between 2003 and 2030 (http://www.eia.doe.gov/oiaf/ieo/ieorefcase.html).

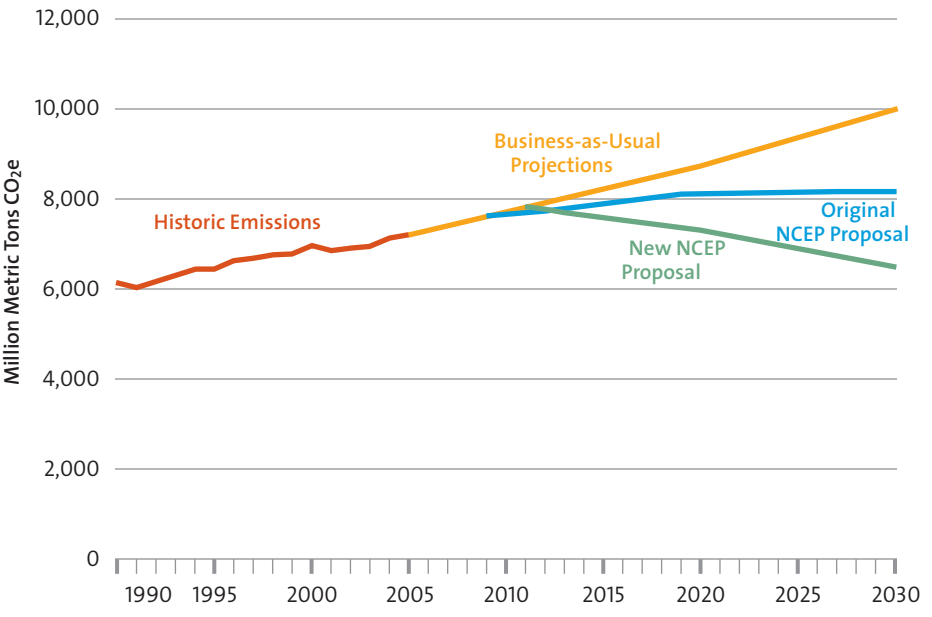
[4] By one estimate, global energy-related carbon emissions grew by approximately 18 percent between 1990 and 2003 (Marland, et al., 2006. <http://cdiac.ornl.gov/ftp/ndp030/global.1751_2003.ems>). Moreover, the annual rate of increase in global emissions seems to have accelerated in recent years, as has the rate at which carbon-dioxide levels in the atmosphere are rising.

difficulty of reaching political consensus on the climate issue. It remains the case that efforts to advance policy must be responsive to political realities and to the inevitable trade-offs that exist between the timeliness and stringency of action. In view of the continuing disconnect between what is required in terms of emission reductions and what is politically feasible in the near-term, we conclude — as we did in 2004 — that moving forward with initially moderate targets is more ecologically protective than continued delay in pursuit of more aggressive goals.

That said, the Commission believes it is appropriate and feasible to strengthen its original program targets in light of the additional time that has elapsed since 2004 and the scientific and technological developments that have occurred in the interim. Specifically, the Commission's current recommendation is to:

- **Strengthen program targets to aim for stabilizing economy-wide greenhouse gas emissions at current (2006) levels by 2020 and achieving a 15 percent reduction below current emissions levels by 2030.**

We recognize that even this revised reduction target remains considerably less aggressive than several proposals now before Congress. Therefore it is important to stress that the Commission continues to support a significant acceleration in the rate of domestic reductions once Congress determines that all major emitting nations are joined in an equitable and effective global response to climate change. The five-year review provision included in our original proposal provides a mechanism for adjusting program targets over time and remains critical to charting an ecologically and economically responsible course for U.S. policy well beyond the initial years of program implementation.



The Commission's original proposal envisioned an initial ten-year implementation period during which program targets would first aim to slow the rate of growth in U.S. emissions before proceeding to "stop" and "reverse" phases in which emissions would stabilize and then begin to decline.

The Commission's new proposal strengthens the program targets to begin emissions reductions immediately upon implementation and achieve a 15 percent reduction below current emissions levels by 2030.

Business-as-usual projections for greenhouse gas emissions are taken from the Energy Information Administration's Annual Energy Outlook 2006.

Price Cap or Safety Valve

The price cap or safety valve has emerged as perhaps the single most contentious element of the Commission's 2004 proposal. More than two years later, we continue to believe that the cost certainty provided by this mechanism is critical to forging the political consensus needed to move forward without further delay. Cost debates inevitably turn on technology assumptions: greater optimism about the development of low-carbon technologies will result in lower cost projections while greater pessimism produces the opposite result. Since there is no objective way to adjudicate different views of the future to the satisfaction of all parties, cost debates are inherently intractable. Even within the Commission, a wide range of opinions exists about the likely cost and pace of technology improvements. By including the safety

valve — and thereby insuring society against the possibility that current assumptions are too optimistic — our diverse group has been able to reach consensus on a common emissions reduction target while maintaining differing expectations about the rate of technological progress. Other proposals currently before Congress use other mechanisms to address economic uncertainty, but in our view the safety-valve still provides a uniquely effective and decisive response to the cost and competitiveness concerns that continue to motivate opposition to mandatory action.

Recognizing that the emissions target and safety valve together determine the overall stringency of the program, the Commission has, in recent months, undertaken further analysis of options for strengthening both parameters. We have concluded that the

combination of a somewhat higher safety valve price and more aggressive emissions targets, coupled with major incentive programs for new technology and complementary policies that have recently begun to attract widespread political support — specifically, an increase in vehicle fuel-economy (CAFE) standards and a federal renewable portfolio standard (RPS) — will produce significantly larger environmental benefits over the next two decades while still meeting the economic test of "no significant harm."

Accordingly, the Commission's current recommendation is to:

- **Raise the starting price of the safety valve to $10 per ton of carbon-dioxide equivalent emissions (compared to $7/ton in the Commission's original proposal) and increase the rate of escalation in the safety-valve price to 5 percent per year in real (rather than nominal) terms.**

The results of recent Commission modeling to analyze the impacts of a higher safety valve price and more aggressive program targets are described in the appendix of this report. On the whole, the analysis confirms that predictions about program impacts are highly sensitive to input assumptions concerning both technology development and the implementation of additional policies. Without supplemental policies and without accelerated deployment of new technologies like carbon capture and storage, the Commission's modeling results suggest that imposing a 15 percent emissions reduction target over the next two decades could — absent a safety valve mechanism — result in allowance prices as high as $50 per ton of carbon dioxide equivalent in 2030. On the other hand, with the supplemental policies, significant energy-efficiency improvements, and a more optimistic view of the effect of increased R&D investment in terms of driving down future technology costs, the same target can be achieved — according to the modeling analysis — without ever triggering the Commission's proposed safety valve price.

Given inherent uncertainty about future technology and policy developments, the Commission believes these results highlight the usefulness of a predictable and well-defined cost-containment mechanism. Many Commission members are optimistic about the level of innovation likely to occur in response to a concrete carbon price signal and about the prospects for implementing important supplemental policies like CAFE, RPS, and incentives for carbon capture and storage. Moreover, our analysis indicates that including these policies is central to achieving more ambitious emission reduction targets without triggering the safety valve.[5] At the same time, the Commission believes it is appropriate and instructive to assess the economic impacts of combining stronger program targets with a higher safety valve price *absent* accelerated technology assumptions and supplemental policies. In that case, modeling analysis indicates that the safety valve price will be triggered relatively early in the program but the overall impact on the economy is very small; indeed the estimated reduction in U.S. GDP relative to the base case totals just 0.12 percent in 2020 and 0.25 percent in 2030. This cost estimate is only very slightly greater than the 0.2 percent reduction in 2030 GDP estimated for the Commission's original proposal and deemed at that time by EIA to constitute "no material impact" on the nation's economy.

Two additional points about the Commission's approach are worth emphasizing. First,

[5] Because supplemental policies like CAFE and RPS have the effect of limiting emissions from specific sectors — in this case transportation and electric power production — their inclusion as part of a comprehensive package of policies reduces demand for allowances within a greenhouse gas trading program, thereby driving down allowance prices. Of course, the supplemental policies also impose costs — costs that, along with the policies, themselves, may be justified by additional public-interest rationales. Vehicle fuel-economy standards, for example, may be justified largely on the basis of energy security considerations, while the chief purpose of an RPS may be to provide sufficient investment certainty for the successful commercialization of technologies that will continue to face substantial deployment hurdles, even in the context of initial carbon constraints.

our current proposal — by combining a stronger price signal with additional deployment incentives — is designed to overcome estimated price differentials for advanced coal systems with carbon capture and storage. Given the urgent necessity of speeding the transition to more climate-friendly coal technologies, the Commission believes this is a key test for any near-term climate policy package.

Second we wish to stress that while a cost-containment mechanism such as the safety valve remains, in our view, essential to building the bipartisan support needed to advance a timely and meaningful domestic climate policy, we also anticipate that ecological considerations will argue for an eventual phase-out of this mechanism in favor of greater emissions certainty once a truly international response to global warming is underway. Our hope, consistent with our emphasis on encouraging comparable action by other nations, is that near-term leadership by the United States will hasten progress toward that objective.

Linkage to International Action

The Commission has always recognized the necessity of engaging other countries in any sustained and ultimately successful effort to manage climate risks — indeed it is precisely for this reason that we assign great urgency to re-asserting a leadership role for the United States. Our original recommendations therefore sought to create a direct linkage between future U.S. emission-reduction commitments and comparable action by other major emitting nations. The primary mechanism included in our 2004 recommendations for this purpose was a periodic review by the President and Congress — to be conducted every five years — for the express purpose of assessing progress both internationally and domestically and for adjusting U.S. policy accordingly. In addition, the Commission specifically called for a tripling of federal expenditures to promote and participate in cooperative international efforts to advance energy research, development, demonstration, and deployment.

Over the last two years it has become clearer than ever that any successful national policy must place considerable emphasis on promoting wider international cooperation. By some accounts, China is now adding new coal capacity at the rate of one large power plant every week to ten days and is set to surpass the United States in total carbon emissions as early as 2009.[6] Though some will argue that this sobering development weakens the case for action by the United States, the Commission draws the opposite conclusion. Our view remains that rapidly industrializing but still far poorer nations are likely to accept emissions limits only after the United States and other wealthy countries have demonstrated a willingness to take the lead. The current trajectory of global emissions not only underscores the liabilities of continued paralysis (in terms of prolonging business-as-usual trends in places like China and India), it argues for concerted measures to bring other countries along as quickly as possible.

Thus, in addition to strengthening key parameters of its proposed domestic policy, the Commission believes it is appropriate to place greater emphasis on accelerating the diffusion of low-carbon technologies to countries like China and India. Specifically, the Commission's current recommendation is to:

- **Create stronger incentives for comparable action on the part of key trading partners by using a share of the public revenues generated by a greenhouse-gas trading program to provide technical and financial resources for the transfer of low-carbon technology. In addition, the United States should signal its intention to work with other countries to develop forceful and coordinated responses to international trade and competitiveness concerns if major emitting nations fail to adopt comparable climate policies in a reasonable timeframe.**

In sum, while the Commission remains firmly convinced that the United States should and must lead by example, we are equally clear that ecological and economic imperatives demand the participation of China, India and all major trading partners in implementing meaningful long-term emission reduction commitments. If other major emitting nations do not participate in future efforts to limit global climate risks, the United States must be prepared to respond effectively to trade and competitiveness concerns and to consider a variety of options for doing so.

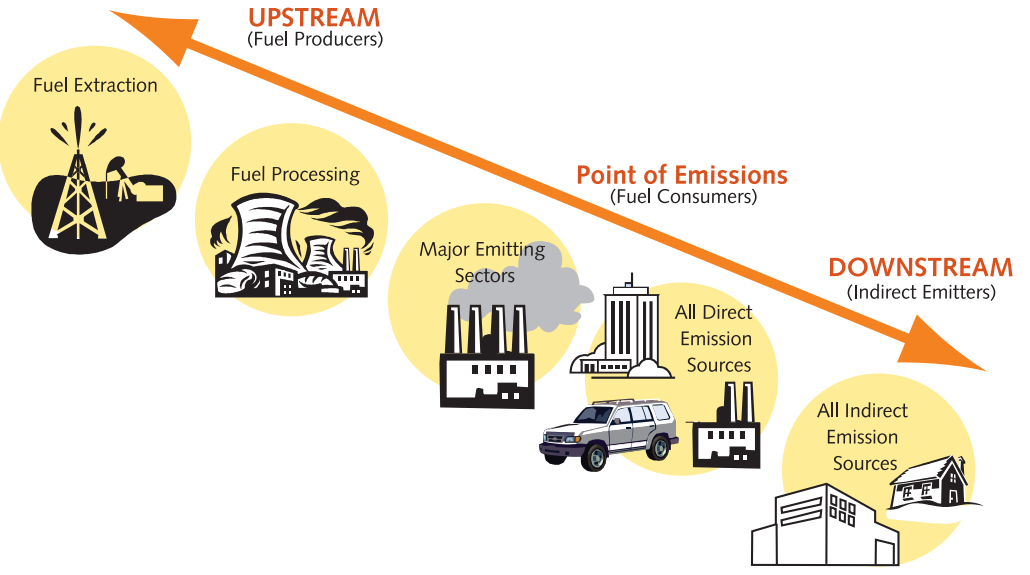
Other Key Program Design Issues

The Commission has also developed more detailed positions on other specific aspects of designing a trading program to limit greenhouse gas emissions:

ALLOWANCE ALLOCATION

- On allowance allocation, the Commission has come to the view, based on further economic analysis, that the number of allowances available on an economy-wide basis under a greenhouse gas trading program

[6] See http://select.nytimes.com/search/restricted/article?res=F50B12F83A5B0C748CDDA80994DE404482



will be more than adequate to both compensate major energy-related industries for any short-term economic dislocations incurred as a result of the program, while also providing substantial resources to address other policy concerns arising from the transition to a lower-carbon economy. Accordingly, we have proposed an initial allocation where roughly half of overall allowances are auctioned or otherwise directed to investment in advanced energy technologies and to mitigating impacts on low-income consumers. The remaining half of the allowance pool should be distributed in a manner that fairly addresses the cost concerns of affected industries (including suppliers of primary fuels, the electric power sector, and energy-intensive manufacturers).[7] We believe this basic approach provides an appropriate balance of public and private interests in the early years of program implementation and avoids the potential for significant windfall gains. Over time, the share of allowances distributed at no cost should diminish in favor of a more complete auction. The Commission recently published a staff paper that discusses the issue of allocation in some detail; this document, entitled "Allocating Allowances in a Greenhouse Gas Trading System," can be found at www.energycommission.org.

POINT-OF-REGULATION

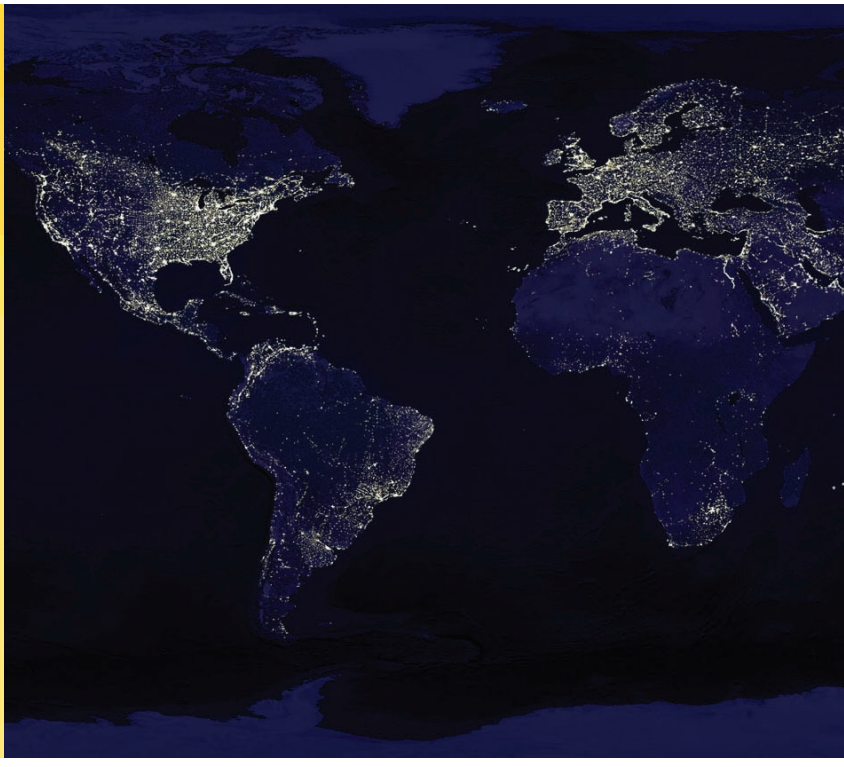
• On point-of-regulation, the Commission recommends that the compliance obligation be placed at or near primary fuel producers or suppliers. Besides reducing administrative complexity and the potential for emissions "leakage," we believe this approach will facilitate efficient pass-through of the carbon price-signal and reduce the potential for distortions introduced by, among other factors, different models of electric utility regulation around the nation.

EMISSIONS OFFSETS

• On emissions offsets, the Commission has concluded that a carefully designed offsets provision can provide a critical catalyst for cost-effective measures not otherwise covered by the trading program. The Commission is concerned, however, by proposals that rely on offsets as a principal means of near-term cost containment. While there is enormous potential for cost-effective carbon sequestration in the agriculture and forestry sectors, relatively little long-term experience exists for measuring, monitoring, and verifying the permanence of emission reductions achieved through terrestrial sequestration. Proposals that expect to achieve significant (>10 percent) compliance through offsets in the near term will be obligated to create a substantial enforcement bureaucracy or risk an influx of illegitimate credits. Either of these outcomes would badly undermine the viability of a meaningful domestic offset program. The Commission believes that the ability to implement a well-functioning offsets program must not be jeopardized by overstating its near-term potential. Rather, a credible program must reflect the differing levels of certainty and verifiability associated with different types of projects and should initially provide allowances from a set-aside within the overall pool of available allowances to encourage harder-to-verify offsets without undermining program objectives. Using a dedicated set-aside from within the program's overall allocation will guarantee the agriculture and forestry sectors the incentives necessary to accelerate learning for this important set of greenhouse-gas mitigation options. By reducing the need for long administrative review processes and expensive reporting requirements, the proposed approach would also provide investors with greater certainty and lower transaction costs. A recent NCEP-commissioned paper on emissions offsets is available at www.energycommission.org.

[7] Importantly, this recommendation should *not* be misinterpreted to imply that each sector is limited to a direct allocation equivalent to 50 percent of its emissions obligation. On the contrary, we propose that the distribution of allowances should roughly follow the actual distribution of net cost burdens imposed on different sectors and industries as a result of the policy. As explained at some length in the Commission's detailed staff paper, this approach would lead to an initial allocation in which some sectors receive substantially more than 50 percent of their emissions obligation and some sectors receive considerably less than 50 percent.

Energy Efficiency and Supply Diversity



One of the Commission's founding premises has been that America's energy challenges call for a comprehensive response — that efforts to address oil security or climate change will fail if they do not also include complementary measures to promote improved efficiency and assure ample, reliable, and affordable energy supplies. As noted in the introduction to this update, progress has been achieved in a number of areas over the last two years, in many cases as a result of provisions introduced under the Energy Policy Act of 2005 (EPAct05) and in some instances through other regulatory or legislative initiatives. This section identifies remaining areas where the Commission believes additional or expanded efforts are called for.

Energy Efficiency

On energy efficiency, EPAct05 established a number of tax incentives for energy efficiency and solar energy technologies. These incentives expire, however, at the end of 2008 — too soon to realize their full benefits. The Commission urges Congress to:

- **Enhance and extend tax incentives for efficiency investments introduced under EPAct05.**
- **Ensure that the U.S. Department of Energy (DOE) fully meets its recent commitment to issue 22 new efficiency standards for major appliance and equipment categories, following an extended period of sluggish progress. DOE must dedicate the necessary administrative resources to establish rigorous standards that capture all cost-effective and technically feasible savings.**

Recognizing that many of the most urgently needed advances in energy-efficiency policy will occur at the state level, the Commission also wishes to note the July 2006 release of a National Action Plan for Energy Efficiency.[8] Developed by a broad-based group of state regulators, utilities, consumer advocates, business interests, and environmental groups, the Action Plan includes a number of useful policy recommendations and deserves close attention from policy-makers and regulators at the state and federal level.

Natural Gas

On natural gas, the Commission's 2004 recommendations stressed the importance — for economic and environmental reasons — of assuring the adequacy of future supplies. At that time we proposed concerted efforts to move forward with the Alaska natural gas pipeline, expand LNG infrastructure, provide additional resources to expedite environmentally responsible leasing and permitting decisions, and conduct a comprehensive inventory of on- and off-shore resources. The Commission therefore welcomes a number of provisions in EPAct05 that should facilitate progress in many of these areas, along with action taken by Congress and the Administration in 2006 to expand access to known reserves in the eastern Gulf of Mexico.

Notwithstanding these important developments, however, the Commission remains concerned about the potential for a growing gap between U.S. demand for natural gas and access to domestic and imported supplies in the years ahead. Given the importance of natural gas as a bridge to an era of lower-carbon electricity production, we believe policy makers must continue to give priority to assuring supply adequacy for this critical fuel. For example, concerns have recently been raised about the adequacy of inventory provisions included in EPAct05: specifically, whether the short timeframe specified for completing the inventory and constraints on the use of federal resources to conduct inventory-related activities in certain areas will hamper efforts to fill in important data gaps. Since rational resource decisions cannot be made absent good information, the Commission urges Congress and the relevant agencies to focus on addressing these concerns and on moving forward to complete a truly comprehensive inventory.

Advanced Coal Technologies

On advanced coal technologies, significant incentives were provided under EPAct05 for integrated gasification combined-cycle (IGCC) coal technology. Recognizing that the future of coal depends on pairing future coal systems with actual carbon capture and storage (CCS), the Commission urges Congress and DOE to ensure that adequate attention and funding is being focused on the CCS side of the equation. The Commission further notes

"...The future of coal depends on pairing future coal systems with actual carbon capture and storage..."

that several states and utilities have adopted or are considering specific constraints on long-term investment in baseload coal generation that lacks provision for responsible disposal of its global warming emissions; given potential costs associated with future regulation of these emissions, such precautions deserve consideration by all generation investors and regulators as a simple matter of fiscal prudence.

In sum, the Commission reiterates in the strongest possible terms its 2004 recommen-

[8] The Action Plan is available at: http://www.epa.gov/cleanenergy/actionplan/report.htm.

dation for a $3 billion program to support the commercial-scale demonstration of sequestration projects in several different geologic settings. We also reiterate our call for immediate deployment incentives; for example, our 2004 report recommended that advanced coal with CCS be eligible for the same production tax credit currently available to renewable energy projects. The Commission's updated recommendations include:

- **Providing CCS systems with deployment incentives that are at least equal to those currently available under EPAct05 for new nuclear power plants and (via the federal production tax credit) for renewable energy resources. In particular, the Commission strongly supports the concept of awarding bonus allowances under a greenhouse-gas trading program for projects with CCS. The financial incentives generated by such provisions could substantially exceed any direct increase in public R&D spending on CCS.**
- **Conditioning eligibility for taxpayer subsidies or public funds for any new coal projects going forward on the actual inclusion of CCS.**
- **Placing greater emphasis on exploring carbon capture options for non-IGCC plants.**
- **Ensuring that CCS is included from the outset in any publicly funded efforts to explore coal-to-liquids technology. Even with CCS, this fuel pathway generates — at best — roughly the same carbon emissions as conventional petroleum fuels; *without* CCS total fuel-cycle carbon emissions nearly double.**
- **Ensuring that the U.S. Environmental Protection Agency (EPA) completes a rigorous, formal public process to formulate effective regulatory protocols governing long-term carbon storage as soon as possible (recognizing that midcourse corrections will likely be needed as experience is gained).**
- **Ensuring that new coal plants built without CCS are not "grandfathered" (i.e., awarded free allowances) in any future regulatory program to limit greenhouse gas emissions.[9]**

"The expansion of nuclear power would enhance fuel and technology diversity in the electricity sector and could reduce vulnerabilities associated with reliance on petroleum and natural gas from unstable regions of the world."

Nuclear Energy

On nuclear energy, EPAct05 included substantial incentives for a new generation of nuclear power plants but did not address the unresolved problem of nuclear waste disposal. The Commission recognizes, of course, that significant additional hurdles with respect to cost, safety, and proliferation risk must also be addressed to allow for an expanded role for nuclear power in the future-all of these issues are addressed in some detail in our 2004 recommendations. Meanwhile, the fact that the licensing of the proposed nuclear waste repository at Nevada's Yucca Mountain remains highly uncertain argues for refocused attention on effective management of spent fuel as an interim step towards permanent disposal. This would increase the probability that nuclear energy could make a significant contribution to the mitigation of climate change in this century. The expansion of nuclear power would enhance fuel and technology diversity in the electricity sector and could reduce vulnerabilities associated with reliance on petroleum and natural gas from unstable regions of the world.[10] Spent fuel can be safely managed with currently licensed and regulated technology for the period likely to be necessary to find disposal solutions. To that end, the Commission recommends that Congress consider several additional steps aimed at ending the current impasse on nuclear waste disposal, including:

[9] A recent MIT study, *The Future of Coal: Options for a Carbon-Constrained World*, notes that "there is the possibility of a perverse incentive for increased early investment in coal-fired power plants without capture . . . in the expectation that the emissions from these plants would potentially be "grandfathered" by the grant of free CO_2 allowances as part of future carbon regulations." (p. xiv)

[10] Although only about 3 percent of U.S. electricity supply comes from oil, the emergence of plug-in hybrids and all-electric vehicles illustrates a potentially significant oil displacement opportunity for nuclear power and other low-carbon electricity sources.

- **Reforming the Nuclear Waste Policy Act (NWPA) to align its requirements with human engineering and scientific capabilities, while simultaneously ensuring adequate protection of public health and safety and of the environment.**
- **Amending the NWPA to require DOE to site and operate consolidated national or regional interim storage options.**
- **Undertaking R&D investments to explore technological alternatives to the direct geologic disposal of waste from a once-through cycle that meet commercial requirements and non-proliferation objectives, reduce the challenge of waste disposal (by reducing heat load and/or transmuting long-lived radionuclides), ensure adequate protection of public health and safety, and extend fuel supply.[11]**
- **Amending the NWPA to codify that interim storage and federal responsibility for disposal of nuclear waste is sufficient to satisfy the Nuclear Regulatory Commission's waste confidence requirement.[12]**
- **Amending the NWPA to require the Secretary of Energy to take possession of and/or remove fuel from reactor sites that have been, or are in the process of being fully decommissioned.**

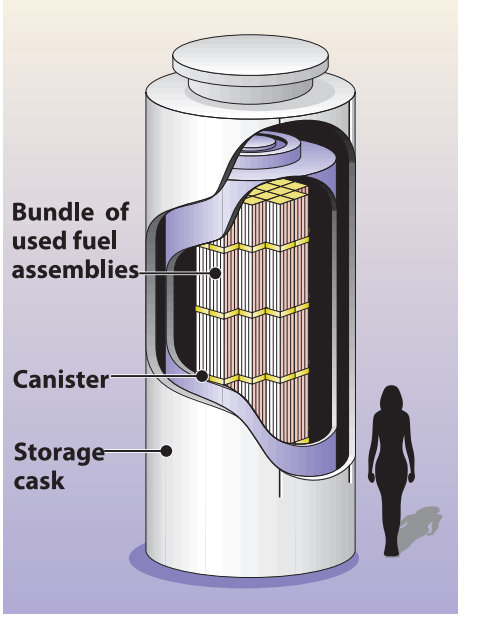
Renewable Energy

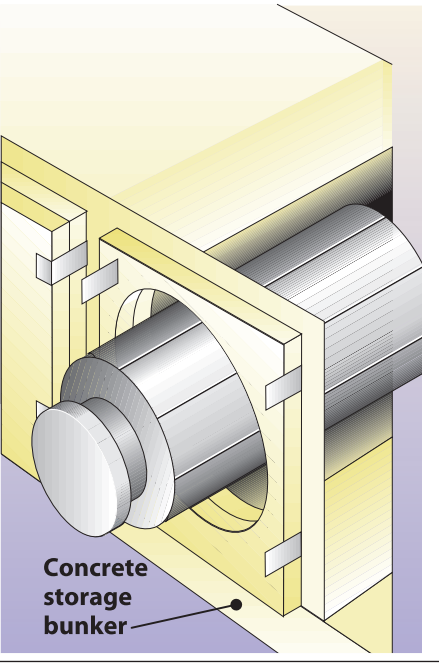
On renewable energy, the primary national-level policy currently in place to promote electricity production using wind and other renewable resources remains the federal production tax credit (PTC). The eligibility period for projects to qualify for the PTC was renewed under EPAct05 and recently extended for an

Dry Storage of Spent Fuel

At some nuclear reactors across the country, spent fuel is kept on site, above ground, in systems basically similar to the ones shown here.

1 Once the spent fuel has cooled, it is loaded into special canisters which are designed to hold pressurized-water reactor (PWR) and boiling-water reactor (BWR) assemblies. Water and air are removed. The canister is filled with inert gas, welded shut, and rigorously tested for leaks. It is then placed in a cask for storage or transportation. In addition, NRC has approved the storage of up to 40 PWR assemblies and up to 68 BWR assemblies in dry storage cask storage systems.





2 The canisters can also be stored in above-ground concrete bunkers, each of which is about the size of a one-car garage. Eventually they may be transported elsewhere for storage.

3 Eventually the canisters shown in (1) or (2) may be placed inside a transportation package for shipment.

Source: U.S. Nuclear Regulatory Commission, Washington, DC.

[11] The recommended pursuit of R&D should not be interpreted as a change in NCEP policy with regard to the "long-standing U.S. moratoria on commercial reprocessing of spent nuclear fuel and construction of commercial breeder reactors."

[12] Pursuant to 10 CFR 51.23. Generic NRC determination of 6 December 1999: 64 Fed.Reg. 68005.

additional year — it now ends in 2008. A more recent and extremely important development has been the proliferation of state programs that require utilities — typically using a mechanism known as a renewable portfolio standard (RPS) — to provide a minimum

"The primary national-level policy currently in place to promote electricity production using wind and other renewable resources remains the federal production tax credit."

percentage of electricity from renewable resources. Policies to promote renewable energy have now been adopted by 23 states and the District of Columbia, generating growing momentum for a national-level program. In this rapidly evolving policy context, the Commission recommends that Congress:

- **Continue to provide investment certainty by extending the eligibility period for federal production tax credits in five-year, rather than two- or one-year, increments. Given that the current window ends in 2008, this would imply extending the PTC eligibility period to at least 2013.**
- **Adopt a federal renewable portfolio standard aimed at increasing the share of electricity generated by renewable resources nationwide to at least 15 percent by 2020.**

In coming months, the Commission intends to examine a number of critical issues pertinent to the design of a federal portfolio requirement with the aim of offering more detailed recommendations in this important policy area. In our view, a number of issues warrant further exploration and analysis, along with further examination of the utility- and economic-policy dimensions of different technology and program options. Specific questions include: (1) whether a more ambitious target for non-carbon resources could be achieved by expanding eligibility to include new nuclear power and advanced fossil systems with CCS; (2) whether and how investments in energy efficiency and distributed power systems might be integrated in a broader portfolio requirement; (3) whether and at what level a safety valve or price cap mechanism should be incorporated in the program; and (4) how a portfolio requirement would interact with other policies, including state RPS requirements and other deployment incentives such as the PTC.

Meanwhile, the Commission has identified a number of important principles as starting points for consideration as Congress begins debating various RPS proposals in the weeks ahead. We believe a sound federal policy should:

- **Apply to all retail electricity providers, not just electric utilities;**
- **Complement but not pre-empt state programs and recognize credits that are used for compliance with state RPS requirements (in other words, a federal RPS should *not* be construed as creating an *additive* requirement on top of whatever state RPS may be in place — where a state RPS also exists, retail providers should be able to use the same renewable energy commitments to meet both requirements);**
- **Be technology neutral — the program should be designed to treat all covered renewable sources equally;**
- **Provide credit for early action — utilities that have invested in renewable energy prior to the enactment of a federal RPS should not be penalized; and**
- **Allow for national trading, including efforts to standardize the monitoring, verification, and distribution of credits in a fair and efficient manner taking into consideration the significant variation that currently exists across state programs; and**
- **Include express provisions assuring retail electricity providers of cost recovery and a fair rate of return for approved renewable energy investments undertaken to comply with a federal RPS.**

Biofuels

On biofuels, EPAct05 included a number of provisions to promote domestic alternatives to today's almost exclusively petroleum-based fuel supply for the transportation sector, most notably by establishing a first-ever, national-level renewable fuels standard (RFS). The current RFS is expected to translate to 7.5 billion gallons of renewable fuel production — enough to displace roughly 4.3 percent of U.S. gasoline consumption on an energy-equivalent basis — by 2012. More recently, President Bush has called for boosting the use of domestic alternative fuels to 35 billion gallons by 2017.

The Commission strongly supports more ambitious goals for renewable fuels use,

recognizing that such goals will require a significant push to commercialize cellulosic ethanol and other promising corn-ethanol alternatives such as biobutanol.[13] Feedstock constraints alone will likely limit the production of corn-based ethanol, which currently dominates the U.S. biofuels market, to less than 10 percent of the fuel requirements of the nation's light-duty vehicle fleet. Recent advances in molecular and systems biology and genetic engineering show great promise for developing improved feedstocks and much less energy-intensive means of producing biomass-based liquid fuels; in addition, promising technologies are emerging that can convert a wide variety of organic waste materials to clean, high-quality diesel fuel. As emphasized in our 2004 report, federal policies and R&D commitments must promote continued progress in these areas. At the same time, the Commission is concerned about the potential climate impacts of expanding fuel production from coal and other unconventional fossil sources, such as oil shale, tar sands, and heavy oil. While not of the view that all efforts to improve energy security must also contribute to climate goals, we believe it would be deeply irresponsible and ultimately counterproductive to pursue policies that are at direct cross-purposes, in the sense that they address one problem while exacerbating another. As noted above, current coal-to-liquids technologies generate nearly twice as much carbon dioxide as conventional petroleum on a full fuel-cycle basis; the climate impacts of existing methods for unconventional oil production are similar or even worse.

To promote needed advances toward commercializing a new generation of more plentiful and environmentally beneficial biomass fuels and to ensure rational policy outcomes from both an energy-security and climate-mitigation perspective, the Commission recommends that Congress:

- **Re-evaluate ethanol subsidies and tariffs in light of current fuel mandates and rationalize existing policies to direct a greater share of scarce public resources to more promising biofuels options, such as cellulosic ethanol; biobutanol; and clean, high-quality diesel fuel from organic wastes.**
- **Address other hurdles to biofuels deployment, including hurdles related to the deployment of critical supporting infrastructures (including gathering systems, distribution systems, and refueling facilities) and compatible vehicle technologies. For example, Congress should consider a combination of incentives and requirements to increase the number of gas stations that dispense fuels containing ethanol at levels up to 85 percent and should support aggressive R&D and engine certification testing to explore whether and how ethanol blends higher than 10 percent can be used in existing vehicle engines and distributed through existing fuel infrastructure.**
- **Take steps to ensure that policies aimed at reducing U.S. oil dependence do not promote environmentally unsustainable fuel alternatives. The Commission believes that California's recently introduced low-carbon fuel standard suggests a useful direction for future policy and deserves consideration at the national level.**

[13] Biobutanol can be produced via fermentation from the same feedstocks as ethanol. It has the advantage of being more like gasoline; it is less corrosive than ethanol, better tolerates water contamination, and is more suitable for distribution through gasoline pipelines.

Energy Technology Innovation

In its December 2004 report, the Commission recommended "doubling annual direct federal expenditures on energy-technology research, development, and demonstration corrected for inflation, over the period 2005–2010 — with increases emphasizing public-private partnerships, international cooperation, and energy-technologies offering high potential leverage against multiple challenges." Although the relatively low cost and relatively non-controversial character of government investments in RD&D compared to other elements of needed national strategy might lead one to suppose that recommendations in the vein might find ready acceptance, nothing like the recommended trajectory has materialized.

In fact, the President's FY2007 request for Department of Energy RD&D on energy technologies (where about 95 percent of the government's expenditures in this domain originate) was slightly *less* than the FY2005 appropriation in real terms. The corresponding FY2008 request is up 15 percent from the FY2005 appropriation in real terms, but essentially all of the increase is concentrated in the rapid ramp-up of a nuclear-fuel-cycle initiative aimed at early demonstration of large-scale reprocessing of spent nuclear fuel — a project considered by many, including this Commission, to be ill-advised. At the same time, the FY2008 request for RD&D on advanced fossil-fuel technologies is 29 per-

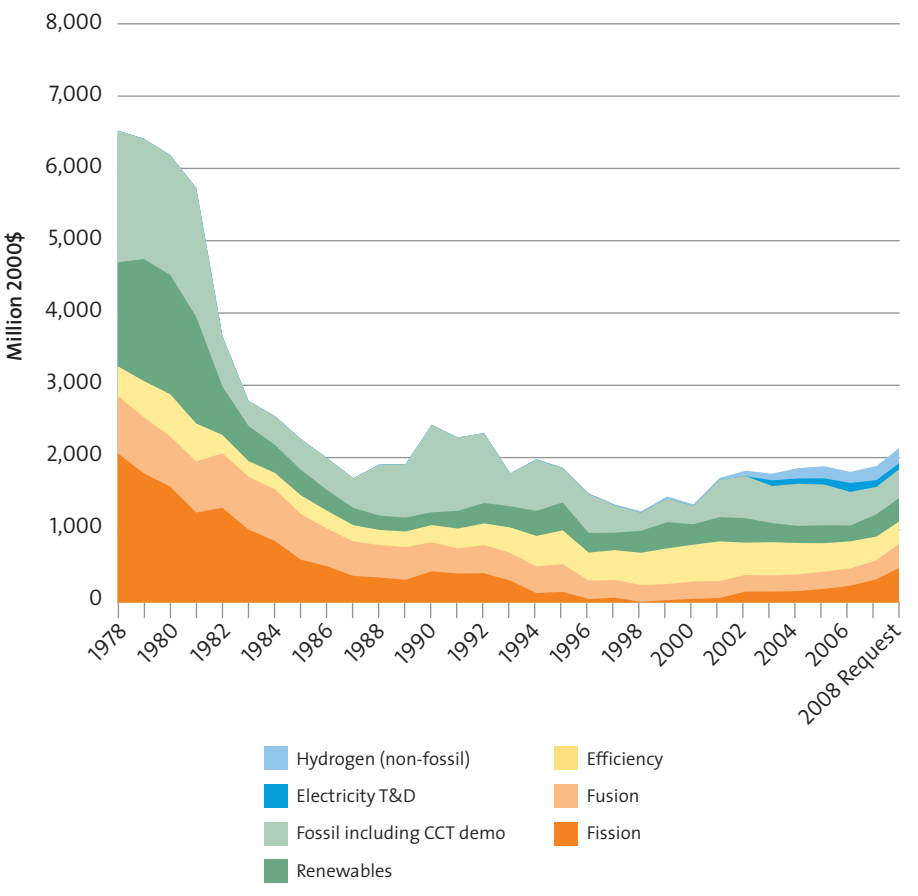
cent below the FY2005 appropriation in real terms, and for RD&D on energy-efficiency technologies the decline is 21 percent.

Even if the question of appropriate allocation of energy RD&D monies is put aside, the increase in the FY2008 request compared to the FY2005 appropriation falls far short of the rate of increase recommended by the Commission in its 2004 report. A doubling of real expenditures over five years requires an average rate of increase of 14 percent per year in real terms, or 16–17 percent per year in current dollars for a 2–3 percent rate of inflation. If the President's request is funded by Congress, the average rate of increase from FY2005 to FY2008 will end up being a third of what we recommended.

Taking all due account of enhanced incentives for private-sector energy-technology RD&D that were embodied in EPAct05 (many along lines recommended by this Commission), as well as the prospect of further such incentives that will materialize when an economy-wide price is established on carbon emissions, the current trajectory of federal expenditures on energy-technology RD&D remains wholly inadequate in relation to the energy challenges facing the United States and in relation to the identifiable relevant opportunities that are badly underfunded. The Commission is undertaking a more detailed analysis of this mismatch for release later this year.

"The increase in the FY2008 request compared to the FY2005 appropriation falls far short of the rate of increase recommended by the Commission in its 2004 report."

U.S. DOE ENERGY RD&D
(Real Spending FY 1978–FY2008)



Source: Gallagher, K.S., A. Sagar, D. Segal, P. de Sa, and J.P. Holdren. 2007. DOE Budget Authority for Energy Research, Development and Demonstration Database. Energy Technology Innovation Project. John F. Kennedy School of Government, Harvard University.

Economic Analysis of Updated Commission Recommendations

Introduction

This appendix describes the results of a modeling analysis undertaken to assess the economic and emissions impacts of updated recommendations issued by the National Commission on Energy Policy in April 2007. Those recommendations sought to accelerate progress in areas where the Commission believes current energy-policy initiatives remain inadequate to the challenges at hand, particularly with respect to oil security and climate change. Specifically, the Commission has recently proposed to strengthen key parameters of the mandatory, economy-wide greenhouse-gas trading program first proposed in its 2004 report, *Ending the Energy Stalemate*, and has recommended a package of supplementary policies to improve vehicle fuel economy, promote energy efficiency, boost incentives for carbon capture and storage, and increase the renewable-energy contribution to the nation's electricity supply.

To analyze the combined impact of these recommendations, the Commission used the National Energy Modeling System (NEMS), a detailed model of energy production and consumption used by the U.S. Energy Information Administration (EIA) to develop forecasts and assess policy options.[1] The Commission was interested in using this tool to estimate benefits, costs, and sectoral impacts under different program parameters and in exploring how technology- and sector-oriented policies might interact with a broad-based greenhouse-gas price signal. Thus, in addition to assessing effects on emissions, energy prices, and GDP, the modeling analysis was undertaken to answer questions such as:

- **Is it possible to strengthen the Commission's original (2004) proposal for a mandatory, greenhouse-gas trading program without causing harm to the broad economy?**
- **Under what circumstances is the safety valve in the NCEP recommendations likely to be triggered?**
- **What assumptions or policies play a particularly important role in enabling emission-reduction targets to be met at an acceptable cost in terms of energy-price and GDP impacts?**
- **Is the combination of a carbon dioxide (CO_2) price and direct technology incentives adequate to speed the development and deployment of carbon capture and storage technology in the power sector?**
- **What is the interaction between a CO_2 price and a national renewable portfolio standard in expanding the future contribution of renewable energy sources?**

In general, the results of the analysis underscore the importance of underlying technology assumptions in driving projections of economic cost and environmental benefit under different policy scenarios. With relatively optimistic technology assumptions — concerning, for example, the potential for energy-efficiency improvements in the transportation and buildings sectors, and the deployment of new technologies like carbon capture and storage — the emission reductions stimulated by a given greenhouse-gas price signal as much as double. Conversely, with less favorable technology assumptions, the price signal required to achieve a given environmental target becomes substantially higher.

The overall results of the modeling analysis provide, in our view, considerable grounds for optimism concerning the feasibility and affordability of undertaking a major shift in the nation's energy trajectory over the next two decades, *provided* the political will exists to implement a well-designed and comprehensive package of policies within the next few

[1] A detailed description of the NEMS model can be found at http://www.eia.doe.gov/oiaf/aeo/overview/index.html. The model was used to forecast impacts to 2030, consistent with the forecasting period used in EIA's Annual Energy Outlook.

years. Specifically, the Commission's findings suggest that the combination of a meaningful price signal for reducing greenhouse-gas emissions and effective technology policies can achieve substantial reductions in greenhouse-gas emissions across all sectors of the economy without triggering the proposed safety-valve mechanism and without incurring significant energy price shocks or GDP losses — and do so while simultaneously preserving a major role for coal, reducing oil dependence, and substantially boosting the contribution of clean, domestic renewable resources. Substantial improvements in vehicle fuel economy and end-use efficiency throughout the industrial, residential, and commercial sectors also play a critical role in achieving this result.

The remainder of this appendix describes the results of the Commission's recent modeling efforts in detail — including providing answers to the above-identified questions. Before proceeding to results, however, it is useful to begin by reviewing the parameters and limitations of the analysis.

Updated Commission Recommendations and Key Modeling Assumptions

Table 1 summarizes the key assumptions used in the modeling analysis to reflect the Commission's updated recommendations concerning the design of a mandatory, greenhouse gas trading program and other policies to improve oil security, assure ample and reliable energy supplies, and overcome market hurdles to the deployment of new, low-carbon energy technologies. It is worth noting that some elements of the Commission's larger package of updated recommendations could not be readily modeled within the NEMS framework and thus are not included in the analysis. For example, the Commission did not model its recommendations to address hurdles to further biofuels deployment. Results of the analysis are presented, throughout the discussion that follows, as changes relative to the EIA's Annual Energy Outlook 2006 business-as-usual reference-case forecast, which includes policy changes introduced under the Energy Policy Act of 2005 (EPAct05).

TABLE 1: KEY MODELING ASSUMPTIONS USED TO ANALYZE UPDATED NCEP RECOMMENDATIONS

Vehicle Fuel Economy	Average combined new car and light-truck fuel economy increases gradually to reach 41 miles per gallon by 2030. This is just slightly below the Commission's current recommendation for a presumptive 4 percent per year (approx. 1 mpg per year) rate of improvement in average light-duty vehicle fuel economy.
Climate Change	Mandatory economy-wide greenhouse gas trading program implemented in 2012 with the following features: • Annual program targets defined to achieve stabilization of emissions at 2006 levels by 2020 and 15% reduction below 2006 levels by 2030. • "Safety valve" price starts at $10 per ton CO_2-equivalent in 2012 and escalates 5% per year in real terms thereafter.
Energy Efficiency	Uses assumptions in EIA's "High Technology" side case from the Annual Energy Outlook 2006 for the residential, commercial, industrial, and transportation sectors. This case is used to reflect the effects of technology improvements resulting from the Commission's updated energy efficiency and RD&D recommendations (see further discussion in main text).
Advanced Coal	Carbon capture and storage projects receive production incentives similar to the renewable production tax credit.
Renewable Electricity	A federal renewable portfolio standard is adopted to increase the nation's share of renewable electricity sales to at least 15% by 2020. Consistent with past legislative proposals, the standard includes a 1.5 cent price cap on the cost of renewable energy credits. (Note that the Commission has not made any recommendations concerning the inclusion of a price cap in a national RPS.)
Technology RD&D	Uses EIA's "High Technology" side case from the Annual Energy Outlook 2006 for the electric sector (which includes high technology assumptions for fossil-fuel, nuclear, and renewable energy systems). This case is used to reflect the effects of technology improvements resulting from the Commission's updated RD&D recommendations.

As indicated in Table 1, the Commission's recommendations with regard to energy efficiency, expanded technology RD&D, and bonus allowances for carbon capture and storage were not modeled directly, but were instead represented using proxy assumptions. Whether these assumptions are more likely to understate or overstate the impact of Commission recommendations is difficult to assess. EIA's "High Technology" case, for example, assumes better than business-as-usual improvement in end-use efficiency in the residential and commercial sectors but is less aggressive than EIA's "Best Available Technology" case, which assumes that the most efficient equipment available in a given year is adopted regardless of cost (see text box on page 33). As such it represents an approximation rather than an effort to precisely estimate the savings likely to occur as a result of related Commission recommendations, which include extending and expanding federal tax incentives for efficiency improvements, issuing rigorous new appliance and equipment standards, and greatly increasing public expenditures on technology RD&D. In other respects, the modeling assumptions are clearly conservative: for example, they do not include additional policies — beyond those introduced in EPAct05 — to boost the use of biofuels.

The Commission also analyzed two additional scenarios to elucidate the effects of the greenhouse gas trading program by itself (that is, without the additional or supplemental policies recommended by the Commission and summarized in Table 1) and to explore the impact of the safety valve in limiting economic costs under less favorable policy and technology assumptions. In one of these scenarios we model the effects of the proposed greenhouse gas trading program with no safety valve and no supplementary policies. In a second scenario, we assume the $10 safety valve is immediately triggered to simulate the maximum economic impact that would be expected if demand for emission allowances — in the absence of supplementary policies and/or with slower technology progress — causes allowance prices to rise to the Commission's proposed price cap.[2] Results from these scenarios are presented, along with results from the main analysis, in the discussion that follows.

Summary of Main Findings

The main findings of the modeling analysis are perhaps best summarized by returning to the questions posed at the outset of this discussion.

- **Is it possible to strengthen the Commission's original (2004) proposal for a mandatory, greenhouse-gas trading program without causing harm to the broad economy?**

The answer to this question is yes. The modeling analysis shows that the more stringent emissions-reduction targets in the Commission's 2007 proposal (i.e., stabilization at 2006 levels by 2020 and a 15 percent reduction below 2006 levels by 2030) can be achieved with impacts on GDP that range from the slightly positive to slightly negative but that are in all cases very small compared to expected growth in the nation's economy. Specifically, in the policy case — which includes the supplemental policy assumptions summarized in Table 1 — improved technologies and reduced energy demand limit energy price impacts and produce a small *increase* in U.S. GDP. In other words, gains from efficiency improvements and better technologies are large enough to offset GDP losses resulting from the emission trading program (although it should be noted that economists are sometimes skeptical of analyses predicting economic gains from efficiency programs as there could be adjustment costs that are not adequately reflected in the modeling). As a result, overall GDP in 2030 is slightly (0.15 percent) higher in the policy case than in the reference case. Under less favorable technology and policy assumptions, the overall impact of the trading program on the nation's economic output turns slightly negative but remains below one half of 1 percent of projected GDP in 2030. While impacts on the broad economy are small, certain sectors, particularly coal mining and coal-consuming sectors, will face higher costs, as coal prices are expected to roughly double by 2030 as a result of the trading program.

- **Under what circumstances is the safety valve in the NCEP recommendations likely to be triggered?**

In the policy case, which includes substantial gains in vehicle fuel economy and end-use efficiency and the accelerated deployment of climate-friendly technologies, allowance prices are projected to remain below the safety valve throughout the forecast. Absent these favorable technology assumptions and supplemental policies, the safety valve in the NCEP recommendations is likely to be triggered in the early years of program implementation. This result suggests that adoption of the supplemental policies included in the Commission's updated package of recom-

[2] The safety valve price is assumed to escalate at 5 percent per year above the rate of inflation.

mendations is critical to achieving targeted greenhouse-gas reductions.

- **What assumptions or policies play a particularly important role in enabling emission-reduction targets to be met by 2030 at an acceptable cost in terms of energy-price and GDP impacts?**

As noted previously, improvements in vehicle fuel economy, enhanced end-use efficiency in the buildings and industrial sectors play an especially important role, although expanded deployment of advanced supply-side technologies — notably, carbon capture and storage and renewable energy — also make a significant contribution to achieving overall program goals. Stronger fuel-economy standards, in particular, are critical because the CO_2 price signal generated by the trading program alone would not be expected to produce substantial emission reductions from the transportation sector. With the level of vehicle efficiency improvement assumed in the policy case, the transport sector delivers roughly 16 percent of projected energy-related CO_2 reductions by 2030[3] and 1.2 billion barrels of oil savings per year by 2030.

Without significant transport-sector emissions reductions, on the other hand, a much larger share of the abatement burden falls to the electric power sector, which would be compelled to make commensurately larger investments in potentially more expensive options such as carbon capture and storage, new nuclear generation, and renewable energy. Technology improvements and associated end-use efficiency gains also play a crucial role *within* the electric sector where — as in the transportation sector — the modeling results suggest that the CO_2 price signal from the trading program would not be sufficient, by itself, to produce substantial demand reductions.

- **Is the combination of a CO_2 price and direct technology incentives adequate to speed the development and deployment of carbon capture and storage technology in the power sector?**

Yes, modeling results for the policy case show significant capacity additions of advanced coal systems with carbon capture and storage (CCS) compared to the reference case. Specifically, 81,000 megawatts (MW) of coal capacity with CCS are added by 2030 in the policy case; as a result, coal consumption in 2030 is actually slightly higher (by 2 percent) than current consumption. By contrast, the reference case shows comparable capacity additions for advanced coal systems, but none of these additions include actual CCS. The modeling results further indicate that the CO_2 price signal alone accounts for a relatively small share of expected new CCS capacity by 2030. This finding underscores the importance of near-term policies aimed at directly supporting CCS technology, including production incentives and support for demonstration projects.

- **What is the interaction between a CO_2 price and a national renewable portfolio standard in expanding the future contribution of renewable energy sources?**

In the case of new renewable electricity technologies (primarily wind and biomass), the CO_2 price signal and a national renewable portfolio standard work together to produce a substantial increase in installed renewable generating capacity and electricity production. Specifically, the CO_2 price signal alone increases RPS-eligible renewable generation to approximately 12 percent of total electricity sales by 2030 compared to 2 percent in the reference case. Implementing a national renewable portfolio standard, as recommended in the Commission's updated proposal, results in further gains such that RPS-eligible renewable generation grows to 18 percent of overall sales by 2030. Importantly, the renewable contribution is limited in the NEMS modeling runs by a 1.5-cent price cap on the cost of renewable energy credits (where credits are assumed to be issued in per kilowatt-hour units). This constraint was included to reflect previous legislative proposals; it is not based on a Commission recommendation. With a higher price cap, the renewable contribution would be even higher under the policy case.

Economic (GDP) and Energy-Price Impacts

Table 2 shows the impact of the Commission's proposed package of policies on energy prices in 2020 and 2030, relative to EIA's reference-case forecast. In general, price impacts are relatively modest, ranging from a 3–7 percent increase in 2030 compared to the reference case, except in the case of coal where prices roughly double by 2030. Significant improvements in end-use efficiency and reduced electricity and natural gas demand, however, mitigate the impact of higher coal prices in the electric sector. As a result, electricity prices remain at roughly the same level as in the reference case through 2025 and rise only 5 percent above the reference case level by 2030.

[3] See Figure 2 on page 32. Energy-related carbon emissions for purposes of this comparison do not include modeled reductions in non-CO_2 gases and reductions attributed to offsets.

TABLE 2: SUMMARY OF ENERGY MARKET IMPACTS[4]

		2020		2030	
	2005	AEO 2006 Reference	Policy Case	AEO 2006 Reference	Policy Case
Emissions of Greenhouse Gases (million metric tons CO_2-e)					
Energy-Related Carbon Dioxide	5,967	7,119	6,020	8,114	5,909
Other Covered Emissions	269	452	193	627	219
Total Greenhouse Gases	6,236	7,571	6,213	8,741	6,127
Emissions Reduction from Reference Case (million metric tons CO_2-e)					
Energy-Related Carbon Dioxide	—	—	1,099	—	2,206
Other Covered Emissions	—	—	259	—	409
Non-Energy Offset Credits	—	—	119	—	157
Carbon Sequestration	—	—	319	—	345
Total Emissions Reduction	—	—	1,478	—	2,771
Total (including sequestration)	—	—	1,797	—	3,116
Allowance Price (2004$ per metric ton CO_2-e)	—	—	$ 8.67	—	$19.60
Delivered Energy Prices (2004$ dollars per unit indicated) (includes allowance costs)					
Motor Gasoline (per gallon)	$ 2.31	$ 2.08	$ 2.04	$ 2.19	$ 2.26
Jet Fuel (per gallon)	$ 1.71	$ 1.42	$ 1.43	$ 1.56	$ 1.70
Distillate (per gallon)	$ 2.34	$ 2.03	$ 2.07	$ 2.14	$ 2.43
Natural Gas (per mcf)	$ 9.89	$ 7.14	$ 7.34	$ 8.22	$ 8.78
Residential	$12.68	$10.48	$10.56	$11.67	$12.20
Electric Power	$ 8.29	$ 5.53	$ 5.39	$ 6.41	$ 6.69
Coal, Electric Power (per million Btu)	$ 1.50	$ 1.39	$ 2.16	$ 1.51	$ 3.21
Electricity (cents per kilowatthour)	8.3 ¢	7.2 ¢	7.2 ¢	7.5 ¢	7.9 ¢
Fossil Energy Consumption (quadrillion Btu)					
Petroleum	40.2	48.1	42.8	53.6	44.6
Natural Gas	22.9	27.7	23.8	27.7	24.0
Coal	23.4	27.6	23.3	34.5	23.8
Electricity Generation (billion kilowatthours)					
Petroleum	115	107	40	115	38
Natural Gas	752	1,102	825	990	819
Coal	2,041	2,505	2,111	3,381	2,276
Nuclear	774	871	865	871	1,002
Conventional Hydropower	267	303	307	303	307
All Other Renewable	109	212	707	256	1,040
Total	4,058	5,099	4,855	5,915	5,482

[4] All 2005 data were sourced from the AEO 2006.

Additional analysis of the alternative scenarios noted above highlights the importance of supplemental policies and technology assumptions in driving model results. The full package of modeled policies achieves targeted emission reductions without triggering the Commission's recommended "safety valve" cap on allowance prices. *Absent* the improvements in vehicle fuel-economy, renewable energy production, and energy efficiency noted in Table 1, however, emissions in the electricity and transport sectors — and associated demand for allowances — are substantially higher. Achieving the same emission-reduction targets in this instance would entail significantly higher allowance costs and energy-price impacts. Specifically, the modeling analysis suggests that the Commission's recommended emissions targets alone — if imposed as a "hard" cap (that is, without a safety valve) and without additional policies — would result in allowance prices of roughly $23 per ton of CO_2 equivalent emissions in 2020 and nearly $50 per ton in 2030. Associated energy-price impacts would also be significantly larger: forecast prices for delivered natural gas, gasoline, and electricity would rise 29 percent, 19 percent, and 22 percent respectively above the reference case forecast by 2030, while coal prices would nearly quadruple.[5]

The existence of the safety valve would, of course, serve to limit price impacts under less favorable technology and policy conditions. To model the effects of this cost-containment mechanism, we assume that allowance prices — in the absence of supplemental policies and accelerated technology progress — reach the safety valve level in the early years of program implementation. In that case, energy-price and GDP impacts are slightly greater than those seen in the full policy case, but fall far short of the impacts seen under the hard-cap case. Specifically, at a safety-valve starting price of $10 per ton of CO_2-equivalent emissions, energy price increases for gasoline, delivered natural gas, and electricity range from 5 percent to 10 percent in 2020, and 8 percent to 15 percent in 2030. Coal prices rise by 83 percent in 2020 and 116 percent in 2030. Because energy expenditures account for only a small share of the overall economy, however, impacts on economic growth are considerably more modest. In 2030, GDP under the $10-per-ton safety-valve-only scenario is just 0.26 percent below projected GDP in the reference case. Cumulative GDP losses as a result of the emission trading program amount to 0.52 percent of cumulative GDP gains over the entire modeling period (2006-2030). In other words, GDP growth is reduced only slightly, from 100.8 percent to 100.2 percent between 2006 and 2030.[6]

Before concluding this section, it is important to stress again that the above-discussed results for safety-valve-only scenarios reflect relatively pessimistic technology and policy assumptions. That is, they assume the climate policy works entirely through the price signal generated by the greenhouse gas trading program *without* any additional benefits generated by supplemental policies or accelerated technology development in key areas like energy efficiency and carbon capture and storage.

Emission Impacts

The Commission's combined proposals result in significant greenhouse gas reductions compared to both current and forecast levels. Cumulative greenhouse gas emissions from covered sources[7] over the 2012–2030 period analyzed are 22 percent below reference-case emissions.[8] Allowance banking allows these emission reductions to be spread out over the forecast period, with regulated entities over-complying in the early years of program implementation when allowance prices are lower. Over 2,950 million metric tons of carbon-dioxide equiva-

[5] Overall GDP impacts would also be higher than in the full policy case (a 0.46 percent reduction in forecast 2030 GDP compared to a 0.15 percent gain in the full policy case), though to a lesser degree in percentage terms than a simple comparison of energy-price impacts might suggest. This is because energy expenditures, though large in aggregate and certainly significant for many households and for certain industries, account for only a relatively small share of the nation's multi-trillion-dollar overall economy.

[6] This result includes economic benefits from the NEMS model's revenue-recycling assumptions. In addition to the economic impacts that result from changes in energy prices and resulting impacts on the production and consumption of energy-intensive goods and services, the model accounts for positive benefits associated with the auction and distribution of greenhouse-gas allowances. The distribution of allowances generates revenue streams to the government and private interests that are represented in the NEMS Macroeconomic Activity Module, which calculates aggregate impacts on prices, output, and employment within the economy. For this modeling exercise, assumptions concerning allowance allocation were taken from draft legislation sponsored by Senator Bingaman that is largely consistent with the NCEP proposal. The assumptions include $50 billion in cumulative RD&D expenditures by 2030 funded from auction revenues. Additional auction revenues that flow to the government are assumed to be used for deficit reduction.

[7] Covered sources include sources of energy-related CO_2 emissions, coal mine methane, nitrous oxide emissions from adipic acid and nitric acid production, and industrial gases (HFCs, PFCs, and SF6). Global warming potential (GWP) conversion factors for non-CO_2 greenhouse gases are taken from the Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis* (Cambridge, UK: Cambridge University Press, 2001).

[8] Cumulative emission reductions include certified emission reductions or "offset credits" from non-covered sources. Unless otherwise stated, the term "greenhouse gas emissions" refers to emissions from all covered sources less offset credits. Additional reductions from agricultural sequestration activities are not included in the totals reported here.

TABLE 3: GDP IMPACTS

	Reference Case	Policy Case	No Safety Valve	$10 Safety Valve
Annual GDP (Billions 2000$)				
2020	$ 17,541	$ 17,571	$17,499	$ 17,514
Percent change from Reference Case	—	0.17%	-0.24%	-0.15%
2030	$23,112	$23,148	$23,005	$23,052
Percent change from Reference Case	—	0.15%	-0.46%	-0.26%
Cumulative GDP Growth (Billions 2000$)				
2006–2030	$11,599	$ 11,633	$ 11,493	$ 11,540
Percent change from Reference Case	—	0.30%	-0.92%	-0.52%

lent (MMTCO2e) allowances are banked by 2022. Emissions then begin to rise above the target as banked allowances are used for compliance. Even with the use of banked allowances, however, emissions in 2030 are 4 percent below current (2006) levels (Figure 1). Allowance prices start at approximately $4.50 per metric ton CO_2e in 2012 and rise to nearly $20 per metric ton CO_2e by 2030 (in real 2004$), but remain below the safety valve price throughout the forecast period.[9] Overall, program targets are met and no additional allowances are purchased through the safety valve mechanism.

Reductions from energy-related carbon dioxide emissions account for roughly 80 percent of projected reductions in the 2020–2030 timeframe. The largest emissions reductions are forecast in the electric power and transportation sectors as a result of the greenhouse gas trading program and more stringent Corporate Average Fuel Economy (CAFE) requirements (see Figure 2). These two sectors account for 53 percent and 15 percent, respectively, of total cumulative emissions reductions over the forecast period In contrast, primary energy consumption in the residential, commercial, and industrial sectors combined accounts for a much smaller percentage (6–12 percent) of annual emissions reductions over the forecast period, although emissions within the industrial sector are nearly 20 percent below the reference case by 2030. Remaining reductions come from other covered greenhouse gases, the bulk of which involve industrial emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur-hexafluoride (SF_6).

The modeling analysis also accounts for the inclusion of a well-defined offsets program to promote cost-effective emission reductions from non-covered sources. The Commission has recommended that emissions offsets be limited to non-covered sources where there is a strong likelihood that emissions benefits can be reliably verified and monitored over time.[10] In the modeling analysis, offsets account for 6–7 percent of the overall emissions reductions implemented between 2020 and 2030 to meet program targets. The modeling analysis also includes a "set-aside" program in which a small percentage of the total annual allowances are used to provide incentives for agricultural storage activities. Because the allowances for the set-aside program are taken from the total pool of available allowances, emission reductions from agricultural storage activities should be viewed as additional reductions beyond those needed to meet the program targets. The set-aside program results in an additional 240–345 $MMTCO_2e$ of reductions annually.

Sector-Level Impacts

The Commission's modeling analysis provides further insights on specific impacts

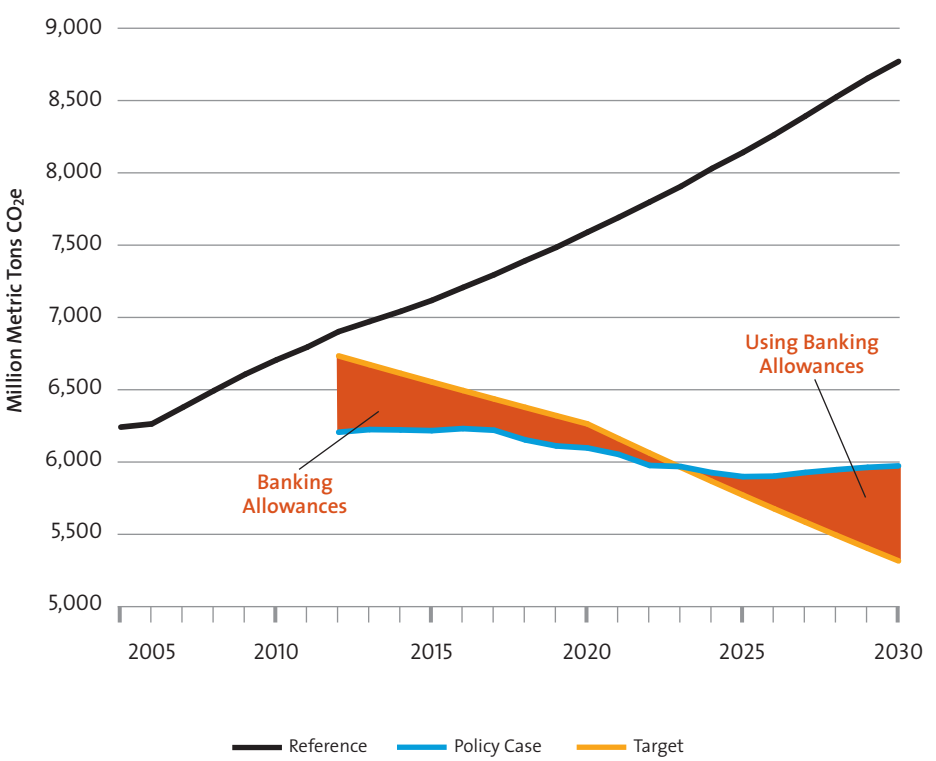
[9] As a result of banking, allowance prices rise at the real discount rate — in this case, 8.5 percent — so that the cost of early versus later reductions is equivalent when adjusted for differences in timing.

[10] Eligible offset projects in this analysis include landfill methane projects, animal waste methane projects, municipal wastewater methane projects, and measures to reduce SF_6 emissions from electrical transformers. Credits for CCS projects at power plants are included in electric-sector emission reductions.

at the sector level. Subsequent sections review results for the electric power sector, the transportation sector, and primary fuel markets.

ELECTRIC POWER SECTOR: The combination of a CO_2 price signal and supplemental policies — notably a national-level RPS and deployment incentives for CCS [11] — produces significant shifts in the resources and technologies used for electricity generation. Over the next two decades, both generation and new capacity shift away from carbon-intensive sources, particularly conventional pulverized coal plants, to nuclear, renewables, and advanced coal systems with CCS. In addition, the modeling results for 2030 show substantially lower levels of electricity generation and capacity in the policy case compared to the reference case. Improvements in end-use efficiency significantly reduce electricity use, principally in the residential and commercial sectors. Electricity demand in the reference case is projected to grow 45 percent by 2030, while demand in the policy case grows only 35 percent.

FIGURE 1: COVERED EMISSIONS LESS OFFSETS



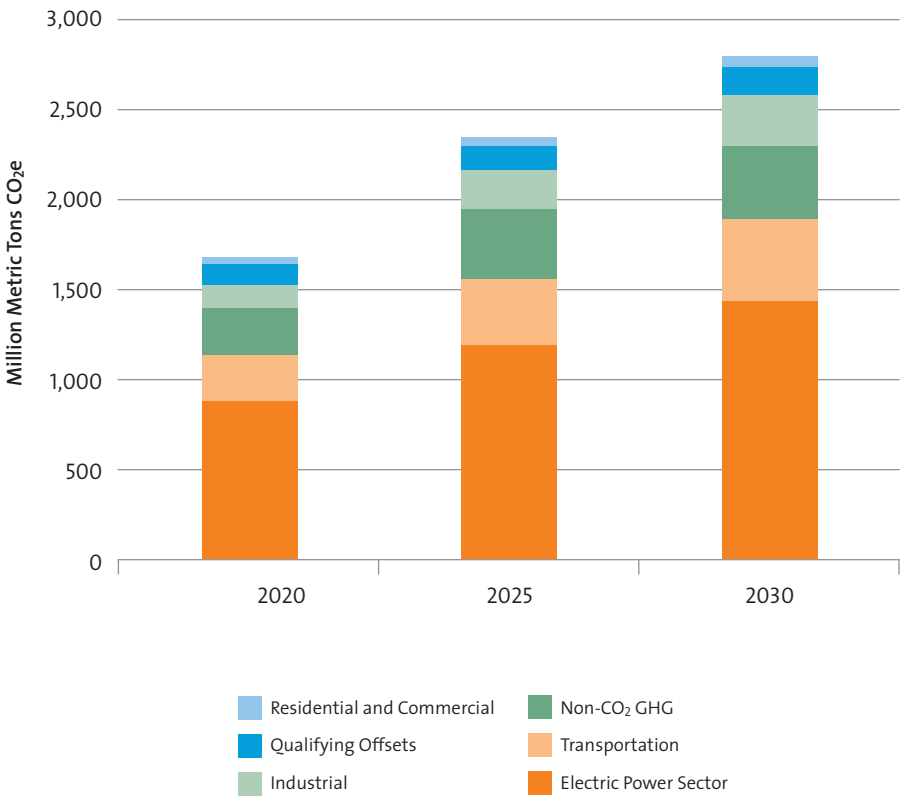
Not surprisingly, electricity generation from renewable resources (excluding existing hydropower) — particularly from wind and biomass — increases substantially under the package of policies analyzed. Electricity from these sources accounts for 13 percent of total sales by 2020 (compared to 1 percent in the reference case), and 18 percent by 2030 (compared to 2 percent in the reference case). Lower electricity demand substantially reduces the need for new generating capacity in the policy case-as a result, there are fewer opportunities for new renewable plants to enter the market. In absolute terms, wind capacity reaches 94,000 MW by 2030 in the policy case, compared to 20,000 MW by 2030 in the reference case; similarly biomass capacity in the policy case reaches 66,000 MW by 2030, compared to 5,000 MW in the reference case. (Current installed wind and biomass capacity totals approximately 10,000 and 2,000 MW, respectively.) Combined, over 157,000 megawatts of new renewable capacity are added by 2030 in the policy case.

While nuclear capacity also grows, modeled increases are much less dramatic than in recent NEMS analyses.[12] This is due in large part to the incentives provided for CCS in the policy case analyzed. These incentives drive down the cost of advanced coal systems, making them more economically attractive than nuclear plants. In the reference case,

[11] To simulate the bonus allowance program for CCS recommended by the Commission, all advanced coal generation with CCS built by 2030 receives a 1.7 cent per kilowatt-hour production tax credit. This is slightly below the current 1.9 cent per kilowatt-hour tax credit for renewables to reflect the fact that CCS systems would likely capture 90 percent (rather than 100 percent) of carbon emissions. As with the renewable production tax credit, plants receive the credit for the first 10 years of operation.

[12] See, for example, the January 2007 EIA report: *Energy Market and Economic Impacts of Reducing Greenhouse Gas Intensity with a Cap and Trade System* at http://www.eia.doe.gov/oiaf/servicerpt/bllmss/pdf/sroiaf(2007)01.pdf.

FIGURE 2: EMISSION REDUCTIONS BY SECTOR



9,000 MW of nuclear capacity are added by 2030 — 3,000 MW through upgrades at existing plants and 6,000 megawatts through new plant construction. In the policy case, by contrast, the total increase in nuclear capacity over the same timeframe is 26,000 MW and nuclear power's share of overall generation remains roughly constant at 20 percent.

Fossil-fired generation, meanwhile, declines from forecast levels under the policy case, but remains roughly equivalent in absolute terms by 2030 compared to current levels. The analysis indicates that while some 47,000 MW of existing coal capacity are retired by 2030, more than 81,000 MW of advanced coal with CCS are added. Overall, coal-fired generation accounts for 44 percent of total electricity generation in 2030 — 15 percent less than in the reference case. Natural gas capacity increases by just 9,000 MW in comparison to the reference case forecast. Although natural gas-fired combined-cycle capacity increases slightly by 2030 compared to the reference case, older, less efficient oil/gas steam units are retired, holding natural gas capacity relatively steady.

Several factors combine to mitigate any increase in electricity prices that would otherwise result from higher fossil fuel prices. As noted above, the substantial reduction in projected electricity demand reduces the need for new capacity and allows less efficient plants to be retired. Fewer new power plants and incentives for renewables and CCS lead to lower natural gas demand in the electric sector. These factors, combined with end-use efficiency improvements in other sectors, lead to a decline in delivered natural gas prices for the electric sector. Because natural gas-fired generation often sets the price in competitive electricity markets, lower natural gas prices offset much of the impact of higher fossil-fuel prices from the greenhouse gas trading program. As a result, the average price of electricity nationwide in the policy case is slightly below the reference case through 2025.

TRANSPORTATION SECTOR: More stringent fuel-economy regulations play a more significant role in driving modeling results for the transportation sector than does the CO_2 price signal introduced by the greenhouse gas trading program. In the reference case, the average fuel economy of new cars and light trucks increases just 4 miles per gallon (mpg), from a current combined average of 25 mpg to 29 mpg in 2030 (this improvement occurs in part as a result of recently adopted changes in the CAFE standard for light trucks). As noted previously, the policy case assumes that the average combined car and light-truck fuel economy of new vehicles increases by 16 mpg to a new average of 41 mpg in 2030 (this scenario is modeled as a proxy for the Commission's recommendation for a 4 percent per year presumptive increase in CAFE standards subject to modification by NHTSA if safety, cost, or economic considerations warrant).

Due to a lag in fleet turnover, the average fuel economy of the in-use light duty fleet

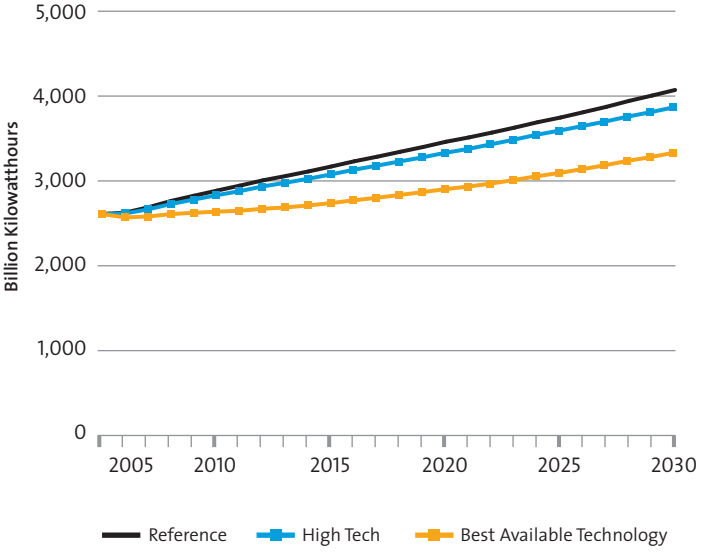
EFFICIENCY AND TECHNOLOGY ASSUMPTIONS

As noted in the main text, EIA's "High Technology" side case from the Annual Energy Outlook 2006 was used as a proxy for the Commission's recommendations when modeling energy efficiency in the residential and commercial sectors. This case assumes earlier availability, lower costs, and/or higher efficiencies for end-use equipment than EIA's reference case, as well as greater improvements in building-shell efficiency. Equipment assumptions were developed by engineering experts, assuming increased research and development in advanced end-use technologies.* In the High Technology case, all new construction is assumed to meet Energy Star specifications after 2010.

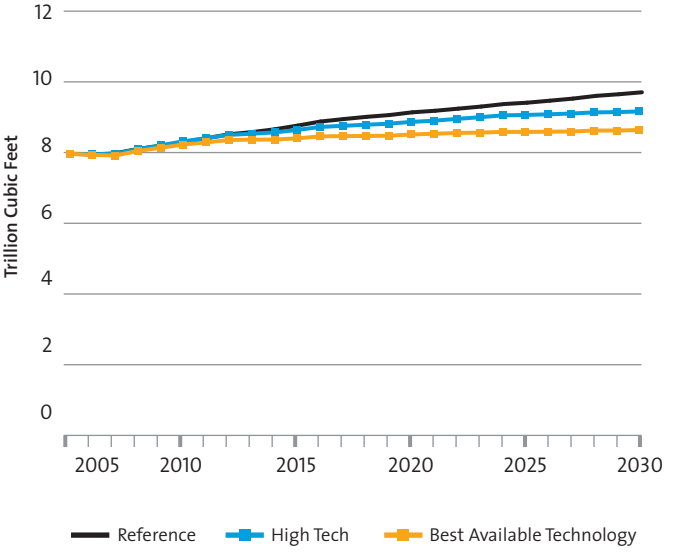
The Commission also modeled its policy scenario using EIA's more aggressive "Best Available Technology" case as an alternative proxy for its efficiency and technology R&D recommendations. This case assumes that all equipment purchases and construction practices from 2007 forward reflect the most efficient choice available in the High Technology case, regardless of cost.

When either of these efficiency side cases is modeled along with the Commission's other policy recommendations concerning vehicle fuel economy, carbon capture and storage, and renewable energy, proposed greenhouse-gas reduction targets are achieved without triggering the trading-program safety valve and the model projects a slight *increase* in future economic growth compared to the reference case. A comparison of modeling results under the High Technology and Best Available Technology side cases underscores a further important point: the additional efficiency investment reflected in the Best Available Technology case achieves substantial additional benefits compared to the High Technology case. Importantly, it leads to significant further reductions in projected demand for electricity and natural gas and substantially less need for new electric-generating capacity. As a result, delivered prices for electricity actually decline in the Best Available Technology case compared to a slight increase predicted after 2025 in the High Technology case, and there is a slightly larger gain in projected GDP for 2030 (a 0.3 percent increase instead of a 0.15 percent increase).

ELECTRICITY DEMAND



NATURAL GAS DEMAND



* The high technology assumptions are based on EIA, Technology Forecast Updates-Residential and Commercial Building technologies-Advanced Adoption Case (Navigant Consulting, September 2004).

improves more slowly than the fuel economy of new vehicles. Specifically, in-use fleet fuel economy improves by just 2 mpg in the reference case (from 20 mpg in 2005 to 22 mpg in 2030). By comparison, in-use light duty fleet fuel economy in the policy case increases to 25 mpg by 2020 and 30 mpg by 2030.

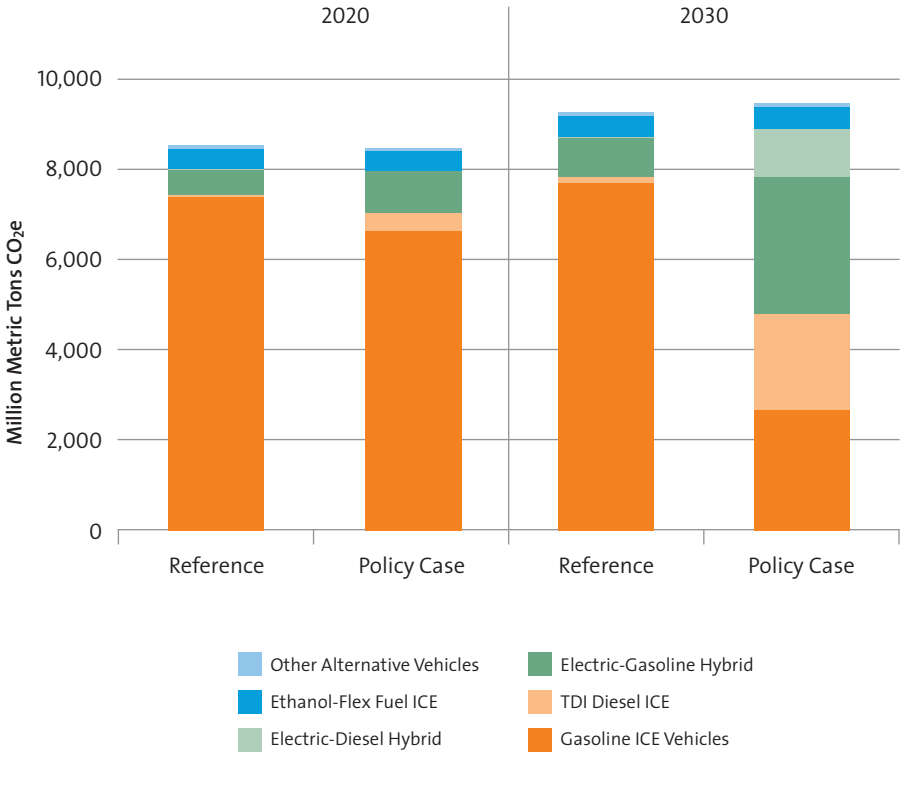
The modeling analysis suggests that hybrid-electric, advanced diesel, and flex-fuel vehicles will play an important role in achieving significantly higher fuel-economy standards. In the reference case, sales of gasoline-electric hybrids are projected to reach 6 percent of new vehicle sales by 2020. By comparison, gasoline-electric hybrids and advanced diesels achieve much higher penetration of the new car market in the policy case, together comprising as much as 19 percent of new light-duty vehicles sales by 2020 and 64 percent of new light-duty vehicle sales by 2030. The price of the average new vehicle in 2030 rises $3,500 (or 12 percent) higher in the policy case compared to the reference case.

F.3 PRIMARY FUELS: Fossil-fuel consumption falls considerably in response to the Commission's recommended policies. Overall fossil-fuel use in the policy case is 92 quads in 2030 — 20 percent below the reference case forecast, although still slightly above the current (2006) level of consumption. The largest reduction is in coal consumption, which falls from 35 quads in the reference case in 2030 to 24 quads in the policy case. While lower demand for coal in the electric sector accounts for the bulk of this decline, industrial sector demand for coals falls 51 percent compared to the reference case by 2030 and accounts for 17 percent of reduced coal demand. In absolute terms, however, projected coal consumption in the policy case in 2030 is equivalent to current (2006) consumption.

Oil consumption in 2030 is roughly 17 percent lower in the policy case than in the reference case in 2030, largely as a result of improved light-duty-vehicle fuel economy. Gasoline consumption is 21 percent below the reference case in 2030 and accounts for just over half of the total projected reduction in oil demand. The remaining reductions in oil use come primarily from other transportation fuels and the industrial sector, where demand falls 17 percent compared to the reference case in 2030. Imports of both crude oil and refined products decline substantially due to lower U.S. consumption, falling 14 percent and 33 percent respectively compared to the reference case in 2030.

Demand for natural gas declines in all sectors, and by 2030 is 13 percent below the reference case. The largest demand reduction for this fuel occurs in the electric sector, where natural gas demand falls by 35 percent. This decline accounts for roughly two-thirds of the total reduction in natural gas demand. As noted previously, significant improvements in end-use efficiency in the residential and commercial sectors, combined with incentives for renewables and CCS, drive down electricity demand. For 2030, residential sector natural gas demand is 8 percent lower in the policy case than in the reference case; the corresponding demand reduction in the commercial and industrial sectors is 6 percent.

FIGURE 4: LIGHT-DUTY VEHICLE SALES BY FUEL TYPE



Notes

Notes

NCEP Staff

Jason S. Grumet, *Executive Director*

Julie Anderson, *Senior Advisor*
Paul W. Bledsoe, *Director of Communications and Strategy*
David Conover, *Counsel*
Nate Gorence, *Policy Analyst*
Emily Hawkes, *Administrative Assistant*
Joe Kruger, *Policy Director*
Sasha Mackler, *Research Director*
Karrie S. Pitzer, *Deputy Chief of Staff*
Billy Pizer, *Senior Economist*
David Rosner, *Policy Analyst*
Vito Stagliano, *Research Advisor*
Marika Tatsutani, *Senior Analyst and Technical Writer*
Tracy Terry, *Technical Director*

National Commission on Energy Policy

1225 I Street, NW, Suite 1000
Washington, DC 20005

T 202-637-0400
F 202-637-9220

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