RFF REPORT

Perspectives on Energy Policy and Economic Research

Results of a Survey

Stephen P.A. Brown, Kristin Hayes, Alan J. Krupnick, and Jan Mares

ENERGY POLICY: A REPORT FROM THE CENTER FOR ENERGY ECONOMICS AND POLICY

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Summary

To gain a greater perspective on the role that economic research can play in shaping energy policy in the United States, Resources for the Future (RFF) staff undertook a survey of more than 80 individuals with significant energy policy experience. The survey was conducted from September 2009 to February 2010. The interviewees represented a wide range of relevant government agencies, congressional offices, academic institutions, think tanks, companies, trade associations, and other nonprofit organizations. The interviews were structured around five questions, but the questions were designed as a point of departure for in-depth discussions about what the interviewees considered to be the most important issues in energy economics and policy.

Collectively, the interviewees identified a broad range of topics as being the most important issues in energy economics and policy. In many cases, the interviewers found that the experiences and occupational responsibilities of the individual respondents shaped their responses. For example, some people whose work is focused on oil responded that topics about oil were the most important.

The most prominent topics were greenhouse gas emissions from energy use, renewable energy sources, the effects of current energy policies, the electricity grid, North American natural gas markets, carbon capture and storage (CCS), and energy efficiency. Less frequently mentioned topics included consumer behavior and energy choices, energy use in emergent economies, nuclear power, energy use in transportation, the relationship between energy and water use, and developments in the world oil market. Other topics, such as the effects of oil price shocks on aggregate economic activity, electric power transmission, taxes, and energy finance were also mentioned.

Perhaps the most surprising result of these interviews was the number of respondents who thought an important contribution could be made by fostering a better understanding of current energy market and policy conditions. These included suggestions for research on the social cost

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1 Stephen P.A. Brown is a nonresident fellow, Kristin Hayes is a research associate, Alan J. Krupnick is a senior fellow and research director, and Jan Mares is senior policy advisor at Resources for the Future. The authors thank Ian Parry and Margaret Walls for helpful comments and all those interviewed for providing such useful responses. Funding for this project was provided in part by the Stephen D. Bechtel, Jr. Foundation. The views expressed are those of the authors and survey participants, and do not necessarily represent those of the Stephen D. Bechtel, Jr. Foundation or Resources for the Future.

of energy use, the size and appropriateness of energy subsidies, peak oil, the effects of consumer behavior on current energy use patterns, and an understanding of the role of speculation in energy market pricing. Some of the interviews also revealed areas where policy is ahead of research and others where research is ahead of policy.

Introduction

To gain a greater perspective on the role that economic research can play in shaping energy policy in the United States, RFF staff surveyed more than 80 individuals with significant energy policy experience. The survey was conducted from September 2009 to February 2010. The interviewees were chosen from a wide range of relevant government agencies, congressional offices, academic institutions, think tanks, companies, trade associations, and other nonprofit organizations.[2] The interviews were guided by a questionnaire developed expressly for the purpose, covering a range of energy policy topics.

The survey consisted of five open-ended questions:

1. What do you see as the two, three, or four most important areas for research in informing the debate in the United States regarding energy policy, and why?
2. What are the two or three most important energy policy areas that are currently under-researched?
3. Should RFF also address international issues? [If yes, what key international issues come to mind, and which countries or parts of the world are of particular interest?]
4. As a research group specializing in economics, RFF is ideally suited to work on market-based policy instruments. Are there any particular broad issues you'd like to see us do research on in instrument design, effectiveness, etc.? [If yes, how would you rank this issue in terms of importance overall in terms of energy research needs?]
5. Policymakers tend to focus on fighting today's fires. What over-the-horizon issues do you see coming up a year or two from now that you'd love to have information about? What about five to ten years from now

The Interview Process

Most interviews were conducted in 30–45 minutes. The interviewers did not press the respondents to answer all the questions. Rather, the interviewers used the questionnaire to develop a dialogue in which the respondents discussed in some detail the issues they considered most important in energy economics and policy. In some cases, respondents provided their comments in writing. In addition, the Research Program Committee, a standing committee of the RFF Board of

2 See Appendix A for a list of the participants and their affiliations.

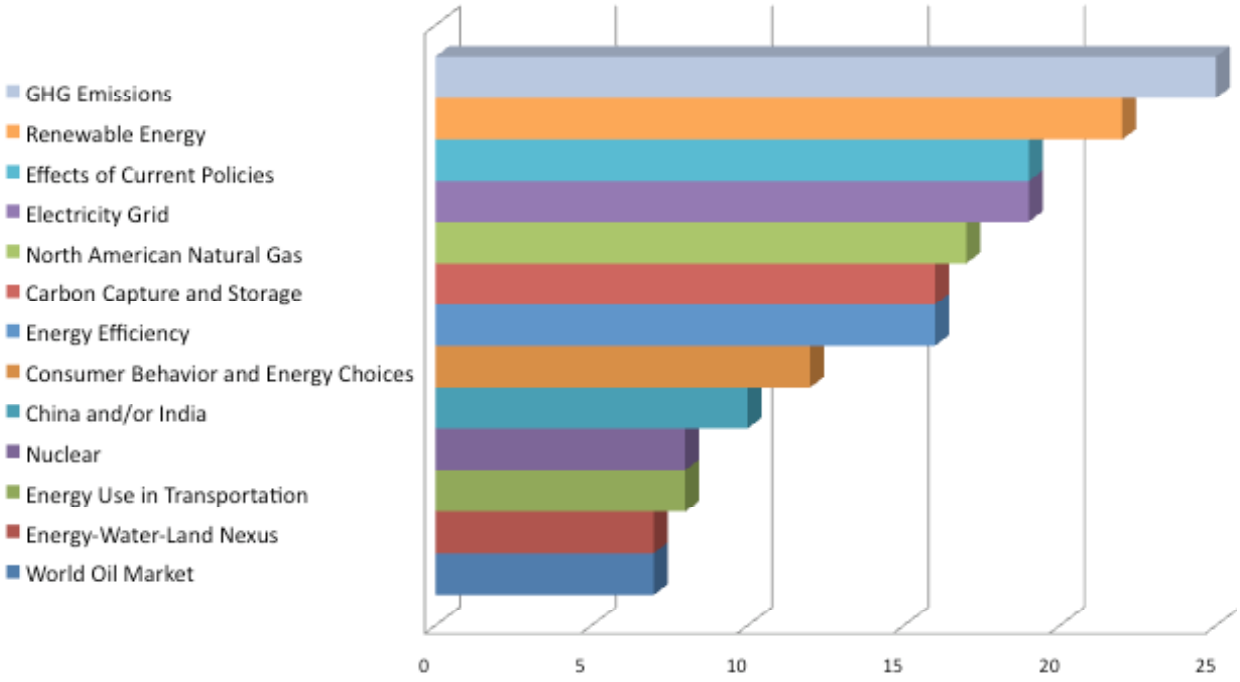
Directors, devoted part of its October 2009 meeting to answering the questions in a dialogue led by the interviewers.

RFF interviewers were people with substantial experience in energy economics and policy, which helped foster the dialogue. They were mindful to elicit the views of the respondents, rather than to share their own.

The Findings

The findings are best understood in their entirety rather than being broken down by individual question. The experiences and responsibilities of the individuals interviewed certainly shaped their responses. Given their varied backgrounds, the respondents expressed a wide variety of opinions about the most important issues in energy economics and policy (Figure 1).[3]

Figure 1. Most Frequently Mentioned Areas for Energy Policy Research



The 80-plus participants provided 281 responses. The 13 areas of research shown individually in the figure were each mentioned by at least 7 participants, with greenhouse gas emissions mentioned by 25. Together, these responses account for 85 percent of the categories mentioned. Another 34 responses were spread out over a variety of other topics.

3 Detailed responses are found in Appendix B.

Among the most prominent topics were greenhouse gas emissions from energy use, renewable energy sources, the effects of current energy policies, the electricity grid, North American natural gas markets, CCS, and energy efficiency. Other topics that were seen as important included consumer behavior and energy choices; energy use in emergent economies; nuclear power; energy use in transportation; the relationships between energy, water, and land use; and developments in the world oil market. Most respondents mentioned many other topics, but those responses were spread over many topics.

Greenhouse Gas Emissions

Not surprisingly, the control of greenhouse gas emissions associated with energy use frequently topped the list of policy priorities. Several respondents mentioned the design of cap-and-trade systems, often coupled with a suggestion that RFF explore and discuss alternative policy options should cap and trade prove politically infeasible. Several respondents noted that an emphasis on climate change policy should not overshadow other issues. In particular, one respondent noted that U.S. energy policy should not be so "carbon centric," and another noted that concerns over carbon dioxide (CO_2) are strongly linked with the transportation sector—and that the latter deserves equal attention on its own. Yet another pointed out that the economic value of damages from climate change is not well understood. Most research is on mitigation, some on adaptation, and very little on the damages themselves.

Renewable Energy

The use of renewable energy sources is of growing interest in the United States, and state and federal authorities are developing policies to promote the use of renewable energy sources. Most issues that the respondents raised were about the intermittency of such sources and costs of increased reliance on renewable energy sources.

Effects of Current Policies

Perhaps the most surprising finding was the number of respondents who thought a contribution could be made by fostering a better understanding of current energy market and policy conditions. Examples of such research include the social cost of energy use; the economic effects of energy subsidies; peak oil; the effects of consumer behavior on current energy use patterns; an understanding of the role of speculation in energy prices; and the economic evaluation of the many existing energy policies, laws, and regulations.

The U.S. Electricity Grid

Under the umbrella of the U.S. electricity grid, several issues arose with some frequency. Interviewees mentioned that the patchwork of regional grids and the failure of the regional transmission organizations to achieve promised improvements had become a hindrance to effective flow of

electricity and well-functioning markets. Some also noted that a critical evaluation of a national "smart grid" concept is needed. Were such a smart grid to deliver all that is promised, it could revolutionize energy storage, encourage distributed generation, and make electricity available for plug-in vehicles at the best time of day. Another popular issue involving the grids is improving the ability to get renewable electric power to market.

North American Natural Gas

Improvements in drilling technology have led to significant expansions of natural gas reserves and considerably lower recovery costs. With this new abundance of relatively low-carbon fossil fuel, many respondents now envision a role for natural gas in easing the transition to a low-carbon future in the North America (and potentially elsewhere in the world). Several respondents suggested a need for more analysis on the potential economic and environmental implications of such natural gas abundance, with one referring to the increased supplies of natural gas as the "800-pound gorilla." Some also thought the role of natural gas in the nation's fuel mix needed closer examination.

Carbon Capture and Storage

CCS was frequently mentioned as an important area for future study. One respondent noted that clean coal requires CCS, but the costs of CCS are not truly understood. Another noted the importance of developing CCS technology as a bridge between carbon-intensive and low-carbon energy production.

Energy Efficiency

Energy efficiency was also frequently mentioned. The majority of people in the energy policy community realize that markets have not led to adoption of the most energy-efficient technologies—even when it makes economic sense. Market imperfections, apparent consumer myopia, and a misunderstanding of the services that energy-using equipment and buildings provide are all part of this issue.

Consumer Behavior and Energy Choices

Consumers often ignore investments that offer greater energy efficiency and cost savings. Such behavior has been described as myopic because the behavior can be explained by assuming that the consumers require inordinately high payback periods before making such decisions. More fundamentally, the emerging field of behavioral economics suggests that consumers may ignore cost savings derived from energy efficiency because they rely on quick and faulty rules of thumb rather than undertaking a thorough analysis.

Energy Use in Emergent Economies

On the whole, respondents agreed that it is important to address international energy policy issues. Top on the list is growing energy use and CO_2 emissions in emergent economies, such as Brazil, China, India, and some Middle Eastern countries. Among the issues raised are the price and climate implications of growing demand for fossil energy in these countries, the possibility for developing policies to foster energy efficiency, and the use of renewable energy sources. Technology transfer and intellectual property rights issues are also of concern.

Nuclear Power

Some respondents expressed interest in nuclear power. The issues raised include funding nuclear facilities, streamlining the process for power-plant approval, disposing the spent fuel, and using nuclear power as a way to reduce greenhouse gas emissions and increase energy security.

Energy Use in the Transportation Sector

For the transportation sector, the topics that respondents found to be of greatest importance include the development of policies to reduce greenhouse gas emissions from transportation, approaches to increasing energy efficiency, the use of alternative fuels, plug-in hybrids and electric vehicles, and examination of the effect that cap-and-trade policies would have on transportation and transportation fuels.

The Energy-Water-Land Nexus

Quite a few respondents highlighted the energy-water-land nexus as an issue of growing concern. Interviewees pointed out the clear link between energy production and water use and to the use of electric power to move water for irrigation and urban consumption. A few respondents also pointed to the emerging conflict over using land for producing biofuels, rather than letting it remain in its natural state or using it to produce crops.

World Oil Market

A number of respondents raised concerns about the world oil market. Will some national oil companies continue to impede the development of global resources? Can other liquids supplant conventional oil? Can the United States develop policies to foster stability in a market that has shown great volatility? Is peak oil an issue?

Policy Interactions and Portfolios

Quite a few respondents indicated that the examination of current policies and how policies interact is of great value, emphasizing that no "silver bullet" exists in developing a comprehensive national energy policy. Invariably, policies have to work alongside and in conjunction with each other. Several respondents said that this interaction between policies—those already in place and those planned—is worthy of attention. Are policies complementary, substitutes, synergistic, or redundant? How can we develop portfolios of policies that make both political and economic sense?

Policy Flexibility

Several respondents emphasized the importance of selecting flexible policies. While policymakers use the best information at hand to make reasonable judgments for the future, there is no guarantee that the mix of policies and technologies chosen today will function well over the long term. Instead, policymakers should hedge against this uncertainty by developing broad-based mechanisms that avoid "picking winners" and remain flexible in the face of various possible futures.

Other

Respondents also identified 34 other topics, such as coal, the role of oil price shocks in aggregate economic activity, energy security, biofuels, green jobs, fuel mixes, electric power generation, and energy infrastructure.

Under-Researched Topics

Question 2 asked respondents to identify areas of inquiry that are under-researched. Collectively, nearly 30 such topics were mentioned, including an economic evaluation of the many energy policies, laws, and regulations that currently exist; an economic assessment of the damages associated with climate change; energy security; the evaluation of energy models; an evaluation of low-carbon fuel standards; an assessment of how to design energy policy that is politically palatable and improves economic efficiency; and an assessment of how coal fits into the portfolio of fuel choices for electric power generation. Details are found in Appendix B.

International Issues

Question 3 asked respondents to indicate whether RFF should address international issues. Most respondents answered affirmatively. Collectively, they suggested 15 issues for consideration including growing energy use in the emerging economies, offsets in climate policy, transnational flows of pollutants, the world oil market, and the development of an international natural gas market.

Market-Based Policy Instruments

Question 4 asked respondents to indicate whether RFF should engage in developing market-based instruments for energy policy. Most respondents who answered this question thought that RFF should do so.

Over-the-Horizon Issues

Question 5 asked respondents to identify over-the-horizon issues that they would like to have information about. The ensuing discussions with the respondents led the answers to this question to be combined with those for questions 1 and 2. Some respondents said that energy market volatility and uncertainty made such a question impossible to answer.

Conclusions

The research team was pleased by the thoughtful answers provided by many interviewees. While the team was not surprised by the major categories in which the specific topics mentioned could be classified, the detailed suggestions (found in Appendix B) were very informative. In addition, the proportion of respondents citing various topics as high or low priority is new information. Some of the interviews also pointed to areas where policy is ahead of research and others where research is ahead of policy. As such, the interviews will be invaluable in shaping the program of RFF's Center for Energy Economics and Policy, which aims to expand the body of knowledge and related discourse that underpins our nation's energy policies.

Appendix A: Participants and Their Affiliations

Anderson, John	President and CEO, Electricity Consumers Resource Council
Anderson, Tom	Senior Advisor for Climate Change Program, Office of Global Climate Change, U.S. Geological Survey, Department of Interior
Baldwin, Sam	Chief Technology Officer, Energy Efficiency and Renewable Energy Office, Department of Energy
Bauer, Carl	Director, National Energy Technology Laboratory
Baugh, Bob	AFL-CIO
Berman, Ellen	CEO, Consumer Energy Council of America
Blair, Peter	Executive Director, Division on Engineering and Physical Sciences, National Academy of Sciences
Blodgett, John	Deputy Assistant Director, Resources, Science and Industry Division, Congressional Research Service
Brenner, Rob	Director, Office of Policy Analysis and Review in Air and Radiation Office, Environmental Protection Agency
Brownell, Bill	Partner, Environmental, Hunton & Williams
Canes, Mike	Former Chief Economist, American Petroleum Institute
Caruso, Guy	Senior Advisor, Energy and National Security Program, Center for Strategic and International Studies; Former Administrator, Energy Information Administration
Connaughton, James	Executive Vice President, Corporate Affairs, Public and Environmental Policy, Constellation Energy
Conway, Roger	Director, Office of Energy Products and New Uses, Department of Agriculture
Cooper, Roger	Executive Vice President for Policy, American Gas Association
Corn, M. Lynne	Specialist in Natural Resources Policy, Resources, Science and Industry Division, Congressional Research Service
Cristofaro, Alex	Director, Office of Regulatory Policy and Management, Environmental Protection Agency
Cruickshank, Walter	Deputy Director, Minerals Management Service, Department of Interior
Difiglio, Carmen	Deputy Assistant Secretary for Policy Analysis, Department of Energy
Duncan, Marvin	Agricultural Economist, Office of Energy Policy and New Uses, Department of Agriculture

Felmy, John	Chief Economist, American Petroleum Institute
Flint, Alex	Senior Vice President, Government Affairs, Nuclear Energy Institute
Gordon, Dick	Adjunct Scholar, Cato Institute
Hayes, Colin	Senate Energy Committee
Hefner, Robert A. (III)	Independent Oil and Gas Producer
Hegburg, Alan	Deputy Assistant Secretary for International Affairs in Policy and International Affairs, Department of Energy
Helkie, Bill	Energy Information Administration
Hohenstein, Bill	Director, Global Change Program Office, Department of Agriculture
Hummell, Holmes	U.S. Department of Energy
Howard, Mike	Vice President, Electric Power Research Institute
Kah, Marianne	Chief Economist, ConocoPhillips
Karpoff, Peter	Acting Director, Office of Technology Analysis, Office of Policy Analysis, Department of Energy
Kelly, Sue	Vice President of Policy Analysis and General Counsel, American Public Power Association
Kenchington, Henry	Deputy Assistant Secretary for Research & Development, Office of Electricity Delivery and Energy Reliability, Department of Energy
Kile, Joseph	Assistant Director for Microeconomic Studies, Congressional Budget Office
Kuuskraa, Vello	President and Chairman, Advanced Resources International
Lave, Lester	Carnegie Mellon University
Lyons, Peter	Principal Deputy Assistant Secretary, Office of Nuclear Energy, Department of Energy
Mallory, King	Senior Counsel, Regulated Markets & Energy Infrastructure, Hunton & Williams
Mancini, Dominic	Office of Management and Budget
Mansueti, Lawrence	Director, State and Regional Assistance, Office of Electricity Delivery and Energy Reliability, Department of Energy
Marlay, Bob	Deputy Director, Climate Change Technology Program, Office of Climate Change Technology, Department of Energy

McGartland, Al	Director, National Center for Environmental Economics, Environmental Protection Agency
Meyer, David	Senior Policy Advisor, Office of Electricity Delivery and Energy Reliability, Department of Energy
Morse, Ed	Managing Director, Head of Economic Research, Lewis Capital Management
Myers, Richard	Vice President, Policy Development, Nuclear Energy Institute
Nedd, Michael	Assistant Director, Minerals, Realty, and Resource Protection Directorate, Bureau of Land Management, Department of Interior
Neff, Shirley	Office of Chief Financial Officer, Department of Energy
Nelson, Rod	Vice President, Communications, Schlumberger
Newell, Richard	Administrator, Energy Information Administration
Neyland, Kevin	Deputy Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget
Nolan, Walker	Electricity Consultant
O'Keefe, Bill	Former Vice President, American Petroleum Institute
O'Neill, Richard	Chief Economist, Federal Energy Regulatory Commission
Owens, David	Executive Vice President, Edison Electric Institute
Parfomak, Paul	Specialist in Energy and Infrastructure Policy, Congressional Research Service
Parker, Larry	Specialist in Energy Policy, Resources, Science, and Industry Division, Congressional Research Service
Percy, Steve	Former Chairman and CEO, BP America, Inc.
Placke, Jim	Cambridge Energy Research Associates
Pugliaresi, Lucian	President, Energy Policy Research Foundation, Inc.
Reynolds, Andrew	Deputy Science & Technology Advisor to the Secretary of State, State Department
Rodgers, David	Director of Strategic Planning, Office of Energy Efficiency and Renewable Energy, Department of Energy
Rusco, Frank	Director Natural Resources and Environment, Government Accountability Office
Rypinski, Arthur	Energy Team Leader, Office of Safety, Energy and Environment, Department of Transportation

Sant, Roger	Chairman, Sant Associates
Scarlett, Lynn	Former Acting Secretary, Department of Interior
Schipper, Lee	Lawrence Berkeley Laboratory and Stanford University
Schleede, Glenn	Energy Policy Consultant
Shelk, John	President, Electric Power Supply Association
Sherlock, Molly	Tax Analyst in Economics, Government and Finance Division, Congressional Research Service
Sieminski, Adam	Chief Energy Economist, Deutsche Bank
Slaughter, Andrew	Senior North American Energy and Economics Advisor, Shell Oil
Smolak, Tara	National Energy Board (Canada)
Stoner, Dena	Vice President for Policy, National Rural Electric Cooperative Association
Taylor, Jerry	Senior Fellow, Cato Institute
Topping, John	President and CEO, Climate Institute
Tyran, Barbara	Director, Washington Relations, Electric Power Research Institute
West, Robin	Chairman, Petroleum Finance Company
Whitman, Kristin	Manager, Government and External Affairs, Shell Oil
Yacobucci, Brent	Specialist in Energy Policy, Resources, Sciences, and Industry Division, Congressional Research Service

RFF Board Members Who Participated:

Bailey, Vicky A.	President, Anderson Stratton, International LLC
Cameron, Trudy Ann	Professor of Economics, University of Oregon
Chiaro, Preston	Chief Executive Officer, Rio Tinto Energy Group
Cutter, W. Bowman	Senior Fellow and Director, Economic Policy Initiative, The Roosevelt Institute

El-Ashry, Mohamed T.	Retired CEO and Chairman, Global Environment Facility
Kagan, Peter R.	Managing Director, Warburg Pincus, LLC
Linden, Lawrence	Linden Trust for Conservation
Robertson, Peter J.	Vice Chairman of the Board (Retired), Chevron Corporation
Sharp, Phil	President, Resources for the Future
Tercek, Mark R.	President & CEO, The Nature Conservancy

Appendix B: Detailed Responses by Topic Area

Authors' Note: This appendix presents a compilation of the individual statements expressed by those whom we interviewed, organized by topic. Our goal is to present the raw, unfiltered opinions of those interviewed. In the interest of clarity and maintaining anonymity, some of the statements were condensed and edited, but we made no attempt to alter any of the opinions, reconcile contradictory opinions, or correct any factual errors that may have occurred in individual statements. We stand behind our approach to assembling this compilation without necessarily agreeing or disagreeing with any or all of the opinions expressed.

Energy Supply Issues

World Oil Market

1. Enhanced oil recovery could lead to enormous amounts of additional petroleum being available. Are there reasons why more enhanced oil recovery efforts are not being used?

2. Are the global issues regarding oil production changing such that significantly higher oil prices are likely in the near future and beyond? For example, depletion of super giant fields without new finds of super giants continues. The national oil companies, except for those in Saudi Arabia, Brazil, and Norway, seem unable to continue to invest in oil exploration and production to offset declines in production by them and others. Restricted OPEC production is likely to lead to higher prices. Offsetting this somewhat is the demand for oil from the developed world, which is dropping or not rising as fast as historically. What are implications of this for United States and other importing countries?

3. Since petroleum will be needed in the United States and the world for years to come, what sorts of policies would it take, or must be avoided, to significantly increase domestic oil production?

4. Have the trade-offs between reducing carbon dioxide (CO_2) emissions in connection with oil sands–based production and the effects of losing a source of heavy crude oil in the domestic refining industry been analyzed and presented for thoughtful consideration? What are the economic and strategic implications of reducing or holding down imports of oil derived from Canadian oil sands?

5. If developed countries become less petroleum dependant, what will be the reaction of the oil-producing countries that depend on oil for a substantial portion of their governmental spending and social programs? What are the economic implications of such possible choices?

6. What are the global implications when national oil companies do not adequately reinvest in oil production, which reduces supply, while other countries, such as India and China, subsidize consumption? What strategic options are available to the various national oil produc-

ers, how will they collectively affect the oil importing parts of the world, and with what consequences?

7. If the major importing countries reduce or cap their oil imports within five or more years, what will be the reaction of oil-exporting states where oil sales are the major source of government revenues?

8. Is the low-carbon fuel standard, as it relates to oil produced from oil sands in Canada, likely to have limited effect on net greenhouse gas (GHG) emissions while increasing direct costs to the United States, lower returns to Canada, and some added security cost to the United States? How would such costs compare to such benefits?

9. The implications on the world oil market of substantial oil exploration and production in Iraq during the next decade deserve study.

10. What are the supply elasticities for Organization of Petroleum Exporting Countries (OPEC) and non-OPEC oil and how have they changed over time?

11. What role has speculation played in the price of oil?

12. How have the national oil companies—as opposed to the international oil companies—affected world oil supplies?

13. What would be the implications of increased access to new areas for oil and gas production?

Resource Scarcity, Including Peak Oil

1. A thoughtful review of the peak-oil issue is needed that points out that as prices rise, technology is developed, and oil is found and available for production increases. No one disagrees with the belief that there is a finite amount of petroleum in the world. The disagreements are over the response of technology, exploration, and production to changes in prices.

2. This issue affects how the United States thinks about oil as an energy source, the price of oil, and potentially its externality costs.

3. When will petroleum demand hit production capacity limits due to physical availability, and at what price? This question, which is related to the peak-oil issue, is complicated because as price rises, new exploration and enhanced oil-recovery technologies become available while demand growth is moderated. The question is also complicated because the nation states controlling significant oil resources may be more interested in maximizing the amount of funds they can use for non-oil purposes, which in turn limits what they spend on exploration and production and their rates of production. The range of price and timing answers to this question will be important to all parties interested in the deployment of technologies that are to replace the use of petroleum products.

North American Natural Gas

1. What are the economic/energy implications of varying amounts of natural gas that may be producible from gas shale formations or methane hydrates at varying prices over future decades (that span the expected useful lives of electric power generation facilities and transmission infrastructure)? Is there enough affordable natural gas to serve as a substitute for coal for electricity in current uses and also to supply the additional electricity that might be used in the transportation sector? How much gas is needed to substantiate the view that natural gas could serve as a bridge to a fully renewable/nuclear low-carbon electricity future? What will be the implications for U.S. industrial output, production of natural gas from Alaska, natural gas price volatility, and the development of the Canadian tar sands?

2. Will "cheap" natural gas swamp all efforts to reduce its use and require carbon capture and storage? If distributed generation using natural gas becomes more widespread, how will the GHG emissions be managed?

3. A better understanding is needed of the extent of U.S. and world unconventional natural gas resources, including methane hydrates.

4. Further research and awareness is needed about the means for removing carbon from conventional and unconventional natural gas. Some of these technologies may have the potential to dramatically lower carbon emissions without the waste-disposal issues associated with carbon capture and storage.

5. What are the fuel-switching issues in the transportation, electricity, and industrial sectors for replacing coal or petroleum with natural gas?

6. To the extent that earlier or greater CO_2 reductions are sought, what supply and demand approaches, including use of natural gas, would be economically attractive?

7. Global gas supply and changing demand are not being seriously considered. The exporting countries are becoming major consuming countries. What are the energy and economic implications of this change?

8. Natural gas can play a critical role in the transition from fossil fuels to alternatives during the coming decades. Uncertainties on both the demand and supply side lend themselves to further research, technical, regulatory, and economic analysis. In particular, the potential regulatory impact on shale gas development warrants attention.

9. What would be the implications of increased access to new areas for oil and gas production?

Coal

1. What is the future of coal for use in electricity in this country? What are the implications of phasing out coal from the energy mix?

2. Recent studies indicate a greater presence of deposited mercury in the United States than had been expected, with significant quantities now coming from China. What are the implications of this?

3. The efficiency of converting coal to electricity can be improved, based on what the Chinese are doing and on the evaluation of the full fleet of U.S. coal-fired generators. What would be the environmental benefits of striving to increase that conversion efficiency in the United States versus the potential cost and regulatory implications, such as the applicability of the New Source Review permitting program? Some believe that a significant reduction in unit CO_2 emissions could be obtained relatively easily and cheaply in the U.S. fleet, if New Source Review does not apply to the proposed efficiency improvements.

Nuclear Power

1. One open question for nuclear is how the front and back ends of the nuclear fuel cycle are handled. Ideas being considered that warrant further examination include international fuel banks, fuel leasing, and guaranteed fuel take-back for reprocessing. A sustainable fuel cycle from initial fuel through to waste disposal is a prerequisite for long-term viability. An independent review of nuclear-waste technology may be beneficial to citizens as well as government policymakers.

2. New large nuclear plants may cost anywhere from $6–10 billion. The market capitalization of the largest U.S. utility is about $30 billion, which is not enough to assume this risk. By comparison Tokyo Electric, EDF, and EON each have market capitalizations of about $150 billion. Consequently, U.S. utility management is extremely hesitant to proceed with such projects. At least two issues warrant evaluation as a result: What range of prices relative to other electricity generation or reduction strategies would result from a new nuclear facility? If the United States decides that GHG reductions are desirable and new nuclear facilities are appropriate, what financial and other incentives would be necessary, at what economic cost, to encourage significantly more nuclear facilities to be built?

3. The experience of other countries in providing incentives for nuclear power plants in the recent past should be examined to determine whether similar approaches can be taken in the United States.

4. The federal and state rules applicable to large projects and/or mergers should be evaluated to determine whether they are hindering new investment in nuclear facilities, and if so, what changes in such rules should be considered that would allow public and private interests in nuclear energy use to be aligned.

5. Other constraints to the development of nuclear power, such as siting, construction, and fuel supply, warrant evaluation.

6. Nuclear power could have a very significant role in the future of electricity. What are the

economic and policy implications of a smaller, modular reactor that had fewer non-proliferation concerns and was easier to install and operate than existing large reactors?

7. Many observers believe that nuclear energy should and will be part of the energy solution to reducing GHG emissions. Therefore, a well-publicized analysis about the economic pros and cons for nuclear power, which also addresses the waste-reprocessing issue, would be beneficial.

8. Policies for nuclear energy warrant further analysis. Most people see nuclear as part of the climate solution. Are there some potentially insurmountable obstacles to efficient siting of nuclear power plants? What are those problems? Do they need to be addressed with new policies? What would be the advantages and disadvantages of such policies?

9. What are the appropriate security costs of nuclear power?

Renewable Energy Sources

Renewable Energy (General)

1. What are the ranges of estimated costs (and timing) for electricity based on renewable generation that has the same reliability as nuclear or fossil facilities, taking into account smaller unit sizes? How are the intermittency factors in renewable electricity production considered in such analysis? Is the cost of storage, transmission, or back-up generation considered?

2. What are reasonable projections for the market penetration and costs of renewable energy sources?

3. What policies are required and what are the likely costs for 80 percent of U.S. energy capacity to based on renewable and nuclear energy by 2050?

4. Based on varying assumptions about rates of improvement in technology, what prices for electricity are needed for renewable energy, without subsidies, to take share from and/or shut down fossil-based electricity generation?

5. Can the United States meet the Renewable Portfolio Standard that is being proposed (e.g., 20–25 percent nationally), and is that the best policy to promote domestic supply and a lower-carbon future? Is the government picking winners through this approach instead of using a carbon-intensity reduction target that companies achieve on their own terms? Is there a value in promoting new technologies?

6. What are the environmental, land-use, and water-use implications of renewable energy production on rural or public lands? Stated differently, is society trading one problem for another by promoting renewable energy for electricity in order to reduce CO_2 emissions?

7. Unless and until truly cost-effective electricity storage is available, will there be significant additional reliability challenges for transmission and local distribution if renewable electric-

ity must be used? What policies should be considered to address these challenges?

8. How does U.S. government support of the renewable industry compare to similar European or Japanese programs?

9. Many claims are being made about the creation of "green jobs" through the development and deployment of renewable energy and increased efficiency. However, those with an economic interest in the outcome make many of the claims. An independent review and analysis of green-job creation, based on a generally accepted definition of the "green economy" and various assumptions about the extent and duration of government subsidies and requirements, would be helpful. Such review should also evaluate the overall affect on the labor market, GDP, and government costs.

10. What is the true cost of using high levels of renewable energy generation of electricity, including any subsidies? How do these compare with other energy-related subsidies? What are the costs of the transmission and back-up generation for renewable power, including implications of running any base-load nuclear power plants below capacity?

Biofuels

1. What are the economic and infrastructure implications of growing and producing multiple types of liquid fuels, recognizing that cellulosic biofuels are not available commercially? Are biofuels a niche product on the global scale or a global solution? How do land, food, and water uses compete with biofuels production? These intertwined issues warrant study.

2. Renewable fuels, mainly cellulosic, are a big issue requiring study. The Renewable Fuel Standard requires the Environmental Protection Agency (EPA) to set quotas for these renewable fuels. There is only so much land in this country, and in the world. An analysis is needed to determine pros and the cons of using this land to grow feedstocks for biofuels.

3. Analysis is needed on the interface between liquid biofuels for transportation and land use. This area has not been adequately considered. Some observers suggest that Renewable Fuel Standard requirements for biofuels will have dramatic, unanticipated effects on agricultural land and therefore warrant further study.

4. One observer indicated that a new National Academy study on biofuels suggests that if automobile efficiencies are dramatically increased and plug-in hybrids become widely used, only 40 billion gallons of biomass-derived liquid fuels could provide for the balance of passenger car requirements. This number is believed to be achievable without dramatically changing the amount of U.S. land in cultivation.

5. What are economic costs of increasing the allowed ethanol in gasoline from 10 percent to 15 percent? Will this lead to more biofuel production, and if so, how much? Will this lead to reductions in domestic petroleum refining and increased imports of petroleum products, and if so, how much?

6. The economic implications of every step from seed to biomass to biofuels have not been considered, particular those dealing with biomass. An independent study is needed.

7. The use of renewable fuels for transportation—including the "blend wall" (the maximum amount of ethanol allowed in fuel), compatibility with existing vehicle fleet or stock, and the distribution infrastructure—warrants additional study.

Solar and Wind Energy

1. Major breakthroughs in this area are needed. Nanotechnology may be useful. What are the economic and technical implications for various paces of improvement in solar technology that would result in such technology requiring subsidies that are similar to other energy sources?

2. The full amount of GHG emissions involved for the manufacture, installation, and maintenance of solar cells is thought to be substantial. The time for these emissions to be offset by operation of the cells may be measured in years. Analysis of this issue should be made and shared with policymakers.

3. Some claim that job creation through wind energy projects is significant while others are skeptical. An independent analysis of such job creation now and in future would be beneficial for policymakers as well as economic decision makers.

4. Analysis and research is needed concerning the value and extent of visual, animal, and natural resources affected by solar or wind facility development.

Portfolio of Supplies and Fuel Mix

1. Many observers worry that the United States is moving too quickly on specific energy solutions, which will add expense to the economy. One suggested way to address this issue is to estimate and evaluate the cost of selecting a particular energy path that proves not to be viable—either because it lacks consumer acceptance, technology does not develop, or a raw material proves scarce. When such a problem arises, the United States would probably have to abandon the economically inefficient policy in favor of an alternative.

2. The United States needs analysis that indicates why any single technology solution will not be sufficient and shows how the market sorts through multiple technologies to find the most economically efficient portfolios better than the governmental/political process.

3. Many observers believe the United States will need a portfolio of renewable, nuclear, and even fossil (with carbon capture and storage) energy sources. However an independent analysis of these strategies and their costs, including transmission and back-up generation or storage in the case of renewables, is very much needed. Potentially an integrated assessment model that evaluates the economics of varying energy supply mixes would be very

useful in the continued policy considerations for means of addressing GHG emissions and climate change.

4. The Waxman-Markey Bill should also be analyzed by an independent organization because its assumptions about technology and baseline energy use seem optimistic, plus it may underestimate the costs of compliance.

5. Policymakers would benefit from a study about the advantages and disadvantages of reducing current government support for fossil energy development as compared to the advantages and disadvantages of increasing current government support for non-fossil energy development.

6. The major issue is climate change and climate change policy. What will be the roles for nuclear power, natural gas, and renewable energy sources?

Electric Power Generation and Transmission

Generation

1. Further work is needed on the comparison of "feed-in tariffs," renewable portfolio standards, and other clean electricity incentives to enhance policymakers' understanding of the advantages and disadvantages of each.

2. Multiple legislative and regulatory policies have been adopted because society has GHG-reduction, environmental, and other goals affecting electricity reliability and supply. Some of these costs seem to be "pancaked" on top of each other, and they may not all be able to be absorbed by the electric system. Is there a way to analyze and explain the implications of these multiple policies, recognizing that federal and state regulators as well as utility executives must deal with them?

3. What is the likelihood that distributed generation will be rapidly and extensively deployed and cause there to be stranded investment in transmission or central station electric power generation?

4. Are there ways to provide sufficient incentives for electric utilities to shut down their dirtiest facilities and replace them with natural gas, and if so, what net reduction in GHG emissions and black carbon would occur? What would be the cost of such unit reductions, per unit incentives, compared to the unit reductions per unit incentives, for other efforts to reduce such emissions?

5. What levels of electricity reliability do U.S. commercial, industrial, and residential consumers desire, and what variation in price would they pay for such varying reliability? How might GHG emission be affected by the reliability demanded of electric utilities?

6. Many people in the world do not have access to electricity. Electric power is a factor in social

stability in societies. Would analysis of the economic consequences and standard of living variations for areas of the world without electricity as compared to areas with electricity be useful for national and international policymakers?

7. What are the electricity production costs (with and without subsidies) for various means of generating electric power, and what are the levelized costs for investment at the margin.

Transmission

1. The electric power system faces major problems because uncertainty in the regulatory/legislative environment has forestalled investment in the face of a potential requirement to accommodate large quantities of intermittent power generation when there is no cost-effective storage. Issues of how and whether the electricity system can remain reliable and the costs and implications of improving the transmission grid to accept renewable electricity need to be addressed.

2. What is cost to society of delays in transmission projects due to all aspects of the "Not in My Back Yard" (NIMBY) phenomenon? Similar analysis could be done regarding siting of nuclear, renewable, and distributed-generation facilities.

3. What are the advantages and disadvantages of various means of paying for transmission, recognizing that those providing the service cannot always capture the direct benefits of transmission? What are the economic and other advantages and disadvantages of providing more power to the Federal Energy Regulatory Commission to facilitate transmission construction and management? Analytical thinking about the benefits of transmission networks could provide additional supporting arguments.

4. How should distributed generation and storage of electricity be taken into account in analyses of new transmission?

5. No broad policy agreement exists regarding the principles for evaluating transmission. There are significant policy differences between those who support use of markets and those who support planning. Market approaches tend to have shorter time horizons and factor in small additions to the grid, whereas planning approaches tend to operate more strategically in more network terms. Would analysis and/or a conference on this issue convened by a neutral source help clarify these approaches and identify ways to obtain the best of both?

6. The dispatch of electric power according to environmental objectives, which has arisen in California and the Regional Greenhouse Gas Initiative, are likely to expand. As renewable electricity is given preference on the grid, utilities will have to provide backup power and other services, which will have economic, energy-use, and environmental impacts. Analysis of these issues is warranted.

7. What is the reliability of the U.S. power grid compared to that of other Organisation for Eco-

nomic Co-operation and Development (OECD) countries, and how do transmission costs/charges compare between countries?

8. In the United States, charges for transmission and electricity do not explicitly include "line losses." Other countries may have more advanced grids and lower losses than the United States. An analysis of the relative efficiencies of various grids and charges for line losses could result in greater attention to this problem and more use of distributed generation.

9. What regulatory policies and incentives would help move the U.S. transmission grid into the modern age?

10. The combination of state and federal regulation of electric power transmission is causing problems that are expensive to society. How should the regulations be redesigned to put the proper incentives into place for electric power transmission?

Smart Grid

1. The smart grid idea has different meanings to different groups, and it raises multiple issues that warrant consideration. It should not be lumped with transmission.

2. There is much discussion about the smart grid and transmission issues but little understanding outside of the specialists. This important area deserves study and greater general understanding.

3. An enormous "game changer" in the electric utility industry will be technology, such as smart grid, distributed generation, and home networks, which allow customers to know about and manage their own electricity consumption. The economic and environmental implications of this change are not yet well understood.

4. Is the smart grid concept being oversold to consumers? What happens when customers choose to override price signals and increase their demand such that "peaks" are not totally diminished?

5. Because large investments are contemplated for the smart grid, is there a means of determining in advance, by experiment or otherwise, the benefits to society of such an investment?

6. The smart grid may be a transformation agent for technologies, business practices, and regulation that warrants economic and policy analysis in the following areas:

    a. rate design,

    b. energy storage,

    c. encouragement of distributed generation,

    d. design and implementation of individual domestic networks to manage their electricity

use, and

e. plug-in vehicles.

7. Does the smart grid make sense for all sizes and types of utilities—small to large, co-ops, and public and investor-owned utilities? If it does not make sense or is implemented poorly, what are the policy and economic implications of implementation?

8. Cyber security for electricity in the context of the smart grid merits significant attention. How should cyber protection be considered in the promotion and development of energy efficiency, smart grid, transmission, and generation?

9. What should be the criteria for economically effective transition polices to move to market pricing and smart metering?

10. What are the implications if "smart metering" is poorly implemented? How can poor implementation be avoided?

Storage

1. Cost-effective electricity storage would be a "game changer." Regulators do not know how to think about storage because it's neither generation nor transmission. How should it be treated in regulatory terms? The heterogeneity of storage possibilities is a big analytical and regulatory issue.

2. Because "cheap storage" is critical for much solar or wind energy to be used, are there additional research, development, and demonstration (RD&D) steps that could be considered and justified to accelerate development of cheap storage?

3. Are there environmental considerations regarding disposal of spent storage elements that warrant consideration before the deployment of such storage?

4. Can current or yet-to-be-developed storage systems like batteries allow some transmission to be deferred indefinitely? Some companies are considering such systems, and they may be willing to collaborate with researchers by providing data that would allow evaluation of the "break points" between storage and transmission.

5. Improvements in storage design and efficiency—including batteries—could change how utilities do business by reducing the need for traditional transmission and even some central station generation. As a result, it may be necessary to evaluate how regulation affects electric utility operations and whether government incentives for electric-power storage are needed.

Distributed Generation

1. How should distributed generation be treated by regulators and land managers in compari-

son to proposals for renewable energy and the related transmission to electricity consuming areas?

2. In the United States, about 6.5 percent of the electricity consumed is based on cogeneration, compared to 50 percent in Denmark. Because cogeneration presents significant GHG reduction possibilities, the United States should evaluate why it is so high in Denmark, as well as the pros and cons of applying Denmark's experience in a differing situation.

3. Some observers find that barriers at the state level restrict the use of cogeneration, energy efficiency goods or services programs, and combined use of heat and power. The price that such systems receive for their electricity affects their development. Analysis of the economic benefits of distributed generation in the context of different energy scenarios is warranted. The experience in Europe and United States suggests that substantial economic savings (including a reduced need for transmission) and GHG reductions could be achieved if distributed generation in the form of cogeneration were more widely used in the United States.

4. Farmers are having difficulty in installing small generation and having the output readily accepted into the grid. This warrants study.

5. Distributed generation could greatly alter the electric utility business, particularly if the utilities are forced to buy power from distributed generation at incentive rates, as is required in parts of Europe and was required under the U.S. Public Utility Regulatory Policies Act. What are the pros and cons of providing government incentives of various types for distributed generation?

General Energy Technology Issues

1. What government policies, if any, are needed to help the movement of new energy technologies from the university and national laboratories through to commercialization? Are there market failures along this chain that warrant government intervention? What kinds of public-private partnerships are available and could help in the societal goal of deploying technologies to reduce GHG emissions? What has been the Sematech, university-incubator, or Synthetic Fuels Corporation experience? Are these relevant to the energy-technology issue?

2. In context of government support for technology development, what is needed to reduce the likelihood that the executive or legislative branch will try to pick winning technologies?

3. Some argue that the public and private investment in energy RD&D has dropped in real terms substantially over the past 20 years. Some suggest that the public benefits justify more public funding of RD&D. Are there economic and policy reasons for the United States to increase its energy RD&D expenditures? If so, what are the economically efficient means of doing so? Would the Clean Energy Deployment Administration be a viable means for such investment?

4. Consumer acceptance seems to have been a limitation on the adoption of many energy-efficient technologies and developments. How will it be taken into account in developing policies regarding the development and deployment of new technologies?

5. Some believe no model exists that readily evaluates energy technologies for their scalability, deployability, and costs. To the extent that a credible model did exist, it would be very beneficial to government policymakers and RD&D decision makers.

6. Some near-commercial technologies may significantly reduce energy demand or GHG emissions. An analysis that was generally available of the cost and timing to deploy in a substantial way one or more such technologies would be useful, not just in evaluating those technologies, but also in alerting decision makers to the enormity of the challenge in changing the U.S. energy system, as well as the world's. One example that could be tested would be to develop the costs and a timeline for major deployment of electric vehicles in the United States. Is it probable or even possible that electric vehicles could make up a significant component of the new vehicle sales within a decade, with what time being required for the fleet to become half electrical?

7. How can intellectual property rights for energy technology development be set to promote development and transfer?

8. Some study of a hydrogen-based infrastructure should be undertaken to inform any possible policy development or legislation.

9. With government assistance, could there be an acceleration of innovations affecting electricity generation, transmission, etc. that might/should allow the supply of affordable electricity? As part of this program, should more support be provided for efforts to increase the efficiency of consumer electricity use?

10. Should the deployment of new energy technology be encouraged through price- or quantity-based mandates when there is uncertainty about future costs of and demand for the technology?

11. Should incentives for deployment of new energy technology be fixed rules, or should they vary with future learning?

12. To what extent has public expenditure on energy R&D actually enhanced economic efficiency?

13. The appraisal of public spending on R&D should be expanded to include the probability of zero success.

14. A number of times in the past three decades, technology advances (e.g., 3-D seismic imaging, horizontal drilling, and improved hydraulic fracturing) have pleasantly surprised energy policymakers by increasing natural gas supply. On the other hand, hopes for advances in solar technology have lagged behind predictions. Emerging issues in technological uncer-

tainty include energy efficiency and carbon capture and storage. From a policy perspective, what approach should we take to incentivize and manage public-sector investment in new technology? Can we predict innovation better? Should we take a portfolio approach? Should we take a real options approach?

Energy Demand Issues

Energy Efficiency and Demand

Energy Efficiency

1. How big is the rebound effect in energy demand as the result of investments in energy efficiency?

2. The United States should evaluate the time, cost, and viable rates of emissions reductions by the three sectors—transportation, industry, and buildings—or multiple technology/policy options to determine which approaches are likely to be more successful in achieving the massive efficiency gains that are believed to be possible in an economically efficient manner.

3. Because the use of prices is recognized as the most economically efficient approach to policy, there should be comparative analysis of the costs and consequences of using the second-best approaches such as setting energy-use standards, energy-efficiency standards, or renewable portfolio standards.

4. Attention should be given to fuel use in the industrial sector to determine whether more energy efficiency or a shift toward natural gas or electricity could be achieved without reducing domestic output and employment.

5. An evaluation is needed of non-market barriers to energy efficiency (e.g., as outlined in the July 2009 McKinsey report) that may not be addressed by carbon pricing. Also greater attention is needed to the opportunity costs of attempts to increase energy efficiency and the out-of-pocket costs to promote this.

6. In order to obtain large energy-efficiency improvements in the building sector, many buildings will need to be retrofitted. What has been the historical experience of encouraging retrofits in existing buildings?

7. What policies would promote energy efficiency in the buildings sector?

8. Because the National Academy of Science study of "America's Energy Future" pointed out that energy efficiency is both the cheapest and quickest means for reducing GHG emissions, an evaluation should be made of whether the U.S. government is putting the appropriate level of funding and effort into this area compared to other areas of energy activity.

9. What is the productivity of marginal additional RD&D investment in energy efficiency versus that of fusion energy or other sources? Should the government use a different allocation system when it evaluates its research activities in the energy area?

10. Use of electricity in New York and California on a per-capita basis is much less than the rest of the country. Are there lessons that can be learned from this experience that would be useful elsewhere?

11. More focus on lighting is desirable, particularly as it relates to light-emitting diodes (LEDs). In the laboratory, LED bulbs consume one-tenth the electricity of incandescent bulbs, and the theoretical limits on LED efficiency are not being approached.

12. Recognizing the role of utilities in distributing electricity and gas, are there alternative ways that should be provided or promoted to encourage them to promote and/or invest in energy efficiency by their customers? What has been the experience of the energy service companies?

13. How can utility capital be leveraged in economically effective ways to promote energy efficiency and a movement of the electricity system away from carbon fuels?

14. How can policy be designed to affect energy use in commercial buildings? What are the pros and cons of renter incentives versus owner incentives?

15. Would there be an advantage to using feebates (a combination of fees and rebates) to improve automobile fuel efficiency rather than CAFE standards? Similarly, would feebates offer an advantage over standards for electricity using consumer durables?

16. If taxes on petroleum products are politically infeasible, are there alternative methods to encourage energy efficiency and conservation, particularly in the transportation sector?

17. What are the comparative advantages of oil taxes, oil price floors, and research and development subsidies at promoting innovation of new oil-saving technologies?

18. Is there a way to construct financing instruments to overcome market barriers so that the interests of owners, renters, developers, and local governments can be aligned when it comes to energy efficiency? Does the Property-Assessed Clean Energy bonds program for energy efficiency provide lessons about the development of such financing instruments that be applied more broadly?

Energy Demand Analysis

1. What drives energy demand? What is the role of capital services? How is energy use embodied in the capital stock? These macro questions warrant thoughtful analysis.

2. Much energy demand analysis is based on averages of many different consumers. Citizens, consumers, and government policymakers would benefit from research that identifies or

estimates the consumer impacts of major energy or environmental proposals. To the extent that consumers can be divided not only into residential and business/industrial groups but also by region, industry segment, income group, and even age, U.S. policy debates would be much better informed.

3. The issue of world energy demand needs more study. Recent years have tested our understanding about energy demand. The policy analysis community has not evaluated the validity (or invalidity) of its assumptions about demand, such as whether energy demand in developing countries will continue rising with per capita GDP. Energy intensity in developed countries has plateaued or is decreasing. What are the inflection and tipping points in rest of world?

Consumer Behavior and Energy Choices

1. An evaluation of consumer behavior and energy choices is needed. To what extent is seemingly myopic behavior in making energy choices the result of poor decision making processes? Do people suffer from systematic errors of perception? To what extent can policy take into account the actual decision making process and nudge people toward efficient energy choices while maintaining freedom of choice?

2. Consumer acceptance seems to have been a limitation on the adoption of many energy-efficient technologies and developments. How will it be taken into account in developing policies regarding the development and deployment of new technologies?

3. What fraction of market actors have to be informed and well behaved for markets or price signals to function effectively?

4. Human behavior issues related to demand reduction in electricity or fuel use are not well understood. Individual consumers seem to have a low tolerance for "inconvenient" technologies. Better understanding of why individuals do or do not invest in what appear to be financially attractive energy-efficiency devices is needed.

5. How quickly will societies of people change their behavior, in a non-war or authoritarian society, to adopt different and/or inconvenient practices for an individual or a greater social good?

Greenhouse Gas Emissions and Climate Change

Greenhouse Gas Emissions and Policies

1. What ranges of CO_2 reductions can be achieved through the deployment of varying technological or efficiency solutions, and what are the effects on U.S. GDP?

2. When it comes to the economic effects, what are the similarities and differences between the taxation of GHG emissions and the use of a cap-and-trade policy?

3. Energy decision makers in and out of government need an independent, non-government analysis of the potential regulatory approaches EPA could take to reduce GHG emissions if there is no new legislation and an assessment of how the regulatory approach might compare to Waxman-Markey or other potential legislation.

4. Climate change is the major issue. If we are trying to solve the problem, we need to set our sights on transformation of the energy system and economy to achieve low- or zero-carbon output. This should also solve any security problem we have. The costs to achieve a low- or zero-carbon economy by varying dates need to be estimated.

5. Observers believe that methane emissions can be reduced relatively easily and quickly and could have positive benefits for overall world effort to reduce GHG. Methane emissions from agriculture are huge and their reduction deserves early attention. Independent analysis of this possibility should be undertaken to enlighten governmental policymakers about potential actions to reduce methane emissions.

6. Observers believe that, at least in the short-term, the price signal from climate change legislation is not likely to be great enough to induce GHG emissions reductions on a pace that would allow the United States to achieve its goals. Therefore, complementary policies will likely be needed. Such policies could include loan guarantees, incentives for first movers, and a series of benefits that vary with the deployment level of the new technologies. Recognizing that the government has a poor record of "choosing winners," what are the economic and policy implications of the potential complementary policies?

7. The Departments of Energy and Commerce and the Office of Science and Technology Policy submitted a report to Congress, in January 2009, about strategies for the commercialization and deployment of technologies and practices to reduce GHG emissions. The report considered 15 advanced technologies to reduce GHG emissions. Further work to identify policies and measures that would reduce the barriers to deployment identified in the report would be useful.

8. An analytical framework is needed to determine and evaluate the price per unit of carbon emission avoided. This will help in the analysis of potential energy-efficiency approaches.

9. California's experience may warrant national consideration. The California Air Resources Board is obliged to address carbon emissions but is concerned that it will be unable to set a price at the level needed. As a result, the board is evaluating regulations of all aspects of the state's economy and addressing leakage and other problems. What are the implications of this experience in California, and how relevant is this for national policymaking?

10. To date, legislative approaches (i.e., Waxman-Markey) to GHG emission reductions appear to have given no consideration to the likelihood that oil refineries will be shut down and substantial amounts of gasoline and other petroleum products imported instead of being domestically produced. The unintended consequences of these policies should be examined.

11. Are incentives required to cover the difference between expected rates of return for consumers and rates derived from market prices? Estimates should be made of additional GHG reductions that might be adopted were there more incentives. This will assist governmental policymakers understand the costs of various means of increasing the utilization of GHG reduction methods.

12. The pros and cons of addressing GHG reductions on a total economy basis versus on a sectoral basis needs development in order to inform policymakers of the more economically efficient approaches to reduce GHG emission.

13. Many groups active in the climate change policy debate are promoting their own solutions. Research and analysis is needed that shows how the various possible technologies and approaches to achieving GHG reductions will affect economic activity and emissions. Such analysis is likely to demonstrate that better economic decisions for the United States will occur if the government allows the market to decide which technologies are best.

14. A study of GHG offsets/supply is needed, including supply estimates for domestic and international offsets and integration of offset supply into GHG models.

15. Is the interaction between energy and aggregate economic activity adequately understood for an effective design of GHG emissions restrictions?

16. Can efforts to promote carbon reduction and a carbon price be reconfigured to promote affordable energy and energy transformation in a way that is more acceptable to many customers and producers? In general, what words and phrases are best at promoting effective policy change?

17. A scenario-based economic analysis of the short- and long-term economic impacts that national climate legislation or a multilateral binding treaty on GHG reduction will have both on the national U.S. economic and the domestic and global energy markets would be of great value to governments and energy policymakers across the world.

18. A solution to the energy/GHG emissions problem without breaking the economy is required, but at this moment, that solution is not apparent.

19. What are best ways to reflect the need to reduce carbon emissions in energy policy? The Clean Air Act is one way to do it. Little work is under way to show the differences (pros and cons) between various approaches. More work on this subject is needed.

20. The mechanisms for measuring and verifying GHG offsets need more research and understanding, at least in the United States. Similarly, monitoring, verification, and analysis are needed of the every nation's commitments to GHG reductions to determine the extent of "free riders" on a global effort.

21. If market-based approaches are used to control GHG emissions, how should the revenues be used?

22. Can climate policy goals be achieved without increased use of nuclear power?

23. What are the implications of climate policy for energy costs?

24. How should monitoring and verification of GHG mitigation goals, including international offsets, be set up to avoid cheating?

25. Offsets are very important parts of the climate change legislation. Are the GHG reductions from offsets sustainable in the long term? To what extent will provision for offsets support cheating? How should U.S. and international climate policy treat these offsets?

26. Reductions in black carbon can have a short-term impact on climate change and substantial public health benefits. The value of reducing a ton of black carbon emissions in comparison to a ton of CO_2 emissions would help inform policy decisions about reductions of each.

Benefits of Addressing Greenhouse Emissions

1. The United States understands how to evaluate and consider the costs of energy-environmental policies but it is very poor at quantifying and considering the benefits. The "precautionary principle" encourages societies to invest in precautions even if the exact benefits are not quantifiable. An independent organization could provide useful analysis along with recommendations regarding the benefits from reducing GHG emissions since this aspect of the climate change discussion is not well explained or understood.

2. What are the estimated costs to the United States, if it and other countries took no further action regarding GHG emission reductions?

Climate Change Issues

1. What are the costs of global warming? The rate at which scientists see changes in the climate must be coupled with the science and an evaluation of the risk and cost of sudden and further change.

2. All impact studies to date have examined "fast responses" to GHG emissions and neglected the "slow responses," such as change in albedo at ground level, which is likely to increase the rate of temperature change. These responses should be separately considered and added in the cost estimates.

3. Most studies are assuming linear or evolutionary changes and no sudden, major discontinuities. However, increasingly science is finding the possibility of major changes, such as methane from hydrates in the permafrost. That leads to the critical question of how society should value risks in systems that might experience or cause catastrophic change?

4. One problem with current long-term analyses is that they assume that the current potential sea-level rise of one meter in one century will stop. Unless the world develops means to

remove GHG from the atmosphere, the seas are likely to continue to rise and put most seaports and many major cities at risk.

5. After the cost analysis of climate change is available, there can be a more thoughtful analysis of the potential actions and costs to change the world's emission paths based on linear assumptions and also on tipping-point assumptions. This analysis will provide boundaries on estimated costs for addressing various climate change problem sets and then facilitate solutions to the problem sets.

6. Offsets are a very important part of the planned solutions to climate change. However, some observers are concerned that the incentives for cheating regarding offsets are very high and urge analysis and adoption of economics and policies that would reduce such cheating.

7. Because climate change is both a very complicated and enormously important issue in economic and other contexts, an independent group could usefully review the assumptions used in the Electric Power Research Institute's PRISM 9th model and Energy Information Administration forecasts to determine the economic implications of the assumptions. This information would better inform the users of those forecasts.

8. The biggest issue driving investment in the electric utility industry is the likely policy responses to climate change. The policy responses will shape industry investment decisions, but the outcome is of considerable uncertainty, and potential directions should be examined.

9. At least one (and potentially more) notional, sustainable concentration of atmospheric GHG concentrations should be selected, and then several least-cost means of achieving such concentrations should be identified. This information would help government policymakers and the private sector boundary the problem and decide on appropriate government and private actions necessary to achieve the target endpoints for GHG concentrations.

10. Related to the analysis in item 9 above and as a direct outgrowth of work in item 1 above, the costs of higher GHG concentration levels and the costs of existing policies to reduce GHG emissions should be evaluated. This, too, would assist governmental and other policymakers.

11. One or more independent research organizations should create a U.S. version of the Stern report.

12. Have European problems with market design for GHG emissions trading been sufficiently identified and analyzed so that the United States can knowingly avoid such problems?

13. Since climate change is already occurring at a slow pace, managers of lands and shore installations should begin considering adaptation strategies. Thus, analysis of economically attractive adaptation strategies should be undertaken.

14. The major issue is climate change and climate change policy. What will be the roles for nuclear, natural gas, and renewable energy sources?

15. How will climate change effects be distributed around the world? Will significantly different effects occur sooner in some areas that could result in political or social outcomes that need to be considered by the United States?

16. In the area of climate change, there is a huge need to understand how the developed countries can best support GHG mitigation in the developing countries. Are there economically sound policies to support such mitigation and achieve other goals as well?

Carbon Capture and Storage

1. A thoughtful evaluation of the dangers, if any, of storing CO_2 in the ground needs to be done along with an evaluation of customer attitudes toward this approach, and how such attitudes might be changed. This is significant because the public may look at CO_2 storage like it has at nuclear waste and reject it regardless of the merits.

2. The technical problems of carbon capture and storage (CCS) can be solved, and the costs of parasitic energy use can be reduced. However the environmental, legal, and public acceptance issues are more significant and warrant analysis to determine economically justified means for federal or state governments to facilitate CCS.

3. The policy to provide substantial subsidies to CCS conflicts with the desire to increase the price of energy and motivate changes in energy consumption. Equity and economic efficiency conflict on this and many other investment-intensive GHG reduction strategies. Further elaboration of the economics of subsidies for CCS and other technologies would assist policymakers.

4. What are the implications when significant amounts of CCS need to be deployed if there are very large amounts of gas from shale formations at reasonable prices?

5. How does the range of expected CCS costs per unit of GHG reduction and kilowatt hour of electricity production compare to the costs of electricity generated by wind or solar that is transmitted to the market? This will help inform policymakers in selecting, monitoring, and maintaining the various incentive programs for GHG reduction activities.

6. What are the economic, environmental, and research and development issues associated with CCS that need to be taken into account in policymaking?

7. Will CCS come online as a viable economic approach to reducing GHG? If not, what are the options for the United States? If its costs are reasonable, it could be a game changer by allowing the United States to continue to use a significant portion of its existing energy infrastructure. This would seem to have significant economic and psychological values.

8. Are there alternatives to CCS? For instance, some theoretical and experimental work suggests that CO_2 collected at generation facilities could be used to make some plastics, fertilizer, or a transportation fuel. To the extent that these and other possibilities exist, should

the government provide funding to promote the research and development until the private sector can decide which uses warrant commercialization? What are the implications of such possible developments if they could be achieved? These ideas are based on the proposition that the United States should not "put all of its eggs" into the CCS basket.

Energy and Environment

1. Knowing more about how nitrogen oxides and sulfur dioxide permits will be valued as carbon emissions are reduced is an important aspect of energy policy that deserves analysis.

2. What are the environmental costs of various energy sources?

3. What are the economic and other implications for the U.S. refining industry and the U.S. economy as a result of the various environmental and GHG-related rules, such as corporate average fuel economy (CAFE), renewable fuel standards, the recent EPA tail pipe emissions rule, and the Waxman-Markey or Kerry-Boxer bills. Several observers expect substantial shutdowns of U.S. refining and increased imports of petroleum products.

4. If market-based approaches are used to control emissions from energy use, how should revenues be used?

5. Reductions in black carbon can be made quickly and relatively cheaply. This will have substantial public health benefits, which will help developing countries. EPA and the United Nations Foundation are working on this issue. Independent analysis, including determining the worth of a one-ton reduction of CO_2 emissions versus a one-ton reduction of black carbon emissions, would help this effort.

6. The United States has a history of not being able to address energy and environmental issues simultaneously. In addition, citizens want to keep energy prices low while encouraging renewable energy with economic incentives. An independent group should analyze and combine the historic and proposed energy and environmental policies into a single assessment that would help the legislatures and citizens understand the issues.

7. As a result of the oil price shocks in the 1970s, the United States increased its efforts to improve energy efficiency and conservation. How can the current need for reduction in energy use prompt evaluation of expanded thinking, such as planting trees to address some energy–environment problems? For example, under the Clean Water Act, the temperature of effluents from stormwater and wastewater discharges must be below a given temperature. Refrigeration is typically used to accomplish this requirement. A lower-cost alternative may be to plant trees along riparian rights of way. In an Oregon community, this proved to be a cheaper and more environmentally positive way to solve the problem. Are there other such instances across the country? An independent organization could evaluate the criteria necessary for such a project to succeed and then seek to identify other locations in the United States where such a project might be in order.

8. There are significant environmental issues associated with eastern coal production including mountain-top removals, acid drainage, and subsidence. About 300 deaths occur per year at level crossings involving coal trains. What are the economic costs of these problems, and how might they be reduced in an economic fashion?

9. Because climate change and other environmental goals can be pursued at varying paces depending on their financial support, what analysis should be done to allow these goals and the goal of a strong economy to be achieved in equivalent measure?

Energy Use in Transportation

1. What are the economic and environmental implications of the various means of reducing GHG emissions, directly and indirectly, in the transportation sector? What are the costs of transportation policies that could be used to reduce GHG emissions with or without a cap-and-trade or carbon-tax system in place?

2. With existing technology, what price of gasoline would be required before alternative energy sources (such as fuel cells, batteries, and ethanol) can compete absent a subsidy?

3. Would there be an advantage to using feebates to improve automobile fuel efficiency rather than CAFE standards?

4. The electrification of the surface transportation sector is potentially important and warrants evaluation on economic, environmental, and consumer-acceptance grounds. Some observers are concerned that the environmental costs and benefits of electric transportation have not been adequately recognized.

5. What are the economic and other issues that arise if the passenger-vehicle system evolves toward increased fuel efficiency and synthetic liquid fuels based on biomass, coal, or natural gas? How do these compare to a more electricity-based system that relies on batteries or fuel cells?

6. What if internal combustion engines were dramatically more efficient and yielded substantial reductions in emissions and fuel demand (thereby reducing crude oil imports much more quickly and less expensively) than converting to electric vehicles?

7. Are there economic and environmental advantages to policies that specifically address the pace of development and support for conversion of the transportation fleet from petroleum-based fuels to other energy sources?

8. Are there land use, public transport, or other perspectives regarding transportation that have significant potential for reducing GHG emissions and warrant further economic analysis and study? For instance, there is significant freight and intermodal freight competition. What are the economic implications of policies that promote the movement of more freight by rail instead of truck, and what GHG emissions reductions might result?

9. Traffic congestion, fuel consumption, and emissions are intertwined. Highway capacity additions may result in increased driving, fuel consumption, and emissions. Congestion behavior and induced demand warrant evaluation along with the possible use of congestion pricing.

10. What are the economic and environmental considerations for the various means of creating liquid hydrocarbon fuels from biomass, coal, or natural gas in ways that substantially reduce the GHG emissions from the production and use of such fuels? Liquid fuels will be needed for aviation, if not also shipping, for years to come.

11. Such technologies as geographic information systems or others could significantly change how transportation services are provided and may have important implications for GHG emissions. Such technologies should be evaluated or at least not be prevented from consideration for adoption when the benefits of their use are clear.

12. The transportation-fuel outlook for the United States is critically important to energy security and liquid fuel prices. More research is required about the security implications of biofuels, electric vehicles, hybrids, and natural gas–fueled vehicles.

13. Transformation of the transportation system will rely not just on the carbon price but also on the choice between electricity, biofuels, or other means of providing transportation. What sorts of incentives or subsidies are needed from the government to assist any one of these alternatives to achieve commercialization? Incentives or subsidies will possibly disproportionately help one technology versus another and so put the government in the position of "picking winners." How should the government decide which technologies should receive what amount of support?

14. One of the greatest areas for energy policy reform may be in congestion/time-of-day pricing for cars. Europe is using congestion pricing. An evaluation of such pricing in the United States and elsewhere is needed.

15. In the economic analysis of transportation, there is an insufficient understanding about the social, economic, and human context in which the service is provided. Such an understanding is better learned through on-the-ground research.

16. Is there learning from mass-transit modifications in countries with emergent economies that would benefit the United States and other countries? What is the feasibility of low-carbon auto alternatives versus smart urban planning and the creation of nodes where people can obtain mass transit close to where they live?

17. What are the policy implications of the evolution of energy sources for light-duty vehicles? Will biofuels or electricity take over the fleet? Will petroleum products remain dominant? Are there limits on biofuels production that need to be taken into account? How do hydrogen and fuel cells fit into the long-term mix for transportation?

Energy-Water-Land Nexus

1. The land and water requirements for biofuels and food production need analytical attention.
2. The United States and the world need a greater understanding of technical and economic implications of using water for energy production (e.g., power generation, biofuels, oil shale, and others) rather than for food production and other societal needs. This issue is thought to be of sufficient significance that it will and/or should affect decisions on deployment of various energy supply systems.
3. What are the principles for appropriate pricing for water; how is it done in other countries?
4. One observer suggested that if water were priced as it is in Israel, profligate uses in the United States would diminish. The pricing rules for water usage in multiple countries and the economic principles for appropriate water pricing should be studied.
5. More attention needs to be paid to water as a resource. The aquifers around the world, not just in the United States are being drawn down at greater-than-recharge rates. Water is needed for growing uses like people, agriculture, and energy production. Thoughtful work is needed on water and energy usage around the world, not just in the United States.
6. Federal land managers need to know more about the values and effectiveness of distributed solar electrical generation in the U.S. Southwest versus development of utility-scale solar projects to decide about allocations of lands for these and other uses.
7. Due to the semi-arid situation of the U.S. West, land managers need to know more about the water-energy nexus to help in their decisions about new energy projects.
8. All government and private-sector energy officials would benefit from the development of economic and policy principles for considering land-use choices between petroleum, coal, natural gas, and shale oil on the one hand and non-fossil energy developments on the other.
9. What approaches could be developed that will help land managers balance interests ranging from energy production to preserving wilderness to allowing free navigation for sport and fishing?
10. Should prices be different for offshore mineral or renewable leases than for on-shore leases? Are the environmental issues at such locations different enough to warrant distinctive economic treatment?
11. Over the next decade, issues of water resources and energy development will become increasingly significant. More research is needed about the economic implications of these intertwined issues.
12. What factors should be considered in determining the fair value of the various uses of federal lands to supply energy services, whether they are fossil, solar, or wind? What are the

economic and policy considerations involved with possibly providing incentives for the use of such lands for renewable resources?

13. How would changes in water-use patterns affect the energy used for its transportation?

14. Infrastructure, land, and water use should be evaluated as to the environmental and economic cost of the various sources of energy available to the United States. Many analyses and promotions of the benefits of renewable do not take into account all their environmental impacts. For example, with shale gas, the concerns about impact on potable water do not appear to be well founded, but fewer concerns have been identified about surface disturbances, roads, and tree cutting from extensive exploration and production of such gas.

15. Renewable fuels, mainly cellulosic, are a big issue that requires study. The renewable fuel standard requires EPA to set quotas for these renewable fuels. There is only so much land in this country and in the world. An analysis is needed to determine the pros and the cons of using this land to grow feedstocks for biofuels rather than using it in agriculture or preserving it in a natural state.

Energy Tax Policy, Including Cap-and-Trade Issues

1. What are the pros and cons of a carbon tax in comparison to a cap-and-trade policy, considering how the tax proceeds are used?

2. If market-based approaches are used to control emissions from energy use, how should the revenues be used?

3. How would proposed changes in energy taxes (including the elimination of fossil-energy subsidies) affect energy use and economic efficiency?

4. Would there be an advantage to using feebates to improve automobile fuel efficiency rather than CAFE standards? Similarly, would feebates offer an advantage over standards for electricity using consumer durables?

5. To what extent can a middle-ground approach that mixes a cap-and-trade policy or carbon tax with supplemental polices, such as technology subsidies or portfolio standards, be regarded as attractive?

6. In addition to considering a middle-ground approach that uses other policy tools to supplement a carbon tax or and cap-and-trade regime, a carbon/energy policy that adopts one or two major policy tools best suited for each sector should be evaluated. For instance, compare the Waxman-Markey approach to one with the following characteristics:

    a. the power sector has a cap-and-trade system, renewable portfolio standard, and renewable energy standard;

    b. the buildings sector has codes, appliance standards, and tax incentives; and

c. the transportation sector has a gas/carbon tax and CAFE.

7. Regulatory alternatives to accomplish the same GHG-reduction goals that can be achieved with either a cap-and-trade policy or carbon taxes should be identified and analyzed.

8. As part of an analysis of a carbon tax or cap-and-trade policy, examine whether natural gas should be treated differently than coal or oil because its use has less environmental and GHG implications.

9. The long-term implications of cap-and-trade systems and carbon taxes need better evaluation.

10. Almost all economists and most CEOs of major corporations believe that a carbon tax is both the most effective means for changing behavior and the most efficient, given that there is a high probability of no climate change legislation before 2011. Consequently, there is a need for analysis of the costs and benefits of a carbon tax as well as the ways of using the proceeds efficiently.

11. Are there credible means of evaluating the impacts of various climate policies on states or major industrial sectors?

12. Since there will be incentives for companies to obtain offsets from foreign countries instead of incurring costs of carbon mitigation, there is the potential for large quantities of funds to move to other counties.

13. The implications for the United States and the world of "failed" verification, monitoring, and corruption involved with overseas offsets in GHG reductions warrants attention. Apparently the Clean Development Mechanism program had major cost escalations. If this were the case with offsets, the actual reductions achieved may be measurably less than anticipated.

14. To what extent is the cap-and-trade system for sulfur dioxide emissions a success because of the availability of cheap low-sulfur coal? To what extent will cap and trade have a more difficult time finding success when applied to CO_2?

15. How do we avoid abuses with a cap-and-trade approach?

16. What is the intersection, if there is one, of overall energy tax policy with the externalities of energy production and use?

17. Do approaches of providing subsidies and allowances for various sectors and populations in the context of the Waxman-Markey Bill lead to ever-more price instability and higher prices with adverse long-term effects on investment and other aspects of the electric energy system?

18. How do we provide affordable electricity through the next 10–12 years under the Waxman Markey construct? "Clean Coal" and CCS are not available, and may never be available. Nuclear facilities are very expensive and the fuel cycle is uncertain; availability and price of

natural gas is also uncertain, so there will be limited investments in new generation for several years. The consequence will be that demand will exceed supply, which will cause sharp price increases. These gains will create a problem for consumers.

19. Society needs a "least regrets" means of reducing carbon emissions. We should put a price on carbon in the United States and elsewhere. Unless such a price is set and artificial subsidies like tariffs on ethanol are removed, economic solutions will not be the result. The goal should be to let the most economic and environmentally desirable solutions emerge. The analysis may show that the playing field between fossil and non-carbon energy needs to be more equal so that the market can pick the solutions. The current system of subsidies is an inefficient way to proceed.

20. What taxes are necessary to account for all the externalities associated with various sources of energy (e.g., coal, oil, natural gas, and solar power)? If such taxes were applied to create a level playing field, how would the energy mix change?

General Issues

Energy and Economic Policies

1. How can energy policy be set so that there is a maximum reliance on market pricing and market-determined outcomes?

2. To what extent can market subsidies and taxation be matched to the realities of market imperfections?

3. What are the consequences of using standards instead of pricing to achieve energy goals?

4. Each industry has a different set of problems/issues relating to how it will address energy, climate, and environmental issues. Most industries are starting with efficiency and then moving to "breakthrough" technologies. The overarching policy question is, what policies can make this evolution work better without the government picking the winner? An independent organization could provide a pilot study of one or two industries to determine what would be needed to enhance this evolution. Evaluating past U.S. government attempts at similar policies should be part of such an analysis.

5. The various current and proposed subsidies and economic incentives to promote differing technologies to reduce GHG emissions should be evaluated and compared with the expected supply impact. Germany and Spain have set limits on such subsidies. Such a study would need to consider subsidies for oil, gas, coal, and nuclear. Such a study could evaluate the cost-effectiveness of past subsidies. The Energy Information Administration and others have conducted significant work on historical subsidies.

6. Related to the subsidy analysis suggested above is the question whether existing subsidies for petroleum, coal, or natural gas production should be changed?

7. What is the real cost of externalities from various energy sources? Without understanding these, it will be very difficult to create a level playing field for alternatives to coal and oil. How do the externality costs of the various energy sources compare to the subsidies or incentives being provided to them?

8. Because most individuals promoting various energy solutions believe them to be low risk, an independent organization should provide a technically comprehensive but reader-friendly analysis of the economic efficiency and effectiveness of the various proposed energy programs and policies. It should compare and contrast the benefits and drawbacks of cap and trade versus a carbon tax, describe market distortions surrounding subsidies, etc.

9. An evaluation of the more recent energy policy acts and their results versus what was claimed for them would help inform the debate regarding further energy and climate change legislation.

10. Better and updated data on the baseline are needed. For example, most research on the elasticities of energy supply and demand is relatively old.

11. How much does the United States depend on other countries for renewable energy technologies? What are the implications of having to import substantial portions of new equipment and parts?

12. Does free trade deserve re-thinking, at least in the energy sector because energy, almost like food, is essential for any economy to function? A related issue is whether affordable energy is so important to the U.S. economy that free trade of goods and services that support of electricity production and distribution should be pursued.

13. What has been the history of eliminating subsidies and allowances? Based on that, can we expect that the proposed subsidies and allowances will ever be removed? And if not, what are the economic consequences?

14. The effects of energy policies on the U.S. manufacturing sector should be considered.

15. What has been the recent experience with commercializing government-funded research? A related issue is whether research funded by other countries has been commercialized in the United States? Are there appropriate and economically efficient means for encouraging commercialization and job creation in the United States other than U.S. government-funded research?

16. What approach to policy would preserve and extend the market-oriented revolution in energy policies of the last three decades *and* promote innovation and efficiency? With all the externalities being considered, there is a strong tendency to fall into social planning at the expense of market-driven decisions.

17. What has been the cost-effectiveness of the many and diverse energy subsidies? What learning from the analysis of such programs could be applied to the future?

18. How will policy-driven reductions in energy use or increases in the effective prices of energy use affect energy-intensive industries and the pace of overall economic growth?

19. Efforts are needed to evaluate various policies—such as renewable fuel standards, CAFE standards, and renewable portfolio standards—from the perspective of the cost of reduced CO_2 emissions. These analyses should address a sufficient range of implementation to provide an examination of the rate at which costs might escalate as such standards are increased.

20. What is the shape of the least-cost supply of carbon reduction policies? At what rate does the supply curve escalate, and are there any important inflection points?

21. Analysis is needed to assess the effects of policies to promote energy efficiency and renewable energy on employment.

22. High-valued sources of energy consumption should be evaluated for the potential to use new energy technologies. For instance, the Department of Defense has calculated that the cost of a gallon of fuel delivered to a combat zone costs about $100. Solar panels on buoys or isolated signs to power their lighting are other examples.

Finance and Investment

1. Many observers report that investment-intensive industries like electric utilities are very uncertain about their future legislative/regulatory environment and are hesitant about making large investments that will require a long time to pay off because the investment climate is very uncertain. That finding leads to the need for analysis of the pros and cons of developing government-encouraged financial structures that reduce investment uncertainty. At the extreme, what are the pros and cons of government investment in large, long-lived solar or wind projects on federal lands as a means of spurring the commercialization of the respective industries, like hydroelectric power in the 1930s?

2. Some have suggested a need for more analysis and a better understanding of the investment criteria used by utilities to choose between technologies with varying potential environmental and GHG benefits when costs are uncertain.

3. A leasing-decision tool is needed that allows decision makers to determine the relative value of potential oil and gas energy resources in an area versus the environmental and social resources in the same area. It should also include means for adequately quantifying non-dollar environmental values.

4. Many observers remark on the enormity of the U.S. energy supply system and the investment challenge to change it to other supplies. Most individuals do not appreciate this chal-

lenge and the current uncertainties in the investment climate. Thus some analysis is needed that could be publicized of the investment costs that will need to be incurred under varying scenarios over an extended period to change the energy system and reduce substantially GHG emissions. The studies by the Congressional Budget Office and the Energy Information Administration are not thought to be sufficient on this matter.

5. Some suggest that the scale of investment for major nuclear or other projects exceeds the ability of individual firms to assume such financial risks. An analysis of the types of investments that have such characteristics and are otherwise believed to benefit consumers and the environment would be useful. Such an analysis should also include discussion of the various types and costs of potential government assistance based on past government and the private-sector experience with financial or related assistance. The Synthetic Fuel Corporation, Sematech, and other models from World War II exist. Non-financial measures, such as encouraging joint ventures of otherwise competing organizations, may also be feasible.

6. The development and publication of an independent analysis of the costs and other implications of the proposed major technical approaches to changes in the energy system could be helpful in persuading the public of the need for such investments. Such analysis might also lessen opposition to new energy investments, which could reduce the uncertainty and cost of such investment.

7. Further research is needed on the differences between the physical energy market and the financial energy market, and how pricing in one market affects the other.

8. Many analyses of the economics of clean coal, CCS, and nuclear power understate the required capital expenditures because they leave out or use outdated estimates of the many ancillary costs like site preparation, permitting, and transmission lines. These estimates need review.

9. Work is needed on risks and risk characterization of various government loan guarantee programs for energy technologies, such as nuclear power and CCS.

Evaluating the Economic Effectiveness of Energy Policy

1. The role of energy in the U.S. economy is significant, and energy prices and availability influence the U.S. economic situation vis-à-vis the industrialized world. As the United States relies increasingly on electricity, its cost will have multiple impacts on the economy. The economic and other roles of manufacturing in the United States warrant study and evaluation in the context of how the sector will fare if U.S. energy costs significantly change relative to the costs of energy at least in other industrialized countries, as well as major emergent economies like China, India, Brazil, and the Middle East.

2. Although there is general agreement in the United States about the desirability of goals such as reasonably priced energy, energy security, and "green energy," there are substantial

differences about the relative weight that should be accorded each. Independent economic and policy analysis of the implications of each goal should help make citizens and decision-makers more knowledgeable of their choices of energy policy and hopefully result in more economically efficient policies.

3. Some observers suggest that many of governmental estimates of the costs of various CO_2-reduction strategies substantially underestimate capital expenditure costs and thus the market prices necessary for the technologies to be widely deployed. Since many of these strategies are very capital intensive, such underestimates may result in economically poor decisions. An independent analysis of these costs is necessary.

4. The economics of GHG emissions-reduction devices from the standpoint of the customer needs to be evaluated and understood. This would address substantial skepticism about the likelihood of millions of customers making multiple decisions to acquire low-emissions devices ranging from compact fluorescents to plug-in hybrids or even new energy-efficient houses.

Issues in Federal and State Policy Relations, Including RTOs

1. Efforts to liberalize or restructure such traditionally regulated markets as electricity and natural gas have not been analyzed to determine if they have provided the intended results and/or to compare the results to those the prior regulatory system would have provided.

2. An analysis is needed to determine the expectations for and economic results from the creation of the regional transmission organizations (RTOs). A conference of the multiple stakeholders could be a forum for at least agreeing on the economic issues affecting them, if not also possible means to address them.

3. Some observers and stakeholders are concerned that the RTO concept has not materialized as was anticipated and that the regulation of transmission warrants study by an independent organization.

4. Is there adequate information available in the RTO markets for customers to knowledgably participate? To the extent that aggregators of electricity demand are able to "sell" reductions of this demand into an RTO market, are there adequate means of monitoring those reductions during high-demand situations to ensure that fraud is not occurring?

5. Too often energy policy issues are inadequately considered in the federal/state context. An analysis of energy-market regulation at the federal and state level should be undertaken. State regulators have short terms and limited research capability. Thus some organization should seek to do relevant economic research and make it available to the regulators.

6. State legislative and public utility commission policies that were established many years ago govern much of the U.S. policy for electricity and natural gas markets. On top of this are a series of federal energy policies that have produced mixed results. The regulatory structures

that control these energy policies should be examined to understand why they exist, what goals they were set up to achieve, how well they have achieved them, the relevance of such goals today, how these goals complement or conflict with larger national policy goals, and the resulting implications.

7. Where natural monopolies or essential functions exist in some aspects of electricity and gas distribution, the regulated utility model may still be the best solution. However, the current means of regulating such utilities may be inconsistent with achieving larger national energy and environmental goals. For example, the concept of regulating a utility's return on investment may favor using existing infrastructure as long as possible rather than replacing it with newer technology. In addition, traditional rate structures reward utilities when their customers increase their energy consumption, while "decoupled" rate structures make the utilities indifferent to per-capita customer energy consumption. The pros and cons of the existing system relative to the national energy and environmental goals and ideas for any improvements would make for a timely research project.

8. Are there better ways for the United States to balance local and national interests in the energy sector? NIMBY is a very significant and seemingly increasing attitude toward CCS, nuclear plants, nuclear waste storage, offshore drilling, wind farms, and other large energy facilities. What have been the experiences in the United States or other countries that could be applied to overcoming these issues?

9. The combination of state and federal regulation of electric power transmission is causing problems that are expensive to society. How should the regulations be redesigned to put the proper incentives into place for electric power transmission?

Energy Security

1. A recent National Academy of Sciences study about the hidden costs of energy use indicates further need for economic research and thinking about energy security issues.

2. What are the national security externalities associated with oil consumption and other fuels?

3. There is a great lack of clarity regarding the definitions and meaning of "energy security" and "energy independence"—and an even greater lack of understanding that the United States cannot achieve energy independence at an acceptable economic cost. Petroleum is a global product with global prices.

4. Energy security has at least two major components: one related to national security, and the other to economic stability. Price volatility, potential for disruptions of imported supplies, and possible impacts on defense spending are important aspects of the general questions, what is energy security, and what are the economic cost to achieve it? Some or all of this issue warrants further research, analysis, and, almost as importantly, widespread publication.

5. In the international context, do greater possibilities exist for civil unrest if energy supplies are significantly disrupted? If so, what are the implications for the United States?

6. Are there more cost-effective alternatives to providing oil products to New England and other parts of the United States than having government-mandated product storage? For instance, what would be the energy system and environmental implications of suspending some fuel specification requirements when shortages occur? Could environmental harm be offset by later periods of tighter-than-normal fuel specifications?

7. The loss of electricity supplies to major energy or other infrastructure of the United States can yield substantial economic damages to the affected area, albeit less than occur to the nation at large. What has been the U.S. experience with such losses, and what level of effort might be economically justifiable to reduce such losses?

8. Bolivia appears to have the largest share of the world's lithium deposits; will it become more than a Saudi Arabia for lithium? What are the consequences of that situation for the United States and other countries?

9. Assuming that some energy security externality costs are currently not reflected in the prices of petroleum products, should there be additional analysis of the nature and amount of such costs and the appropriateness of applying such costs directly or indirectly to fund national moves away from petroleum products?

10. Evaluate new options to use the Strategic Petroleum Reserve as a way to provide a countervailing force against market volatility, such as converting the reserve into a revenue-producing asset where part of the decision about when and how much oil to release is in private hands.

International Issues

1. Standards for various energy-efficient products vary from none to substantial across the globe. The differences lead to confusion among customers. What are the ways to address the quality of internationally traded products? Is the standard and quality issue noticeably different for energy-using goods than for other goods?

2. The mechanisms for measuring and verifying GHG offsets need more research and understanding, at least in the United States. Similarly, monitoring, verification, and analysis are needed of every nation's commitments to GHG reductions to determine the extent of "free riders" on a global effort.

3. How will climate change effects be distributed around the world? Will there be significantly different effects sooner in some areas that could result in political or social attitudes that the United States needs to consider?

4. Inconsistent standards for carbon content in traded products could be considered trade

barriers. What are the amounts and significance of such products exported from the United States to OECD countries or imported by the United States from any country?

5. In the international sphere, how does the world encourage economic development in countries with emergent economies in a way that balances growth with energy use and the environment, particularly when such issues may not be at the forefront of policy in such countries? What policies could lead to rapid advancements in this area? What current policies impede such development?

6. What are the implications for the United States if other countries take different courses of action toward climate change and their exports to the United States are advantaged while United States exports are disadvantaged?

7. As the developing world grows in population and economic activity, there will be increased demand for food and energy. How will this affect the United States? This issue has not been adequately studied.

8. Russia, Japan, the European Union, and, in the not-too-distant future, the United States have or are likely to have stable or declining populations. To what extent do the various economic and policy analyses regarding energy use consider this likelihood?

9. Greater understanding of U.S. and global economic issues in a changing energy system is necessary and could be developed by an independent analytical organization. This analysis could include studying the potential for geopolitical instability brought on by significant or inadequate changes in energy portfolios. Specifically China's and India's policies and actual practices toward GHG emissions warrant continued monitoring and analysis.

10. A major issue where an independent analysis could make a contribution is the flow of pollutants from one country to another. Mercury from coal-fired electricity-generation facilities in China and elsewhere is an example. No one is considering international curbs on mercury emissions. Should this issue be analyzed?

11. Have the lessons of the European Union in implementing a cap-and-trade program for CO_2 emissions been sufficiently published and understood so that the United States will be able to avoid the adverse experience in Europe?

12. What are the implications of energy use embedded in U.S. imports? The United States has reduced its energy consumption per unit of GDP over the past 20 years. What happens to these estimates when we consider energy consumption as adjusted for the energy use embedded in imports?

13. Are there adverse results for the United States if the major design and manufacturing of renewable technologies, advanced nuclear reactors, and advanced lighting or other energy-efficient household or building devices become increasingly manufactured in Asia instead of the United States? If so, what are appropriate policies to eliminate or otherwise offset such results in ways that are beneficial to U.S. economy and workforce?

14. In the area of climate change, there is a huge need to understand how developed countries can best support GHG mitigation in the developing countries. Are there economically sound policies to support such mitigation and achieve other goals as well?

15. The implications for the world energy markets of the countries with rapidly growing economies—such as, China, India, and the Middle East—deserve more study because of these countries have a growing share of world energy usage.

16. Many people in the world do not have access to electricity. Electric power is a factor in social stability in societies. Would analysis be useful for national and international policymakers of the economic consequences and standard-of-living variations for areas of the world without electricity as compared to areas with electricity?

Under-Researched Issues

1. What have been the effects of the many energy-efficiency policies, laws, and regulations that currently exist? (The Department of Energy has a database that lists about 500 such policies.)

2. What have been the most effective approaches for the executive branch to collaborate with the legislative branch in creating sustainable and effective energy-environmental legislation? In particular, what approaches increase the probability that economic principles will be used appropriately in legislation?

3. How does coal fit into the U.S. portfolio of energy choices? What are the costs associated with using coal and of avoiding the use of coal?

4. What are the consequences of using standards, such as renewable portfolio standards or efficiency standards, instead of pricing to achieve energy goals?

5. What is the economic value of damages from climate change? Most research is on mitigation, some is on adaptation, and very little is on the damages themselves.

6. A recent National Academy of Sciences study about the hidden costs of energy use indicates further need for economic research and thinking about energy security issues.

7. What are the national security externalities associated with oil consumption?

8. What are the external environmental costs of various energy sources?

9. The economics of promoting GHG-reducing technologies needs analysis. What are the implications and likelihoods of success of the various available or proposed incentives or policies, such loan guarantees for adaptation?

10. Further work is needed on the "Valley of Death"—that is, the step between government- or university-funded research at the basic and applied level to the final commercial and private

sector–funded deployment of GHG-reducing technologies.

11. Further research is needed on the differences between the physical energy market and the financial energy market, and how pricing in one market affects the other.

12. Because energy and natural resources in the United States are managed on federal lands by an antiquated system without fees for hard-rock minerals and coal and with only modest fees for oil and natural gas, what are the economic pros and cons for an alternative approach where the market sets a value for the exploited acreage?

13. Should there be targets for reducing oil imports, and if so what should the levels be?

14. The methodology for life-cycle analysis of GHG emissions and biofuels needs to be regularized. Models are needed that will respond to price changes and policy changes.

15. Potential changes in agricultural productivity in the United States and the world need further evaluation. Increasing GHG emissions will have an effect on agricultural productivity at the same time as industry is developing new seeds and technology to improve productivity.

16. The significance and amount of "indirect land use" as a result of the movement toward biofuels needs evaluation. EPA is using some estimates of GHG emissions for indirect land use in its development of the renewable fuels standard. Congress has directed EPA and the Departments of Energy and Agriculture to study the issue over a five-year period.

17. What are the implementation risks for the various strategies being adopted in regulations or statutes for reducing GHG emissions? What happens if the assumptions are not borne out? How does the United States exit an ineffective strategy? For the sake of argument, what happens if the long-term price for oil turns out to be in the $60–$80 range, instead of more than $100, as is being projected? What would be implications of such a price on the various legislative or regulatory requirements regarding aspects of energy production and usage? A different way of stating the same question is, what are the no-regrets strategies for reducing carbon emissions?

18. Companies hedge their bets by taking out insurance or having alternatives that they could follow. Are governments doing the same for the GHG emissions–reduction strategies being adopted? If not, what could or should governments do to hedge their bets or diversify away from the risks?

19. Many computable general equilibrium models that are being used for energy-policy analysis appear to assume that transitions in energy use and other portions of the economy are gradual and iterative. Some people believe that significant disruptions will occur if the energy and industrial sectors are forced to make historically sizable and rapid changes in energy systems to use different energy sources. Such rapid changes are costly, but many of the models being used for analysis do not take such costs into account. A responsible, independent organization should review the models being used to determine the extent that the costs of rapid change are not being considered and the extent to which an adjustment of the

results from such models is warranted.

20. What are the implications for distillate prices and crude itself if the world can produce, at relatively low costs, very large supplies of natural gas from shale or hydrates? If the price of natural gas is low relative to traditional oil pricing, the conversion of natural gas to liquids becomes more economically attractive. If the price of such liquids is below the price of distillate oil from petroleum refining, it will shift the refinery mix and reduce the price of crude oil.

21. Should there be a new pricing index for natural gas rather than a direct connection to the price of oil? European buyers are unhappy with existing contracts that tie the natural gas price to that for oil. Take-or-pay clauses in the contract are obligating importers to buy substantial quantities at high prices. None can be transshipped to the United States because market-determined natural gas prices are much lower in the United States. Consequently, the Europeans are looking for a new way to price natural gas. How could a new pricing index be established for long-term natural gas contracts in Europe?

22. An evaluation of the low-carbon fuel standard is needed because some believe it provides no net benefit to society.

23. The value to the United States of keeping much or most of its existing energy infrastructure should be adequately considered.

24. What are best ways to reflect the need to reduce carbon emissions in energy policy? The Clean Air Act is one way to do it. Scant work shows the pros and cons of various approaches.

25. President Obama has laid out a vision of clean energy for the United States based on achieving the multiple goals of employment, lower pollution, lower GHG emissions, more energy, and increased sustainability. An analysis of different future scenarios and the implied clean energy program is needed. Is there a realistic scenario?

26. A major energy policy area that is currently under-researched is the demand outlook for natural gas and the potential for shale gas outside of North America.

27. What are the supply elasticities for OPEC and non-OPEC oil, and how have they changed over time? We have a much better sense of demand elasticities than supply elasticities.

28. How important are China and India to thinking about future energy use?

29. How can policy be set to achieve efficiency and political palatability?

Miscellaneous Issues

1. More holistic thinking is needed about the interaction between the environment, agriculture, transportation, the economy, and energy use.

2. The big three goals for energy and GHG policy are equity, environment, and affordability, with security taking a lesser role. The trade-offs between these goals should be examined.

3. Because most energy issues are intertwined with transportation, housing, buildings, or manufacturing, the views of the users and providers of these services deserve more consideration in the evolution of energy policies if such policies are to be accepted and successful.

4. What are the economic and policy pros and cons of an environmental economic development policy that focused on enhancing the environment as well as U.S. industrial employment?

5. Geoengineering appears to be very cheap. Some countries or groups within countries may well urge the use of geoengineering rather than taking efforts to reduce emissions. What are the pros and cons and implications of geoengineering?

6. How regressive are market-based instruments (like fuel taxes) to affect energy usage? What are the most economically efficient means of addressing this issue?

7. Is there a need for an independent, non-government, energy information and analysis center that is able to use and challenge information generated by governments? If so, what would be its audience, work product, staffing and governance, and funding?

8. What are the issues of mineral/element availability for manufacturing new energy technologies (e.g., for storage) and ultimately recycling or disposing of them that deserve economic and environmental analysis even now?

9. Federal energy policy is an iterative process with long cycle times. Are there better models for national energy policy management that cede some decisionmaking to bodies that can make more timely adjustments? For example, should the mode of the Joint Atomic Energy Committee (both authorizers and appropriators for atomic energy in the House and Senate) be evaluated for application to today's situation? Similarly, should any change in the executive branch be considered that would make the energy-policy process better without being unduly disruptive in implementation and in congressional oversight?

10. Because substantial intellectual effort and the beginnings of enormous public and private investments are being made based on the science of climate change, are there knowledgeable, uninvolved climate scientists who could credibly provide a coherent report on the state of climate change science before the next IPCC report? The purpose of such effort would be in significant part to address the "leaked e-mails," challenges of models regarding their design, and the impact of the various solar and other cycles that affect climate.

11. Should there be a different discount rate for natural systems that is matched to the growth rate of such systems? This would be quite different from traditional discount approaches.

12. What means exist even to roughly estimate the value of such unquantifiable benefits as space, species, etc.? If there were some means of quantifying these benefits, then at least

two estimates of benefits could be developed: one totally quantifiable and the other with the addition of the less-certain but estimated non-quantifiable benefits. This might encourage those who do not support cost–benefit analyses to be more receptive to them.

13. More research is needed on the aggregate economic effects of energy price movements.
14. What is the effect of rising energy prices on the energy-intensive industries?