1577

S. HRG. 102—796

CO_2 STABILIZATION AND ECONOMIC GROWTH

HEARINGS

BEFORE THE

JOINT ECONOMIC COMMITTEE CONGRESS OF THE UNITED STATES

ONE HUNDRED SECOND CONGRESS

SECOND SESSION

APRIL 28, 1992

Printed for the use of the Joint Economic Committee

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON: 1992

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-039301-9

JOINT ECONOMIC COMMITTEE

[Created pursuant to Sec. 5(a) of Public Law 304, 79th Congress]

SENATE

PAUL S. SARBANES, Maryland,
Chairman
LLOYD BENTSEN, Texas
EDWARD M. KENNEDY, Massachusetts
JEFF BINGAMAN, New Mexico
ALBERT GORE, Jr., Tennessee
RICHARD H. BRYAN, Nevada
WILLIAM V. ROTH, Jr., Delaware
STEVE SYMMS, Idaho
CONNIE MACK, Florida
ROBERT C. SMITH, New Hampshire

HOUSE OF REPRESENTATIVES

LEE H. HAMILTON, Indiana,
Vice Chairman
DAVID R. OBEY, Wisconsin
JAMES H. SCHEUER, New York
FORTNEY PETE STARK, California
STEPHEN J. SOLARZ, New York
KWEISI MFUME, Maryland
RICHARD K. ARMEY, Texas
CHALMERS P. WYLIE, Ohio
OLYMPIA J. SNOWE, Maine
HAMILTON FISH, Jr., New York

STEPHEN A. QUICK, *Executive Director*
RICHARD F KAUFMAN, *General Counsel*
EDWARD W. GILLESPIE, *Minority Staff Director*

CONTENTS

WITNESSES, STATEMENTS, AND SUBMISSIONS FOR THE RECORD

TUESDAY, APRIL 28, 1992

PAGE

CO_2 STABILIZATION AND ECONOMIC GROWTH

TUESDAY, APRIL 28, 1992

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The Committee met, pursuant to notice, at 2:01 p.m., in room SD–562, Dirksen Senate Office Building, Honorable Albert Gore, Jr. (member of the Committee) presiding.

Present: Senator Gore and Representative Scheuer.

Also present: Marc Chupka, professional staff member.

OPENING STATEMENT OF SENATOR GORE, MEMBER

SENATOR GORE. The hearing will come to order.

I'd like to welcome our witnesses and guests today.

This afternoon, we're examining a critical and fundamental issue: The economic impact of stabilizing emissions of carbon dioxide, the principal cause of global warming.

The lines in this debate seem to be clearly drawn between those who say we cannot afford any agreement to reduce carbon dioxide emissions and those who say that such an agreement would not only be affordable but profitable, and would strengthen our economy and our ability to compete in a global market place. Considering the implications of global climate change and of ever-increasing levels of carbon dioxide in the atmosphere, we cannot afford inaction.

But what is possible?

The Administration has just released a document entitled "U.S. Views on Global Climate Change." Aside from the usual measured prose concerning the science of climate change and the potential for economic harm, the document presented for the first time the Administration's estimates of the greenhouse gas reductions that are likely to occur as a result of existing and emerging programs.

By all accounts, the economic analysis that supported the findings was the subject of intense debate within the Administration. And it is still not clear if the conclusions of that report were moved as much by politics as by policy. But by the Administration's own reckoning, the United States can nearly achieve stabilization of CO_2 emissions at 1990 levels by the

year 2000, largely with voluntary measures. That is, the United States, by the Administration's own reckoning, could nearly meet the targets and timetables expressed in language now on the table in negotiations for a new international agreement on global warming, an agreement President Bush and his Administration have stubbornly blocked.

The new Administration programs, moreover, will reduce C02 emissions at a profit—no surprise for the many people who have been working long and hard to focus attention on the profitable energy conservation measures that already abound in the economy.

What is surprising is the Administration's continued opposition in light of this new analysis to a meaningful international agreement on global climate change, and the agility, speed and creativity the Administration has shown in finding yet another new round of excuses for inaction.

The Administration had argued, we couldn't afford the agreement and we couldn't meet its deadlines and targets. But this latest analysis says that's wrong. What was once too expensive is now a bargain too good to pass up. Political pressures seems to be igniting a veritable firesale on policy options. Look back at previous DOE analyses, such as the National Energy Strategy and the CO_2 report to Congress, which concluded that many of the options now considered not just available but profitable would, in fact, hurt the economy. The Administration justified its stubborn opposition to a climate change agreement to any serious effort to reduce emissions of carbon dioxide by arguing, we couldn't afford it. Apparently, the line between profitable and painful can change rapidly when politics forces a re-examination of economic analysis.

And in politics, as in life, timing is important. This most recent analysis comes as nations from around the world once more try to get beyond the obstacles the United States has thrown up and to move forward toward a new international agreement to stop global warming.

This Thursday, the sixth negotiating session—the final negotiating session before the Earth Summit—convenes.

The Administration's own analysis should be enough to knock down those obstacles and allow the agreement to move forward. It's the Administration's own analysis that concludes that we could commit to stabilizing emissions of CO_2 while preserving economic growth. Yet, the Bush Administration resists the logic of its own analysis. The Administration just doesn't want to sign an agreement that could hold them to a commitment. They want to tell the rest of the world, the check is in the mail. Take our word for it, we'll deliver.

Well, that's not enough. Without specific agreements, without specific deadlines and targets, there are no assurances that what must happen, will happen. We'll issue a proclamation, but not a promise.

So, for reasons unknown, the Administration remains stalled, stuck between what their economic analysis now tells them and what their political instincts seem to still tell them.

Maybe they still suspect that the economic analysis is somehow flawed. If so, this hearing will examine that issue directly and in some

detail. Perhaps, the Administration has sincere concerns regarding how CO_2 reductions might affect economic growth. Well, if that's the case, testimony given today will establish that the private sector is eager to respond to the stabilization challenge and that profitable energy conservation opportunities still exist throughout our diverse economy.

We can create more jobs by expanding conservation than we can by expanding energy production. That's just a fact. A recent study by Economic Research Associates, for example, concluded that additional conservation investments in Louisiana would provide more than twice as many jobs as an expansion of conventional power generation, about 12,600 additional jobs over 20 years in that state in that one industry. A similar study performed for Virginia demonstrated essentially the same thing.

Maybe it's something else. Perhaps the Administration does not want to commit to stabilization because it doesn't believe that other industrialized nations are bargaining in good faith. Perhaps the Administration fears that these other nations will renege if they encounter unwelcome economic consequences as a result of a stabilization commitment. Well, if that's the case, testimony at this hearing will also show how other nations could, and almost certainly will, enhance economic growth from a CO_2 stabilization commitment. If we want to be competitive in tough global markets, it will be in our self-interest economically to work to increase energy efficiency, to increase energy conservation, and to reduce emissions of carbon dioxide. If we don't, then other nations alone will reap the benefits of creating a more productive economy.

Our first panel will help put the recent Administration analysis and previous analyses into perspective. Eileen Claussen is the Director of Atmospheric and Indoor Air Programs at the Environmental Protection Agency. She will describe many of the programs that go beyond the National Energy Strategy that reduce CO_2 emissions at a profit. Howard Gruenspecht is the Associate Deputy Undersecretary for Program Analysis for the Department of Energy. He will discuss the Department of Energy's perspective on these issues.

Our second panel focuses on the electric power sector, since this sector accounts for the bulk of the CO_2 emission increase projected in the United States over the next decade, according to DOE. David Moskovitz of the Regulatory Assistance Project will describe how regulatory reform could reduce CO_2 emissions while decreasing electricity bills and increasing utility profits. John Fox from Pacific Gas and Electric will tell us how PG&E will meet additional electricity service demands while holding CO_2 emissions steady. Lynn Sutcliffe, President and CEO of the Energy Service Company SYCOM, Incorporated, will share his business plans with the Committee. His company will be out there creating the jobs and reaping the profits, presumably, that will accompany a CO_2 stabilization commitment.

Our third panel will broaden the focus somewhat to look at the economywide potential for profitable energy efficiency and CO_2 emission

reductions opportunities, both here in the United States and abroad. William Chandler, senior scientist at Battelle Institute, has studied the energy economies of the United States, Western Europe and Japan, and most recently has been assisting the emerging democracies in Eastern Europe and in the former Soviet Union as they attempt to make the transition to a market-based economy. Florentin Krause has recently completed a study of profitable CO_2 emission reductions in Western Europe for the International Project for Sustainable Energy Paths. In his position at the Lawrence Berkeley Laboratory, he has co-authored an influential handbook of least-cost utility planning for the National Association of Regulatory Utility Commissioners in the United States. And then, finally, Richard Stroup is a professor of economics at Montana State University and is affiliated with the National Center for Policy Analysis.

I want to thank all of our witnesses for joining us today. We are looking forward to your testimony.

Before we proceed, Congressman Armey, who was unable to attend today's hearing, has asked that his opening statement be included in the record.

[The written opening statement of Representative Armey follows:]

WRITTEN OPENING STATEMENT OF REPRESENTATIVE RICHARD K. ARMEY

Good afternoon. I am pleased to welcome our three panels of witnesses today to discuss CO_2 Stabilization and Economic Growth. The issues involved are of great importance, and it is appropriate that the Joint Economic Committee provides this forum. Proposed regulatory responses to reducing CO_2 and other greenhouse gases would have serious impacts on future economic growth.

I am concerned that we may be rushing to "do something" about a problem that may not really exist. Carbon dioxide concentrations in the atmosphere have increased in the past century, but the global warming predicted by early climate models has not happened. Global warming is not a fact, but a hypothesis that is under increasing criticism in the scientific community.

In this climate of scientific uncertainty, drastic and costly new taxes and regulations aimed at CO_2 levels cannot be justified. There may be sensible alternatives, however. Improved energy efficiency would have other benefits besides CO_2 reduction, and could be achieved through voluntary means. Government may be able to help improve energy efficiency in a way that does not hamper economic efficiency. Such market-friendly mechanisms include energy market deregulation, the coordination of private sector initiatives, and the public dissemination to improve awareness of energy choices. Free markets efficiently allocate scarce resources, and we can help improve this efficiency by removing barriers imposed by government.

At present, developing countries far exceed the U.S. in the amount of greenhouse gases they emit per dollar of GNP. More modern technologies are cleaner and more efficient, producing lower levels of these gases. Technological cooperation with developing countries through free trade will tend to reduced greenhouse gas emissions without the need for costly new government regulation.

Nuclear generation of electricity emits no pollutants and no carbon dioxide. Japan and other of our international competitors plan to greatly expand their reliance on nuclear power in future years. One step toward CO_2 emission reduction which would not harm the economy or cost American jobs would be to develop a rational policy toward nuclear power.

SENATOR GORE. I'm honored to be joined by Congressman Jim Scheuer.

I call on Congressman Scheuer for any opening comments he wishes to make.

OPENING STATEMENT OF REPRESENTATIVE SCHEUER

REPRESENTATIVE SCHEUER. I wish to congratulate Senator Gore for holding this hearing. It's an extremely useful exercise.

The Administration is not saying—trust me—"We're going to go ahead and do the right thing." Actually, they've been saying precisely the opposite—"We're not willing to make any commitments. We laud some of your goals, but we're not willing to engage in a financial commitment to go along any of these routes."

It's a totally wrong-headed policy. Experience shows clearly that energy-efficient policies and environmentally-benign policies make for a cleaner world. They make for far more efficient energy use. And they make for a more competitive and productive society.

The Japanese started out a decade ago to achieve a more benign environment through the reduction of air pollutants so that they would achieve a very efficient burn. That also had enormous energy efficiency implications.

Today, the Japanese produce two units of industrial production for every unit of energy, compared to our production of one unit of industrial production for every unit of energy consumed.

That means that the Japanese consume energy twice as efficiently, twice as productively, and twice as competitively as we do.

Now, we ought to begin to learn some of the lessons of the past. The 3M Company—Minnesota Manufacturing and Mining Company—has gone heavily into the business of energy efficiency in a whole wide variety of ways. Just last year, they saved about $25 to $30 million on energy efficiency alone. That is the path of the future and any company or any corporation that ignores that lesson will do so at its peril.

Again, I congratulate the Chairman for calling this hearing and I look forward to the testimony.

SENATOR GORE. Well, thank you very much, Congressman Scheuer. Let me just say parenthetically, I've certainly enjoyed working with you for many years on these issues and appreciate your participation here today.

Our first witness on the first panel would be Howard Gruenspecht, Associate Deputy Undersecretary for Program Analysis at the Department of Energy, and a very active participant in all of these intra-Administration debates and conversations and analyses.

We look forward to your perspective this morning, Mr. Gruenspecht. Welcome.

STATEMENT OF HOWARD GRUENSPECHT, ASSOCIATE DEPUTY UNDERSECRETARY FOR PROGRAM ANALYSIS, DEPARTMENT OF ENERGY

MR. GRUENSPECHT. Thank you very much, Mr. Chairman.

I'm pleased to be here today to discuss the economic implications of CO_2 emission reduction strategies.

My testimony will focus on the recent Department of Energy study that you mentioned, "Limiting Net Greenhouse Gas Emissions in the United States." I believe Ms. Claussen's testimony will focus on some of the recent interagency deliberations.

For several reasons, it's difficult to pin down the implications of a fixed set of policies for future energy use and emissions levels.

First, the projected impact of individual policies is often highly sensitive to energy market conditions and assumed market penetrations of energy-efficiency technologies. Second, projections of baseline energy use and emissions levels from which the effect of policies are measured are often highly dependent on assumed economic growth rates and relative fuel prices.

Finally, there are market interactions and overlaps when many policies are considered simultaneously. An integrated analysis, as was done in the NES, can help to address this latter concern.

Both the National Energy Strategy and additional Administration policies to reduce greenhouse gas emissions, which address methane and nitrous oxide, as well as carbon dioxide, are based on a commitment to specific actions and policies, not to the projected outcome of those actions. The Administration does not support mandated caps on energy use or emissions.

We can, however, remove market barriers and improve information flows to help increase the penetration of efficient technologies. This is a key thrust of both DOE programs, such as support for integrated resource planning and demand-side management and EPA programs, such as the Green Lights and other Green programs, which aim to encourage voluntary energy-efficient efforts.

Both the National Energy Strategy analysis and the "Limiting Net Greenhouse Gas Emissions in the United States" study are based on relationships derived from actual consumer and business behavior.

Another approach to analysis—so-called "bottom-up" analysis—relies primarily on technical assessments of opportunities to increase energy efficiency. Pure bottom-up modelling may ignore important considerations, such as other product attributes, the opportunity cost of investment resources, take-back or rebound effects as increased efficiency lowers the price of energy-related services, and the diversity of potential applications.

The technological frontier represented in these bottom-up models may not be attainable in the real world.

"Limiting Net Greenhouse Gas Emissions in the United States" discusses policy options for reducing emissions of carbon dioxide and other greenhouse gases.

The National Energy Strategy—NES—in conjunction with other Administration policies, significantly reduces both future energy demand, in large part because of its focus on increased energy efficiency, and emissions of carbon dioxide and other greenhouse gases. In particular, I would point towards a 34-percent reduction in carbon dioxide emissions for the NES projections from the baseline in the year 2030, which is used as a starting point for the analysis in the "Limiting Net Greenhouse Gas Emissions" study that builds on the NES. The study looks at a wide variety of instruments—regulatory and fiscal instruments. However, given the limited time today, I'm going to focus on some of the emission charges results.

Because emissions charges influence all points of the production/consumption chain and are focused on emissions rather than emissions rates, an analysis of charges can be used to gain insight into the cost of an efficient set of measures to reduce emissions.

In the DOE study, which again I point out was based upon the NES and does not include some of the later interagency actions, a tax of $140 per metric ton of carbon was projected to hold carbon dioxide emissions in the year 2000 to their 1990 level.

The tax projected to keep emissions at this level in 2010 rose to $200 per metric ton, reflecting a larger reduction from baseline. So, it's important to keep in mind that results for the year 2000 don't necessarily hold for later years.

Another scenario combined the carbon tax with the enhancement of carbon sinks through an aggressive afforestation program, and this reduced the tax necessary to hold net emissions to their 1990 level. This is, again, part of the U.S. comprehensive strategy to focus on net emissions, taking account of both sinks and sources. The charge necessary to hold emissions at the 1990 level in 2000 was reduced to the range of $12 to $27 per metric ton. Caveats in this latter case include uncertainties in the afforestation supply curve, in the carbon uptake relationship, impacts on the agriculture and forest products sectors, the issue of forest maturation, and the assumption of a constant carbon uptake baseline.

We ran a sensitivity case without the NES nuclear power component to illustrate some of the importance of the NES actions upon which the study was built. The projected total cost in 2030 of maintaining a 50-percent reduction in net carbon dioxide emissions, including afforestation, increased collections by between $50 and $70 billion a year, as compared to a case predicated on full NES implementation.

We use taxes in large part as a proxy for an efficient set of measures, but if we are considering taxes as an actual policy instrument, it's important to avoid confusing the cost of carbon emission reduction with the issues of tax reform, the split between business and consumer taxes, and the overall level of taxation and government spending.

Efforts to improve the tax system are better served by a comprehensive review of available reform options than as an afterthought linked to greenhouse policy.

Our study, which considers deficit-neutral and deficit-reducing dispositions of carbon tax revenues, but not a case in which additional taxes are used to increase the size of government, shows that the disposition of carbon tax revenues can have significant fiscal policy impacts.

Finally, let me point out that DOE results, or the results of the "Limiting Net Emissions of Greenhouse Gases in the United States" study, are in the same range as the results of similar recent economic studies, including work by the Congressional Budget Office, Manne & Richels, Nordhaus, and Edmonds and Barns.

We are also aware of other recent studies that reach different results, and we will examine them closely as we update our work. We are working both within DOE and in collaborations with outside researchers to compare, analyze and develop improved methodologies for energy system modelling.

The written testimony has more detail on that.

Thank you very much.

[The prepared statement of Mr. Gruenspecht follows:]

PREPARED STATEMENT OF HOWARD GRUENSPECHT

Mr. Chairman and members of the Committee, I am pleased to appear before you this morning to discuss the economic implications of CO2 emission reduction strategies. My testimony will focus on a recent Department of Energy (DOE) study, Limiting Net Greenhouse Gas Emissions in the United States. First, I will discuss our general approach to the study, its methodology and key assumptions. I will point out some of the analytical and conceptual challenges that arise in quantifying the impact of carbon dioxide emissions of individual actions, with particular attention to actions that promote energy conservation and efficiency. Second, I will discuss the major findings of the study in terms of costs and emission reductions and compare the results of our study to those of other recent studies. Finally, I will discuss ongoing DOE efforts to update and refine our analysis of CO2 emission reduction strategies.

Limiting Net Greenhouse Gas Emissions in the United States was prepared in response to a Congressional request in 1988 that the Department analyze policy options for achieving a 20% reduction in domestic carbon dioxide emissions within 5 to 10 years and a 50%

reduction in 15 to 20 years. The scope of the congressional request suggested a broad, integrated approach such as DOE was using in developing the National Energy Strategy (NES). We therefore adopted the NES as a starting point for our analysis and incorporated its baseline assumptions regarding economic growth, technology availability, the structure of the energy system, and current policies.

The task of estimating the impact of various policy actions on emissions, the energy system, and the economy is a complex undertaking. The projected impact of individual policy actions can, in some cases, be very sensitive to energy market conditions. For example, the competitiveness of alternative fuels depends not only on their own production cost, but on the projected market price of conventional fuels, which is in turn closely tied to oil market conditions.

Population and economic growth rates, and relative fuel prices are also important in establishing baseline energy use and emissions levels from which to evaluate the impact of policy actions. For this reason, even if the impact of individual actions could be forecast perfectly, the resulting levels of energy use and greenhouse gas emissions could not be. It follows that no fixed set of actions can assure attainment of absolute energy use or emissions targets in the future.

Finally, because individual policy actions can have significant overlapping impacts (or positive synergies), and because of additional interactions via effects on energy prices, an integrated analysis rather than a simple summation of single-action effects is needed to estimate the impact of a set of policy actions. For example, energy efficiency information programs and investments by utilities to promote more efficient use of energy by their customers would each be projected to reduce greenhouse emissions. However, to the extent that these two types of programs would lead to some of the same efficiency investments, their combined impact on energy use (and greenhouse emissions) may be significantly less than the sum of their individual effects.

There are two main approaches to estimating the impacts of policies that affect energy use:

- economic modeling, which uses relationships derived from real-world behavior, and
- engineering cost analysis (bottom-up modeling), which uses information on technical opportunities to produce energy-related services such as lighting, space conditioning, or transportation. To the extent that not all factors in energy efficiency decisions are reflected in an engineering cost analysis, such modeling efforts may select technologies using lower amounts of energy than are used by the technologies actually selected by consumers and businesses.

Economic modeling is based on actual behavior involving energy use decisions, while engineering cost analysis is based on an analysis of how these decisions "should" be made. The latter approach is inherently more "theoretical", (placing economic modeling on the reality high ground), outlining decisionmaking in a frictionless world where the only relevant consideration is the tradeoff between first cost and energy efficiency over time.

There are many issues in bottom-up modeling, including:

- other attributes -- We can't always reach the engineering energy efficiency frontier because the assumption in engineering models that everything else can be held constant is not valid in the arena of consumption choices by individuals and firms. Car buyers, for example, may care about acceleration, reliability, or servicing cost as well as purchase price and fuel economy.
- opportunity costs -- Money spent on energy efficiency in the home or in the firm is money not invested elsewhere. The forgone returns on these investments, or the opportunity costs of energy efficiency, can be substantial. Consumers don't have access to investment capital at a rate consistent with the "social discount rate" used in some analyses to establish the desirability of particular energy-efficiency investments.
- takeback or rebound effects -- At any given level of energy prices, the use of more energy-efficient equipment

lowers the cost of energy services in many cases leading to increased demand for those services and a significantly smaller reduction in energy might be projected assuming fixed service demand. Consumers may make their energy consumption choices with a view to keeping their out-of-pocket costs within a comfortable range, not necessarily with the objective of consuming a fixed amount of energy-related services. For example, a recent National Academy of Sciences study of CAFE regulations cites takeback estimates ranging from 5 to 90 percent of fuel savings projected under a constant travel assumption.

- average vs. actual use -- Often the engineering efficiency frontier is not applicable to specific applications. Efficient lighting technologies that make sense in busy hallway, may not be a cost-effective in a seldom-opened closet. The diversity of potential applications is one important reason to avoid a one-size-fits-all approach to policy.
- failure to account for reality of market penetration -- Inadequate attention is paid to the time lags between the development and widespread adoption of new technologies and products. Edwin Mansfield, a world-renowned economist in the field of technology development and adoption, has noted the 79-year lag between the invention of the fluorescent lamp and the first sale. Electronic,

as opposed to mechanical, thermostats were first mentioned in the press in 1978. Despite their efficiency, reliability, and convenience attributes, market penetration is not yet high, although sales of these devices are increasing. Of course, some technologies do have shorter time lags before market acceptance. The VCR first became practical in 1976. Almost four years later, it was present in only 1 percent of households, but by 1985 it was in widespread use.

For all of these reasons, the technological frontier represented by the engineering models may not be attainable, or even approachable, in the real world.

The Administration supports a number of programs that assist the public and industry in identifying profitable conservation opportunities. The NES seeks to move the knowledge frontiers outward through R&D and to remove the barriers to applications of that knowledge. For example, in the electric utility industry, the NES supports broader use of an Integrated Resource Planning (IRP) process in which the same investment criteria are used to evaluate both conservation investments and investments in new generation capacity. The aim is to remove the current regulatory bias that favors new capacity over conservation in meeting our electricity needs. Voluntary Information-spreading initiatives such as EPA's

Green Lights Program are a valuable complement to these efforts.

Since new opportunities continually emerge from the process of technical innovation, the best conservation strategy is inherently an evolving one. While we can certainly seek to improve information flows to accelerate the penetration of technologies whose adoption would serve social goals, the inherent lag in technology diffusion is not in itself a market failure that could justify a policy to override reliance on market forces to guide investment funds to their most productive uses. Second-guessing private choices regarding investment in plant, equipment, and commercial technologies may well serve to slow economic growth, and lengthen the time that the existing, and generally less energy-efficient, capital stock is in operation.

The DOE Study: Methodology and Results

Limiting Net Greenhouse Gas Emissions in the United States analyzes additional policy options beyond the NES actions for reducing greenhouse emissions. DOE began work on this study in 1989. Potential policy actions were drawn from the array of policy instruments documented by DOE in a 1989 study, A Compendium of Options for Government Policy to Encourage Private Sector Responses to Potential Climate Change. Three types of emissions reduction actions beyond the NES were simulated -- purely fiscal measures, purely regulatory measures, and mixed packages. Within these categories, policy actions were chosen that on theoretical and

empirical grounds appeared to hold the promise of effectiveness in reducing greenhouse gas emissions.

DOE developed a wide assortment of policy scenarios in preparing the study. We examined longer term impacts, deep CO2 reductions, and policy actions that reduce greenhouse gases other than carbon dioxide. However, in keeping with the focus of today's hearing, this testimony concentrates on carbon dioxide emissions.

A scenario that has been the subject of substantial attention in recent months is one that holds net U.S. annual carbon dioxide emissions in the year 2000 to their 1990 level. One policy option examined to meet this objective was a carbon tax. A charge would be assessed on each tonne of carbon emitted into the atmosphere. The DOE study found that a carbon charge of $140 per metric ton in the year 2000 was projected to hold U.S. carbon dioxide emissions in that year to their 1990 level. The charge projected to keep emissions at this level was found to rise to $200 per metric ton in 2010, reflecting the larger percentage decrease from the projected 2010 baseline level.

To explicitly illustrate the role of the NES Actions in minimizing costs, a sensitivity case was constructed, using as an alternative starting point the NES Actions Case without its nuclear power component. This change made little difference in the projected marginal and total costs of meeting emissions reductions targets

through the year 2010. However, the absence of nuclear power had a major impact in the later years of the study period. For example, the projected total cost in 2030 of maintaining a 50% reduction in net carbon dioxide emissions (in a program where the carbon-sequestering impact of additional planting of new trees could be counted in the calculation) increased by between $50 and $70 billion per year in the case without nuclear power, as compared to the case predicated on full NES implementation.

Generally, the cost of achieving specific objectives involving the reduction of emissions to some fraction of their 1990 levels rose between the years 2000 and 2015 and fell thereafter. The tendency for costs to rise was driven by population and economic growth, which led to a rising demand for energy services. Energy conservation and fossil fuel substitution were most important in achieving emissions reduction objectives in the near term. In the long-term, new energy supply technologies with improved greenhouse characteristics, such as renewable and nuclear forms of energy, were able to make a significant contribution to meeting total energy service demands. Further analysis needs to be done to determine the sensitivity of the results to alternative modeling assumptions.

Another policy scenario combined a carbon tax with actions to enhance carbon sinks through afforestation. Under this scenario, a refund from carbon tax revenues would be granted on the basis of

the carbon uptake of the trees planted in the continental United States. Because there is significant uncertainty as to the afforestation supply curve -- the relationship between the rate that trees remove carbon and the levelized cost of acquiring forest land, and planting and maintaining the trees, DOE examined two different specifications of this relationship.

Holding net U.S. annual carbon dioxide emissions at 1990 levels in the year 2000 under these scenarios would require carbon taxes of between $12 and $27 per tonne. While the relatively low cost figures associated with afforestation make it appear to be an attractive policy option, several caveats are in order. First, as mentioned previously, there are substantial uncertainties as to the afforestation supply curve. Second, DOE has made no attempt to describe the mechanism by which an afforestation policy would be implemented and administered. An afforestation program would have broad implications for land use policy across the U.S. Third, no attempt has been made to describe how an afforestation would fit in with other parts of the U.S. economy. We have not estimated how the demand for forest land would affect agricultural or forest product prices. Finally, we did not examine how an afforestation program would deal with the maturation of trees. We assumed a constant uptake of carbon by trees over a 40 year period after planting. The actual carbon uptake profile is not uniform and is highly species-dependent. Even the average carbon uptake in the forest system is highly uncertain. Moreover, the net carbon uptake

of trees declines sharply after they reach maturity. Ultimately, it may be possible to increase the use of trees as a substitute for fossil fuels in a variety of applications, to provide emissions reduction benefits over the longer term. Such a fuel cycle is already implemented through energy production from combustion of municipal wastes containing forest products.

In addition to estimating the level of carbon taxes needed to achieve various emission reduction targets, DOE also examined the consequences of alternatives for recycling carbon tax revenues. We looked at two alternatives: 1) use of revenues to reduce the Federal deficit, and 2) use of revenues to achieve "deficit neutrality" by reducing payroll and personal income taxes. When tax revenues were used for deficit reduction, the net reduction in aggregate demand resulted in reduced GNP over the short-term. Eventually the use of revenues for deficit reduction increased GNP due to a fundamental shift toward lower personal consumption and increased capital formation as reduced government borrowing leaves more resources for private sector investment. Recycling of tax revenues to consumers to achieve "deficit neutrality" tended to reduce GNP losses in the short-term but increase them in the long-term. We did not examine a case in which tax revenues were used to increase the size of government. This case may be of considerable practical significance.

It should be noted that the GNP effects are pure fiscal policy

effects that have little relationship to the costs of carbon dioxide emissions reductions per se. Bundling consideration of the costs of reducing carbon emissions with issues of tax reform, the split between business and consumer taxes, and the overall level of taxation and government spending tends to obscure rather than clarify the issue of whether the benefits of reducing carbon emissions outweigh the costs. The objective of improving the tax system, something that many believe is possible, is best served by a comprehensive review of available reform options.

The results of the DOE study are within the same range as many other similar economic studies such as Nordhaus (1979), Edmonds and Barns (1990), the Congressional Budget Office (1990), and Manne and Richels (1990). For example, Manne and Richels found that stabilization at 1990 levels in the year 2050 would require a carbon tax of between $110 and $250 per tonne. CBO found that a set of actions with results ranging from six percent above to five percent below 1988 levels would cost $110 per tonne. The DOE study's estimated costs of emission reductions are neither the highest nor the lowest among these studies. Recent studies comparable to the DOE study are reviewed in Chapter 11 of the DOE report. Variations in the studies are due primarily to differences in reference case forecasts of U.S. fossil fuel carbon emissions; the rate of labor productivity growth; and the rate of exogenous end-use energy intensity improvement.

Ongoing and Future DOE Economic Analyses

You will hear today from researchers involved in several studies that were not available during the 1989-1991 timeframe during which the National Energy Strategy and the DOE study was being developed. Their work and other recent studies will be examined closely as DOE updates the NES and its analyses of policy options to reduce net U.S. greenhouse gas emissions. DOE is casting a wide net, and is working with other government agencies, with the Energy Information Administration, with the national laboratories, and with private sector experts to insure that Administration analyses and estimates are of the highest possible quality. As you know, the NES was always intended to be an evolving strategy: we expect that to be clear when we issue the second edition of the NES in the spring of 1993.

The Department also has an interest in assuring that its models are continually improved. For example, the Energy Information Administration is developing a new system of energy models that will provide improved consideration of key energy, economic, and environmental relationships. Besides providing additional information on environmental variables, these models will incorporate considerable detail at the regional level. This detail will allow for consideration of the differential impact of policies to control greenhouse gas emissions in regions with different energy supply mixes.

Our interest in improved analysis is also reflected in several collaborations with outside researchers to compare, analyze, and develop methodologies for energy system modeling. For example, we are participating in the Energy Modelling Forum exercise, which is comparing findings as to greenhouse gas emission control costs, using a variety of models run under a common set of assumptions. Another key research thrust being pursued is to link MARKAL, a technology rich optimization model, to economic models is an effort to gain increased insight into the interaction of economic forces and technology. Two parallel efforts here are the linking of Manne's MACRO model to MARKAL and the development of a modelling system incorporating Dale Jorgenson's DGEM model and MARKAL to enrich the information available on technology and economic linkages.

Given that potential climate change is a shared global concern, and the widespread agreement among analysts that the U.S. share of total greenhouse gas emissions will decline sharply with the rapid rise in emissions from developing countries over the coming decades, credible global-scale modeling frameworks are clearly required. To meet this need, DOE is supporting efforts at Pacific Northwest Laboratory to develop a second generation of global models that builds upon the widely used Edmonds-Reilly framework.

The evolution of scientific understanding will also affect the analysis of global change. For example, the DOE report uses global

warming potential (GWP) values for individual greenhouse gases taken from the 1990 Intergovernmental Panel on Climate Change (IPCC) Scientific Assessment. The IPCC Assessment Supplement released last month suggests that the increase in forcing due to emissions of CFCs may have been substantially offset by the effects of stratospheric ozone depletion to which they contribute. The Supplement also notes the role of sulfate aerosols as a major influence on climate, the consideration of which will require a downward adjustment in modeled climate change resulting from a given emissions scenario. These and other findings, which require further examination within the scientific community must be considered in the execution of future DOE analyses.

Conclusion

Mr. Chairman, I thank you for the opportunity to present DOE's views on the economic implications of carbon dioxide emission reduction strategies. I would be happy to respond to any questions that you or the members of the Committee might have.

SENATOR GORE. Very good. Thank you. We'll have quite a few questions, but we'll hold them until after Ms. Claussen has testified.

Let me introduce again, Eileen Claussen, Director of the Office of Atmospheric and Indoor Air Programs with the Office of Air and Radiation at the Environmental Protection Agency.

Please proceed, Ms. Claussen.

STATEMENT OF EILEEN CLAUSSEN, DIRECTOR, OFFICE OF ATMOSPHERIC AND INDOOR AIR PROGRAMS, OFFICE OF AIR AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY

Ms. CLAUSSEN. Thank you, Mr. Chairman.

I'm really delighted to be here to discuss with you our programs aimed at reducing emissions of greenhouse gases.

Let me begin by saying that we believe that these programs make very good sense for a variety of reasons beyond their ability to reduce CO_2, methane, or nitrous oxide. They also reduce sulfur dioxide and nitrogen oxide, two pollutants we regulate under the Clean Air Act.

We also believe that most of them are either profitable or of very low cost. They are thus very good examples of programs that have both economic and environment benefits, and should be embraced not only by government, but also by industry.

And let me hasten to add that for those programs that are already up and running, the response from industry has been extremely favorable.

The programs really fall into three general categories. Corporate purchasing programs, where the goal is for corporations to purchase efficient products for their own use and move from a focus on first costs to a focus on products with the lowest life cycle cost. Green Lights, Green Motors and Green Buildings fall into that category.

Labelling programs, where the goal is to allow corporations and individual consumers to make energy-efficient product choices based on a green label. Green Computers falls into that category.

And third, programs to enhance the market for energy-efficient products that are now on the drawing board, but have not found their way to market, like the Golden Carrot for refrigerators.

In addition, we have many efforts underway to deal with institutional barriers to investment in more efficient products. For example, we're working with utilities and utility commissions, and with state governments and others to remove impediments that would inhibit greenhouse gas reductions.

Perhaps it would be most helpful if I described some of these programs and gave you a sense of the emission reductions they can achieve.

SENATOR GORE. Ms. Claussen, if you could suspend briefly. I apologize to you and to my colleague. I don't want to miss a word of this.

We have a vote on the floor. I'm going to do my best to set a record for the round-trip circuit from the Dirksen Building to the Capitol and back.

We'll stand in recess for, I would estimate, about eight minutes.

[Recess.]

SENATOR GORE. The Committee will come back into session.

I apologize for the disruption, but there was a conference report being voted on on the floor.

Ms. Claussen, we were right in the middle of your statement. Please proceed.

Ms. CLAUSSEN. I think I was just about to say that I would get into some of the programs specifically. So, let me talk about Green Lights first.

As you know, this is a voluntary program where corporations agree to install energy-efficient lighting wherever it is profitable. We now have just under 500 participants in the program, and the program has only been up and running for about 15 months, and more than 2.5 billion square feet committed, which is greater than 2 percent of all commercial and industrial space in the country, and more than all the office space in New York, Los Angeles, Chicago, Houston, Dallas and Detroit combined.

And let me emphasize that this is not a paper commitment. Eighty million square feet are being upgraded right now, and the early returns from our partners in terms of money saved are quite stunning.

For example, Johnson & Johnson has upgrades underway at 20 facilities for more than $338,000 in annual savings. Amoco replaced 6,000 light switches with 6,000 occupancy sensors, with an annual savings of $316,000, while avoiding 4.5 million kilowatt hours per year. The Boeing Company has upgraded an incredible 4 million square feet since becoming a Green Lights partner. Fourteen million kilowatt hours and $500,000 have already been saved. The Oliver Carr Company in Washington has upgraded more than 1.3 million square feet, for an estimated annual savings of $480,000. The Green Lights program goal for 1992 is the recruitment of another 3 to 5 percent of the Nation's square footage, and I would say that we have an extremely good chance for success at meeting that goal.

Another program we have that is already underway is the Golden Carrot refrigerator program. Here, interested utilities are in the process of committing around $30 million, and others may soon bring this total to $45 million, to be used in a request for proposals for development and marketing of a refrigerator that will be at least 25 percent more efficient than is required by the 1993 DOE standard.

SENATOR GORE. Excuse me. Is TVA a part of that group?

Ms. CLAUSSEN. No.

SENATOR GORE. Not yet?

Ms. CLAUSSEN. Not yet.

[Laughter.]

SENATOR GORE. Okay. Go ahead.

Ms. CLAUSSEN. Interest on the part of both utilities, as evidenced by the amount of money being committed and the refrigerator companies, has been very high. We believe, based on discussions with many of the key players, that several manufacturers will bid a whole refrigerator line, not just a model, and we will see bids for refrigerators that would be 40 to 50 percent better than the 1993 standard.

We're now in the process of finalizing a memorandum of understanding with both IBM and Apple for our Green Computer labelling program. Of importance here is the interest on the part of many of our Green Lights partners to purchase only green computers, leading us to the view that the synergism between these programs will help make them all successful.

The paper released by the Administration last week clearly cites potential impacts from these programs and others. All are based on the models I've suggested—corporate purchasing, market enhancement and labelling. Taken together with reductions from the National Energy Strategy and subtracting out possible overlapping programs, we have been able to come up with total reductions of from 125 to 200 million tons of carbon equivalent.

For the most part, the programs listed are voluntary in nature, have clear environmental benefits, and are either profitable or very cost-effective. We believe they are sound and sensible and represent an effective strategy for reducing emissions of greenhouse gases.

That concludes my oral statement. I'd be happy to take questions.

[The prepared statement of Ms. Claussen follows:]

PREPARED STATEMENT OF EILEEN CLAUSSEN

IT IS A PLEASURE TO APPEAR BEFORE YOU THIS MORNING TO DISCUSS WITH YOU A NUMBER OF VOLUNTARY ENVIRONMENTAL PROTECTION AGENCY (EPA) INITIATIVES THAT CAN REDUCE BOTH GREENHOUSE GAS EMISSIONS AND AIR POLLUTANTS BY PROMOTING PRIVATE INVESTMENT IN ENERGY EFFICIENCY. AFFECTED GREENHOUSE GASES INCLUDE CARBON DIOXIDE, METHANE, NITROUS OXIDE, NITROGEN OXIDE AND SULFUR DIOXIDE.

STRATEGY FOR INCREASING THE ADOPTION OF NEW ENERGY-SAVER TECHNOLOGIES

THE EPA VOLUNTARY PROGRAMS ARE BASED ON THE PREMISE THAT MEASURES TO ENCOURAGE FULL AND MORE RAPID INFORMATION DISSEMINATION AND ADOPTION OF IMPROVED TECHNOLOGIES BY MARKET LEADERS CAN INCREASE THE EFFICIENCY OF ENERGY USE AND LEAD TO FURTHER REDUCTIONS IN GREENHOUSE GAS EMISSIONS. THESE MEASURES CAN HELP IN THE FOLLOWING WAYS:

- AN IMPROVED UNDERSTANDING OF PURCHASE PRICE AND TOTAL LIFE-CYCLE COST IN DECISIONS FOR SELECTING PRODUCTS;

- INCREASED PENETRATION OF IMPROVED TECHNOLOGIES IN U.S. AND WORLD MARKETS LEADING TO EARLIER PRICE REDUCTIONS FOR EFFICIENT PRODUCTS;

- GENERALLY INCREASED AVAILABILITY OF ECONOMICALLY-EFFICIENT TECHNOLOGIES FOR A RANGE OF APPLICATIONS FOR PREVENTING, CONTROLLING AND MITIGATING GREENHOUSE GAS EMISSIONS AND, WHENEVER POSSIBLE, FOR RECOVERING ENERGY;

- EARLIER PENETRATION BY EXISTING EFFICIENT PRODUCTS SENDING THE SIGNAL TO MANUFACTURERS THAT THERE IS A MARKET FOR SUCH PRODUCTS, AND EVENTUALLY FOR EVEN MORE ADVANCED TECHNOLOGIES; AND FINALLY,

- IMPROVED INFORMATION AND ACCELERATING DEMAND FOR ENERGY EFFICIENCY INVESTMENTS WILL ENCOURAGE CHANGES IN UTILITY REGULATIONS RELATING TO POTENTIAL EFFICIENCY INVESTMENTS.

59-626 0 - 92 - 2

TO ADDRESS ENERGY EFFICIENCY AND GREENHOUSE GAS REDUCTION OBJECTIVES, EPA HAS DEVELOPED A FIVE-PART STRATEGY: (1) CORPORATE AND GOVERNMENT PURCHASING; (2) ENHANCED PRODUCT MARKETS; (3) REGULATORY AND LEGAL REFORMS; (4) METHANE INITIATIVES WHICH CONTROL EMISSIONS AND, WHEREVER POSSIBLE, ALSO RECOVER ENERGY; AND (5) EXPANDED INTERNATIONAL MARKETS.

AN INTERAGENCY PROCESS INVOLVING EPA, THE DEPARTMENT OF ENERGY, THE OFFICE OF MANAGEMENT AND BUDGET, THE DEPARTMENT OF AGRICULTURE, THE COUNCIL OF ECONOMIC ADVISORS AND OTHERS IN THE ADMINISTRATION HAS RESULTED IN AGREEMENT THAT THIS STRATEGY, INCLUDING MEASURES UNDER THE CLEAN AIR ACT AND THE ADMINISTRATION'S NATIONAL ENERGY STRATEGY--AS WELL AS UTILITIES' INTEGRATED RESOURCE PLANNING AND DEMAND-SIDE MANAGEMENT PROGRAMS--CAN REASONABLY BE ESTIMATED TO ACHIEVE SUBSTANTIAL REDUCTIONS IN GREENHOUSE GAS EMISSIONS. THE SPECIFIC ESTIMATES OF EMISSIONS REDUCTIONS FROM INDIVIDUAL PROGRAMS PRESENTED TODAY ARE A PRODUCT OF THIS INTERAGENCY ANALYSIS.

I WILL NOW EXPLAIN HOW THIS STRATEGY WOULD WORK BY PLACING IT IN THE CONTEXT OF PROGRAMS THAT EPA HAS ALREADY DEVELOPED, OR IS CURRENTLY DEVELOPING, IN EACH OF THESE STRATEGIC AREAS. ALSO,

PLEASE RECOGNIZE THAT THESE EPA PROGRAMS BUILD UPON AND ARE A PART OF THE LARGER UTILITY DEMAND-SIDE MANAGEMENT (DSM) AND INTEGRATED RESOURCE PLANNING (IRP) MOVEMENT AS WELL AS THE NATURAL PRIVATE SECTOR INVESTMENT ALREADY UNDER WAY TO IMPROVE ENERGY EFFICIENCY.

CORPORATE AND GOVERNMENT PURCHASING

OUR FLAGSHIP PROGRAM IN THE AREA OF CORPORATE AND GOVERNMENT PURCHASING IS "GREEN LIGHTS," WHICH WAS FORMALLY LAUNCHED ON JANUARY 16, 1991. GREEN LIGHTS IS A VOLUNTARY POLLUTION PREVENTION PARTNERSHIP BETWEEN EPA AND CORPORATIONS, STATES OR LOCAL GOVERNMENTS. GREEN LIGHTS PARTNERS COMMIT TO EVALUATING CURRENT LIGHTING NEEDS THROUGHOUT THEIR FACILITIES AND INSTALLING ENERGY-EFFICIENT LIGHTING WHEREVER IT IS PROFITABLE (AS MEASURED BY THE PRIME RATE PLUS 6 PERCENT). EPA PROVIDES TECHNICAL ASSISTANCE THROUGH BUILDING SURVEY SOFTWARE, SUPPORT TO A PRODUCT TESTING LABORATORY, INFORMATION ABOUT MANUFACTURERS AND FINANCIAL ASSISTANCE SOURCES, AND PUBLIC RECOGNITION.

WE BELIEVE THAT THIS PROGRAM WILL BE VERY SUCCESSFUL SINCE APPROXIMATELY 500 PARTICIPANTS HAVE ALREADY SIGNED UP--OVER TWO BILLION SQUARE FEET COMMITTED--WHICH IS SIGNIFICANTLY MORE THAN

THE OFFICE SPACE IN NEW YORK, LOS ANGELES, CHICAGO, HOUSTON, DALLAS AND DETROIT COMBINED.

WHILE CORPORATIONS HAVE FIVE YEARS TO COMPLETE THEIR UPGRADES, RESULTS FROM SOME EARLY INSTALLATIONS LOOK QUITE PROMISING, WHEN COUPLED WITH DSM AND IRP PROGRAMS. INTERAGENCY ANALYSES INDICATE THAT INVESTMENT IN ENERGY EFFICIENT LIGHTING COULD LOWER GREENHOUSE GAS EMISSIONS FROM ELECTRICITY PRODUCTION BY 22-55 MILLION METRIC TONNES OF CARBON--IN ADDITION TO SIGNIFICANT REDUCTIONS OF SULFUR DIOXIDE AND NITROGEN OXIDES.

WHY HAVE THESE LIGHTING UPGRADES NOT HAPPENED EARLIER, GIVEN THAT THE INVESTMENTS IN EFFICIENT LIGHTING PRODUCTS ARE OFTEN PROFITABLE? THERE ARE A VARIETY OF REASONS. A FACILITIES MANAGER RESPONSIBLE FOR LIGHTING IS USUALLY ALSO CHARGED WITH MAKING THE ELEVATORS RUN AND ENSURING THAT THE BUILDING TEMPERATURE IS COMFORTABLE. EVEN WHEN THIS MANAGER IS EDUCATED ABOUT OPPORTUNITIES THAT EXIST FOR IMPROVING EFFICIENCY IN LIGHTING AND SAVING MONEY, AND ABLE TO SORT THROUGH THE VARIOUS PRODUCTS AND THEIR CLAIMS, ADEQUATE AND RELIABLE INFORMATION AND THE ORGANIZATIONAL SUPPORT MAY NOT ALWAYS BE AVAILABLE TO MAKE THE NECESSARY INVESTMENTS. IN SOME CASES AN ORGANIZATION'S DECISION

MAKING MAY PUT HEAVY WEIGHT ON PURCHASE PRICE RATHER THAN LATER COSTS. IN OTHER CASES THERE MAY BE OTHER FACTORS THAT ARE IMPORTANT TO THE SPECIFIC FIRM.

THANKS TO CHANGES IN STATE REGULATORY CLIMATES, UTILITIES ARE STARTING TO MAKE MAJOR INVESTMENTS IN ENERGY EFFICIENCY MEASURES IN CONJUNCTION WITH THEIR CUSTOMERS, INCREASING THE ATTRACTIVENESS OF THESE PROGRAMS. AT THE SAME TIME, EPA'S GREEN LIGHTS PROGRAM ASKS PARTICIPANTS TO ESTABLISH EFFICIENT LIGHTING AS A STRATEGIC DECISION UNDERTAKEN AT A HIGH LEVEL WITHIN THE CORPORATION, AND IT PROVIDES INFORMATION REGARDING THE COORDINATION OF OPTIONS AVAILABLE FROM THE EXISTING RANGE OF LIGHTING PRODUCTS AS A SYSTEM. THE SOFTWARE, PRODUCT TESTING AND FINANCING INFORMATION SUPPORT PROVIDED BY EPA HELP THE CORPORATION MAKE THE MOST ATTRACTIVE UPGRADES. AND THE PUBLIC RECOGNITION AFFORDED BY THE GREEN LIGHTS PROGRAM, AS WELL AS THE SIGNIFICANT POTENTIAL SAVINGS, PROVIDE INCENTIVES FOR CORPORATE LEADERS TO COMMIT TO IMPROVING THEIR ENERGY EFFICIENCY.

EPA IS CURRENTLY DEVELOPING SEVERAL OTHER VOLUNTARY PROGRAMS THAT COULD OPERATE SIMILARLY TO THE GREEN LIGHTS MODEL WITH REGARD TO CORPORATE AND GOVERNMENT PURCHASING, INCLUDING

GREEN COMMERCIAL BUILDINGS, GREEN ENERGY CORPORATIONS AND GREEN INDUSTRIAL MOTORS.

THE GREEN BUILDINGS PROGRAM WOULD FOCUS PRIMARILY ON EFFICIENCY OPPORTUNITIES FOR HEATING AND COOLING BUILDINGS. AS WITH LIGHTING, EFFICIENT TECHNOLOGIES EXIST TODAY THAT COULD SIGNIFICANTLY REDUCE BUILDING ENERGY NEEDS. THESE TECHNOLOGIES INCLUDE VARIABLE SPEED DRIVES FOR AIR HANDLERS AND CHILLERS, REFLECTIVE PAINTING ON ROOFTOPS AND WINDOW IMPROVEMENTS.

FOLLOWING UP ON INTEREST FROM SOME OF OUR GREEN LIGHTS PARTNERS, EPA IS ALSO EXPLORING THE POSSIBILITY OF A HOLISTIC PROGRAM TO HELP ENCOURAGE CORPORATE ENERGY EFFICIENCY ACROSS THE BOARD--IN OTHER WORDS, A GREEN ENERGY CORPORATION PROGRAM THAT WOULD ASK PARTICIPANTS TO MAKE SPECIAL EFFORTS TO ENSURE THAT ALL EQUIPMENT PURCHASES CONSISTENT WITH THE PRINCIPLES OF LIFE-CYCLE PROFITABILITY.

EPA'S EXPERIENCE TO DATE WITH GREEN LIGHTS--AND SIMILAR "GREEN" PROGRAMS--SUGGEST THAT SIGNIFICANT POLLUTION PREVENTION CAN BE ACHIEVED BY PROVIDING INFORMATION AND TECHNICAL ADVICE TO CORPORATIONS AND GOVERNMENT OFFICES. INTERAGENCY ANALYSES

SUGGEST THAT, TAKEN AS A WHOLE, THE ENERGY-EFFICIENCY PROGRAMS IN THE CORPORATE AND GOVERNMENT PURCHASING ASPECT OF EPA'S STRATEGY, COUPLED WITH NATURAL PRIVATE INVESTMENT AND UTILITY DSM/IRP PROGRAMS, COULD HELP REDUCE 39-72 MILLION METRIC TONNES OF CARBON EMISSIONS ANNUALLY.

IN ADDITION, EPA HAS WORKED WITH DUPONT TO ADD REDUCTIVE FURNACES TO PLANTS PRODUCING A KEY ELEMENT FOR NYLON PRODUCTION --ADIPIC ACID--THAT CAN GREATLY REDUCE N2O EMISSIONS ASSOCIATED WITH THE MANUFACTURE OF NYLON. INTERAGENCY ANALYSES INDICATE THAT A "GREEN NYLON" PROGRAM COULD PREVENT THE EQUIVALENT IN GLOBAL WARMING POTENTIAL OF AN ADDITIONAL 8-12 MILLION METRIC TONNES OF CARBON EMISSIONS.

ENHANCED PRODUCT MARKETS

A SECOND ASPECT OF EPA'S STRATEGY IS TO HELP CREATE MARKETS FOR THE MOST EFFICIENT TECHNOLOGIES. EPA'S PREMIERE EXAMPLE OF ENHANCED PRODUCT MARKETS IS THE "GOLDEN CARROT" SUPER-EFFICIENT REFRIGERATOR PROGRAM. THE GOLDEN CARROT PROGRAM TAKES THE REBATES UTILITIES HAVE AGREED TO PROVIDE TO THEIR CUSTOMERS WHO BUY EFFICIENT REFRIGERATORS AND AGGREGATES THEM INTO A SINGLE BID POOL. MANUFACTURERS THEN BID ON THIS POOL OF REBATE MONEY. THE

BID POOL IS OFFERED TO THE MANUFACTURER THAT IS ABLE TO PROVIDE THE GREATEST NUMBER OF (NON-CHLOROFLUOROCARBON USING) SUPER-EFFICIENT REFRIGERATORS AT THE LEAST COST BY 1994-95.

UNDER PRESENT LAW, A DEPARTMENT OF ENERGY (DOE) MINIMUM EFFICIENCY STANDARD IS APPLIED TO ALL REFRIGERATORS. THE WINNING GOLDEN CARROT REFRIGERATOR MODEL IS REQUIRED TO BE AT LEAST 25 PERCENT MORE EFFICIENT THAN THE 1993 DOE APPLIANCE STANDARD. THE DRAFT REQUEST FOR PROPOSALS (RFP) IS CURRENTLY BEING REVIEWED AND WILL BE OFFERED IN JUNE OF THIS YEAR. UNDER THE PROGRAM, THE REBATES WILL BE AWARDED DIRECTLY TO THE WINNING MANUFACTURER AND THE FIRST SUPER-EFFICIENT REFRIGERATORS MAY BE SHIPPED AS EARLY AS 1994.

OPPORTUNITIES FOR MANY OTHER "GOLDEN CARROT" PRODUCTS EXIST. IN FACT, AN ORGANIZATION HAS RECENTLY BEEN FORMED BY EPA, UTILITIES AND CONSERVATION GROUPS--THE CONSORTIUM FOR ENERGY EFFICIENCY--TO COORDINATE "GOLDEN CARROT" AND OTHER UTILITY DEMAND-SIDE MANAGEMENT PROGRAMS. THE CONSORTIUM STRIVES FOR SIMILAR APPROACHES AMONG UTILITY PROGRAMS TO SEND CLEAR AND CONSISTENT SIGNALS TO EQUIPMENT MANUFACTURERS, DISTRIBUTORS AND RETAILERS. IN THE FUTURE, THE CONSORTIUM FOR ENERGY EFFICIENCY WILL

FACILITATE INFORMATION EXCHANGE AND COORDINATED PURCHASING OF VARIOUS SUPER-EFFICIENT EQUIPMENT.

EPA HAS IDENTIFIED A LARGE NUMBER OF OPPORTUNITIES FOR FUTURE "GOLDEN CARROTS," INCLUDING HEAT PUMPS, CLOTHES WASHERS, CLOTHES DRYERS, SOLAR WATER HEATERS AND CENTRAL AIR CONDITIONERS --RESEARCH AND DEVELOPMENT IN THESE AREAS, A PORTION OF WHICH IS ATTRIBUTABLE TO GOLDEN CARROT PROGRAMS, WAS ESTIMATED BY THE INTERAGENCY GROUP TO REDUCE UP TO 10 MILLION METRIC TONNES OF CARBON EMISSIONS ANNUALLY.

ANOTHER AREA IN WHICH EPA PROGRAMS ARE ENHANCING MARKETS FOR EFFICIENT PRODUCTS IS OFFICE EQUIPMENT. COMPUTER EQUIPMENT IS THE FASTEST GROWING ELECTRICITY LOAD IN THE FASTEST GROWING ELECTRICITY SECTOR: COMMERCIAL. EPA'S GREEN COMPUTERS PROGRAM IS A VOLUNTARY EFFORT JUST UNDERWAY WITH MANUFACTURERS OF COMPUTER EQUIPMENT TO PRODUCE AND MARKET ENERGY-EFFICIENT DESKTOP COMPUTERS. EPA WILL PROVIDE THE MANUFACTURERS WITH A LABEL THAT MANUFACTURERS CAN USE TO INDICATE TO CONSUMERS THAT THEIR COMPUTER IS ENERGY-EFFICIENT. WE BELIEVE THAT THIS CONCEPT CAN ALSO BE EXTENDED TO OFFICE COPIERS, FAX MACHINES, AND OTHER ENERGY-CONSUMING COMMERCIAL AND RESIDENTIAL PRODUCTS. BY

AMPLIFYING MARKET SIGNALS FOR EFFICIENT PRODUCTS, THESE LABELING PROGRAMS CAN STIMULATE REAL SAVINGS BOTH IN TERMS OF ENERGY USE AND REDUCED GREENHOUSE GAS EMISSIONS, ESTIMATED AT ANOTHER 10 MILLION METRIC TONNES OF CARBON EACH YEAR.

REGULATORY AND LEGAL REFORMS

SINCE THE MID-1980'S, THE DEPARTMENT OF ENERGY (DOE) HAS HAD A PROGRAM OF WORKING WITH THE NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS AND INDIVIDUAL UTILITIES IN SUPPORT OF INTEGRATED RESOURCE PLANNING, AN APPROACH THAT SEEKS TO ENSURE THAT BOTH SUPPLY AND DEMAND OPTIONS ARE EVALUATED AND REWARDED SIMILARLY. THIS EFFORT, TOGETHER WITH PIONEERING WORK IN MASSACHUSETTS AND CALIFORNIA BY UTILITIES AND STATE COMMISSIONS, HAS LED TO A CHANGE IN STATE REGULATORY TREATMENT OF ENERGY EFFICIENCY INVESTMENTS BY UTILITIES. BECAUSE THE VOLUNTARY PROGRAMS OUTLINED ABOVE WILL BE MOST EFFECTIVE WHEN ALIGNED WITH UTILITY INCENTIVES, EPA STRONGLY SUPPORTS THESE EFFORTS. THIS IS A CENTRAL THRUST OF THE NATIONAL ENERGY STRATEGY.

DURING THE PAST TEN MONTHS, EPA HAS ENGAGED IN A WIDESPREAD OUTREACH EFFORT THAT BUILDS ON THE DOE PROGRAM. EPA IS MEETING WITH STATE UTILITY COMMISSIONS AND GOVERNMENTS TO DISCUSS THE

ENVIRONMENTAL AND ECONOMIC BENEFITS OF REGULATORY REFORMS. RELEVANT ISSUES INCLUDE DE-COUPLING PROFITS FROM SALES AND "SHARED SAVINGS" PLANS, IN WHICH UTILITIES HAVE POSITIVE ECONOMIC INCENTIVES TO AGGRESSIVELY PURSUE EFFICIENCY IMPROVEMENTS. CONSERVATION IS ALSO EMPHASIZED AS A STRATEGY FOR COMPLYING WITH THE ACID RAIN PROVISIONS OF THE CLEAN AIR ACT AMENDMENTS. EPA HOPES TO CONTINUE THIS POSITIVE WORKING RELATIONSHIP WITH MEMBERS OF THE STATE REGULATORY COMMUNITY.

METHANE INITIATIVES

WHILE NOT BASED ON PRODUCTS OR CORPORATE PURCHASING PER SE, EPA HAS IDENTIFIED SEVERAL WAYS FOR REDUCING EMISSIONS OF METHANE TO THE ATMOSPHERE THAT ALSO FIT INTO THE STRATEGY. METHANE IS AN ATTRACTIVE FOCUS FOR REDUCING GREENHOUSE GAS EMISSIONS BECAUSE IT IS MORE POTENT AT TRAPPING HEAT THAN CARBON DIOXIDE (CO2) AND BECAUSE IT HAS ENERGY VALUE--SO PROFITABLE SYSTEMS CAN BE DESIGNED TO RECOVER AND BETTER UTILIZE THIS METHANE. THIS IS POSSIBLE WITH METHANE FROM LANDFILLS, METHANE FROM THE MANAGEMENT OF ANIMAL WASTES (DAIRY AND SWINE FARMING) AND METHANE FROM COAL MINING. EPA HAS IDENTIFIED MARKET OPPORTUNITIES FOR METHANE RECOVERY THAT CAN BE ENHANCED IN ALL OF THESE AREAS, THROUGH DEMONSTRATIONS OF

METHANE CONTROL TECHNOLOGIES AND EFFORTS TO IDENTIFY AND REMOVE BARRIERS TO ENERGY RECOVERY AT LANDFILLS AND COAL MINES.

EPA IS CURRENTLY INVOLVED IN THREE COMMERCIAL-SCALE DEMONSTRATIONS TO CONTROL METHANE AND RECOVER ENERGY. TWO OF THESE ARE THE WORLD'S FIRST APPLICATIONS OF A FUEL CELL FOR THIS PURPOSE ON LANDFILL GAS, AND ALSO AN ANAEROBIC DIGESTER GAS. A THIRD DEMONSTRATION IS DIRECTED TOWARD ADVANCED DE-GASIFICATION OF DEEP COAL MINES. IN ADDITION, EPA IS ALSO DEMONSTRATING PROFITABLE "ON-SITE" ENERGY GENERATION FOR FARMS (WHILE SOLVING NON-POINT SOURCE RUNOFF PROBLEMS). IN AN EFFORT TO REMOVE BARRIERS TO ENERGY RECOVERY, EPA HAS IDENTIFIED PROPERTY RIGHTS ISSUES THAT CURRENTLY LIMIT THE RECOVERY OF "PIPELINE QUALITY GAS" EMITTED DURING COAL MINING IN APPALACHIA. THE UNDERLYING ISSUES NEED TO BE EXAMINED WITH A VIEW TOWARD FINDING A SOLUTION.

INTERAGENCY ANALYSIS INDICATES THAT THE AFOREMENTIONED METHANE PROGRAMS, TOGETHER WITH REDUCTIONS IN EMISSIONS FROM A LIVESTOCK DIETARY PROGRAM, COULD PREVENT THE EQUIVALENT IN GLOBAL WARMING POTENTIAL OF 52-58 MILLION METRIC TONNES OF CARBON EMISSIONS ANNUALLY (GIVEN A GLOBAL WARMING POTENTIAL (GWP) OF 22 FOR METHANE, OR HALF THAT AMOUNT WITH A GWP EQUALING 11).

EXPANDED INTERNATIONAL MARKETS

FINALLY, EPA IS HELPING TO DEVELOP INTERNATIONAL MARKETS FOR EFFICIENT AMERICAN TECHNOLOGIES. AT PRESENT, WE HAVE PROJECTS UNDERWAY IN CHINA (REFRIGERATORS AND COALBED METHANE), RUSSIA (NATURAL GAS PIPELINES) AND POLAND (COALBED METHANE). OTHER PROJECTS ARE EXPECTED IN ASIA AND ELSEWHERE. THESE TECHNOLOGY COOPERATION PROJECTS WILL CONTRIBUTE SIGNIFICANTLY TO GLOBAL ENVIRONMENTAL IMPROVEMENT AND POTENTIALLY CREATE LARGE MARKETS FOR DOMESTIC GOODS AND SERVICES TO THEREBY DRIVE PRICES FOR THESE GOODS AND SERVICES DOWN, BOTH ABROAD AND WITHIN OUR OWN BORDERS.

CONCLUSION

VOLUNTARY PROGRAMS--FOLLOWING THE MODEL OF EPA'S GREEN LIGHTS PROGRAM--HAVE SHOWN TO OUR SATISFACTION THAT THEY CAN SIGNIFICANTLY REDUCE GREENHOUSE GAS EMISSIONS BY IMPROVING INFORMATION DISSEMINATION ABOUT EFFICIENCY AND STIMULATING TECHNOLOGY DEVELOPMENT. THESE VOLUNTARY PROGRAMS, IN CONJUNCTION WITH NATURAL PRIVATE INVESTMENT AND UTILITY DSM/IRP PROGRAMS, MAY REDUCE CARBON DIOXIDE, METHANE AND NITROUS OXIDE EMISSIONS BY THE EQUIVALENT OF 107-178 MILLION METRIC TONNES OF CARBON ANNUALLY (BEFORE SUBTRACTING OUT THE OVERLAP OF THE

SENATOR GORE. The Energy Information Administration, which is responsible for that highly respected outlook, has 2.3 percent annual growth. And over a decade, the difference between 3.2 percent annual growth and 2.3 percent annual growth is about 9 percent.

This is an enormous difference. Given the mismatch between your predictions and the real world for the two years that we've had a chance to look at, and given the difference between the NES figure and the Annual Energy Outlook figure, has DOE now revised its modelling results to reflect a more realistic assumption of GNP growth?

MR. GRUENSPECHT. First of all, let me point out that the economic growth rates used in the National Energy Strategy are basically the budget projections. That's what was used before.

SENATOR GORE. Are you saying that we should look at the NES as a political document and not as a piece of serious analysis?

MR. GRUENSPECHT. No, I think it is a piece of serious analysis.

SENATOR GORE. Well, let's concentrate on that figure. Is that figure a political figure or a serious analytical assumption?

MR. GRUENSPECHT. I think it's a serious analytical assumption.

SENATOR GORE. Well, if it's serious, shouldn't it be revised in light of new evidence?

MR. GRUENSPECHT. The way we look at these assumptions is as a series of sensitivity analyses. In conjunction with running the model with NES data, we ran various growth rates. In conjunction with work we are doing, have done, and will do, we're continuing to run a wide range of growth rates—low growth rates, medium growth rates and high growth rates.

SENATOR GORE. Okay. I'm following you, but I'm going to come back to the question.

MR. GRUENSPECHT. Go ahead.

SENATOR GORE. You still have the 3.2 percent plugged into your model. Is that the answer? Has the model been revised to reflect a more realistic growth rate?

MR. GRUENSPECHT. I think they've been revised. One case is run with the budget growth rate assumptions, and there are other cases run with other growth rates. The growth rates are parameters in the model. They're not built into the model.

SENATOR GORE. But the result produces conclusions which are then used as the basis for policy.

So, if you are telling me that there is a range, and if you use the Annual Energy Outlook figure produced by the Administration and change your model to reflect a more realistic GNP growth rate, what impact does this have on baseline CO_2 emission growth?

MR. GRUENSPECHT. That is a difficult question to answer. Let me try to follow a path that might help along those lines.

SENATOR GORE. As long as it's not too long and winding.

[Laughter.]

MR. GRUENSPECHT. Okay. Well, I'll try not to make it too long and winding.

Let me pick one key sector—the utility sector. And the way in which GNP growth and other factors would affect CO_2 emissions would be through the rate of electricity demand growth.

SENATOR GORE. Could we hold onto that because that's my next set of questions, okay?

MR. GRUENSPECHT. Okay. I don't know how to hold on that because I believe that's the basis——

SENATOR GORE. But specifically, and I don't want to be argumentative, seriously, because it will be a long afternoon. But the specific question is, if you use a more realistic GNP growth rate for the gross output of your model, if you use the figure that's used by the Energy Information Administration in the Bush Administration, which is acknowledged by one and all to be a more realistic GNP growth rate, if you plug that number of 2.3 percent into your model and make no other changes, what does that do to baseline CO_2 emission growth?

MR. GRUENSPECHT. I think it would bring it down.

SENATOR GORE. From what? Bring it down how far?

MR. GRUENSPECHT. We can provide that for the record.

[Material subsequently supplied for the record:]

INSERT FOR THE RECORD

Replacing the GNP growth rates used in the Current Policy Base case with a constant annual 2.3 percent growth rate would lower projected carbon emissions by about 4.2 percent in 1995 and by more than 10 percent in 2010. A more detailed description of the impact of GNP growth rates on carbon emissions is reported in Table 1.

Table 1
Comparison of Carbon Emissions
(million metric tons)

Year	1995	2000	2005	2010
Current Policy Base	1401	1549	1709	1892
2.3% GNP growth case	1341	1452	1562	1696
% Difference	-4.28	-6.26	-8.60	-10.36

SENATOR GORE. Could you do that while we're talking here?

MR. GRUENSPECHT. I'm not sure that we've run these——

SENATOR GORE. I'm talking to your staff. We'll supply that for you in a moment.

[Laughter.]

Now, related to the GNP growth, you were anticipating the questions about electricity demand growth. The National Energy Strategy has the figure at 2.5 percent annually between 1990 and the year 2000.

Again, the EIA Annual Energy Outlook projects a growth rate for electricity demand of only 1.9 percent. You were, perhaps, attempting to say this earlier, but just for the record, a revised GNP growth assumption would translate into reduced demand for electricity. Correct?

MR. GRUENSPECHT. Generally, that's correct. I would point out that electricity demand growth in 1991—a year in which GDP shrank—was approximately 2 percent.

SENATOR GORE. Well, in the NES, in your Technical Annex, Display Table A-23, you give the basis for your electricity demand growth assumption that indirectly cites a 1986 Electric Power Research Institute study that concludes that a total of 57-billion kilowatt hours will be avoided by utility demand-side management programs by the year 2000. It is not my purpose at all to impugn the competence of EPRI in any way. But this study upon which you rely for your electricity demand growth was done in 1986 by EPRI.

EPRI updated that study in 1990, prior to the publication of the NES. The 1990 version called, "Impact of Demand-Side Management on Future Customer Electricity Demand–An Update," concludes that instead of 57-billion kilowatt hours, 106-billion kilowatt hours will be saved by the year 2000, almost twice the amount.

So, the baseline seems to be constructed, at least where this key element is concerned, on the basis of a study by the industry, which the industry itself had already corrected several months before the NES came out. This forecast was available when the NES analysis was conducted and is in fact close to current projections of electricity demand growth.

First of all, let me just ask you, have you re-estimated your baseline conclusions to reflect this more realistic figure for electricity demand growth?

MR. GRUENSPECHT. We have in the NES additional IRP and demand-side management programs. We have not reestimated the baseline.

SENATOR GORE. So, is it fair for the Committee to conclude that at least on this point, the NES estimate of the baseline carbon emissions is wrong?

MR. GRUENSPECHT. Yes. I——

SENATOR GORE. Was that a "yes"?

MR. GRUENSPECHT. Well, that was a "thinking about it."

[Laughter.]

Basically, the NES base-case analysis reflects an analysis that was frozen in the early part of 1990. So, in that sense, you can draw the conclusions you want about it, considering that the underlying assumptions were frozen in 1990.

SENATOR GORE. All right. It's an honest answer. You froze the inputs prior to the time when EPRI recalculated the figure.

But it seems fair to conclude that, at least in this particular—and we'll go into some others—it's simply wrong and has not as yet been reestimated to reflect this new figure. Correct?

MR. GRUENSPECHT. The NES has a higher estimate of demand-side management than that figure.

SENATOR GORE. Yes. And hasn't been reestimated. Correct?

MR. GRUENSPECHT. That's correct.

SENATOR GORE. All right.

MR. GRUENSPECHT. The baseline has not been redone, but the NES has a higher figure.

SENATOR GORE. Okay. Incidentally, for the record, if you look at the mathematics on this, this alone results in about 10 MMT in carbon in the year 2000. That's based on an underestimate of 49 billion kilowatt hours.

Of course, DOE has never given innovative electric utility conservation programs of the kind that have produced part of this recalculation by EPRI much support. I would argue that this analysis reflects that policy bias within DOE.

We have a utility from whom we'll hear, PG&E, that has committed to obtaining 75 percent of new service demand from conservation investments. I really don't understand why DOE can't reflect this new reality in the utility industry in its analysis.

Is it just too difficult to update the analysis? Here, we have this raging argument in the Administration and you are dug in with both feet on the absolute truth of the NES, and here, the industry's figures prove that, at least in this one particular, it's wrong.

I know that it's hard to keep up with new information, but do you want to respond to that? That question is worthy of a response, if you want. I'll give you a chance to respond, then we'll move on.

MR. GRUENSPECHT. Well, we certainly view the NES as a continual process. As you know, we plan to update it. We look at information from the industry. I did point out to you that the NES has more IRP and demand-side management than the numbers you cite from EPRI. And I believe that the Energy Information Administration, the source that you quoted earlier, has come out with some new estimates that are below EPRI's. So, that's really all I would say on that. We plan to update the NES continually.

SENATOR GORE. Okay. The DOE report to Congress used the Fossil2 model. And you referred in your testimony to the result which said that there would have to be a tax of $140 per metric ton in order to stabilize CO_2 emissions at 1990 levels in the year 2000.

Now, this model that you're using, and from which you quote in your testimony before the Committee today, has one especially severe limitation, according to DOE itself.

Let me quote to you from the Executive Summary:

> It is worth noting that the Fossil2 model may tend to underestimate the responsiveness of the energy sector in extreme cases. This is because the model has no mechanism for prematurely retiring capital stocks, even when they are no longer economically viable. The model simply continues to operate them throughout their useful lifetimes.
>
> This behavior is reasonable when, for example, carbon taxes are low. But when carbon taxes rise above $100 per metric ton of carbon, this behavior may not reflect the full extent of economic response and may therefore tend to underestimate the impact of the modelled policies.

I've had enough experience with computer models, as have we all, to know that when the people who design the model tell you to watch out in a particular case, you'd better watch out because models can predict results that are wildly different from what you would expect in the real world. And when you know ahead of time that that's what it's doing, then it would seem to me to be a slippery basis for a firm statement about exactly the result you are warned in advance is not reliable.

But before I give you a chance to respond on this, let me just quote from one of our witnesses, William Chandler, who says in his testimony, "The DOE report to Congress was unable to fully account for retrofit measures due to model limitations." And he further finds that accelerated equipment turnover is a major source of economical energy savings.

Doesn't this indicate that that result is unreliable?

MR. GRUENSPECHT. I don't believe it's unreliable. We provide the caveats in the report, as you quoted. I believe that when carbon taxes got very high, we deliberately stopped running the model for the reason outlined in the caveat.

I believe that there is an issue and we did raise the issue.

SENATOR GORE. Is this the only, or just the biggest, flaw in the model?

MR. GRUENSPECHT. I think all models have limits, but the model is actually very useful in integrating and organizing an analysis. I'm sure, as in the case of all models, there are many issues that arise.

SENATOR GORE. Are there any other flaws in the model that you know about that you would say are bigger than this one?

MR. GRUENSPECHT. I am not an expert in the Fossil2 model.

SENATOR GORE. Are there other models without this particular flaw that could be used to calculate the key factor that you're stating, based on this flawed model?

Are there other models that could be used to calculate this particular factor, other than the one that your modelling experts in DOE tell you that this one can't be used?

MR. GRUENSPECHT. When the National Energy Strategy was being put together—which was before my arrival at DOE—looking at the available modelling possibilities, it was determined that Fossil2 was the best.

SENATOR GORE. You may supplement that response for the record, if you desire to do so.

MR. GRUENSPECHT. Okay.

SENATOR GORE. But what's the impact of this flaw in the model? Would you want to withdraw that part of your testimony, or that part of the report to the Congress, in light of the fact that it says it's unreliable here?

MR. GRUENSPECHT. No, I don't think we would want to withdraw our testimony.

SENATOR GORE. Okay. Well, we'll leave the record open in case you change your mind on that one.

On Friday, the Administration announced this new statement and found dozens of additional policy options beyond NES actions that would reduce CO_2 at a profit.

But as late as September, 1991, in the DOE report to Congress, you couldn't find any of these actions. Let me quote from the report to Congress:

> We have been unable to identify any measures beyond NES actions capable of reducing greenhouse gas emissions for which benefits exceed costs. This does not mean that at some future date, attractive policy instruments will not be identified.

I guess the obvious question is, since you reported to the Congress on limiting greenhouse—limiting net greenhouse was in the title of the report—that you were unable to find any. And then just a few months later, the Administration finds lots and lots of them.

How hard did you look before the report to Congress?

MR. GRUENSPECHT. I believe the report to Congress, which was published in September 1991—a very large two-volume study—reflects work over a period of time contemporaneous with the NES. You've already mentioned the difficulty of continual real-time updating.

SENATOR GORE. Okay. So, should we assume that in the September 1991 Administration report to Congress, there was nothing that could be done where the benefits exceeded the cost to reduce greenhouse gas emissions, and that the report was also frozen sometime early in 1990?

You said that it was based on work done contemporaneously with the NES.

MR. GRUENSPECHT. I actually believe that work began on the report before the NES and then was stopped while the NES was developed.

Is that correct?

[Pause.]

So, we froze the base case at the same time in which we basically froze the assumptions used to develop the NES base case.

SENATOR GORE. Okay. So, the report in September 1991 really reflected the state of your thinking as of early 1990.

MR. GRUENSPECHT. As of late 1990.

SENATOR GORE. Late 1990? Well, we had the EPRI update in late 1990.

MR. GRUENSPECHT. Again, I think there was an effort to freeze the base case. As regards the EPRI update—keep in mind, the NES has more integrated resource planning than the EPRI update—the EPRI update has more integrated resource planning than the EIA.

SENATOR GORE. No. The point I'm making is that the EPRI update, which I talked about earlier, came out at the end of Summer 1990, and you said that the NES was frozen before that time.

MR. GRUENSPECHT. The reference case was frozen. The policy cases kept moving.

SENATOR GORE. Kept moving for another month or two?

MR. GRUENSPECHT. Until the end of 1990. The NES was issued in February of 1991, and as you point out, there was a need to freeze the baseline, and then talk about the policy options.

SENATOR GORE. Okay. So, the answer to the question that I asked, "How hard did you look," is that between the latter part of 1990 and September 1991, you didn't look at all.

MR. GRUENSPECHT. Again, we're updating the NES report on a two-year schedule. I believe there's an update due in the spring of 1993.

SENATOR GORE. So, there's a major policy debate within the Administration, which just unfortunately occurred in between these biennial windows in which you actually take a fresh look at it.

MR. GRUENSPECHT. I think we're continually looking. But the NES report is updated on a two-year schedule.

SENATOR GORE. Now, in the seven months since the DOE report to Congress, the Administration found options beyond NES that would reduce carbon emissions by between 43 and 76 million metric tons in the year 2000. At that rate, the Administration should be able to identify quite a few more opportunities. A couple more months, we may be over the top here.

But I can appreciate the fact that the Administration is trying a little harder, even if it does make you wonder how carefully DOE was actually paying attention to these policy options during the process. I'd like to take a look at that process now.

The DOE report, "Limiting Net Greenhouse Gas Emissions in the United States," is predicated, as you have indicated, on the assumption that the National Energy Strategy analysis accounted for all of the cost-

effective efficiency opportunities in the United States. And we're going to examine that particular assumption later in the hearing.

But let me just ask you about the NES analysis.

Would you agree with the following quote describing the NES analysis: "Energy efficiency improvements were invoked by DOE in some cases and ignored in others. Many efficiency measures seem to have been inadequately studied preparatory to the analysis."

MR. GRUENSPECHT. That would be difficult for me to answer since I arrived at DOE after the study was complete.

I have no basis for agreeing with that statement.

SENATOR GORE. Well, you've worked with it and you have cited it for the basis of your very strong statements about the fact that no other options exist.

So, you have some confidence in it, I'm sure. Do you have enough confidence to disagree with the statement that many efficiency measures seem to have been inadequately studied preparatory to the analysis?

MR. GRUENSPECHT. I can't speak to the preparatory part.

SENATOR GORE. Okay. The quote interested me because it came from the National Research Council, in a report that was commissioned by the Secretary of Energy, to study the way in which the NES was developed.

The report, incidentally, was issued in January of 1991, after the NES was released and before the DOE report to Congress.

So, if DOE is reporting to Congress in the midst of this roaring debate about whether it's possible for our country to stabilize greenhouse gas emissions, and DOE reports with absolute confidence that there's nothing else that can be done—and the NES is the final word on the subject—but the Secretary of Energy has asked the National Research Council and the National Academy of Sciences to study how the thing was put together, and the NRC tells the Secretary of Energy, "nuh nuh, you missed it—inadequate study; ignored some options"—then how can you send a report to Congress where the analysis on which it's based was frozen back in 1990, when the report from the NRC that you have requested tells you that it's inadequate?

MR. GRUENSPECHT. I'm not quite sure what report you're referring to.

SENATOR GORE. National Research Council. This is on page 108, Appendix B.

MR. GRUENSPECHT. I believe the NRC did a report on the National Energy Modelling System of the EIA.

Is that the report you're referring to?

SENATOR GORE. Yes. This is Appendix B of that report, and was requested by the Secretary of Energy.

MR. GRUENSPECHT. This is the report in January 1992, not January 1991.

SENATOR GORE. The interim report delivered to the Secretary was January 1991.

MR. GRUENSPECHT. That was the interim report, okay.

SENATOR GORE. That's correct. And the final report—you are quite correct—the final report came out in January 1992. The interim report was delivered to the Secretary in January 1991.

MR. GRUENSPECHT. I think one of the initial conclusions of the report is that the modelling system used to develop the National Energy Strategy is not perfect, and that's something that you've cited, and it's something that DOE would accept. I believe the report also states that it was the best that could be done with the tools available.

I'm talking about the final report, I guess.

SENATOR GORE. No. Well, I also have the final report here. Here's what it says further:

> Much of the energy data pertaining to the NES modelling and analysis are on the supply-side of the energy markets. To date, much less effort has been expended on obtaining demand-side data. As a consequence, analyses of the demand side are weak.

MR. GRUENSPECHT. Well, again, the conclusions that I believe the NRC reached were that the Department had done a good job with what was available at the time. We are working to improve our energy models, both the demand-side and the supply-side representation.

SENATOR GORE. Now, let me read you this from the interim report:

> In the presentations to this Committee, little reference was made to the validation of the models used in the NES analysis. Policymakers should appreciate the important role of *a priori* assumptions and simplifications and the off-line contributions made by the NES modelling subgroups in shaping the scenarios. To a great extent, such assumptions and off-line analyses, rather than the model *per se*, dictated the results of model runs.

I mean, that's incredible. Let me continue.

> The compatibility of the Fossil2 model with the other models is also not well understood. The influence of the off-line inputs to the Fossil2 model does not seem to have been adequately studied.
>
> For example, the influence of the coal-dominated ARGUS model in determining fuel choices for electric power production in the Fossil2 model could be important and perhaps overly restrictive.

This begins to make the analysis upon which you based your report to Congress look extremely shoddy. And the important point here is that you had this devastating criticism by the National Research Council delivered to the Department of Energy nine months before you confidently asserted to Congress that nothing else could be done because the NES tells us so. These analyses were presented to the Congress without addressing the

shortcomings clearly identified by the National Academy of Sciences in an analysis requested by the Department.

Is that a responsible report to Congress? Here, we're in the middle of one of the biggest debates in history about what the United States' role in this international process is going to be, and the Department of Energy tells the Congress confidently, "no, we've studied this and nothing else can be done," when you have at your disposal a devastating critique by the NAS saying, in essence, "it's weak; it's not right; it's not reliable."

Is that responsible, to report to the Congress on such a basis?

MR. GRUENSPECHT. Again, we clearly have a different view of the NRC/NAS study. Our view is that they indicated that while improvements in the modelling system could be made, it was the best approach that could be used at the time.

SENATOR GORE. Well, we sure do have a different way of reading it.

Now, let me move on.

Much has been made of the discount rate sensitivity case, where you drop the discount rates from the 20 to 60 percent range to 5 percent. And I know you've had some dialogue about this previously.

In the September 1991 report to Congress, you say:

> The discount rate sensitivity case reduces the tax necessary to hold carbon emissions constant through the year 2000 relative to 1990, from approximately $140 per metric ton of carbon, to zero.

But evidently, DOE could not handle the implications of this, so you emphasize in the report, and I'm quoting again:

> This analysis does not argue that the computed reduction in the cost of greenhouse gas emissions reductions is either potentially achievable or achievable with any identifiable policy instrument. This analysis is conducted purely as a sensitivity and is an attempt to express the bottom-up approach within the top-down analytical structure. We further note that one of the effects of the successful implementation of the NES actions is to capture potentially available gains from energy technologies.

Now, the Green Lights program, which we heard about a moment ago, explicitly targets the discount rate for commercial lighting upgrades. Compared with the NES assumption of a 60-percent real discount rate, a Green Lights partner invests in conservation at the rate of the prime plus six points—currently about 12 percent—or a real discount rate of about 8 percent, accounting for inflation.

Let me just pause here and say, parenthetically, by way of background, that the whole concept of a discount rate is a little bit hard to grasp. But basically, whether one is an individual or one is the owner of a business, one constantly faces decisions that require a judgment about the relative

value of money saved now in the present versus money saved at some future time.

And when economists look at behavior and calculate what the real economic decisions that people make are, they can actually quantify how much of a discount, even after you adjust for inflation and everything, how much more valuable is it to have the money now than it is to have the money ten years from now.

If you would just as soon have $200 ten years from now, in real terms, as $100 now, what would that be? Ten percent annual discount rate?

I thought I was choosing an easy case. Pardon me?

I didn't think it was that easy. About 7 percent compounded.

VOICE. 7.2 percent, Senator.

SENATOR GORE. 7.2 compounded. Thank you very much. I need all the help I can get.

Now, curiously enough, the way that utilities make these calculations and the kind of discount rates that utilities make in deciding how much to invest now that will pay off now, and how much to invest that will pay off later, utilities are pretty careful about that because they're used to thinking over the long term. They deal with a rate base and they use some very rational assumptions often.

Individuals and businesses, for a variety of reasons, tend to use much higher discount rates, unless their attention is focused on it in some way. So, in any event, in calculating how likely it is that individuals will buy new compact fluorescent lightbulbs, for example, or how likely it is that businesses will buy much more efficient energy consumption technologies that reduce their demand, you have to pay attention to what that discount rate is going to be.

And so, when you looked at the likely emissions of carbon in the year 2000, one of the key factors in your model is the discount rate that you use. I understand that the report to Congress used consumer discount rates, or investment hurdle rates, of up to 60 percent. Correct?

MR. GRUENSPECHT. Yes. The rates were based on observed, actual behavior.

SENATOR GORE. Okay. No, I'm not arguing with you about that. And it may be that the high discount rates that you use do in fact reflect observed market behavior. I will stipulate that.

But if they do—and we could debate the evidence in some particulars—but just for the purposes of argument, let's assume for the moment that they do reflect market realities. It seems to me that high discount rates are a symptom of a severe energy efficiency sickness, a kind of first-cost disease. And DOE is supposed to address things like that—monitor the health of the energy economy, diagnose things that are wrong with it, and recommend solutions.

If you have a 60-percent discount rate, that's like having a 106-degree fever, a Code Blue that ought to galvanize DOE into some kind of remedial action. I would argue that the Congress meant what it said in the Department of Energy Organization Act when it mandated that DOE

"create and implement a comprehensive energy conservation strategy that will receive the highest priority in the national energy program."

Do you worry at all about the high discount rates that you observe in the market? Does that indicate cost-effective conservation potential in the real market place?

MR. GRUENSPECHT. It can. It can also reflect the role of other attributes that are not taken account of in the decisions that are being modelled and a variety of other factors.

SENATOR GORE. Wait a second. If I could follow up on the first part of your answer.

A 60-percent discount rate could reflect cost-effective conservation choices in the market?

MR. GRUENSPECHT. It can reflect market barriers that should be removed.

SENATOR GORE. But you said that it might be healthy. It might indicate cost-effective conservation policies.

Could that be so?

MR. GRUENSPECHT. There are a variety of factors that would affect people's decisions.

SENATOR GORE. Okay.

MR. GRUENSPECHT. If you're looking to——

SENATOR GORE. I can't believe that. I don't think you really believe that a 60-percent discount rate is indicative of a healthy, cost-effective approach to conservation investments, do you?

MR. GRUENSPECHT. I think there are a variety of factors that get tangled together, and from case-to-case, it is difficult to know.

We are very interested in removing those market barriers.

SENATOR GORE. But some of it may be market barriers.

Correct?

MR. GRUENSPECHT. That's correct.

SENATOR GORE. What are you doing about those market barriers?

MR. GRUENSPECHT. We have information efforts underway at DOE. We are supporting integrated resource planning and demand-side management. That's an example of an attempt to overcome the difference in hurdle rates typically used on the supply-side of the energy sector and hurdle rate used on the demand-side of the energy sector.

We are all in favor and support voluntary programs, be they our own, be they EPA's programs. We have energy efficiency audit programs that we've supported that try to call people's attention to opportunities to increase energy efficiency.

But, again, I think it's important——

SENATOR GORE. Did you look at the options on energy efficiency prepared by the National Labs?

MR. GRUENSPECHT. Again, I was not at DOE at the time.

SENATOR GORE. Well, there was a report published by the National Labs called, "Energy Efficiency—How Far Can We Go?," published in

January 1990. I'm quoting from the introduction and I assume this is accurate:

> We undertook the review at the request of the Office of Policy, Planning and Analysis in the Department of Energy. Our purpose was to provide background information needed by the Department in formulating a new national energy strategy.

That analysis by the National Labs to which William Chandler contributed—one of our later witnesses—concluded that profitable conservation could effectively stabilize energy use between 1990 and 2000, and limit the growth between 2000 and 2010 to less than 1 percent per year, actually 0.64 percent. And the researchers did not assume any efficiency gains in energy conversion—that is, more efficient energy power plants—in order to estimate energy savings.

All of these recommendations, unfortunately, were ignored when the National Energy Strategy was formulated. Or, at least, they certainly appear to be ignored since they're all left out.

But you weren't there when that was prepared.

MR. GRUENSPECHT. I assume the Department did look at the report, evaluated it, and made appropriate decisions.

SENATOR GORE. DOE acknowledges that it received public review, but nowhere do these recommendations show up.

When you tell the Congress that there aren't any other options that are cost effective, because these were left out of the NES, you don't have any independent knowledge of them, do you? You've never heard of these before, have you, the National Labs report on energy efficiency options?

MR. GRUENSPECHT. I have seen it. I don't have details on much of it.

SENATOR GORE. Okay. So, when you say there's nothing else that's cost efficient available, you've independently decided that they're wrong about this.

MR. GRUENSPECHT. Yes. Let's——

SENATOR GORE. We can stipulate that.

Now, let me say that I hope that DOE improves its ability to aggressively pursue cost-effective CO_2 emission reduction options. I really think it's important. And I think that when you have these kinds of devastating critiques of the work that you're doing and then you base these broad statements on them, it raises very serious questions.

Turning to today's testimony, you say:

> You will hear today from researchers involved in several studies that were not available, during the 1989 and 1991 timeframe, during which the NES and DOE report to Congress was being developed.

What about the Oak Ridge study, "Energy Efficiency—How Far Can We Go?," which was developed explicitly for the NES development?

Are you referring to that in your statement and testimony?

MR. GRUENSPECHT. No. I believe I was referring to Mr. Krause's study.

SENATOR GORE. All right.

MR. GRUENSPECHT. I don't believe Mr. Krause's study is available now, although there's been some briefings on it.

SENATOR GORE. Okay. You weren't referring to the EPRI study, either, I assume.

You go on and say:

> These and other recent studies will be examined closely as DOE updates the NES and its analysis of policy options to reduce net greenhouse gas emissions. We are committed to examining other promising actions that could reduce net greenhouse gas emissions. DOE is casting a wide net.

I'll tell you what worries me, instead of casting a wide net, DOE is casting a wet blanket over these efficiency and conservation options.

Let me quote to you from a biweekly trade publication called Electric Power Alert, March 18, 1992. The article is titled, "CO_2 Emissions—New England Cuts of 20 Percent Would Save Money, Researcher Reports." It describes Dr. Krause's study. And I quote:

> A researcher from a government laboratory reported last week that power plant carbon dioxide emissions can be reduced in New England by as much as 20 percent, with no increase in the overall cost of power. In a briefing to state regulators, Dr. Florentin Krause of the Department of Energy's Lawrence Berkeley Laboratory said that a moderate goal of freezing CO_2 emissions at current levels can be achieved at a robustly negative cost. These findings assume that only 50 percent of the potential for demand-side management is achieved and assume that nuclear power plants are retired when their current licenses expire. The least-cost scenario developed by Krause includes no renewable resources. Krause's research was jointly funded by the Department of Energy and the Environmental Protection Agency, and is currently under review by those agencies.

Will this New England CO_2 study have any influence on DOE's thinking about the economics of CO_2 stabilization?

MR. GRUENSPECHT. Again, when we see the study, we'll have more information. I don't believe that a study has been submitted yet.

I would also point out that whatever the flaws that you seem to find in our work, in fact, in terms of electricity demand, if anything, we are very much in the range of private forecasts. And with the additional actions described in the climate change document distributed last Friday, we would be considerably below the range of most forecasts of electricity demand growth.

So, I think it's important not to paint DOE as being off in some strange corner of the world on this issue. I believe DOE, especially with the actions outlined in the Friday document—the United States government, including DOE—is pretty far below the consensus value on how much electricity demand will grow in the United States over the coming decade. It's important not to lose perspective on that.

SENATOR GORE. Well, just to correct the record, this study by Dr. Krause has, in fact, been submitted to DOE and has been available. I don't think it was submitted long ago, but it has been submitted.

You also say in your statement that the NES was always intended to be an evolving strategy. But you say today that you look at it every two years, intensively at least.

To me, evolution also implies extinction. A more realistic baseline and the new actions in *U.S. Views on Global Climate Change*—the report just out Friday—undermines NES and the report to Congress and make them analytical fossils, in my opinion, because evolution and analysis has been very rapid in this area.

In the year after NES, and seven months after the greenhouse gas report to Congress, the Administration discovers actions which completely dwarf the original NES actions to reduce greenhouse gases, and it renders the previous analysis completely and totally obsolete as a basis for any informed judgment, in my opinion.

I want to come back to some of this, but I want to ask you some questions, Ms. Claussen. The centerpiece of your efforts, thus far, has been the Green Lights program, which accounts for a large portion of the projected carbon reductions. The successes that you cite in your testimony provoked my earlier comment, I think, it is a policy that's well put together. Are you confident that the Green Lights program will at least achieve the potential estimated in your testimony?

Ms. CLAUSSEN. I don't remember exactly what I said in the written testimony, but the answer is yes.

SENATOR GORE. Are there provisions in the House and Senate energy bills that were not considered in the inter-agency analysis?

Ms. CLAUSSEN. I'm not an expert on the bills, but I think there are some things that deal with issues that we dealt with here, but go somewhat beyond them.

I think there are certain provisions that expand some of the things that we have here.

SENATOR GORE. Will some of these provisions produce additional carbon dioxide emissions reductions?

Ms. CLAUSSEN. Probably, but we've not estimated them.

SENATOR GORE. The Department of Energy analysis of the House bill indicates that by the year 2000, the measures in the bill would result in a savings of 117 million metric tons of CO_2, approximately 30 million metric tons of carbon.

Is that correct?

Mr. Gruenspecht, I'll ask you that question.

MR. GRUENSPECHT. I think, if you don't account for overlap, that's correct.

SENATOR GORE. Okay.

MR. GRUENSPECHT. But I think there is overlap.

SENATOR GORE. Excuse me?

MR. GRUENSPECHT. But I believe there is significant overlap.

SENATOR GORE. Between what and what?

MR. GRUENSPECHT. Among a lot of the fuel measures. Again, I need to check into it for the record, but I understand that that does not count overlaps with the NES. And some, perhaps, with the Clean Air Act.

SENATOR GORE. Okay. Here's an analysis that does take account of overlaps from the American Council for an Energy Efficient Economy and from the Alliance to Save Energy, both of whom analyzed the House and Senate bills, and they estimate that approximately 45 million metric tons of carbon will be avoided when the legislation is implemented.

This analysis is higher than DOE's, in part because the ACEEE and the Alliance have analyzed the combined impact of the most aggressive measures in each bill, and presumably, the conference would result in some modification there. DOE only analyzed the provisions of the House bills.

But let me ask about something else here. The *U.S. Views* document, this document, which came out on Friday as a result of the interagency analysis, indicates on page 3 that the emission reduction estimates include only the impacts of actions being taken at the federal level. Correct?

The document recognizes, however, and I quote:

> State and local governments in the United States are also taking actions that will have the effect of reducing greenhouse gas emissions, and that an inventory of state and local programs will be provided later, together with estimates of how these programs will affect greenhouse gas emissions.

Now, if the Administration says that voluntary federal actions alone will bring us very nearly to the point of stabilization, and yet, the analysis doesn't include action at the state level, that seems to me to be significant.

Here is an analysis, an 83-page analysis of initiatives that state governments are already putting in place. Let me just cite a few for you and ask for your comment.

In New York, by implementing a program that increases fuel efficiency in all phases of energy production and in every sector of energy use, buildings, transportation, natural gas efficiency and electricity demand-side management, the state estimates that it will save some 59 million metric tons of carbon by the year 2010. The California Energy Commission has prepared a state plan that will result not only in stabilization, but in an 8-percent reduction in emissions by the year 2002. This is especially impressive given that California already consumes less energy per capita

than nearly every other state, and given the continued rapid population growth that California expects during the same period of time.

Now, we're going to hear a little bit more about the accomplishments in California in later testimony. John Fox from PG&E—the largest investor-owned utility in the Nation—will describe the programs they have in place to meet 75 percent of electric-load growth for the rest of the decade, with customer energy efficiency and a large portion of the remaining 25 percent to be met through increased reliance on renewable energy sources. In any event, over the course of the decade, PG&E estimates that they will reduce the carbon dioxide emissions by some 20 million tons.

The State of Washington, again in this analysis, estimates that it will reduce CO_2 emissions by some 3.3 million tons annually by tightening residential energy codes. The State also estimates that these efficiency improvements will save 16.5 million tons annually.

In Connecticut, 1990 legislation imposes standards for auto fuel economy, and addresses energy efficiency in building codes as well as in public utility decisions, and sets energy performance standards for existing and new state buildings that are intended to reduce energy use by 15 percent in 1995, 30 percent by 2000, 50 percent by 2010.

In Iowa, 1990 legislation includes a multitude of efficiency measures, including the following: State agencies are required to identify energy costs in their budgets and adopt life-cycle costing for new building contracts. New building efficiency rating system is being developed. New state vehicle purchases must meet minimal fuel economy ratings, etc., with carbon savings.

Let me ask you, Ms. Claussen, what about savings after the year 2000? Why does the analysis in the *Views* document just stop at the year 2000?

What can you tell us about the implications of that analysis for the years following the year 2000?

Ms. CLAUSSEN. I guess it stops at the year 2000 because we were exhausted and just didn't complete any analysis after the year 2000.

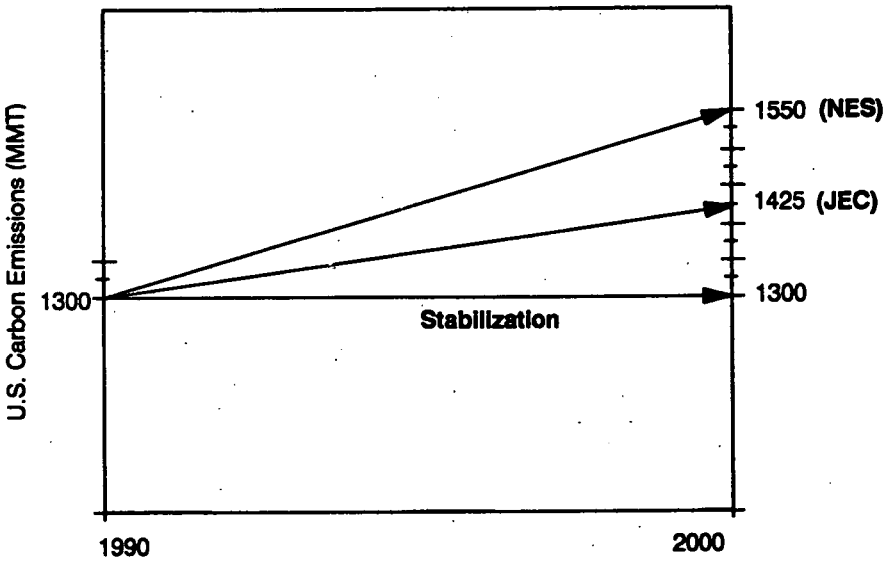
I think it's not exactly clear what happens after 2000. There are lots of uncertainties about economic growth. There are lots of uncertainties about energy prices. All of those tend to suggest that after the year 2000, things may not be quite as easy as they may be before.

On the other hand, a lot of these programs won't actually go into effect until late in the 1990s. A lot of their effects will carry forward into the 2000s, and that may balance it out.

But, quite honestly, we haven't done the analysis, and I'm not sure that I'm in a position to really be specific about it.

SENATOR GORE. All right. Fine. Let me sum up what I think the Committee has learned from this panel. I'd like to use a chart here that shows some of these numbers. (See the following chart and material based on the Annual Energy Outlook and the National Energy Strategy data.)

Projections of U.S. Carbon Emissions



Comparison between NES "Current Policy"
and Annual Energy Outlook 1992

ENERGY ANALYSIS

Annual Energy Cons. (quads)	Projected Increase 1990 - 2000 NES	AEO 92	AEO 92 Increase as Pecentage of NES Growth
Petroleum	5.2	2.6	50%
Natural Gas	4.4	3.2	73%
Coal	4.4	1.6	37%
Total Fossil	14.0	7.4	53%

CARBON ANALYSIS

Annual Carbon Emissions (MMT Carbon)	Increase 1990 - 2000 (Equals Reduction Needed for Stabilization) NES	AEO 92	AEO 92 Increase as Pecentage of NES Growth
Proportional:	250	132	53%
Carbon Adjusted:	250	125	50%

Carbon Weights:	
Petroleum	0.32
Natural Gas	0.25
Coal	0.43
Total:	1.00

DOE/EIA-0383(92)
Distribution Category UC-950

Annual Energy Outlook 1992

With Projections to 2010

January 1992

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

lawmakers' interest in energy security had heightened—increasing the chance that major legislation would be adopted.

Toward the end of 1991, the debate over *comprehensive* energy legislation intensified. The National Energy Security Act (S. 1220), a bill that became the central focus in the Senate, was introduced by J. Bennett Johnston (D-LA) and Malcolm Wallop (R-WY) on June 5, 1991, in lieu of an earlier version (S. 341), which had been introduced on February 6 and approved by the Senate Energy and Natural Resources Committee on May 23. However, S. 1220 failed to muster a cloture vote to overcome an opposing filibuster on November 1; and, when Congress recessed at Thanksgiving, no comprehensive energy legislation had yet been brought to the Senate floor.

As presented, the Johnston-Wallop bill is a sweeping 16-title piece of legislation that covers issues ranging from automobile mileage standards to electric utility reform. It is similar to the bills sponsored by the Bush Administration (S. 570, H.R. 1301); and it offers weaker conservation measures and stronger production initiatives than the primary Democratic alternative in the Senate (S. 741, introduced by Timothy Wirth, D-CO). For most of the year, legislation moved more slowly in the House of Representative than in the Senate—in part because a comprehensive energy bill needs to be approved by more committees in the House.

As *AEO92* went to press, it was still uncertain what form final legislation will take. No final action on any of the all-encompassing bills could be expected during 1991. To provide a framework for discussing the major components of such comprehensive energy legislation, however, key areas covered by the Johnston-Wallop bill are discussed in the next section.[1] It should be understood that the Energy Information Administration does not support any bill nor predict which bills or elements thereof will survive the legislative process. Unless otherwise indicated, the forecasts in *AEO92* make no effort to incorporate initiatives that have merely been proposed or contemplated, but not actually adopted.

Comprehensive Energy Legislation

One of the most controversial provisions in comprehensive energy legislation introduced in 1991 is a proposal to allow drilling for oil and natural gas in the Arctic National Wildlife Refuge (ANWR). Proponents point out that increased domestic production (assuming commercial discoveries are made) will decrease the Nation's need for imported oil. Environmentalists oppose drilling in ANWR because it may threaten the fragile ecosystem of one of the last wilderness areas of Alaska. Other oil production measures are also being considered, such as ways to encourage offshore drilling on the Outer Continental Shelf (OCS).

Considerable controversy has also arisen over whether comprehensive energy legislation should include specific fuel-efficiency requirements for motor vehicles. Proponents of specific standards argue that this is the most effective way to reduce the demand for oil, whereas opponents generally maintain that the domestic auto industry will not be able to meet excessive standards without sacrificing vehicle safety and sales. In separate legislation (S. 279), Sen. Richard Bryan (D-NV) has proposed an increase in the Corporate Average Fuel Economy (CAFE) standards of 40 percent above the current 27.5 miles per gallon by the year 2001. Other proposals have called for an increase in CAFE standards to lower levels than the Bryan bill.

Another major element of comprehensive energy legislation is regulatory reform for electric utilities. One such reform would exempt wholesale electric generators from the 1935 Public Utility Holding Company Act (PUHCA), allowing them to operate in more than one State. Proponents of the provision argue that it could encourage more independent power producers to operate generating plants, increase competition, and lead to lower capital costs—ultimately lowering costs to consumers. Nevertheless, some critics are concerned that there will be insufficient safeguards to protect consumers from monopoly abuse. Others believe that the competitive forces spurred by amending PUHCA will be hindered unless utilities are obligated to make their transmission networks accessible to wholesale generators—an idea that sparks sharp controversy on its own.

In an effort to decrease U.S. dependence on oil, consideration is being given to streamlining the regulatory processes for nuclear power, hydroelectric power, and natural gas to facilitate the use of these energy sources. In the case of new nuclear power facilities, it has been proposed that only a single, "combined" license be required for both construction

[1]The discussion framework is provided by the version of the Johnston-Wallop bill (S. 1220) whose consideration on the floor was blocked by falling short in a cloture vote on November 1, 1991.

Table A1. Total Energy Supply, Disposition, and Prices (Quadrillion Btu per Year, Unless Otherwise Noted)

Supply, Disposition, and Prices	Reference Case					Annual Growth 1990-2010 (percent)
	1990	1995	2000	2005	2010	
Production						
Crude Oil and Lease Condensate [1]	15.74	14.54	13.13	12.64	12.56	-1.1
Natural Gas Plant Liquids	2.16	2.16	2.27	2.36	2.28	.3
Dry Natural Gas [2]	18.27	18.96	19.89	20.74	20.06	.5
Coal	22.46	22.95	24.33	26.49	31.23	1.7
Nuclear Power	6.19	6.54	6.97	7.06	6.92	.6
Renewable Energy [3]	6.62	7.52	8.51	9.51	10.36	2.3
Total	71.45	72.67	75.10	78.81	83.40	.8
Imports						
Crude Oil [4]	12.70	13.77	16.59	18.51	18.76	2.0
Petroleum Products	4.29	5.91	5.89	6.22	7.67	2.9
Natural Gas [5]	1.45	2.31	2.80	3.20	3.42	4.4
Other Imports [6]	.09	.61	.75	.98	1.18	13.6
Total	18.53	22.61	26.02	28.91	31.03	2.6
Exports						
Coal	2.77	3.15	3.72	4.64	6.08	4.0
Petroleum	1.80	1.63	1.66	1.73	1.82	.0
Total	4.57	4.79	5.38	6.37	7.90	2.8
Net Stock Withdrawals	-1.32	-.22	-.23	-.17	-.21	-8.7
Discrepancy [7]	.93	.22	.10	-.03	-.20	-
Consumption						
Petroleum Products [8]	33.79	35.01	36.39	38.23	39.59	.8
Natural Gas	19.38	21.17	22.57	23.82	23.37	.9
Coal	19.09	19.86	20.70	21.97	25.21	1.4
Nuclear Power	6.19	6.54	6.97	7.06	6.92	.6
Renewable Energy/Other [9]	6.57	7.91	8.96	10.06	11.02	2.6
Total	85.02	90.49	95.61	101.20	106.10	1.1
Net Imports - Petroleum	15.18	18.05	20.61	23.01	24.61	2.4
Prices (1990 dollars per unit)						
World Oil Price ($ per barrel) [10]	21.78	20.80	26.40	30.50	33.40	2.2
Natural Gas Wellhead Price ($ per Mcf)	1.72	2.02	2.72	3.70	4.65	5.1
Coal Minemouth Price ($ per ton)	21.76	24.01	26.64	28.71	31.63	1.9

[1] Includes other hydrocarbons.
[2] Includes synthetic gas.
[3] Includes utility and nonutility electricity from hydroelectric, geothermal, wood and wood waste, municipal solid waste, other biomass, wind, photovoltaic and solar thermal sources; non-electric energy from renewable sources such as active and passive solar systems, groundwater heat pumps, and wood; alcohol fuels from renewable sources; and in addition to renewables, electricity from waste heat.
[4] Includes imports of crude oil for the Strategic Petroleum Reserve.
[5] Represents net imports.
[6] Includes coal, coal coke (net), electricity (net), and methanol.
[7] Balancing item. Includes unaccounted for supply, losses, and gains.
[8] Includes natural gas plant liquids, crude oil consumed as a fuel, and nonpetroleum based liquids, such as ethanol.
[9] Includes utility and nonutility electricity from hydroelectric, geothermal, wood and wood waste, municipal solid waste, other biomass, wind, photovoltaic and solar thermal sources; non-electric energy from renewable sources such as active and passive solar systems, groundwater heat pumps, and wood; and in addition to renewables, electricity from waste heat, plus net coal coke imports, and net electricity imports.
[10] Average refiner acquisition cost for imported crude oil.

Note: Totals may not equal sum of components due to independent rounding.

Sources: 1990: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(91/07) (Washington, DC, July 1991). Figures for 1990 may differ from published data due to internal conversion factors within the AEO 1992 Forecasting System.
Projections: Energy Information Administration, AEO 1992 Forecasting System run AEO92B.D092391B.

NATIONAL ENERGY STRATEGY

Technical Annex 2

Integrated Analysis Supporting The National Energy Strategy: Methodology, Assumptions And Results

A series of technical papers developed to support the
National Energy Strategy
First Edition
1991/1992
Washington, DC 20585

Table 2-2. Energy Summary - Current Policy Base Case

	1990	1995	2000	2005	2010	2020	2030
Primary Energy Production (quads)							
Petroleum	17.6	15.6	14.7	13.7	12.3	11.7	8.8
Natural Gas	18.1	19.2	21.3	20.4	20.2	19.9	17.3
Coal	22.5	23.0	26.7	32.4	39.1	50.2	62.1
Nuclear	6.1	6.1	6.2	6.4	6.4	3.5	0.4
Renewables	6.8	7.5	8.2	9.5	10.4	13.1	16.8
Total Production	71.2	71.4	77.0	82.3	88.3	98.5	105.4
Net Imports (quads)							
Petroleum	15.4	21.0	24.0	27.8	31.5	37.9	43.2
Natural Gas	1.4	2.5	3.1	3.5	3.5	3.1	3.2
Coal	-2.6	-2.6	-3.3	-4.3	-5.8	-6.8	-7.2
Methanol and Electricity Imports	0.1	0.3	0.2	0.2	0.2	0.3	0.4
Total Net Imports	14.3	21.1	24.0	27.2	29.4	34.5	39.8
Primary Consumption (quads)							
Petroleum	33.5	36.6	38.7	41.5	44.8	49.6	52.0
Natural Gas	19.3	21.0	23.6	23.2	23.0	22.4	19.9
Coal	19.0	20.4	23.4	28.0	33.3	43.4	55.0
Nuclear	6.1	6.1	6.2	6.4	6.4	3.5	0.4
Renewables	6.8	7.5	8.2	9.5	10.4	13.1	16.8
Methanol and Electricity Imports	0.1	0.3	0.3	0.2	0.3	0.3	0.4
Total Consumption	84.8	91.9	100.3	108.8	118.1	132.3	144.4
End-Use Consumption (quads)							
Liquids	32.1	34.6	36.6	39.6	42.9	47.6	50.9
Natural Gas	16.3	16.0	17.1	17.0	17.2	16.5	16.1
Coal	2.8	2.8	3.1	3.6	4.3	4.8	4.8
Electricity	9.2	10.6	12.3	13.9	15.3	18.5	21.2
Renewables	3.0	2.9	3.3	3.9	4.5	5.7	7.4
Total Consumption	63.4	66.9	72.3	77.9	84.2	93.0	100.4
Energy Input to Electricity Generation (quads)							
Petroleum	1.3	1.9	2.0	1.8	1.8	1.9	1.0
Natural Gas	2.9	5.1	6.7	6.4	5.9	6.0	3.9
Coal	16.1	17.5	20.2	24.3	28.9	38.4	50.0
Nuclear	6.1	6.1	6.2	6.4	6.4	3.5	0.4
Renewables	3.7	4.6	4.9	5.7	6.0	7.6	9.4
Total Consumption	30.1	35.2	39.9	44.4	48.8	57.9	64.8
Energy Prices							
World crude oil ($1990/bbl)	22.00	21.21	29.26	34.94	39.39	45.02	1.02
Wellhead natural gas ($1990/mcf)	1.77	2.43	3.82	4.56	5.55	7.04	99
Minemouth Coal ($1990/ton)	22.18	24.65	26.62	27.20	30.59	33.05	.63
Average electricity ($1990/kWh)	0.065	0.066	0.068	0.071	0.074	0.076	0.078
Energy-Related Emissions							
SO2 (mill. tons/year)	23.3	24.2	24.6	26.5	27.9	25.1	22.2
NOx (mill. tons/year)	22.7	23.2	23.8	25.2	26.9	29.4	30.2
Carbon (mill. metric tons/year)	1299	1401	1549	1709	1892	2234	2543
Global warming potential (MMT/year)	7458	7588	7255	7789	8425	9668	10623
Gross National Product (bill. $1990)	5463	6474	7472	8600	9786	11881	13931

If we look at the CO_2 projection in the National Energy Strategy base case, this runs from 1990 on the left to the year 2000 on the right. The vertical columns are denominated in millions of metric tons of carbon. The base case is 1300 million metric tons of carbon.

Now, in the National Energy Strategy document—this is a moveable line—the base case shows that carbon emissions grow from 1300 million metric tons in 1990 to 1550 million metric tons in the year 2000.

Therefore, if that describes the path of the energy economy over the next ten years, the goal of stabilizing emissions of carbon at 1990 levels in the year 2000 would require very large savings from any new programs that are implemented. This is the so-called business-as-usual approach.

But if we take into account the mistaken GNP growth estimate and use instead the GNP growth estimate used by the Energy Information Administration, which I'll acknowledge is far more accurate than the one included in the NES, then the base case actually begins to come down.

First, in the National Energy Strategy base case, the annual U.S. fossil fuel use—I apologize for the fact that you can't see this, but we will reproduce it. Maybe the witnesses can see it and those in the first few rows can see it.

Let's look at the National Energy Strategy base case in a little more detail. Annual U.S. fossil fuel use increases by 14 quads between 1990 and the year 2000. Now, that is also a big overestimate compared with the Annual Energy Outlook that shows an increase of only 7.4 quads of fossil- fuel energy use.

Now, look at individual fuels. Here, the Annual Energy Outlook growth is 50 percent of the NES forecast, 2.6 quads compared to 5.2 quads, while the coal use doesn't rise nearly as fast.

You can see the difference in coal is really quite pronounced. Do you see that—4.4 quads in the NES, only 1.6 quads in the Annual Energy Outlook. Now, this goes back also to what the National Academy of Sciences said about the coal-dominated model producing faulty results for coal.

As the text of the Annual Energy Outlook explains, DOE did not assume that the National Energy Strategy actions would occur, so this lower fuel growth is due to more modest economic growth and electric demand assumptions.

The points that we covered earlier in this question period about your faulty GNP growth figure and about your faulty electricity demand figure account directly for the difference between 4.4 quads of coal energy use increased between now and the year 2000 and only 1.6 quads in the more reliable Annual Energy Outlook.

MR. GRUENSPECHT. Senator, I'm not sure. The numbers, do they reflect demand at the primary energy level or at the secondary energy level?

SENATOR GORE. Primary consumption.

MR. GRUENSPECHT. Because I'm not sure that the 14.7 matches up with the document that I have here.

I guess the other——

SENATOR GORE. What 14.7 are you——

MR. GRUENSPECHT. 14.0 percent.

SENATOR GORE. 14.0 percent. Okay. That's the increase between 1990 and the year 2000, calculated in the NES.

MR. GRUENSPECHT. Most of which is——

SENATOR GORE. It's from fossil fuels. It's about evenly divided in the NES between petroleum, natural gas and coal.

MR. GRUENSPECHT. Okay.

SENATOR GORE. Okay? Got it?

MR. GRUENSPECHT. And we have, as I understand it, in this analysis, relatively high oil prices and relatively high gas prices.

There are a lot of issues involved in coming up with——

SENATOR GORE. What drives your mistake here is the faulty figure on GNP growth in the model and the faulty figure in electricity demand growth in the model.

The Annual Energy Outlook projection takes its more accurate figures and can they then be applied to CO_2 emissions growth.

If we took——

MR. GRUENSPECHT. With all due respect.

SENATOR GORE. Sure.

MR. GRUENSPECHT. You keep talking about the NES base case and the NES policy case, which is the case from which our study takes off. Again, electricity demand growth is very much in line with the EIA numbers, is very much in line with the wide majority of private estimates of electricity demand growth. I guess I don't quite understand the assumption that DOE is some kind of outlier on this.

SENATOR GORE. Well, these are DOE's own figures from the NES, in detail. We're down in the guts of your model now.

MR. GRUENSPECHT. I understand.

SENATOR GORE. And we're looking with a microscope at exactly where you made your mistake, Mr. Gruenspecht, all right?

This difference between 4.4 quads from coal use and 1.6 quads, as calculated by the Annual Energy Outlook, has implications for CO_2 emissions growth. If we just looked at all fossil fuels and took a naive approach, you could say that that's going to be roughly, reduce the CO_2 emissions by about 53 percent.

But notice again that the figures for coal are very, very different from the figures for oil. Again, that comes from yet a third error, and that is the way the model over-emphasizes coal, as pointed out by the National Academy of Sciences.

So, if you factor the carbon implications of coal versus natural gas and petroleum, then you get a projection from the Annual Energy Outlook report of an increase of only about 125 million metric tons of growth.

According to the Annual Energy Outlook case, we have cut the base case in half. We need only another 125 million metric tons of carbon restrictions in the year 2000 to stabilize emissions.

If we use the more reliable Annual Energy Outlook figures, let's change the graph line, because this is in error and we want to bring it down to halfway.

Now, we have 125 million metric tons in addition that are needed to stabilize in the year 2000. Here we have the new actions document released on Friday, okay?

The actions—voluntary in nature—described by the Administration on Friday, yield a range of reductions from 89 to 121 million metric tons of carbon reductions—121 million gets us real close to stabilization.

We only need a little bit more to stabilize. Maybe, if we did something that wasn't purely voluntary ... wait a minute. What about these state actions?

These state actions bring us actually below stabilization, with no other federal actions. But even if we don't count on the states, can we think of anything else that might possibly be done during the next eight years that would account for this little bit that might be left for the extra reductions that we need?

Ms. Claussen?

Ms. CLAUSSEN. I always think anything is possible, Mr. Chairman.

SENATOR GORE. Mr. Gruenspecht?

MR. GRUENSPECHT. I guess what you're saying is that you're very pleased if the actions that we've already undertaken and are confident that they will have the effect you desire.

We are committed to those actions and will happily pursue them. And certainly, we would be pleased with the results we get are those we project.

SENATOR GORE. Do you think we can stabilize greenhouse gas emissions in the year 2000?

MR. GRUENSPECHT. I think that depends on assumptions about economic growth, energy prices, rates of market penetration, which are all spelled out in the action plan document. It depends on growth in electricity demand, and DOE has views that are very similar to other views in the private sector.

Beyond that, we are committed to those actions. We believe that they make sense and we'll take it from there. That is where we are.

SENATOR GORE. Well, actually, I think what this reflects is a leadership gap, because we are now trying to decide whether or not it is feasible for the United States to agree that we can stabilize CO_2 emissions at 1990 levels by the year 2000.

Do you think we should enter into a global agreement to stabilize emissions at 1990 levels by the year 2000? Or do you think we should refrain from doing so because it might be impossible without economic harm?

Ms. CLAUSSEN. I think I should refrain from answering your question.

MR. GRUENSPECHT. That one is above my pay-grade as well.

SENATOR GORE. Do you have an opinion, Mr. Gruenspecht?

MR. GRUENSPECHT. That one, as I said, is above my pay-grade.

SENATOR GORE. All right. Well, there are so many options that we have talked about here today that seem to make it easy to reach the intended savings, and it seems to me that it is incredible that people in the Administration are arguing—largely on the basis of this NES report—that there's nothing that we can do to reach it.

I did find the additional amount here. Many have speculated about the effects of Mr. Sununu's retirement having an impact on this policy area.

Actually, I can't take credit for this, but somebody actually calculated—NRDC did this—based on the air travel during two years in the White House, the avoidance of that much carbon would just about get us to stabilization.

In any event, let me say to both of you that I know this debate within the Administration is continuing. The conclusion that was arrived at on Friday, that we can just about stabilize with only voluntary measures, would lead any objective observer to say, okay, the main reason for not entering into an agreement at the Earth Summit was that we can't stabilize without doing economic harm. And since that objection has now been demolished, we can now agree.

Instead, incredibly, spokesmen for the President—let me rephrase that—voices within the Administration who speak with purported authority to newspaper reporters say, well, now that we know we can stabilize without a treaty, we don't need a treaty.

It's like saying, I know I'm not going to rob a bank, so we don't need laws against robbing banks.

We have been engaged in this furious debate worldwide to get an international agreement to stabilize emissions at 1990 levels by the year 2000. The leader of the world has been the only industrialized country resisting that treaty—that provision of the treaty—and has resisted on the grounds that we are uniquely incapable of stabilizing at those levels.

Now, the Administration says, well, we can actually stabilize at that level with purely voluntary measures. And since we can, we don't need a treaty.

The object is to find out how the United States of America can lead the world toward a desirable outcome. If every industrial country in the entire world not only stabilizes, but reduces emissions by 50 percent, and the rest of the world stays on its present course, CO_2 emissions will increase by 250 percent within 30 years.

How can we lead the world toward a different outcome. If we say that we alone among industrial countries refuse to be a part of this treaty, then our capacity for leadership is severely diminished.

If our principal reason for failing to lead is a sincere belief that we are uniquely damaged by an effort to stabilize, then that argument must be examined. When the Administration itself examines its own argument and comes to the conclusion it no longer has any validity, then the one reason given for the United States not providing leadership has been eliminated.

It remains to be seen whether the leadership gap will be filled or not. But we have some more panels and I appreciate very much you going through this very long and extensive inquiry, Mr. Gruenspecht and Ms. Claussen. We've tried to get into the details of where these models go wrong in producing the results that they did.

I think your testimony has been helpful and extremely enlightening.

[Material referred to subsequently supplied for the record:]

Department of Energy
Washington, DC 20585

The Honorable Al Gore
Joint Economic Committee
United States Senate
Washington, D.C. 20510

Dear Senator Gore:

At the hearing before the Joint Economic Committee on April 28, 1992, you read selected quotes from the January 30, 1991, First Advisory Report of the National Research Council (NRC) on the Development of the National Energy Modelling System. I noted at the hearing that the NRC Advisory Committee had been generally complimentary towards the Department's NES modelling efforts, but I did not have a copy of that document with me and could not therefore offer a direct quote. I would like to call your attention to the following statement made in the First Advisory Report and reemphasized in the Final Report. Namely,

> In the Committee's view, the approach taken by DOE in using available models as appropriate, along with off-line supplemental analysis as necessary, was a rational response to the Department's need for expedient support of the NES process. The rough integration of the modeled and off-line intermediate analysis that DOE accomplished through the calibration of the FOSSIL2 model has been a useful way to maintain consistent accounting and reporting of results.

I would also note that the Congressional Research Service in a October 9, 1991, memorandum to the Senate Committee on Energy and Natural Resources regarding the National Energy Strategy (NES) analysis found "that in general the results projected by the DOE model are in the expected direction and order of magnitude."

While all models depend on the assumptions that underlie them, we believe that the modelling efforts undertaken by DOE in support of the NES and the subsequent report on greenhouse emissions reflect a responsible and reasonable approach to integrated energy system modelling.

I request that you insert this letter into the record of the April 28 hearing as part of my answer to your question regarding the efficacy of the DOE modelling efforts.

Sincerely,

Howard K. Gruenspecht

Howard K. Gruenspecht
Associate Deputy Under Secretary
for Program Analysis
Office of Domestic and International
Energy Policy

SENATOR GORE. So, thank you both, and we will call our next panel. There is one change in the next panel. Mr. Richard Stroup will be on Panel 2 instead of Panel 3.

Thank you both very much.

Let me call to the witness table David Moskovitz from the Regulatory Assistance Project in Gardiner, Maine; John C. Fox, Manager of Energy Efficiency Services at PG&E in San Francisco; Lynn Sutcliffe, President and CEO of SYCOM Enterprises in Bethesda; and Richard L. Stroup, Professor of Economics at Montana State University, the Political Economy Research Center in Bozeman.

Thank you all very much. We're going to begin—we're going to go from my left, your right. That means starting with you, Mr. Moskovitz. Thank you very much for coming here. We look forward to your testimony.

Please proceed, Mr. Moskovitz.

STATEMENT OF DAVID MOSKOVITZ, THE REGULATORY ASSISTANCE PROJECT, GARDINER, MAINE

MR. MOSKOVITZ. Thank you very much, SENATOR GORE. I'm very pleased to be here.

I'm a principal and cofounder of the Regulatory Assistance Project. I also served as a public utilities commissioner in the State of Maine from 1984 through 1989, and after that, worked as a private consultant in these matters to many state commissions and the Department of Energy before forming the Regulatory Assistance Project.

The Regulatory Assistance Project is a nonprofit group which is funded by the Pew Charitable Trust and the United States Environmental Protection Agency. Our purpose is to provide training, education and other assistance to state public utility commissioners and their staffs on all issues relating to least-cost planning or integrated resource planning, and I do use those terms interchangeably.

Our training covers a broad range of issues, but we tend to spend a great deal of time on energy efficiency and, in particular, regulatory reform that's necessary within the electric utility sector to assure that least-cost planning activities actually become implemented.

The purpose of my testimony is to touch upon three simple issues: The role of least-cost planning, and in particular, its role in carbon dioxide reduction, some of the economic implications of greater reliance on integrated resource planning, and the need for federal leadership in accelerating the implementation of least-cost planning at the state and federal levels.

As you in the Committee no doubt know, integrated resource planning is a planning process that seeks to meet the needs of consumers in the least costly fashion. Its principal distinction from traditional utility planning is its great focus on incorporating energy efficiency into the mix.

You will hear in a few minutes from John Fox from Pacific Gas & Electric about the fairly recent and very impressive success that PG&E has had in increasing the energy efficiency of its customers in its service territory, and the positive impact that that has had on California's competitiveness.

Similar success stories can also be shown in other states, such as Maine, Massachusetts, Vermont, New York and Washington.

In my own State of Maine, where I served on the public utilities commission, utility investment in energy efficiency went from essentially zero in 1984 to in excess of 5 percent of the utility's gross revenues in 1989. Investment and reliance on renewable resources also went from roughly zero to over 30 percent, and now leads the country in both DSM spending and investment and reliance on renewables.

We know from experience in the State of Maine, when we looked at the option of investing more in energy efficiency and renewables, as opposed to importing power from both Seabrook and Hydro-Quebec, that the state's economy would benefit by tens of thousands of new jobs and a great deal of additional state income and revenues if we went the energy efficiency and renewable route.

Well, what can IRP do overall for the Nation?

In a recent study for the American Council for an Energy Efficiency Economy, ACEEE—a source that you cited just a few minutes ago and which I authored, together with Steve Nadel and Howard Geller—we took a careful look at some energy efficiency strategies which could be applied to the electric utility industry nationwide.

The U.S. Department of Energy projected that over 245,000 megawatts of new power plants would be needed by the year 2010. Our study looked at how that projection would change if integrated resource planning were fully adopted.

Our conclusions were quite simple and quite different from the Department of Energy's conclusions.

First, the growth in electricity sales would be sharply reduced. The growth would be reduced by 70 percent, roughly consistent, by the way, with PG&E's own success. And would reduce the annual growth rate of electricity to a mere 0.5 percent.

Carbon dioxide emissions from this sector would be at 1990 levels. And consumer energy bills—the real test for competitiveness—in real terms, would drop by about 16 percent, or a savings of $60 billion, by the year 2010.

The single largest factor contributing to that substantial improvement was the more widespread and rapid adoption of least-cost planning or integrated resource planning. And in particular, not just integrated resource planning, but integrated resource doing and turning some plans into real, concrete action.

The single largest impediment to integrated resource planning is the incentives that are embedded in the current regulatory system that are

used at the state and federal levels to control and regulate our electric utility industry.

Also, in a report entitled, "Profits and Progress through Least-Cost Planning"—and Senator Gore, you were quite interested, I know, in the profitability of these activities—which I authored for the National Association of Public Utility Commissioners, I explained how, under the existing traditional way we regulate electric utilities in this country, every single kilowatt hour an electric utility sells, adds to their profits.

It doesn't matter how much it costs to produce the kilowatt hour, or how little they charge for it. Every single one they sell adds to their profits.

Unlike any other business, unlike any other competitive business in this country that I'm aware of, electric utilities can actually produce a product, sell it at a price that's less than their cost, and make it up on volume.

Conversely, every kilowatt hour that a utility saves through investment in energy efficiency cuts their profits. In fact, every kilowatt hour——

SENATOR GORE. Wait a minute. Excuse me for interrupting. Go back to that sentence that ended up, make it up on volume.

Can you say that again?

MR. MOSKOVITZ. Sure. Electric utilities, given the way we regulate them, given the system that we put into place both at the state and federal level, and how it's evolved over the years with fuel adjustment clauses and the like, a utility can actually produce a kilowatt hour for more money—it costs them more money than they can turn around and sell it to a consumer for. They can produce it for a dime, sell it for a nickel, and make it up on volume.

Even McDonald's can't do that. Even Sam Walton couldn't do that.

That profit motive, by the way, is incredibly potent. A 1-percent change in utility sales on a systemwide average basis—a hundred basis points in return on equity—it's an enormous increase in the utility's profitability as sales increase.

The flip side is equally true and equally potent.

Every kilowatt hour that's lost—cost-effective energy efficiency hurts utilities' profits. Even zero cost energy efficiency compared to very costless power supply, hurts utilities' bottom line.

There is some good news. NARUC, the national association of us public-utility-commissioner-types—recognized the problems, knew that least-cost planning was good for the country, and recognized that it was inconsistent with the way we regulate utilities. And they passed a resolution in 1989, calling upon the states to fix the problem.

A few states now have taken action and changed that formula, so in a few states—California is one, Maine is another, New York, Washington, and there are a few other examples out there now—utilities can actually now make money saving their customers money through investments in energy efficiency.

The results of these regulatory reforms have been exactly as predicted. Utility investment and cost-effective energy efficiency has skyrocketed and the cost of providing energy services to consumers has been reduced substantially.

The environmental benefits have also been significant.

As is so often the case, however, it's easy with 50 states to find a few that can lead. What we typically find, though, is that leadership tends not to make it to the majority of the states. What we really need is a Federal Government that can see the promising solutions that have already been implemented by a number of states out there, build upon those actions through federal leadership to assure the acceleration and implementation of those same types of progressive and cost-effective energy policies, and spread them to the rest of the country.

We look forward, obviously, to this Committee pursuing those types of activities.

I'd be happy to answer your questions.

[The prepared statement of Mr. Moskovitz, together with an attachment, follows:]

PREPARED STATEMENT OF DAVID MOSKOVITZ

I am a principal and co-founder of The Regulatory Assistance Project. I served as a Commissioner on the Maine Public Utilities Commission from 1984 through early 1989 and then worked as a private consultant until forming The Regulatory Assistance Project earlier this year.

The Regulatory Assistance Project is a non-profit organization funded by The Pew Charitable Trust and the United States Environmental Protection Agency. Our purpose is to provide education, training, and advice to state public utility commissioners and their staffs on all issues relating to least-cost planning (LCP) or integrated resource planning (IRP), terms which I use interchangeably. Our training assistance covers all issues pertaining to utility-sponsored energy efficiency programs, regulatory reforms needed to reconcile utilities' financial interests with least-cost planning, and the role of integrated resource planning in environmental improvement, including how energy efficiency components of IRP can help with compliance with the Clean Air Act. The Regulatory Assistance Project is operated as a program of the American Council for an Energy Efficient Economy and our training and education activities are coordinated with the national labs of the U.S. Department of Energy.

We are currently working with public utility commissions in five states: Ohio, Michigan, Texas, Georgia and Florida. The Regulatory Assistance Project is also involved in a U.S. Department of Energy funded project to implement new and innovative approaches to accelerating utility reliance on new renewable energy sources.

177 Water Street, Gardiner, Maine 04345 • Telephone: (207)582-1135 • Fax: (207)582-1176
Funded by The Pew Charitable Trusts and The U.S. Environmental Protection Agency. A program of The American Council for an Energy-Efficient Econo

The purpose of my testimony today is to address three simple issues: 1) the role of integrated resource planning and in particular its role in carbon dioxide reduction, 2) some of the economic implications of greater reliance on IRP, and 3) the role of federal leadership in accelerating the implementation of IRP at the state and federal levels.

Integrated resource planning is a utility planning process which seeks to meet consumers' energy service requirements in the least costly fashion. Integrated resource planning differs from traditional utility planning primarily because of its focus on the cost of energy services, rather than simply on the cost of electricity. More specifically, IRP considers cost-effective energy efficiency opportunities such as substituting technology and capital investment at the customers' premises for electricity production by the electric utility. For example, more efficient lighting fixtures combined with less electricity may be a more cost-effective way to produce needed light than reliance on more electricity and lighting fixtures which are low-cost but less efficient. It may be, from the very narrow perspective of an electric utility, that more use of electricity is always better but this is not the case from the perspective of consumers, the nation or the world overall.

John Fox, from Pacific Gas and Electric, will, in a few moments, describe to you some of the recent and very impressive success that PG&E has had in increasing the energy efficiency of customers in its service territory. Efficiency has led to the greater competitiveness of customers served by Pacific Gas and Electric and because of the innovative regulatory reforms instituted by the California Public Utilities Commission, PG&E's efforts have also resulted in higher profits for the shareholders of PG&E.

Successes similar to those of Pacific Gas and Electric have been experienced in a number of other states around the country. Maine, Massachusetts, Vermont, New York and Washington state are all examples of what integrated resource planning can do. In

each of these states utility annual investment in cost-effective energy efficiency has gone from token levels in the 1-2% range of annual revenues to levels as high as 5-10%.

A recent study by the American Council for an Energy Efficient Economy, which I authored together with Steve Nadel and Howard Geller, entitled *Increasing the Efficiency of Electricity Production and Use: Barriers and Strategies*, took a careful look at how wide spread and rapid implementation of least-cost planning would affect the nation's projected energy use. The U.S. Department of Energy projects that over 245,000 MW of new power plants will be needed by the year 2010. Our study looked at how this projection would change if IRP were fully adopted. Our conclusions were quite simple. Growth in electricity sales as predicted by the Department of Energy can be reduced by more than 70%, reducing the annual growth rate to .5%; carbon dioxide emissions from the electricity sector can be held to 1990 levels; and consumer electricity bills would decline by 16% in real terms from present day levels, representing nearly $60 billion of savings in the year 2010.

The single largest factor contributing to the substantial improvements in cost and environmental quality is the more widespread and more rapid adoption of least-cost or integrated resource planning. The single largest impediment to integrated resource planning is the incentives imbedded in the regulatory system the state and federal governments apply to the electric utility industry. It is now widely recognized that the current regulatory process provides very potent disincentives to energy efficiency and equally powerful incentives to utilities to do nothing but increase electricity sales. In a report entitled *Profits and Progress through Least-Cost Planning*, published by the National Association of Public Utility Commissioners (NARUC), I explained how, under the traditional ratemaking formula, every kilowatt hour an electric utility sells adds to its profits, no matter how low the selling price or how high the cost to generate the power.

Conversely, each kilowatt hour a utility saves through energy efficiency, regardless of how little the energy efficiency measures cost, hurts the utility's bottom line. Even zero-cost energy efficiency, or energy efficiency for that matter that is implemented entirely by consumers acting perhaps on the good advice of their utility, hurts the utility's bottom line.

The only financial incentive the utility has to invest in cost-effective energy efficiency is the risk that the failure to do so might be held against the utility by regulators, resulting in large revenue disallowances.

NARUC, in its watershed 1989 resolution, recognized the national importance of least-cost planning and the inherent inconsistencies between least-cost planning and the current regulatory system. NARUC called upon state regulators to amend the ratemaking formula in ways that reconcile utilities' financial interests with sound least-cost planning.

Acting upon NARUC's resolution, some states have taken steps in the right direction. Four states in particular deserve mention: Maine, Washington, New York and California have all "decoupled" utility profits from sales and substituted mechanisms which reward utility acquisition of cost-effective energy efficiency measures. In these states, utility profits are now a function of a utility's ability to cut costs and save money for their customers through wise investments in cost-effective energy efficiency. The results have been exactly as predicted, namely, that utility investment in cost-effective energy efficiency has skyrocketed and the cost of providing energy services to consumers has been reduced. The environmental benefits of these actions have also been significant.

As is so often the case, the nation is being shown the way by a few leading states.

We can typically expect a few of our fifty states to innovate, refine, and produce a workable model for the rest of the country. Recognizing promising solutions to national problems and taking steps to accelerate the implementation of those solutions is the job of the federal government. Absent federal leadership, we know that even the best and most innovative solutions will spread very slowly and often never reach the majority of states. What is sorely needed is federal leadership. Greater encouragement through the judicious use of carrots and, if necessary, sticks, can go a long way.

Two possible actions in particular merit your attention. First, the jurisdictional lines that separate federal and state control of electric utilities make very little sense. A state may have complete control over all aspects of a 1,000 megawatt power plant constructed by one of its utilities, but virtually no jurisdiction over a 1 megawatt non-utility supplier located in a state and seeking to sell power to a utility in the state. One potentially effective and cost-free approach is to cede federal jurisdiction to state public utility commissions over transactions which are currently within the jurisdiction of the Federal Energy Regulatory Commission, on the condition that states adopt integrated resource planning and implement the necessary regulatory reforms to accompany IRP.

Second, the Department of Energy should substantially increase financial assistance to states wishing to implement IRP. Environmental regulation provides a useful model. Many of the nation's environmental laws and policies are established at the federal level while implementation and enforcement takes place at the state level. States desiring authority to administer environmental laws must demonstrate compliance with minimal federal standards. In return, substantial portions of the operating budgets of the state environmental agencies are provided by the federal government. This same approach can substantially accelerate integrated resource planning. The federal government should provide financial resources to the states necessary to implement and administer integrated resource planning processes.

I appreciate the opportunity to address the Joint Committee and I'm prepared to answer your questions.

Attachments: Profits and Progress through Least-Cost Planning (NARUC), David Moskovitz, November 1989.

Increasing the Efficiency of Electricity Production and Use: Barriers and Strategies (ACEEE), David Moskovitz, Steven Nadel, Howard Geller, November 1991.

Annu. Rev. Energy. 1990. 15:399–421

PROFITS AND PROGRESS THROUGH LEAST-COST PLANNING

David H. Moskovitz

Energy and Regulatory Consultant, Hollywood Boulevard, Alna, Maine 04535

KEY WORDS: least-cost planning, incentives, regulatory reform, conservation, electric utilities.

OVERVIEW

Energy efficiency is, and should remain, the cornerstone of the nation's energy policy. Significant progress in implementing available and highly cost-effective efficiency opportunities is not being made, however. Electric utilities could play a large role in this regard. Unfortunately, the system of regulation in this country seriously penalizes utilities pursuing efficiency options while rewarding those selling even more power. This article discusses the source of the problem and the regulatory reforms needed to remedy it.

THE PROBLEM

The US Department of Energy's "National Energy Strategy," pursued vigorously in 1989 but not yet completed as of spring 1990, will have several things in common with every state or federal government or utility energy plan since 1973.

First, it will call on every conventional source of power to contribute to the nation's new energy needs. Second, it will claim to be least cost. Third, it will claim to balance the need for energy with environmental concerns. Fourth, and most important for the purpose of this article, it will state that increased energy efficiency is the cornerstone of the strategy.

As with plans that preceded it, expect significant infusions of federal

subsidies and research in every new power source. Perhaps the plan will also propose institutional rearrangements to make it more expedient, less risky, and more profitable to invest in new power plants.

As for the strategy's cornerstone, energy efficiency, there will no doubt be a few crumbs and some admirable rhetoric. The small and poorly organized energy-efficiency lobby will likely be satisfied with federal funding efforts that double or triple the current funding level. Little mention will be made of the fact that such an expansion would make efficiency funding a tiny fraction of the coal, oil, or nuclear subsidies that will flow.

Regardless of the funding level, real progress toward increasing the nation's energy efficiency will not be realized unless we are prepared to invest heavily in energy efficiency and reorder the regulatory framework of our energy industries.

Flavin & Durning (1) report that in the global race for energy efficiency, the United States ranks 9th out of the 10 industrialized nations that are members of the Organisation for Economic Cooperation and Development. We use twice as much energy as Japan, West Germany, or Sweden to produce a dollar of GNP. Only about half of the differences in energy use can be explained by factors that do not relate to energy efficiency. Responsible estimates show that cost-effective technologies available today can cut the nation's energy use by 20% [according to the Electric Power Research Institute (EPRI)] (2) to 75% (as estimated by Lovins) (3) without life-style changes or lowered GNP growth.

Adopting cost-effective energy efficiency as the nation's investment strategy would reduce the United States's annual energy bill by $27–200 billion. Such savings would substantially improve the global competitiveness of US business and industry, our trade deficit, and our dependence on foreign oil. Putting this much capital to productive use would measurably increase our standard of living.

In this decade, when energy policies will be increasingly driven by national and global environmental responsibilities, increased energy efficiency will result in direct and immediate benefit to the environment. Ketcham-Colwill (4) and MacKenzie (5) report that electric utilities now account for 20% of the gases linked to the atmospheric greenhouse effect, 70% of the nation's sulfur dioxide, and 33% of the nitric oxide emissions that cause acid rain, as well as 50% of all nuclear waste. Increasing the efficiency of our energy use, particularly electricity, can produce substantial environmental and health benefits at a fraction of the cost of adding pollution-control equipment or other mitigating approaches.

A growing number of policymakers and utility regulators are pursuing "least-cost planning" (LCP) in the battle against environmental and efficiency problems. LCP is a process of examining all electricity-saving [demand-side management (DSM) options] and electricity-producing (supply side) options to select a mixture of options that minimizes total consumer cost and that includes consideration of environmental concerns and other spheres of responsibility.

While least-cost planning principles have come a long way and have been adopted by a majority of states, the most vexing problem remains. Specifically, how do regulators, policymakers, and lawmakers translate talk and ideas into action? And action means utility investment in energy efficiency.

A few states and utilities have begun to show that the energy-efficiency opportunities are vast. During the energy conservation heyday, California utilities led the nation, spending about 1.5% of gross operating revenues on energy-efficiency programs. Spending has diminished to about 0.5%, a trend that is now being rapidly reversed at the urging of the California Public Utilities Commission.

More recently, however, utilities in New England and Wisconsin are showing that spending levels in excess of 5% of gross revenues do not exhaust the cost-effective energy-efficiency opportunities.

Advances in efficiency technologies and more effective delivery and marketing approaches are being used to make the nation's proven reserves of energy-efficiency opportunities grow despite the accelerating pace at which some utilities are mining the efficiency resource.

While a few utilities are demonstrating the possible, the vast majority of utilities shun efficiency. Excluding the few progressive utilities, the average utility in the United States spends less on energy efficiency than is spent on load growth, load shifting, power marketing, and discount and incentive rates. The same priorities are reflected in EPRI's research and development budget.

Thus, the critical question for regulators, policy makers, and lawmakers is how do we ensure that electric utilities fully embrace and implement least-cost planning in their own planning and investment decisions and begin investing in energy-efficiency opportunities in a serious way?

The Causes

The impediment between LCP the idea, and LCP the practical reality, is the utility industry's regulated economic environment, to which the utilities are responding rationally. Traditional state and federal rate-setting regulation provides a strong economic disincentive to the utilities' implementation of least-cost plans or investment in energy-efficiency programs. In particular, implementing least-cost plans will produce lower earnings or profits than pursuing increased sales. Throughout this paper, the terms "earnings" and "profits" are used interchangeably. Except where the context is clearly to the contrary, adding to or subtracting from earnings or profits refers to the

incremental change in earnings or profits, not the absolute level of either. It matters not whether earnings or profits are 8% or 16%, or whether earnings or profits are above or below an allowed rate of return. In all instances, the paper focuses on the incremental increase or decrease in earnings, or profits, that flow from a specified course of conduct.

The ratemaking process generally used in most states has the following unintended, but nevertheless powerful and perverse incentives.

1. Each kilowatt-hour (kWh) a utility sells, no matter how much it costs to produce or how little it sells for, adds to earnings.
2. Each kWh saved or replaced with an energy-efficiency measure, no matter how little it costs, reduces utility profits.
3. The only direct financial aspect of regulation that encourages utilities to pursue cost-effective conservation is the risk that dissatisfied regulators may disallow costs.
4. Purchases of power from cogeneration, renewable resources, or other nonutility sources add nothing to utility profits, no matter how cost-effective they are.

These real and powerful incentives are inconsistent with otherwise efficient investment by utilities in conservation or many supply-side options. Regulators rightly insist on least-cost planning, but they also rule over a process that rewards utilities financially when they sell more power. LCP is likely to find little success until ways are found to eliminate these mixed messages and align the financial interest of the utility industry with the goals of least-cost planning.

What is it about the traditional rate-setting process that produces all the wrong incentives?

PROFITS ARE NOT FIXED First, as regulated monopolies, utilities are entitled to have their prices for electricity set at a level that allows recovery of all prudently incurred operating expenses and fixed costs. These fixed costs include taxes, interest, and a reasonable rate of return, or profit on their rate base (calculated as their capital investment in power plants and other hardware, minus depreciation).

Actual profit levels earned by utilities are not etched in stone. Instead, state public utility commissions examine utilities' historical and forecast expenses in rate cases and set the price of electricity at levels expected to earn the utility a specified rate of return. However, once the price is set, i.e. between rate cases, the utility has an incentive to sell more electricity whenever its marginal revenue from the sale of a "block" of power exceeds its marginal cost to produce and distribute that "block." Because a utility is virtually always "between rate cases," and because fuel clauses and utility accounting practices ensure that marginal revenue exceeds marginal cost, a utility can always improve its earnings by selling more power.

The result flows directly from the facts that prices are fixed and that fuel clauses are reconciled. The term "reconciled" is used in this paper in a number of areas, most generally relating to fuel clauses. A fully reconciled fuel adjustment clause means utilities recover dollar for dollar all fuel expenses including interest on fuel costs. Several states use partial reconciliation, which can take many different forms. In some states, interest costs are not allowed; in others, a portion of the difference between projected and actual fuel cost is left at the utility's risk, to provide an incentive to the utility to minimize fuel costs. For example, in New York, a utility recovers only 80% of the difference between projected and actual fuel cost. The manner and extent of reconciliation are very important considerations in evaluating incentive plans.

The problem is unaffected by the procedure or assumptions used to fix prices, for example historic vs future test year, or the level of sales or conservation used to set rates. The only aspects of regulation that make a difference are provisions that are reconciled or trued-up, or subject to deferred accounting and recovery. Even without fuel adjustment clauses, whenever electricity prices are higher than the marginal fuel cost to produce power, the incentive to sell remains, albeit as a lesser incentive.

If profits rise too high, regulators can step in and lower the price that the utility can charge for electricity, but only after time-consuming hearings in which the utility will generally oppose any change. (Shortening the time to complete rate cases or increasing the frequency of rate cases is not a solution because utilities will still always be "between rate cases.") Even when rates are lowered, the utility is not required to give refunds or credits to customers to make up for past excess profits. Thus, a utility can keep all the profit it can make. To be sure, the system also provides an incentive to reduce some types of costs. This aspect of the current regulatory system should not be lost when searching for new regulatory mechanisms.

THE "FUEL ADJUSTMENT CLAUSE" In its understandable quest to maximize profits, a utility's most powerful incentive for selling more electricity is hidden in its fuel adjustment clause. Some 40 to 50% of the price of electricity is determined by the cost of fuel. (In 1987, the national average price of electricity was about 6.5 cents per kWh.) This cost is subject to considerable volatility, especially for oil and gas. To insulate utility shareholders from the impact of fluctuating fuel prices on earnings, nearly all states allow utilities to adjust customer prices periodically so that changing fuel costs do not affect profits, according to the National Association of Regulatory Utility Commissioners (NARUC) (6) and several state commissions.

NO REASON TO CONSERVE FUEL The "fuel adjustment" protection operates whether a utility's total fuel bill increases because of rising prices, or because more fuel is used to satisfy an increased demand for electricity. A utility that spends more than it has projected on fuel can raise the price of all electricity to spread the excess cost among its customers. If, however, it spends less than projected, the utility must pass on the savings to consumers through lower rates. Thus, the utility has little (or no) direct economic incentive to conserve fuel or to purchase the lowest-cost fuel. As always, the risk that regulators will detect and punish wasteful practices will be present.

Utilities even make money when they sell power for what initially appears to be less than it costs to produce. For example, to meet increased demand during peak periods, a utility may crank up a relatively inefficient diesel generator that consumes 10 cents worth of fuel to produce one kilowatt-hour (kWh) of electricity. The regulated price of power might be seven cents per kWh, which represents five cents in fixed costs and two cents allotted for the utility's "average" fuel costs. But the utility can recover the extra eight cents in fuel costs later (that is, the generator's 10-cent fuel cost minus the two-cent average fuel cost) by invoking the fuel adjustment clause to raise rates. In effect, the utility charges customers 15 cents for the kWh, seven cents now and eight cents later, through the true-up provisions of the fuel clause. Meanwhile, the five-cent nonfuel, or base part of its rate remains in place, contributing to its bottom line.

There are at least two reasons perhaps not to eliminte a fuel adjustment clause entirely, and adopt declining block rates with the tail block rate equal to or less than the utility's marginal fuel cost as a solution to the problem. First, there may be sound reasons for retaining some aspects of fuel clauses. For example, without fuel clauses, for utilities dependent on oil or gas, volatile fuel prices would be the primary determinant of profits. If utilities have no significant control over fuel prices, little could be gained by exposing them to this risk. Second, setting tail block rates at or below the cost of fuel would give customers the wrong price signal and would therefore seriously undermine the goals of LCP. For LCP to work, customer prices for incremental consumption should reflect the full cost of new resources.

RECOVERY OF FIXED COST Generally, in the short term, incremental sales of power to existing customers add no costs other than for the fuel needed to produce the power. In contrast, new customers require new meters, poles, wire, and additional customer accounting costs.

In short, the combination of price-setting and accounting practices means that each kWh sold includes a piece of nonfuel cost-recovery even when there are no additional nonfuel costs. Even when the marginal sales price is equal to or less than the marginal fuel cost, utility accounting continues to treat a part of the sales price as a contribution to nonfuel cost. This means each kWh sold adds to earnings.

The incremental contribution to the bottom line occurs whether the sale takes place before or after the utility has reached its projected level of sales. A nickel made on the sale of the first kWh is the same as a nickel made on the sale of the millionth or billionth kWh. A common misconception is that the disincentive to conserve exists only if the utility has sold less electricity than was assumed when prices were set. The incremental effect of sales or conservation on earnings is the same regardless of the level of sales.

Similarly, the incremental effect on profits remains undisturbed by a utility's achieved rate of return. Stated most simply, an incremental five cents is five cents whether it comes when the utility is earning an 8%, 12%, or 16% rate of return. While much of this discussion has described the effect of sales on profits, the effect of not selling power is the same. Each kWh not sold, or conserved, has a negative effect on earnings.

SELECTING AND IMPLEMENTING REGULATORY REFORMS

Incentives and disincentives embedded in the current system of regulation present serious obstacles to the successful implementation of LCP. This fact is now well accepted by regulators. In July of 1989, NARUC adopted a resolution that concluded that regulatory reform was needed to remove the disincentives to LCP and to make a utility's least-cost plan its most profitable venture. The resolution is set forth in its entirety below:

Resolution in Support of Incentives for Electric Utility Least-Cost Planning

WHEREAS, National and International economic and environmental conditions, long-term energy trends, regulatory policy, and technological innovations have intensified global interest in the environmentally benign sources and uses of energy; and

WHEREAS, The business strategy of many electric utilities has extended to advance efficiency of electricity end-use and to manage electric demand; and

WHEREAS, Long-range planning has demonstrated that utility acquisition of end-use efficiency, renewable resources, and cogeneration are often more responsible economically and environmentally than traditional generation expansion; and

WHEREAS, Improvements in end-use efficiency generally reduce incremental energy sales; and

WHEREAS, The ratemaking formulas used by most state commissions cause reductions in utility earnings and otherwise may discourage utilities from helping their customers [illegible]

WHEREAS, Reduced earnings to utilities from relying more upon demand-side resources is a serious impediment to the implementation of least-cost planning and to the achievement of a more energy-efficient society; and

WHEREAS, Improvements in the energy efficiency of our society would result in lower utility bills, reduced carbon dioxide emissions, reduced acid rain, reduced oil imports leading to improved energy security and a lower trade deficit, and lower business costs leading to improved international competitiveness; and

WHEREAS, Impediments to least-cost strategies frustrate efforts to provide low-cost energy services for consumers and to protect the environment; and

WHEREAS, Ratemaking practices should align utilities pursuit of profits with least-cost planning; and

WHEREAS, Ratemaking practices exist which align utility practices with least-cost planning; now, therefore, be it

RESOLVED, That the Executive Committee of the National Association of Regulatory Utility Commissioners (NARUC) assembled in its 1989 Summer Committee Meeting in San Francisco, urges its member state commissions to

1. consider the loss of earnings potential connected with the use of demand-side resources; and
2. adopt appropriate ratemaking mechanisms to encourage utilities to help their customers improve end-use efficiency cost-effectively; and
3. otherwise ensure that the successful implementation of a utility's least-cost plan is its most profitable course of action.

Recognizing the existence and extent of the problem is an important first step. The next step is to devise approaches that correct the problem.

Clearly, one approach to changing the incentives of the current regulatory regime is to scrap the existing rate base rate-of-return form of regulation entirely and begin with a clean slate. Even the current vertically integrated structure of the industry could be reconsidered. Changes of this scope should be considered, but any such massive alterations will come after long and heated national debate and may easily take years or decades to accomplish. Meanwhile, no progress will be made. This paper, therefore, addresses manageable changes to the existing system of regulation that can be accomplished within a reasonable time frame.

Three General Categories

At least a dozen different incentive plans have been proposed, but they all fall into one of three general categories: rate of return adjustments, shared savings, and bounty. For a thorough review of this subject, see Section Three of this author's recent NARUC publication (7).

RATE OF RETURN ADJUSTMENTS Utility prices are set to permit the utility to have a reasonable opportunity to earn a specific rate of return. Many incentive plans take advantage of this aspect of the rate-setting process by allowing (*a*) a higher rate of return if certain goals are achieved, (*b*) a higher rate of return on certain types of investments, such as investments in conservation and other demand-side management (DSM) programs, (*c*) an adjustable rate of return based on performance relative to other utilities, or (*d*) combinations or variations of the first three approaches.

SHARED SAVINGS By definition, investments in cost-effective DSM measures produce societal or customer savings. Many incentive plans are designed to identify savings in one way or another and to split the savings between consumers and the utility.

BOUNTY Each increment of power saved through an investment in energy efficiency has an identifiable savings to the utility. This last group of incentive plans builds on this fact and pays the utility a specified amount, i.e. a bounty, for each kilowatt (kW) or kilowatt-hour saved. Ordinarily, the bounty is some fraction of the savings attributable to the particular DSM measure.

Whichever direction is chosen, a regulatory reform plan and its implementation should not be held to an extremely high standard. Regulatory reform proposals should always be compared to the existing regulatory system. For example, under the current regulatory system, utilities operate under financial incentives that encourage all opportunities to sell electricity, whether efficient or inefficient. Regulators considering a regulatory reform proposal that may discourage utilities from promoting load growth should not ask if the plan is ideal, but whether such an incentive structure is better or worse than the existing incentive structure inherent in the current system.

Similarly, no regulatory system can eliminate the possibility that utilities might engage in actions which, if undetected by regulators, unjustly enrich the utility. The decision to implement an incentive plan that does not eliminate this possibility should be based on whether the motivation to engage in imprudent behavior is great, or whether such behavior would be more difficult to detect in the new plan than it is under the existing system.

Every proposal, no matter how well conceived, will have its weaknesses and peculiarities. Nevertheless, the plan should be judged in relation to other proposals and the extraordinarily bad incentives in the existing system of regulation. While the ultimate goal is to have a plan that is completely consistent with least-cost planning, as a practical matter, states should pursue proposals that significantly improve on the status quo.

Profit Maximizing Strategy

The remainder of this article presents a common framework of the most important considerations against which to test and evaluate each current and future alternative solution.

The single overarching standard against which proposed incentive plans should be measured is whether the new financial incentives will encourage the utility to implement a successful least-cost plan.

The critical test for an effective incentive proposal lies in the answer to this question: Viewed from the perspective of the utility, what course of action would be consistent with a profit-maximizing strategy?

Framework for Analysis

To simplify the evaluation process, regulators are starting with a list of questions that describe important considerations. For example:

1. What happens to profits if the utility sells another kWh?
2. What happens to earnings if sales are reduced by one kWh through conservation programs that cost $0.01 per kWh?, $0.02?, $0.10?
3. What happens to profits if a utility invests in load control and shifts a kW from on-peak to off-peak? What happens if the utility pursues a power marketing strategy?
4. What happens if the utility selects the more costly of two supply-side options; or the more costly of two demand-side options; or a supply-side option that is more costly than a demand-side option?.

Answering the questions requires detailed knowledge of all of the specific ratemaking and accounting practices used in the state. Of special importance are (*a*) the exact workings of fuel and purchased power clauses and associated reconciliation provisions, (*b*) any other ratemaking provisions allowing deferred expense accounting, including deferred accounting for conservation cost, and (*c*) rate design and revenue accounting provisions that affect the level of base revenue contributions of marginal sales of power to each customer class and for each rate period for time-of-use rates.

The utility's most profitable course of conduct should be to implement a successful least-cost plan. If the utility's most profitable course of conduct is to pursue programs that do not reflect a cost-minimizing plan while still promoting sales that are not cost-effective, the incentive plan fails to meet the primary criterion.

Regulatory reforms that have been tried thus far, and more specifically the implementation of incentive mechanisms to encourage investment in energy efficiency, miserably fail this simple test.

For example, treating utility conservation investment in the same manner as investment in power plants, i.e. ratebasing conservation investments, is not even a partial solution. The basis of this conclusion is explained later. The extra incentive provided by states like Washington, which not only ratebase conservation investments but also allow these particular investments to earn a higher rate of return, still fail the test.

The various incentive approaches implemented by the Wisconsin Public Service Commission also fail the test. These approaches have been relatively successful in causing utilities to invest heavily in demand-side management programs, but the success cannot be credited to regulatory reform that rewards energy efficiency.

There are many ways to reform the regulatory system correctly. Some of the approaches address the adverse earnings impact in three separate parts: lost revenues, DSM program cost-recovery, and incentive components. Other approaches are entirely different.

For example, consider a state that, like most, has a reconciled fuel adjustment clause, full recovery of all direct DSM program costs, and relatively high marginal fuel or production costs. Assume that "Utility X" has a marginal revenue or marginal price of five cents per kWh and a marginal fuel cost of six cents per kWh. (The five-cent price might be two cents of nonfuel base revenue and three cents of average fuel.) At first blush, a marginal kWh sold produces a net loss of one cent and "Utility X" would have no incentive to pursue this sale. On closer examination, however, the existence of the reconciled fuel clause means the entire six-cent marginal fuel cost will be returned to the utility. Because the utility is held harmless from the increased fuel cost, the sale that looked like a loss is, in fact, profitable.

If, on the other hand, "Utility X" pursues conservation, even zero-cost conservation, it will experience a net loss of earnings. The kWh saved means a five-cent revenue loss to "Utility X," which is not offset by any cost reduction because the six-cent fuel cost saving is passed on entirely to customers. "Utility X" realizes a net loss. Thus, the utility has an incentive to pursue a five-cent sale rather than zero-cost conservation, even though the kWh sold "cost" six cents to produce.

Consider how the incentives shift when the fuel clause reconciliation process is changed slightly and fuel costs continue to be reconciled for changes in fuel prices, but not fuel quantity. If the utility's fuel bill increases because fuel prices increase, it continues to be protected by the reconciliation, or true-up, provisions of the fuel adjustment clause, provided the amount of fuel the utility consumes is equal to the forecast. If, however, the total fuel cost rises because sales increase, the utility must bear the extra cost. Likewise, the utility keeps any reduction in fuel cost caused by lower sales resulting from successful DSM efforts.

In this case, the incremental six-cent fuel cost is borne by the utility if it sells another kWh, and it is a cost savings to the utility if it conserves a kWh.

Under these conditions, an incremental sale produces a one-cent loss, and zero-cost conservation produces a profit. With this simple change to just one aspect of the fuel adjustment clause, the sale of the marginal kWh would not be a profit-maximizing strategy. Instead, the new profit-maximizing strategy for "Utility X" would be to pursue energy conservation over increased sales.

Recall that "Utility X," like most utilities, recovers its DSM program costs separately so the six-cent fuel cost saving is not offset by the cost of conservation. In addition, recall that for this utility the marginal fuel cost exceeds its marginal revenue. This condition is very rare given today's relatively low fossil fuel costs.

Notice that in this example of an "incentive plan," no elements of the plan restore lost revenues or provide a separate DSM incentive. Yet, the utility's incentives are tied to the successful implementation of DSM programs. The effectiveness of this approach depends on the relationship of marginal fuel cost to the price of electricity. If the price of power exceeds the marginal fuel cost, this approach is only partially effective.

Unlimited Scope

Ideally, an incentive plan will encompass both demand and supply aspects of LCP. Indeed, trying to simplify the task of finding the right incentive plan by limiting the scope of the undertaking is probably a mistake. To date, most proposals tend to be limited to making DSM programs profitable and do not address the incentives to increase sales or any aspect of supply-side options. This should come as no surprise because the existing incentives for DSM are most skewed.

Limiting the scope of the undertaking will narrow the range of options available, and may needlessly eliminate approaches that fit well with ratemaking or accounting practices unique to the state. For example, an option that changes portions of the fuel adjustment clause would affect both DSM programs and sales incentives. Narrowing the scope of incentive plans to only DSM incentives will needlessly foreclose the use of this type of approach. Recall, the existing "incentives" are:

1. All sales, whether cost-effective or not, add to earnings; and
2. All conservation, whether cost-effective or not, is unprofitable.

The aim is to make only cost-effective selections, whether demand-side or supply-side, the profitable choice.

If a plan is limited to making DSM desirable, both sales and conservation would be profitable. While incentives limited to DSM represent a clear improvement, they stop short of producing a strategy that makes pursuing a least-cost plan the most advantageous course of action.

Measurement

Incentives resulting from any proposed reform plan will be greatly influenced by how, what, and when to measure. Consequently, measurement issues should not be viewed as merely technical when policymakers discuss the merits of different incentive options. Many incentive plans, especially those limited to the demand side, require measurement of both capacity and energy savings. In addition, plans that explicitly restore DSM-related lost revenues also generally require a measure of DSM-induced revenue loss.

Reliance on engineering and economic judgments, instead of actual measurement of capacity and energy savings, may be adequate for the purposes of program design. In contrast, regulatory incentive proposals not measuring actual achievements may result in the wrong underlying incentives.

For example, consider the substantially different incentives produced by an electric water heater insulation program under two incentive plans where the only difference is how and when program savings are measured. The first plan has kWh savings based on extrapolating test data, engineering estimates, or measurements made at other times (or in other states). The second plan is the same in all respects, except that program savings are based on random, statistically valid, on-site measurements of utility-installed measures.

Suppose, under the first plan, an agreement is reached that an electric water heater insulation blanket will yield 600 kWh per year in energy savings. Under this plan, the utility will be allowed to recover direct and indirect program costs, 600 kWh's worth of lost revenues, and an incentive based on any rational approach. For the purpose of this example, the exact nature of the incentive element is not important. The analysis is the same whether it is a shared savings approach or a fixed payment for each kWh saved.

What happens when the utility actually achieves 700 kWh in savings through better quality-control or other efforts under its control? It loses money!

In contrast, what happens when the utility selects poor-quality contractors and has inadequate quality-control efforts? Actual savings drop to 500 or 400 kWh per year, and utility profits increase!

Profits increase because the utility still recovers lost revenue based on an assumed 600 kWh savings when in fact not all of these revenues were lost. In addition, the incentive portion is unaffected by the lower actual savings. Solely as a consequence of a measurement decision, the utility's profit-maximizing strategy would be to select measures that would test well under the measurement criteria imposed, but perform poorly.

Under the second plan, where actual measurements of achieved results are used, what happens if the utility is able to achieve 700 kWh in savings? Profits go up. As it should be, earnings go down if the savings are less than

600 kWh. The profit-maximizing strategy's motive is to get more savings rather than fewer.

Decoupling Profits from Sales

Under current regulation increased sales always mean increased profits. As long as every increment kWh sold adds to profits, a strong likelihood remains that a profit-maximizing strategy will lead to more sales and less DSM, even if DSM programs are profitable. Even when a plan succeeds in making a kWh conserved more profitable than a kWh sold, perceived risks and unfamiliarity with DSM programs will tend to bias a profit-maximizing strategy toward sales.

This does not mean that all sales of electricity should be discouraged. Sales, however, should not be profitable regardless of the cost of electricity or the cost of alternatives, including energy efficiency.

Decoupling can take either of two forms. First, decoupling may merely eliminate the incentive to increase sales. This approach generally holds the utility harmless from fluctuating sales levels and provides no financial incentive or disincentive to increase or decrease sales. Several different approaches can accomplish this first type of decoupling.

The most widely known approach is California's Electric Revenue Adjustment Mechanism (ERAM). Under ERAM, the California commission establishes annual nonfuel revenue limits based on forecasted sales. The utility is allowed to collect only the established revenue limit regardless of the actual level of sales. Thus, if sales exceed the forecast level, the incremental nonfuel revenue is returned to consumers through the annual ERAM adjustment.

Other, very different, approaches can also accomplish very similar results. For example, fuel revenue accounting changes implemented in Maine set the nonfuel revenues from marginal sales equal to, or near, zero. The result is that incremental sales do not add to profits. This has been accomplished by changing accounting rules that generate no changes in retail prices.

Interestingly, plans that incorporate recovery of only lost revenues specifically attributed to efficiency programs do not decouple profits from sales. At most, this approach links conservation to profits the same way sales are already linked to profits. The disincentive to energy efficiency is removed, but the overall incentive to sell power remains intact. Sales are always profitable regardless of the cost of producing the power. Oddly, consumer advocates often favor this approach because it is more limited in scope than an ERAM-type approach. In fact, this approach presents the worst choice for consumers. First, this approach does not decouple profits from sales, and second it is an adjustment that always works in one direction, providing more revenue to the utility. In contrast, ERAM does decouple and it refunds money to consumers if sales increase.

The second form of decoupling is with the use of plans that provide incentives when sales are decreased by cost-effective DSM measures and disincentives when sales increase. For example, plans that increase a utility's rate of return if customer bills decrease, and decrease rate of return when customer bills increase, can decouple profits from sales even though there is no lost revenue adjustment. Because only a few incentive plans decouple profits from sales in this fashion, it is necessary to combine most incentive plans with separate decoupling options to produce the most desirable overall incentives.

Cost Minimization

Will the proposed program encourage the utility to deliver conservation programs at the lowest cost to consumers?

Consider two incentive plans, both of which measure actual achieved conservation results. The first pays the utility a predetermined, fixed amount for each kWh saved. The fixed payment will be less than the utility's avoided cost and will therefore help ensure that only cost-effective efficiency is purchased. The payment covers direct program cost and an incentive for the utility. The second plan pays the utility 110% of its actual program costs for each kWh actually saved.

To maximize profits under the first plan, the utility will try to reduce its cost of saving kWhs to maximize the difference between the fixed payment it receives and its out-of-pocket costs. To maximize profits under the second plan, the utility would get as much conservation as it could, regardless of the cost.

Generally, plans should be designed to encourage utilities to obtain DSM savings at the lowest possible cost.

Administrative Simplicity

Achieving significant reform of a regulatory system that has been in place for nearly a century will require substantial public and political support. Gaining the needed support will be difficult if the proposed plan is too complex or obscure.

Incentive plans should be simple and efficient to administer, or the cost of regulation may outweigh the benefit. The cost of regulation includes items such as the cost to the regulatory commission of administering the system, the cost to the utility of collecting and reporting any additional information, and the cost to all parties of participating in any new regulatory proceedings that may be needed.

In practice, this principle means avoiding incentive plans that rely on complex formulas or unverifiable measurements. For this reason, policymakers may want to avoid approaches that require separate proceedings in favor of plans that can be implemented within the framework of existing regulations.

Balance

Incentive proposals should have a reasonable risk/reward relationship. Once measurement criteria are set, superior performance should yield higher earnings and inferior performance should yield lower earnings. The plan should not provide utilities with unreasonable opportunities to profit at the expense of ratepayers, nor should the plan deprive the utilities of a reasonable opportunity to earn a fair return. While this discussion may seem self-evident, there are plans outside the scope of this article that run afoul of this consideration.

To gain public acceptance and increase the likelihood that an incentive plan will produce the desired result, the plan should operate symmetrically, i.e. rewarding superior and punishing inferior performance. Incentive plans that only reward utilities for good performance and have no effect when performance is poor will be criticized as being unfair and ineffective.

Fuel Switching

Will the plan reward, punish, or be indifferent to programs that achieve cost-effective fuel switching by customers?

Instances exist in which large electricity and overall energy efficiency savings are feasible through fuel-switching programs. Even so, the availability of fuel switching as an element of a least-cost plan varies from state to state.

In some instances, switching may occur from electricity to natural gas, while in others, electricity is exchanged for a renewable fuel, for example, solar or wood. In either case, alternative incentive plan evaluations should consider how electric utility profits change as a result of customer fuel switching. Of course, under the current system, electric utilities generally discourage fuel switching, no matter how cost effective, because it always means lower profits.

Environmental Costs

Many states that have adopted LCP also attempt to incorporate environmental externalities in the planning and decision-making process. Traditional utility planning has always included consideration of a utility's directly incurred environmental control costs. Thus, the cost of building and operating a sulfur dioxide scrubber is reflected in the cost of a new coal-fired power plant. Even a scrubbed coal plant, however, emits pollution whose environmental damage is neither borne by the utility nor reflected in its prices. In increasing numbers, states attempt to take these externalized costs and reflect them in the LCP decision process.

None of the general approaches to incentive plans expressly consider environmental externalities. Nevertheless, once a state has decided how to incorporate environmental concerns in its decision-making process, reflecting that decision in any of the alternative plans is not difficult.

To illustrate, a state might decide that its consumers and society overall would be served by imposing a 20% economic penalty for fossil fuel sources of generation when making its resource decisions. In other words, a state might decide that ratepayers and society would be better off paying 20% more for electricity, but saving the costs that higher levels of pollution would cause. Incorporating this type of decision into an incentive plan means that the utility's correct decision to select a 20% more expensive but cleaner option should not jeopardize its efforts to achieve the same earnings level it would have without the clean option selection. Thus, special attention should be paid to any incentive plan that measures performance against a standard without the same 20% environmental cost premium.

Nonparticipant Impacts

Is the proposed program designed to minimize nonparticipant impacts? Depending on the utility's average and marginal costs and the state-specific mechanisms for DSM cost recovery, DSM programs may have adverse impacts on average prices, thereby raising prices and bills for customers who do not participate in DSM programs. Rates for participating customers increase as well, but the DSM program causes their bills to decrease.

As a general matter, the nonparticipant impact of even very large DSM programs is much smaller than the impact of supply-side options. [Cavanagh (8) has a more complete discussion of this and related topics.] Nevertheless, incentive plans can be structured to encourage utilities to design DSM programs in ways that minimize nonparticipant impacts. Generally, however, three steps can be taken that may address this concern.

First, a number of the variations of alternative plans provide incentives to minimize the costs of energy-efficiency programs. Minimizing the cost of energy efficiency will tend to minimize nonparticipant impacts.

Second, plans can be designed to provide incentives for utilities to obtain as much contribution as possible from participating customers. The greater the customer contribution toward energy efficiency, the lower any nonparticipant impacts. For example, rate-of-return adjustments based on average customer bills can exclude from the bill calculation of any direct participant contribution. The greater the participant contribution, the larger the apparent bill savings and the larger the incentive. This approach, however, tends to undermine the level of participation in energy-efficiency programs and, thus, may be counterproductive.

Finally, nonparticipant impacts may also be addressed by ensuring that energy-efficiency programs are widely available to all customers and all customer classes. Wide program availability will tend to minimize the number of nonparticipating customers.

Skimming the Cream

Will the proposed incentive plan encourage the utility to engage in cream-skimming programs, and, if so, how much of a concern is that practice?

Skimming the cream in this context means designing and carrying out only the lowest-cost measures while leaving behind other cost-effective opportunities for energy efficiency. The most common example occurs in new construction, where cost-effective measures left out at the time of construction are prohibitively expensive to fix later.

In another example, commercial lighting retrofits might cost two cents per kWh saved, while heating and cooling improvements might cost four cents if done on the same trip, but six cents if done separately. An incentive program that paid the utility five cents for each saved kWh might cause the utility to improve the lighting and earn three cents while forgoing the four-cent cooling improvement that would have netted only one cent. An incentive plan that paid the utility three cents for lighting and five cents for heating and cooling would net the utility the same one cent for both projects. In this case, one might still encounter another type of cream skimming where the utility pursues only the easiest lighting and heating opportunities.

The most important reason to avoid cream skimming is that cost-effective opportunities will be permanently lost and consumers will pay more than necessary for energy services. In all cases, the DSM opportunities at risk are cost effective, but the payback on the less cost-effective measures is below the hurdle rate for the investing entity.

Of course, in comparison to existing regulation, a plan that suffered only from the potential for cream skimming would be a vast improvement over the current system. Nevertheless, one should be aware of the possible problem and the available solutions, including solutions outside of an incentive plan itself. Cream-skimming potential is generally the greatest with plans that provide strong incentives to utilities to minimize the cost of energy efficiency.

In general, there are three ways to lessen the potential for cream skimming. First, some level of regulatory oversight of program design can be retained to ensure that cream-skimming programs are not implemented. This is the current approach, and this level of regulatory oversight could continue even with significant reforms of financial incentives associated with DSM program implementation. In addition, experience with collaborative design efforts in New England suggests utilities and energy-efficiency advocates can work together to design conservation programs in which cream-skimming potential is minimized.

Second, any of the incentive plans may be implemented in a more disaggregated fashion. For example, bounty plans can be established to create different bounty levels for different types of programs. Lower bounties for relatively inexpensive conservation measures, and higher bounties for more expensive programs, would tend to minimize any financial incentive to pursue cream-skimming opportunities.

Third, plans that allow utilities to recover actual program costs separately from incentive plans tend to remove cream-skimming incentives. This approach, however, also removes the incentive to minimize program costs.

Predictability

While regulators will always maintain a wide range of discretion in rate-setting proceedings, incentive proposals that clearly lay out guidelines and expectations are likely to motivate utility managers more than alternatives that rely heavily on the exercise of commission discretion. An extreme example of a plan that relies on commission discretion consists of a general promise by regulators that a utility will be treated generously if it succesesfully pursues any LCP.

Regardless of how responsible, consistent, and objective regulators are, suspicion will always exist between regulatory commissions and utilities. Even where there is no distrust, the relatively short tenure of most commissioners—about four years in the United States—adds to the lack of predictability of approaches that rely on commission discretion. Consequently, incentive proposals that rely on the discretion of commissioners may not achieve full potential in motivating utility managers, even if the commission discretion is always exercised in a responsible manner.

Predictability does not mean that the utility should know in advance, or be guaranteed, a particular level of earnings. Rather, the utility must know that a specific accomplishment will produce a particular and predetermined effect. The greater and more immediate the cause and effect, the more likely it is that the regulatory incentives will have a positive influence on utility managers. Similarly, incentives that reward promptly, rather than in the distant future, will be most effective.

Avoid Gaming

Any regulatory system, including traditional utility regulation, is subject to efforts by parties to engage in short-term "gaming." Simple manipulations, like the timing of rate case filings, or the timing of certain maintenance expenses (such as plant maintenance or tree trimming), which can be deferred or accelerated, can have a significant effect on the utility's bottom line. Care should be taken when selecting and designing regulatory proposals so that the opportunity for gaming is no greater than it is already.

One way to lessen the incentive for manipulation is to ensure that the implemented plan will remain in effect long enough to make such gaming risky. In addition, short-term gaming temptations would be minimized by allowing the capitalization and amortization of DSM program costs in a way

that bears some relationship to program benefits. A recent study by the Alliance to Save Energy includes an excellent discussion of this issue (9).

Distribution of Incentives

The effectiveness of economic incentives is a function of where the incentives are directed within the utility company, i.e. shareholders, managers, employees, etc. Regulatory incentives that benefit only distant stockholders will not be as effective as incentives that are at least in part directed toward utility executives and managers responsible for the successful, or unsuccessful, implementation of the least-cost plan.

Many utilities already have incentive compensation plans, which may or may not be consistent with LCP incentive plans. For example, a compensation plan that weds the salary of a plant manager to heat rate may be compatible with LCP, while a compensation plan tied to sales levels would not.

One New England utility bases its incentive rewards to top managers on its rates relative to other New England utilities and on the company's earnings per share. By selecting relative rates instead of bills, managers' salaries go up if there is little or no conservation, and down if the company succeeds in implementing substantial amounts of cost-effective efficiency. The same is true for earnings per share. Earnings go up if sales increase.

Effects of External Causes

One criticism of some proposals is that they fail to hold utilities harmless from factors outside the utility's control. The entire notion of holding utilities harmless from factors outside their control is a subject in itself, and is unique to regulated industries. In the context of regulatory reform, critics often point out that particular proposals result in benefit or harm that flow from plant performance, fuel prices, economic conditions, etc. While regulators are generally sympathetic to some or all of these concerns, it is worth noting that competitive businesses are subject to the same considerations and are not held harmless. To be sure, the differences in the risk profiles of various industries can and should be reflected in allowed rates of return.

Generally, however, it makes little sense to have regulatory incentives to which the utility manager cannot respond. Therefore, regulatory incentive plans should attempt to hold utilities harmless from factors truly outside their control. For example, weather is outside a utility's control, and no useful purpose is served by allowing profits to be subject to sales fluctuations caused by weather. Both weather and economic conditions can have a significant effect on utility sales and earnings. Indeed, the strong economy and hot weather of recent years have increased utility earnings.

Unless utility profitability is somewhat insulated from the influence of some outside factors, such as the price of fuel, the earning fluctuations occasioned by these factors may be so large in relation to the desired regulatory incentives that the incentives become ineffective. For example, consider a plan that allows a utility's rate of return to rise or fall up to 100 basis points based on DSM program performance, but also removes all financial protection from changes in fuel prices. Once the 100 basis point cap is reached, the incentive plan is ineffective. Thus, if utility managers reasonably expect that the cap will always be hit owing to changing fuel prices, the incentive plan will be much less effective than intended.

TIME FOR CHANGE

The system of regulation used in this country for electric utilities runs afoul of national and state energy policy and, most of all, it runs afoul of common sense. Fortunately, the regulatory system was made by people and it can be changed by people. For significant regulatory reform to spread nationwide, action is needed on several fronts. First, federal legislation calling for change in state and federal regulatory systems and endorsing least-cost planning can prove an important catalyst.

By way of example of the government's potential clout, in 1978, Congress passed the Public Utility Regulatory Policies Act (PURPA), which established an entirely new policy framework within which state utility regulators were to encourage the development of cogeneration and small power-production facilities. Under PURPA, utilities were required to purchase electricity from such facilities at fair market prices. Cogeneration and small power-production plants were scarce when the act was passed—but today they are major components of the nation's electrical grid system. Indeed, they have accounted for more new generating capacity than has been added by the utility industry itself.

Fortunately, federal help may be forthcoming. Representative Claudine Schneider's (R-RI) Global Warming Prevention Act would, among other things, provide $10 million "to assist states in addressing the various issues related to removing incentives against LCP, which exist in the current system of state and federal regulations." This would support activities such as studies to develop alternative utility rate-setting strategies, pilot projects in several states to assess alternatives, and widespread dissemination of the results through conferences and publications.

The bill also calls for adding energy conservation to the mandates in PURPA, so utilities would be required to "buy" cost-effective energy-efficiency improvements from outsiders. For example, utilities would be required to reimburse homeowners for installing home energy-efficiency improvements that save electricity (for the cost of the improvement less the

cost to produce the energy saved). Utilities would also have to pay energy service companies that could provide energy savings at a cost below the going rate for energy supply. The companies would deliver the savings by making conservation improvements in homes and businesses at no charge to the owner.

The National Energy Efficiency Act of 1989 proposed by Senator Tim Wirth (D-CO) and cosigned by more than a dozen lawmakers, has similar features. But it would go a step further in fostering LCP by establishing federal rate-setting standards that states must adopt within two years. The standards would require that the prices electric (and gas) utilities could charge "shall be such that the implementation of least-cost supply measures [including conservation] permit the utility to realize higher earnings than would be realized from the implementation of other supply measures."

Both the Senate and House of Representatives versions of the climate change bills cover a broad range of issues, which span the jurisdiction of many separate committees and subcommittees. Consequently, individual parts of the bills are being separated and inserted into other pieces of legislation.

For example, in 1989, Congress approved the Foreign Operations Appropriation, which placed LCP conditions on projects funded by the US Agency for International Development. Similarly, LCP conditions were placed on the World Bank when Congress passed the 1989 International Bank Reauthorization. Both provisions were direct outgrowths of the more expansive climate change bills in the House and Senate.

Potent federal action is also outlined in bills introduced into the House of Representatives in 1988 and again in 1989, aimed at reducing acid rain damage. Acid rain cleanup cost-sharing arrangements limit funds for acid rain cleanup to states that reformed their utility rate-setting systems to encourage LCP. Other acid rain control bills that do not embody cost-sharing condition other benefits on rate reform. Provisions like these need to find their way into new acid rain legislation. After all, the conservation measures that would be fostered by LCP represent a cheaper way of ensuring an adequate supply of electricity than does burning sulfur-rich coal, while providing tremendous environmental benefits in the bargain.

Although federal legislation can help set the agenda, responsibility for implementing regulatory reform rests with the states. The ratemaking process is so rigidly spelled out in some states that entirely new laws will be needed. In many states, however, lawmakers simply need to pass enabling legislation granting authority to public utility commissions to require some form of LCP. Indeed, a number of states are beginning to consider such action.

To help speed progress, organizations with expertise can develop model state laws, which are frequently adopted by state legislators and ultimately find their way into practice. The National Audubon Society, with chapters in each state, often drafts model laws on environmental issues and has already expressed interest in utility reform. Other groups capable of doing the job are the National Governors' Association, the council of State Governments, and NARUC.

Of course, the buck always stops with the public utility commissions. Fortunately, progress has been better than expected. As a result of NARUC's recent resolution, more than a dozen states are racing toward implementation of reform plans.

So change is in the wind—but it's been a long time coming. When electric generating companies were first being established, Thomas Edison foresaw difficulties with the emerging incentive structure. He preferred to sell lighting instead of kilowatt-hours and was convinced that utilities would strive to achieve maximum efficiency and reduce customer costs if their profits were tied directly to customer satisfaction. He failed to convince enough people of the desirability of this approach. Now opportunity knocks again. Overthrowing a century of tradition is never easy. But the many benefits promised by regulatory reform, as well as the problems that will multiply if utilities continue with business as usual, leave no choice but to act.

Literature Cited

1. Flavin, C., Durning, A. B. 1988. *Building on success! The age of energy efficiency. Worldwatch Paper No. 82*, p. 8
2. Keelin, T. W., Gellings, C. W. 1986. Impact of demand-side management on future customer electricity demand. *EPRI EM-4815-SR*. Palo Alto, Calif: Electr. Power Res.
3. Lovins, A. 1989. The great demand-side bidding debate rages on. *Electr. J.* 2:2
4. Ketcham-Colwill, J. 1989. Acid rain: science and control issues. *Environment & Energy Study Institute Special Report July 12, 1989*. Washington, DC
5. MacKenzie, J. J. 1989. *Breathing Easier: Taking Action on Climate Change, Air Pollution, and Energy Insecurity*. Washington, DC: World Resour. Inst.
6. Natl. Assoc. Regul. Util. Comm. (NARUC). 1986. *Annual Report on Utility & Carrier Regulation 1986 Ed.*, pp. 415–16. Washington, DC: NARUC
7. Moskovitz, D. H. 1989. Alternative approaches. *Profits & Progress Through Least-Cost Planning*, 3:15–44. Washington, DC: NARUC
8. Cavanagh, R. 1988. Responsible power marketing in an increasingly competitive era. *Yale J. Regul.* 5:331. New Haven: Yale
9. Reid, M. 1987. *Ratebasing of Conservation Program Costs*. Washington, DC: The Alliance to Save Energy

Increasing the Efficiency of Electricity Production and Use: Barriers and Strategies

David Moskovitz
Steven Nadel
Howard Geller

American Council for an Energy-Efficient Economy
1001 Connecticut Avenue, N.W. #801
Washington, D.C. 20036

Energy Efficiency Issues Paper #5

November, 1991

SUMMARY

Our focus is on the nation's energy policy as it relates to electricity.

We begin by examining the implications of staying with existing policies and find that our failure to invest more heavily in energy efficiency will increase consumption and consumer bills, thereby eroding the United States' competitiveness in the global economy, and worsening our standard of living. Under existing policies, a large number of new power plants will be needed, plants that are expensive to build, risky to finance, and difficult to site. Furthermore, existing policies leave emissions of carbon dioxide and nitrous oxides largely unaddressed, and do little to reduce imports of oil for use in power plants.

Next, we explore the causes for low investment in energy efficiency, including market barriers which inhibit the adoption of cost-effective efficiency measures, meager utility efforts to promote efficiency, regulatory processes which discourage utility investment in energy efficiency, low and poorly structured electricity prices, underinvestment in power plant efficiency, and low levels of federal and private funding of energy efficiency.

We then offer alternative policies -- policies which lead to a different future. These policies include:

- Adopt least-cost planning at the state level, allow states to join together to adopt regional least-cost plans, require federal regulatory decisions to be consistent with state and regional least-cost plans;

- Reform state and federal regulatory practices to remove disincentives to least-cost planning by decoupling utility profits from the level of sales. Also adopt positive incentives for pursuing implementation of least-cost plans.

- Increase utility efforts in efficiency including the number of utilities offering programs, and the breadth and quality of programs each utility offers;

- Amend federal laws to give energy efficiency vendors the same benefits currently possessed by cogenerators -- the right to sell power to utilities whenever the saved power is less costly than alternative power supplies;

- Reflect all costs, including environmental costs, in energy pricing and planning. Initially environmental costs may only be included for planning purposes, but over the long-term environmental costs should be included in all energy prices through the substitution of energy taxes for other taxes;

- Adopt innovative price structures including time-of-use rates, interruptible rates, and hook-up fees; abolish preferential price structures under which electricity is sold for less than its long-run marginal cost;

- Strengthen building codes and equipment efficiency standards including adoption by the states of current and improved state-of-the-art building codes,

adoption by the federal government of improved efficiency standards for products which are currently regulated, and adoption by the states and federal government of efficiency standards for new products such as lights and motors;

- Promote more efficient generation options through research, development, and demonstration efforts. a revenue-neutral system of fees for inefficient plants and incentives for efficient plants, and possibly, efficiency standards for new and/or existing power plants;

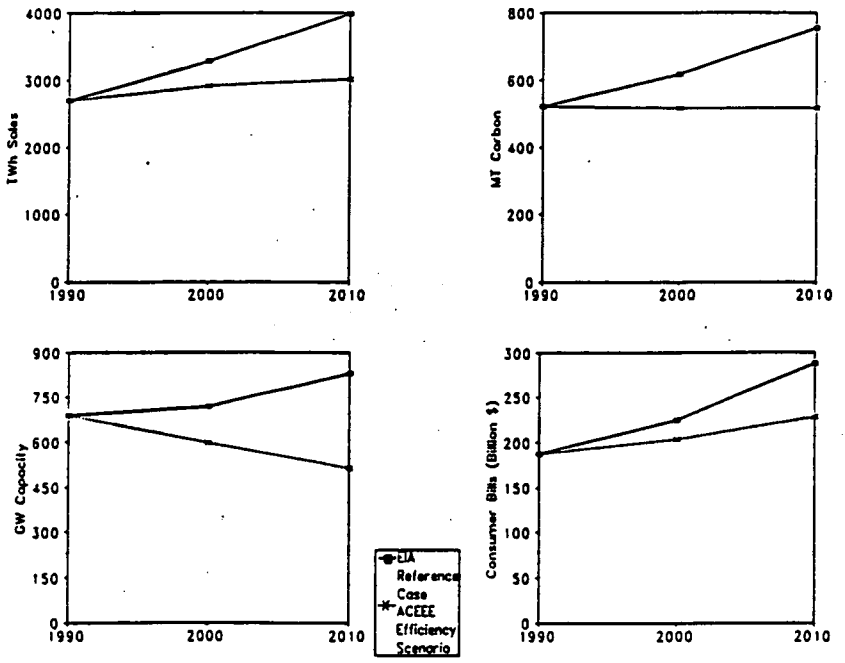
- Increase efficiency R&D efforts including efforts by DOE and EPRI; form development of state R&D centers in states which presently do not have such centers.

Finally, we conclude with an analysis of the savings that could result over the 1990-2010 period if our recommendations are adopted. In particular, we examine a mix of new power plant construction and increased investment in energy efficiency that can best meet the nation's economic and environmental needs. Our conclusions (which are summarized in Table 1 and Figure 1) are quite simple: relative to levels predicted by the U.S. Energy Information Administration in its most recent base case forecast, growth in electricity sales can be reduced by more than 70% (reducing the annual growth rate to 0.5%), the need for generating capacity will actually decline, carbon dioxide emissions from the electricity sector can be held to 1990 rates, and consumer electricity bills in 2010 will decline by 16% in real terms from present day levels, representing nearly $60 billion in savings in 2010.

Table 1. Summary of Estimated TWh, GW, and Carbon Savings from Adoption of Strategies Recommended in this Paper

	TWh Sales		GW Capacity		MT of Carbon		Consumer Bills (billion 1990$)	
	1990	2010	1990	2010	1990	2010	1990	2010
EIA Reference Case	2700	3985	689	830	522	755	$187.4	$287.7
Annual growth rate	--	2.0%	--	1.5%	--	2.0%	--	2.2%
Demand-side savings								
Codes and standards	0	407	0	157	0	77		
Utility DSM programs	0	568	0	158	0	108		
Total	0	975	0	315	0	185	$0.0	$59.5
ACEEE Post DSM Case	2700	3010	689	515	522	571	$187.4	$228.2
Annual growth rate	--	0.5%	--	-1.4%	--	0.4%	--	1.0%
Supply-side savings					0	53	$0.0	$4.9
ACEEE Efficiency Case					522	518	$187.4	$223.3
Annual growth rate					--	0.0%	--	0.9%

Figure 1. Comparison of EIA Reference Forecast with ACEEE Efficiency Scenario.



SENATOR GORE. Well, thank you very much. We appreciate your testimony.

Mr. Fox, we'll have questions, but they'll be after the panel has concluded.

Mr. Fox, please proceed.

STATEMENT OF JOHN C. FOX, MANAGER, ENERGY EFFICIENCY SERVICES, PACIFIC GAS AND ELECTRIC, SAN FRANCISCO, CALIFORNIA

MR. FOX. Mr. Chairman, I am the manager of Energy Efficiency Services at Pacific Gas and Electric in San Francisco. I'm pleased and honored to testify today on the economic and environmental benefits of PG&E's energy efficiency programs.

As I think you stated earlier, PG&E is the Nation's largest investor-owned gas and electric utility. We serve 11 million Californians from the Oregon border south to Santa Barbara. We have been in this business for over 100 years.

For us, energy efficiency is understood from a system perspective. We have provided energy efficiency services to our customers for more than two decades. We also pursue supply efficiencies, including renewable energy, high efficiency gas conversion technologies, as well as efficiencies in the transmission and distribution systems.

Over the past ten years, we have demonstrated beyond reasonable doubt that energy efficiency and renewable technologies can be the foundation of an electric supply strategy for California and, to a large extent, for the United States as a whole.

PG&E plans to meet 75 percent of electric load growth projected for the 1990s, with customer energy efficiency. These programs will save the equivalent of 2,500 megawatts of power generation. The remaining load growth will be met with renewable generation and more efficient use of existing facilities and of the distribution grid.

We are encouraged that over the past two years, we have exceeded our ambitious annual energy savings goals.

Our confidence in relying so heavily on energy efficiency is based on our belief that the market potential for cost-effective energy efficiency is large and, I stress, cost-effective. Our own very conservative studies conducted in 1988 and 1989 suggest that in excess of 25 percent of current electric use could be saved. Later studies by the Electric Power Research Institute suggest a range of 22 to 44 percent, while Rocky Mountain Institute claims that up to 75 percent could be saved.

Our ability to capture these potential savings offers us and our customers the opportunity to reduce costs and increase productivity and competitiveness, while significantly reducing the adverse environmental impacts associated with energy production and use.

We support the theory that the marketplace should determine the amount and type of each energy option used. However, it's our sad

experience that the marketplace for energy efficiency technologies contains significant and pervasive barriers that preclude widespread adoption of even the most cost-effective efficiency measures.

A detailed description of these barriers is contained in the earlier PG&E testimony which was provided for the record. These barriers range from lack of customer information to the lack of qualified technicians, the separation of buyers of equipment from the users of equipment, and the regulatory systems that encourage supply-side investments over demand-side investments.

We believe that a coordinated effort by utilities, customers, the private sector, regulators, and state and federal governments is necessary to overcome these barriers.

California and an increasing number of states have reformed regulatory processes to remove disincentives from pursuing energy efficiency and have, in some cases, rewarded utilities for successful energy efficiency programs.

In this environment, PG&E has increased its energy efficiency efforts. We now plan to spend over $2 billion in the next decade on 40 programs that will provide cost-effective energy opportunities to all customer classes.

It has been our experience that every customer, even those with relatively aggressive efficiency programs, have significant untapped opportunities for cost-effective investments in energy efficiency.

Also included in our earlier testimony is a general description of the programs.

Our market research tells us that customers place a high value on these programs. For commercial industrial customers, these efficiency improvements increase productivity and reduce costs, both of which lead to higher profits and enhanced competitiveness in national and world markets.

For residential customers, our assistance to help control energy costs is a key determinant of customer satisfaction and increased disposable incomes.

Average customer bills are lower because of our programs. Put another way, these cost-effective efficiency investments result in society paying less for energy than they would if we constructed more power plants.

In the case of PG&E, we estimate that net of program cost, we will collect $2.4 billion less from our customers this decade than we would have had to if we had constructed power plants. We estimate customers would spend about $1.1 billion on energy efficiency equipment, leaving $1.3 billion available for other nonenergy purchases of equipment that stimulate the economy and create new or additional jobs.

Our experience also shows that substantial air emissions reductions are possible commensurate with a net savings to the economy. Due to PG&E's energy efficiency efforts, air emissions in this decade will be reduced by 20 million tons of carbon dioxide, 27,000 tons of nitrogen oxides, and over 5,000 tons of sulfur dioxide. An equivalent energy efficiency program in many other parts of the country would have even

greater environmental impacts since PG&E reliance on fossil generation is below the national average and is limited almost exclusively to natural gas.

I'd like to conclude by turning briefly to the barriers to adoption of energy efficiency and possible roles for state and federal governments.

Energy legislation now pending before Congress will be helpful. In the energy efficiency area, we are particularly pleased with the new labelling and standard-setting activities for motors, office equipment, and heating and cooling equipment, and with steps to encourage states to reform utility regulation.

We hope that the Congress will also take steps this year to eliminate taxation of utility rebates as income, which could prove to be a significant impediment to the marketing of efficiency programs.

Carrying out the legislative intent will require vision and initiative of both federal and state governments. PG&E is pleased with the regulatory support in California, but there's an opportunity to improve support in other parts of the country.

In many states, significant changes in regulatory policy will be needed to give energy utilities a balanced choice between efficiency and supply alternatives. Leadership and funding from the Federal Government will also be important to speed these changes.

The President and Congress have both recognized the example that federal agencies can set in using energy efficiency criteria for their own purchasing practices. In addition, goals for improving the energy efficiency of federal facilities will not only set an example and save substantial energy and money, but they will also provide an important stimulus to the service and manufacturing industries that provide energy-efficient products.

PG&E has embarked on a long-term strategy of reliance on energy efficiency and renewable energy as its prime sources of new electricity supply. No single program or strategy will work for all American utilities. But we believe providing them with incentives for efficiency investments will further the nation's drive for sustained economic growth and improvement in the environment.

I will be happy to take questions at your convenience.

[The prepared statement of Mr. Fox follows:]

PREPARED STATEMENT OF JOHN C. FOX

Mr. Chairman and members of the Committee, I am John Fox, and I am the manager of the Energy Efficiency Services Department at the Pacific Gas and Electric Company in San Francisco. I am pleased and honored to testify today on the economic and environmental benefits of PG&E's energy efficiency programs. I have attached to my statement the previous testimony submitted by PG&E to both the House and Senate during the 102nd Congress, which relates to the topic before you today.

PG&E is the nation's largest investor-owned gas and electric utility, serving 11 million Californians from the Oregon border south to Santa Barbara. We have over 100 years of experience in the energy arena and a reputation as an industry innovator.

For us, energy efficiency is understood from a system perspective. We have provided energy efficiency services to our customers for more than two decades. But we also pursue supply efficiencies, including renewable energy and high-efficiency gas conversion technologies, as well as efficiencies in transmission and distribution. Especially over the last ten years, we have demonstrated beyond a reasonable doubt that energy efficiency (broadly defined) and renewable technologies can be the foundation of electric supply strategies for California and, to a large extent, for the United States as a whole.

PG&E plans to meet 75% of electric load growth projected for the 90's with customer energy efficiency. These programs will save the equivalent of 2,500

MW of power generation. The remaining load growth will be met with renewable generation sources and more efficient use of existing facilities and of the distribution grid. We are encouraged that in the past two years, we have exceeded our annual energy savings goals.

Our confidence in relying so heavily on energy efficiency is based on our belief that the market potential for cost-effective energy efficiency is large. Our own very conservative studies suggest that in excess of 25% of current electric use can be saved. Later studies by the Electric Power Research Institute suggest a range of 22-44%, while Rocky Mountain Institute claims that up to 75% of current use can be saved.

Our ability to capture these potential savings offers us and our customers the opportunity to reduce costs and increase productivity and competitiveness, while significantly reducing the adverse environmental impacts associated with energy production and use.

We support the theory that the marketplace should determine the amount and type of each energy option used. However, it is our sad experience that the marketplace for energy efficiency technologies contains significant and pervasive barriers which preclude widespread adoption of even the most cost-effective efficiency measures. A detailed description of these barriers is contained in the earlier PG&E testimony I have provided. These barriers range from the lack of consumer information to the lack of qualified technicians, the separation of buyers of equipment from the users of equipment, and the regulatory systems that encourage supply side investments over demand-side investments.

We believe that a coordinated effort by utilities, customers, regulators and state and federal governments is necessary to overcome these barriers.

California and an increasing number of states have reformed regulatory processes to remove disincentives to pursuing energy efficiency and have in some cases rewarded utilities for successful energy efficiency programs.

In this environment PG&E has increased its energy efficiency efforts. We now plan to spend well over $2 billion in this decade on more than 40 programs that provide cost-effective efficiency opportunities to all customers. It has been our experience that every customer, even those with relatively aggressive efficiency programs, have significant untapped opportunities for cost-effective investments in energy efficiency. Also included in our earlier testimony is a general description of our programs.

Market research tells us that our customers place a high value on these programs. For our commercial and industrial customers, these efficiency improvements increase productivity and reduce costs, both of which lead to higher profits and enhanced competitiveness in national and world markets. For residential customers, our assistance to help control energy costs is a key determinant of customer satisfaction and increased disposable income.

Average customer bills are lower because of our programs. Put another way, these cost-effective efficiency investments result in society paying less for energy than it would if we constructed more power plants. In the case of PG&E, we estimate that, net of program costs, we will collect $2.4 billion less from our customers in this decade than we would if we met customer needs by building generating capacity. This is $2.4 billion that is available for other purchases or investments that stimulate the economy and create new or additional jobs.

Our experience also shows that substantial air emission reductions are possible commensurate with net savings to the U.S. economy. Due to PG&E's energy efficiency efforts, air emissions in this decade will be reduced by 20 million tons of carbon dioxide, 27,000 tons of nitrogen oxides, and over 5,000 tons of sulphur dioxide. An equivalent efficiency program in many other parts of the country would have even greater environmental benefits, since PG&E's reliance on fossil generation is below the national average, and is limited almost exclusively to natural gas.

I would like to conclude by returning briefly to the barriers to adoption of energy efficiency, and the possible roles for state and federal governments. Energy legislation now pending before Congress will be very helpful. In the

energy efficiency area, we are particularly pleased with the new labelling and standard-setting activities for motors, office equipment, and heating and cooling equipment, and with steps to encourage states to reform utility regulation. We hope that the Congress will also take steps this year to eliminate the taxation of utility rebates as income, which could prove to be a significant impediment to the marketing of efficiency programs.

Carrying out the legislative intent will require vision and initiative of both Federal and state governments. PG&E is pleased with the regulatory support in California, but there is an opportunity to improve support in other parts of the country. In many states, significant changes in regulatory policy will be needed to give electric utilities a balanced choice between efficiency and supply alternatives. Leadership and funding from the Federal government will also be important to speed these changes.

The President and the Congress both have recognized the example that Federal agencies can set in using energy efficiency criteria in their own purchasing practices. In addition, goals for improving the energy efficiency of Federal facilities will not only set an example and save substantial energy and money, they also provide an important stimulus to the service and manufacturing industries that provide energy efficient products.

PG&E has embarked on a long-term strategy of reliance on energy efficiency and renewable energy as its primary sources of new electricity supply. No single program or strategy will work for all American utilities. But we believe providing them with incentives for efficiency investments will further the nation's drive for sustained economic growth and improvement to the environment.

Mr. Chairman, I would be happy to answer any questions the Committee may have.

SENATOR GORE. Thank you very much. We certainly appreciate that. Mr. Sutcliffe, please proceed.

STATEMENT OF S. LYNN SUTCLIFFE, PRESIDENT AND CEO, SYCOM ENTERPRISES, BETHESDA, MARYLAND

MR. SUTCLIFFE. Mr. Chairman, my name is Lynn Sutcliffe. I am the President and CEO of SYCOM Enterprises, an energy services company.

It's a pleasure to be here today to inform you of a mechanism within the market system that is delivering substantial amounts of energy conservation to the electric utilities and their end-users.

I would like to briefly introduce SYCOM. It provides demand-side management services to utilities and their customers. At the present time, it has under contract 71 megawatts of conservation that it has to deliver on time, on budget, and maintain for a ten-year period.

So, it basically is in the business of producing conservation power plants. As mentioned in the testimony, that's the equivalent of providing electricity over ten years for 30,000 homes.

SENATOR GORE. Correct me if I'm wrong on this, but let me see if I understand what your business is.

When utilities look at demand-side management, some of them don't have much experience in that. And back in the 1970s, first in 1973, then in 1979, when oil prices shot up and coal followed and electricity rates then went up and demand went down, a lot of investments in new generating capacity were mooted. Investors had to eat a lot of that. And when utility commissions wouldn't let them hit the rate-payers with all of it, they discovered demand-side management. And since they didn't have experience, some of them said, help, and some entrepreneurs created this new business to go in and provide the service to utilities that they have not built up out of their own experience.

And that's what your business does. You go in and tell utilities how to manage, how to create new capacity through managing demand.

Is that roughly it?

MR. SUTCLIFFE. That is very much the type of business. The business cannot flower or develop without the changes that Mr. Moskovitz has discussed, in terms of the regulation, because the utility cannot turn to real savings until such time as their revenues are decoupled from sales, and they won't really pursue it aggressively until they are rewarded an incentive that is equal to the profit that they would otherwise have made by generating electricity. So, our entrepreneurial activity is very much dependent upon getting the regulatory signals properly aligned at the state regulatory level.

But basically, your understanding is correct. We serve, however, three customers. We serve the utility and its ratepayers, because we are providing new sources of energy at lower than generated cost. We are also making billpayers more competitive by reducing their overall cost of

energy. Finally, we are serving the pollution-mitigators or the polluters by offsetting or avoiding pollution.

The secret to drive the market is to get all three customers to pay a fair share so that the market penetration can succeed. As we like to say, borrowing from, again, Mr. Moskovitz's statement, we are in the business of least-cost doing, and we frankly think that the time for least-cost talking and studying has passed us by, and we should get on with the business of providing an important service to the economic engine in our society.

What an energy services company does is organize itself to overcome all known barriers to conservation. We provide services to end-users at no up-front cost. We receive a payment based upon measured savings and we don't get paid unless we produce measured and verifiable results.

I would like to go into briefly how that works.

Our standards for operation are being set by the utilities themselves. Sometimes the standards they set for us are far less than the standards that they set for themselves, and I think that's something that the Federal Government and state governments have to be aware of.

You had asked through your staff to estimate the job generation in comparison—demand-side management to generation. And as a general rule of thumb, we will produce three to four times as many jobs in producing a megawatt of saved energy as opposed to a megawatt of generated energy.

But let me describe to you specifically how we operate so that you can understand how this delivery system is overcoming the traditional barriers.

We will respond to a bid from a utility or negotiate a contract with a utility to get paid so much cents per measured savings. That becomes our payment from the rate-payer and that is always below avoided generating costs.

So, we're always saving the ratepayer's money. As John has described here in the PG&E system, $2.4 billion over the next ten years will be saved because they're doing demand-side management rather than generation.

We market the program being used. Our sales force aggressively goes out and explains conservation to customers. We conduct a free audit. We make a proposal. We offer to install all cost-effective energy conservation measures without any charge. And we rely upon our payments based upon measured savings from both the ratepayer through the utility and from the end-user.

So, we have two revenues coming in if we are successful in producing the savings that we've estimated. If we're not successful, we lose. We take all the risk. No one else does.

So, first of all, by spreading the price signal out, we can overcome the 60 percent rate-of-return hurdle rates that most end-use customers impose upon themselves. We can take away the risk and the inertia within the corporate structure or the residential structure about being skeptical of these new devices.

So, that's how the system works. We are, as I mentioned, a creature of contract law, in that our contracts are basically set by the utility. They say, we'll only pay for what we get. The burden is on you, the ESCO, to prove what you're getting and what you're giving us. If you don't give us what you're supposed to give us, you're going to pay us penalties for it. We're going to treat you just like a generator.

So, the business is maturing to a point where the DSM delivery system is producing the kind of certainty and the kind of responsibility that the generation system is matching. And as we start talking about the $200 billion that may be spent on conservation, this is an important protection for both the ratepayer, the billpayer, and the environment.

I'll mention the environmental point later.

Measurement has progressed over the last year dramatically. We are now required to submeter everything that we are saving, and those submetering results are then presented to both the end-use customer and the utility to govern our payment structure. If we do not maintain the conservation over a ten-year period, we will start paying damages to the utility.

So, it's a very, very difficult structure and one that is imposing disciplines that should be monitored and replicated from a public policy standpoint in other jurisdictions that have not yet adopted them.

I'd like to take you through a microcosm of what this means for CO_2 reduction. One example. In a typical retrofit in the lighting arena, we take out four bulbs, put in two bulbs; put in a specular reflector; take out two magnetic ballasts, put in one electronic ballast.

We save between 100 and 116 watts per fixture. And it's not unusual to be going through facilities where you're putting in 20,000 to 30,000 fixtures at one time. That usually has a simple payback of two years or less, depending upon what the retail rate structure of the utility is.

EPA has estimated, on a national average, that that saves 882 pounds of CO_2 per year per one fixture replacement. It is cost-effective. EPA estimates—and it's something that we believe meets the realm of reason—that CO_2 emissions could be reduced 5 percent by just doing reasonable cost-effective lighting.

But there are many other opportunities that we undertake in the area of motors, variable-speed drives, heating, ventilation and cooling.

So, there are substantial opportunities for reducing environmental degradation, while also saving billpayers and ratepayers money.

There's another area that I think deserves attention. In specific requirements for Clean Air Act activities, conservation can be used as a cost-effective means of meeting clean-air requirements. I refer you to the example of a refinery that we have just completed a study on and have started a pilot program with. They have a retrofit under the Clean Air Act that would cost them $12 million. The component being retrofitted has a useful life of only eight years, then they're going to have to replace it. They don't want to make that $12 million investment, but to meet the Clean Air Act requirements in the nonattainment area, they will have to

make that investment unless they can find a way to offset the pollution from that in a more cost-effective, economically viable way.

We have been able to show them that by undertaking aggressive conservation within their own facilities and some schools and hospitals in their area, they can basically save enough energy, knock off the pollution from the dirtier power plants, and create offsets so that they don't have to make the $12 million investment, and they'll also put $5 million in their own pocket from their own energy savings from the aggressive program that they and we have undertaken together.

So, here you have a very dramatic illustration where not only just for conservation purposes, but as very specific, market-based offset strategies, you can have a $17-million swing for a major company in the United States.

Now, I've been asked to address what roles the states and the Federal Government can play in promoting conservation.

As mentioned, it's a very simple formula. It's simply one that has to be undertaken aggressively. Decouple sales from profits so that the utility does not suffer a penalty from conservation. Make sure that lost revenues are made up. Provide incentives to utilities for saving energy, which are as attractive as profits for generating energy. It's not very complicated.

Make sure that there's a competitive market to promote new efficient technologies. We are in the Neanderthal stages of energy-saving devices right now. We don't have the least idea of what will be offered in five to ten years in the energy conservation market if you create the market and you have a delivery system that's effective and efficient.

The federal level, I have a tendency to say the best thing at the federal level is to stay out of the way and let the market function. I do think that they can, however, assist the states in creating the proper regulatory environment.

I think that the most important thing that EPA can do is to make sure that the savings are measured and monitored. While I agree with you that the concept behind Green Lights is very important, we find a lot of concern about the type of conservation that's being done. I want to end on that point.

All conservation is not the same, from its billpaying ratepayer to its environmental savings. We like to talk about negawatts versus vaporwatts. A negawatt is the saved unit of energy that is measured, monitored and maintained over a substantial period of time. Under our contracts, it's ten to fifteen years.

A vaporwatt—and there's a lot of vaporwatt activity going on—is one that is partially created by an energy-saving device that doesn't hold up, is not maintained, or, in some circumstances, under some improperly operated utility programs, the conservation measure never goes in, even though the utility is paying for it.

So, you have to be very, very careful about promoting conservation without a qualitative concern for what conservation you're promoting and what kind of life cycle maintenance and monitoring you're doing, because

if you have vaporwatts, you won't have green watts. We like to talk about green watts as those that are both saving money for the end-user and the ratepayer, and are also protecting the environment.

So, on that note, I would suggest that the policy directions should be very carefully considered. Tie utility conservation incentives to the best available measurement and monitoring technologies.

Under the Clean Air Act, make sure that any allowances that are offered are based upon a measurement or monitoring of the savings over time. And then make sure that any pollution offsets that are awarded for conservation also have that measuring or monitoring, or we'll end up with a very disappointing end result for conservation when that disappointing result can and should be avoided.

Thank you.

[The prepared statement of Mr. Sutcliffe follows:]

PREPARED STATEMENT OF S. LYNN SUTCLIFFE

SYCOM Enterprises

TESTIMONY OF SYCOM ENTERPRISES BEFORE THE JOINT ECONOMIC COMMITTEE -- APRIL 28, 1992

- Introducing SYCOM
- Introducing The Energy Services Industry
- Implications For Meeting CO_2 Goals
- Federal and State Roles In Promoting Market-Based Conservation
- Caveat: Not All Conservation Is The Same

AFFILIATED WITH PG&E/BECHTEL

SYCOM Enterprises

Introducing SYCOM

- SYCOM is an energy services company (ESCO) providing energy conservation/demand side management (DSM) services to electric utility customers through electric utility programs
- SYCOM has under contract (or is in final negotiation on) 71 MW of conservation -- enough saved energy to provide electricity to over 30,000 homes each year for ten years
- SYCOM has entered into a joint venture with PG&E/Bechtel Generating Company. The joint venture is called SYCOM Enterprises
  - In the joint venture SYCOM Corporation is acting as the managing general partner and has retained the majority economic interest
  - SYCOM provides conservation services for the Generating Company to offset pollution from its plants and enable it to produce electricity with a zero net pollution impact

AFFILIATED WITH PG&E/BECHTEL

SYCOM Enterprises

Introducing SYCOM (Cont'd)

- SYCOM has three customers --
  - Electric utilities (ratepayers)
  - End users of electricity (bill payers)
  - Pollution mitigators (polluters)
- SYCOM provides its services primarily through DSM bidding

AFFILIATED WITH PG&E/BECHTEL

SYCOM Enterprises

Introducing The Energy Services Industry

- **Energy Services Companies** or ESCOs provide conservation services to end users typically at no up-front cost and receive payment based upon measured performance over a substantial period of time.
- **How the ESCO operates**
- **DSM bidding is setting the standards for ESCOs**
- **DSM is estimated to create 3 to 4 times as many jobs as generation**

AFFILIATED WITH PG&E/BECHTEL

SYCOM Enterprises

How the ESCO operates

- Responds to a bid and, if successful, gets paid X cents per measured kWh or kW of saved energy
- Markets its program to end users
- Conducts a free audit
- Presents a proposal for saving energy
  - Identifies the measures to be installed (*e.g.* lighting, motors, variable speed drives, HVAC improvements)
  - Projected savings to be achieved
  - Payments to be made to the ESCO out of the savings
- Contracts with the end user
- Installs the measures
- Measures and maintains the measures for 10 or more years
- The successful ESCO produces Negawatts -- measurable and persistent saved units of energy

AFFILIATED WITH PG&E/BECHTEL

SYCOM Enterprises

DSM bidding is setting the standards for ESCOs

- **A creature of contract law**
  - Terms of the contract are set by the utility
  - Contract philosophy
    - "We'll only pay for what we get. . .
    - "The burden is on you to prove what we're getting. . .
    - "You'll pay us penalties if you don't deliver what you promise. .
    - "We're going to treat you just like a generator. . .
- **Measurement**
  - Measure-by-measure real time measurement (e.g. submetering)
  - Persistence: 10-year minimum measurement
- **Damages for lack of persistence**

SYCOM Enterprises

Implications For Meeting CO_2 Goals

- Pollution is being avoided at a profit to both ratepayers and bill payers
- Typical CO_2 avoidance from a standard lighting retrofit
  - Example: Making energy efficient a standard 2'x4' fixture
    - Reflector
    - Four lamps to two lamps
    - Two ballasts to one electronic ballast
    - Savings: 116 watts per fixture
    - Cost: 2 year pay back or less
  - Pollution savings based upon EPA estimates:

SYCOM Enterprises

Implications For Meeting CO_2 Goals (Cont'd)

- 882 lbs of CO_2 per year
- 4 lbs of SO_2 per year
- 2.5 lbs of NOx per year

- Cost-effective lighting can cut total CO_2 emissions 5% according to EPA
- There are many other cost-effective conservation strategies
  - Motors
  - Variable speed drives
  - Heating, ventilation and cooling (HVAC) technologies and controls
- **These CO_2 savings can occur while the ratepayer and the bill payer save money (and society saves money too)**

SYCOM Enterprises

Implications For Meeting CO_2 Goals (Cont'd)

- External cost of the pollution saved by one fixture replaced as described above: $20.68 per year or 4.5 cents per kWh saved (Tellus Institute values)
- Conservation as offset strategy: Refinery example
  - Cost of retrofit to meet new Clean Air Act standards: $12 million with useful life of 8 years
  - Profit to create offsets through conservation to avoid the need for the retrofit: $5 million of bill payer savings
  - $17 million swing to the positive
    - Clean Air Act goals achieved
    - Money put in the pocket of the refinery owner rather than removed

SYCOM Enterprises

Federal and State Roles In Promoting Market-Based Conservation

- **State**
  - Decouple sales from profits
  - Provide incentives to utilities for saving energy which are as attractive as profits for generating energy
  - Insure a competitive market through competitive conservation contract offers or DSM bidding
- **Federal**
  - Assist the states in creating the proper regulatory environment
  - Make sure that savings are measured and monitored

SYCOM Enterprises

Caveat: Not All Conservation Is The Same

- Negawatts versus vaporwatts
  - A **Negawatt** is a saved unit of energy which can be substituted for a unit of generated energy (Megawatt)
    - Measurable
    - Long-lasting
  - A **Vaporwatt** is a saved unit of energy that is not measured and maintained, and, therefore, vaporizes partially or completely
  - A Negawatt is a **"Greenwatt"**; a Vaporwatt is not
    - "Green" in two senses
      - Saves bill payers money
      - Reduces pollution that would otherwise have had to occur to meet the demand for electricity

SYCOM Enterprises

Caveat: Not All Conservation Is The Same (Cont'd)

- Policy should be directed toward negawatt conservation
  - Utility incentives should be tied to the best available measurement and monitoring
  - Under the Clean Air Act allowances earned through conservation should be tied to the best available measurement and monitoring
  - Pollution offsets from conservation should be tied to the best available measurement and monitoring

SENATOR GORE. Thank you very much.

We'll have some questions, but we'll now hear from Richard L. Stroup, Professor of Economics at Montana State University in the Political Economy Research Center.

We moved you to this panel after seeing your statement, Professor Stroup, because it seemed to address the subjects that this panel is dealing with. We always have a policy of hearing a variety of points of view. We welcome you here today and look forward to your statement.

STATEMENT OF RICHARD L. STROUP, PROFESSOR OF ECONOMICS, MONTANA STATE UNIVERSITY, POLITICAL ECONOMY RESEARCH CENTER, BOZEMAN, MONTANA

MR. STROUP. Thank you, Mr. Chairman. I appreciate the opportunity to provide my views on this topic. I've been working since the 1960s, when I was in the air resources program at the University of Washington, on the economics of emissions controls.

My experience also includes 2½ years as Director of the Policy Analysis Office at the Department of the Interior.

SENATOR GORE. What years were those, may I ask?

MR. STROUP. 1982 through 1984.

SENATOR GORE. Under Secretary Watt?

MR. STROUP. Under Secretary Watt and Secretary Clark, that's right.

SENATOR GORE. Okay. Go ahead.

MR. STROUP. A number of studies have been referenced today, studies to predict the cost of emissions leading to global warming and to the cost of mitigating global warming by reducing those emissions.

However, those studies cannot and do not claim to give the full picture. I'd like to share with you some additional considerations that I believe need to be taken into account.

First of all, reducing carbon dioxide emissions may provide some benefits. It will also require some sacrifices. Of course, the sacrifices will be not just in dollars, but they will be real costs, and some of them aren't measured, in fact, in dollars.

It turns out, in fact, that there are actually some benefits from increasing carbon dioxide. Those need to be considered as well.

Some proposals for reducing carbon emissions are so extensive that they'll have major impacts on the structure of government, on the economy, and on the lives of future generations. New regulations and new subsidies, if they're aggressive, will cause some serious problems, potentially, at least.

Responsible analysis also needs to consider who gains and who loses, of course, under each policy option, both because of questions of morality and also questions of political feasibility. And yet, any attempt to shift the burden of the policy by government-to-government transfers, for example, tends to create its own problems.

What I'd like to do is speak briefly to each of those five points.

First, not all of the effects of the build-up of carbon dioxide are negative. There are large calculated gains to agricultural production from CO_2 increase, quite apart from any climatological effects. There is little doubt that those particular benefits exist and will grow as concentrations grow.

Some of the benefits, in fact, that are currently attributed, or have been in the past few years, to the green revolution may in fact have been due to rising CO_2. The present value to world agriculture from a doubling of CO_2, apart from climatic effects, one estimate is $38 billion dollars. In that particular study, that amounted to half of that study's calculated losses to agriculture due to climatic changes. Those two in that study were offsetting, or they tended to be offsetting.

Other researchers are more optimistic. Goudriaan & Unsworth, reviewing a number of studies relating the direct effects of CO_2, together with the indirect effects of higher temperatures, concluded that, together, they would probably show a predominantly positive picture.

How certain are these fertilization effects and the water effects, by the way? It turns out that there is a reduction in the demand for water with increased CO_2. Well, those particular effects are smaller than a lot of the projected damages from global warming. On the other hand, they're far more certain than the projected changes in regional climates from which the climate losses are predicted.

In the process of providing nutrients to plants, as I indicated, adding CO_2 reduces the plant's water requirements. It not only reduces the amount of water required, it also provides some drought resistance. One leading researcher in the area, Sherwood Idso, says that doubling atmospheric CO_2 doubles the water-use efficiency of nearly all plants. Not all plants respond identically.

So, the warming itself, if it occurs, will bring gains and losses around the globe. Nobody knows just exactly how the weather patterns might change. Warming will be welcome in some areas. Back home in Montana, some folks are kind of looking forward to such a thing. Other areas, it would be quite unwelcome.

In fact, we don't even know whether sea levels will rise or fall if the temperatures rise.

The second point is that costs are not just monetary costs. There's no question that the use of carbon fuels can be reduced. There are costs of doing so.

Now, mind you, as many in this hearing have pointed out, and quite properly so, as technology moves along and we become more wealthy, there are many, many economizing on carbon fuels that will occur naturally, and that is a wonderful thing.

To go beyond that involves not only monetary costs, but other costs as well. The recent investigations of the effects of corporate average fuel economy standards—the CAFE standards—have shown pretty conclusively that as those standards became binding on automakers, producers went to smaller cars, and auto safety suffered and excessive highway deaths

resulted. Tighter fuel economy standards clearly will bring more deaths for any given state of technology. A recent case in the Federal Appeals Court, here in Washington, D.C. circuit, established that fact and accepted that evidence.

Energy can be conserved, but the energy we use also bring benefits. The fact is that because of larger cars and so on, we and our children can travel in relative comfort and safety. Kids from Montana can see the Nation's Capital. Citizens from the East Coast regularly visit Yellowstone Park, near where I live, and the Grand Canyon. So, even a working-class family in this country can get in the family car, see other parts of the country, and see their heritage.

If, on the other hand, tighter regulations were changed to, in effect, require small cars, or if a high carbon tax made travel in family-sized cars very expensive, then such travel would be much less comfortable. It would be much less safe. And it would be much less likely.

Third, there is the point to be made that wealthier in fact is healthier and more environmentally sound. In order to gain some insurance against global warming; that is, insurance beyond what economic growth and technology change brings us without added laws and regulations, and to go beyond what that change brings us will require the sacrifice of wealth and income and economic efficiency, as it is usually measured.

Yet, exactly that societal wealth and efficiency, economic efficiency, have important benefits. They're probably the most important risk-reducing and health-enhancing factor in every society.

Richer nations that have experienced economic growth have, in fact, much cleaner and more healthful environments than poor nations. A recent study from the World Bank explains how, the extent to which, and why.

First of all, to become richer, societies or those that do that are those who use the technological tools more efficiently. And in doing that, they almost automatically place less stress on the natural environment.

Second, people who have met their basic needs will demand a better environment after that. When community income rises 1 percent, the research I have seen says that community demand for environmental quality rises three times that fast. In other words, the demand for environmental quality rises with income at about the same rate as does the demand for BMWs.

A third reason why there is that correlation between wealthier and more environmentally healthy is that there is a strong correlation between private property rights and the private sector in the richer countries and their wealth.

When resources are privately owned, they tend to be protected by those who own them against polluters. I've written extensively on that topic and don't have time today to say very much more about it.

Any policy that reduces a nation's income, though, will reduce its willingness and ability to pay for policies that pay for environmental

quality. Policies that promote economic growth will lead to a better environmental quality.

Notice that it's not just individually affluent people who benefit from the society's wealth and economic efficiency. All we have to do is ask ourselves—rich or poor—would we rather be caught in a disaster in a rich country or in a poor one? I don't think it matters what kind of a disaster. The fact is that we're better taken care of in a rich country.

By far, the best hope to avoid or survive crises for human beings, crises of almost any origin—it doesn't matter if we're talking about a large meteor on a collision course with the earth or a new and more virulent form of AIDS—the best insurance we can possibly have is to be rich and technologically advanced. Therefore, our society would be more resilient.

If we buy insurance against a particular risk, whether it be a military risk from outside, or global warming, or against some potential viral attack, if that's bought at a cost of reduced economic growth, then we have given up a decline in the automatic insurance represented by wealth and societal resilience brought on by wealth. It's one of those costs borne by future generations. It may be a cost worth bearing, as a matter of fact, but it's surely not a cost worth bearing without careful consideration.

The fourth question, can the emissions be reduced at little cost? Technological advance and wealth do provide automatic gains. Could additional insurance against global warming be forced or purchased via subsidy without significant cost?

In other words, going beyond what people will choose voluntarily from the new options on their menu, can that insurance be purchased at low cost? Well, it's one thing to point out an attractive set of existing and new technical possibilities for the problem, but it's quite another to design and implement a policy that brings that set of possibilities to fruition, if people would not freely choose those options. If we're talking about free choice, there is no such problem, of course.

Well, no doubt, technological advance will continue, regardless of our greenhouse gas policy, regulations and subsidies. Carbon taxes are another possibility. Those could bring some forcing of technology. But if we channel or harness technology to this goal, that means diverting the technology from other goals.

Just think of, if we had taken cars in 1952 and said, okay, we're going to have this level of performance, this level of safety, this level of other benefits, and we're going to put all of our technical change into better mileage. Today, we could have, I think, better mileage than we do. There's no question that we can have better mileage.

The thing is that if we channel all the technological abilities into better mileage, we wouldn't have the other gains that bring other kinds of benefits, including safety. The cars are much more safe now than they used to be.

If we try to go beyond those results, if we try to force those kinds of results by fiat, then problems emerge. Even when the new technologies

are attractive, we get these problems. Where I live, wind power is being tested. We have a very windy place near us a few miles away, and there's a wind farm there. Wind power is being tested.

It's being opposed. It's being opposed on environmental grounds. Every environmentalist I know is against that wind power testing. It's noisy, they say. It's dangerous to birds. It aesthetically insults some people just by looking at it.

Every new development, however benign, seems to increasingly attract protesters seeking to stop that particular development. It's not easy, even if that is a good technology, and it may be. It may well be a great technology.

So, it's easy to point out shortcomings in current uses and point out new possibilities. It's a little more difficult to actually bring them into fruition by planning, by force.

One recent lesson in that—an obvious lesson—is just to compare East and West Germany, and see how those two Germanies dealt with energy over the past 40 years—one a planned economy and one a market economy.

There's no comparison. Planned economies—Western Europe versus Eastern Europe, East Germany, West Germany, it doesn't matter how you cut it—planned economies use twice the amount of energy per unit of output as do market economies, almost exactly twice as much. It's the same in steel. They use twice as much steel using a planned approach.

Planned approaches in this country don't have a real good track record, I think, in terms of efficiency. Energy programs are a great example. Environmental programs are another.

There's an increasing body of literature showing that from the Clean Air Act to Superfund, reduction in environmental risks politically has often taken a backseat to political considerations, naturally enough, such as appealing to populist fears and assuring ample public works spending.

No doubt those policies have produced benefits. But the technology was reducing air pollution faster before the Clean Air Act than since that act was passed.

When one analyzes the pressures and incentives facing political decisionmakers—state, local and national level—the reasons behind regulatory inefficiencies, and they are legion, become understandable.

Efficiency has no political constituency. Trying to plan for greater efficiency is a very difficult proposition within the political system. As the former head of a policy shop, I came to learn that lesson rather vividly in contact with the political people.

So, researchers estimating the costs and benefits of proposed regulations seldom actually try to predict what actual results will come after the politics and the bureaucracy have worked themselves through the process. And some of those studies that we have been referring to today quite honestly point out that they do not try to take into account inefficient regulatory behavior in their studies.

The same kind of consideration applies to a carbon tax. One economic study that's out there has looked at the possibility that a carbon tax would actually be more efficient than some of the taxes we have currently going.

That may well be, but some questions arise. Will, in fact, revenues from the one tax be used to offset the other? Economists have known for a long time that some of our current taxes are very inefficient. Those taxes are in place. Why are they in place? There are good political reasons, I presume, why they're in place.

Would a new tax displace those reasons? Would it change those reasons? If large new revenues came in, would they be spent or would they replace a tax, or would they—for heaven's sakes—replace the most distortionary tax?

And finally, there's the problem of aid to help poorer countries.

Obviously, there would be a huge burden. If we tried to stabilize carbon dioxide emissions, there would be a very large burden on poorer people, and especially in poorer countries. Maurice Strong, it has been reported, very recently said that something like $600 billion a year for a very long time would be needed, and that at least $100 billion per year would need to be transferred perennially from First to Third World nations.

That's a lot of money that you would have to be given, I think, through existing governments of poor nations. But massive aid to governments of poor countries has unfortunate side effects in the recipient nations. Peter Bauer, the eminent development economist, catalogues a lot of the reasons why foreign aid from richer countries usually harms instead of helps the citizens of poor nations.

For one thing, foreign aid slows the changes needed to bring about healthy economic growth. That is, if the Soviet Union had been getting enough foreign aid, my guess is that that government would not have toppled and the needed changes wouldn't have come about so quickly.

SENATOR GORE. Mr. Stroup, if you could, as a courtesy to the other witnesses, I don't want to rush you along, but we normally have a time limit on statements. Since you were specifically requested by the Minority, I want to be very courteous and give you all the time you need. But if you could move toward a conclusion, because we're going to run out of time.

MR. STROUP. Thank you. I have one more paragraph.

SENATOR GORE. Okay.

MR. STROUP. I apologize for the time.

SENATOR GORE. That's all right.

MR. STROUP. If policy action to reduce CO_2 emissions by influencing market choices is to be undertaken, timing is critical. But that doesn't mean that precipitous action is the right policy. It is an elementary fact of economic life that forced, quick responses always entail much larger costs than responses that are taken with the allowance to reflect both the gains and the sacrifices for quick change.

It is even more true when we consider the possibility of substantial increases over time in technical knowledge. That's happening right now, substantial increases over time in technical knowledge, which will enable responses in the future to be more effective in dealing with the problem.

Fast action is much more costly than actions taken with deliberate speed. In the case of global warming, scientific uncertainties abound. But these uncertainties will be reduced as research progresses.

As economist William Nordhaus points out, "The best investment today may be in learning about climatic change, rather than in preventing it."

Thank you, sir.

[The prepared statement of Mr. Stroup follows:]

PREPARED STATEMENT OF RICHARD L. STROUP

Mr. Chairman and Committee members: I want to thank you for the opportunity to provide my views on the economics of policies regarding the emissions of carbon dioxide. I have been applying economic analysis to environmental and natural resource questions since my participation in the 1960s, as an economics doctoral candidate, in the Air Resources Program at the University of Washington. My dissertation, written in conjunction with that program, was on the economics of controlling sulfur dioxide emissions. Since that time I have been researching, writing and teaching about environmental and natural resource issues as an economics professor at Montana State University and as a senior associate of the Political Economy Research Center. Under the Intergovernmental Personnel Act, I also spent two and a half years as Director of the Office of Policy Analysis at the U.S. Department of the Interior.

A number of studies have been conducted by economists that attempt to predict the costs of global warming and the costs of mitigating global warming by reducing greenhouse gas emissions. However, these studies cannot and do not claim to give the full picture. In my remarks, I would like to share with you some considerations that should be included in your analysis of policies designed to deal with emissions of carbon dioxide and other greenhouse gases.

Proper decisionmaking requires examining both the gains from, and the sacrifices demanded, by any policy option. While reducing carbon dioxide emissions may provide benefits, it will also require sacrifices, and it's important to recognize that those sacrifices will be real; they cannot be dismissed simply by being expressed as expenditures of dollars. There are, in fact, some benefits from increasing carbon dioxide, and those, too, should be considered. In addition, some proposals for reduction of carbon emissions are so extensive that they will have major impacts on the structure of government, the economy, and upon the lives of future generations.

Finally, responsible analysis also requires consideration of who would gain and who would lose under each policy option. The issue of who will gain and who will lose influence our view of the morality of a policy, and will help to determine the political feasibility of some policy options. Yet an attempt to shift the burden of a policy by government-to-government transfers can create its own problems.

The Effects of a CO_2 Buildup Are Not All Negative

Let me begin by pointing out that not all the effects of a buildup of CO_2 are negative. Large calculated gains to agricultural production from CO_2 increase itself are typically ignored in estimating the impact of forced warming, yet there is little doubt that they exist and will grow as CO_2 concentrations grow.

A recent estimate is that the present value to world agriculture from a doubling of CO_2, apart from any climatic effects, is $38 billion, or half of the same study's calculated loss from climate change due to a doubling of all greenhouse gasses.[1] Many other researchers are more optimistic. Goudriaan and Unsworth, reviewing a number of studies relating the direct effects of CO_2 and the indirect effects of higher temperatures, concluded that "[d]irect and indirect effects together will probably show a predominantly positive picture."[2]

How certain is this fertilization effect? It is far more certain than any of the projected changes in regional climates from which the climate losses are estimated. Commercial greenhouse operators purchase CO_2 for release in their facilities, precisely for its value as a fertilizer. In the process of providing nutrients to plants, adding CO_2 to the atmosphere reduces the plants' water requirements; it thus also provides drought resistance. According to Sherwood Idso, a leading researcher in this field, doubling of atmospheric CO_2 doubles the water use efficiency of nearly all plants.[3]

As for warming itself, if it occurs,it will bring gains and losses around the globe. No one has a good idea of just how weather patterns might change; warming will be welcome in some areas, unwelcome in others; indeed we don't even know whether sea levels will rise or fall,[4] if global temperatures rise as some scientists predict.

Costs Are Not Just Monetary Costs

The use of carbon fuels can certainly be reduced. However, there are not only monetary costs; there are others as well. When the Corporate Average Fuel Economy (CAFE) standards began to be binding on American automakers, producers began to more strongly emphasize smaller cars. Auto safety suffered, and excessive highway deaths resulted.[5] Tighter fuel economy standards will bring more deaths.

Energy can be conserved, but our energy use brings many benefits, such as the fact that we and our children can travel in relative comfort and safety; kids from Montana can see New York and the nation's capital; citizens from east coast cities regularly visit Yellowstone Park and the Grand Canyon; even a working-class family can get into the family car and see other parts of their country and their heritage. But if regulations were changed to require mini-cars, or if a high carbon tax made travel in family-size cars very expensive, then such travel would be much less comfortable, less safe and less likely.

Yes, Wealthier Is Healthier and More Environmentally Sound

In order to gain some insurance against greater global warming, it will be necessary to sacrifice income wealth and economic efficiency, as it is usually measured. Yet societal wealth and economic efficiency have important benefits for everyone; they are probably the most important risk-reducing and health-enhancing factors in all societies.

Richer nations, that is, the nations that have experienced significant economic growth, have cleaner and more healthful environments than poor nations.[6] There are two reasons for this: First, to become richer, societies develop technological tools that use resources more efficiently and thus place less stress on the natural environment. Second, people who have met their most basic needs and do not need to worry about where the next meal will come from will demand a better environment and can afford it, just as they demand, and can afford, better food, shelter and medical care. Preliminary results from one study suggest that when community income rises by one percent, community demand for environmental quality rises by three times that amount. In other words, the demand for environmental quality rises with income at about the same rate as does the demand for BMWs![7]

The correlation between income and environmental quality will not surprise anyone who knows that the members of environmental groups such as the Sierra Club have incomes that, on average, are double those of the average American.[8] Any policy that reduces a nation's income will reduce its willingness and ability to pay (in economists' lingo, its demand) for environmental quality. Policies that promote economic growth will lead to better environmental quality.

It isn't just individually affluent people who benefit from a society's wealth and economic efficiency. Any person, whether rich or poor, is much better off to be caught in a disaster such as a flood or an earthquake in a rich country than in a poor one. A rich nation can protect itself better against foreseen dangers and unforeseen developments as well.[9] To the extent that nations (and humankind generally) have the advantages that come from societal wealth, they have by far the best hope to avert or survive crises from threats of almost any imaginable origin–from a large meteor on a collision course with Earth to a new and more virulent form of AIDS. Richer societies are more resilient. If "insurance" against a particular risk, such as the threat of global warming, is bought at the cost of reduced economic growth, then a decline in the automatic insurance represented by wealth, and the societal resilience it provides, is one of the costs borne by future generations. It is a cost that might be worth bearing, but surely not without careful consideration.

Can Emissions Be Reduced at Little Cost?

Could insurance against global warming be purchased without significant cost, as some have suggested?[10] It is one thing to point out an attractive set of existing and new technical possibilities for dealing with a problem; it is quite another to design and implement a policy to bring that set of possibilities to fruition.

A dominant factor in the various models used to estimate the cost of reducing greenhouse gas emissions is the set of assumptions about projected technical change. To what extent will newly emerging non-carbon technologies cut the cost of reducing CO_2 emissions? No doubt technological advance will continue, regardless of greenhouse gas policy, and regulations, subsidies, or carbon taxes could bring some technology forcing.

However, problems emerge whenever new energy production and utilization techniques begin to be used, and assumptions about alternative technologies should be viewed cautiously. For example, windpower is sometimes viewed as an attractive alternative technology; yet windpower experiments near where I live are currently being opposed on environmental grounds. They bring noise, danger to birds, and esthetic insults to some residents. Scientific and engineering projections of future development costs and timetables are notoriously poor, and each new development, however benign, seems increasingly to attract protesters seeking to stop that development.

It is easy to point out shortcomings in current uses of fossil fuels and other practices which generate CO_2. To a large extent, these uses have been selected by a market system and constrained by market forces, and it is easy to theorize that better choices could and ought to be made. In practice, however, it is clear that markets lead to more efficient choices, including more efficient choices in energy, than do command-and-control, centrally planned initiatives. Comparing East and West Germany (or Eastern and Western Europe) over the past forty years is one way to see this. As Mikhail Bernstam has pointed out, planned economies use about twice the amount of energy per unit of output as do market economies.[11]

Indeed, when centrally planned, regulatory approaches are employed in free nations such as the United States to solve environmental and other problems, they do not fare particularly well. Regulatory regimes in the U.S. do not have a good track record for efficiency or fairness. An increasing body of literature has shown that from the Clean Air Act to Superfund, the reduction of environmental risks has often taken a backseat to political considerations, such as appealing to populist fears and assuring ample public works spending.[12] No doubt the nation's environmental policies have produced some benefits. However, technology was reducing air pollution faster before the Clean Air Act was passed than since![13]

When one analyzes the pressures and incentives facing political decisionmakers, the reasons behind regulatory inefficiency become clear. Efficiency, after all, has no political constituency. Each important political group naturally seeks advantage for itself and its point of view from the political system. The political system cannot operate efficiently when to do so gets in the way of powerful interest groups or populist passions. Unfortunately, researchers estimating the costs and benefits of proposed regulations, including those to curb global warming, seldom try to predict what actual results will come after politics and bureaucracy have worked themselves through the process. Manne and Richels, for example, "make no attempt to quantify the losses due to inefficient regulatory behavior in the administration of a carbon limit."[14]

This tendency to ignore political forces and how they shape final policy is leading to inappropriate optimism about a carbon tax. Such a tax is currently one of the more popular schemes to gain reductions in CO_2 emissions, and, compared to some other taxes, it has some appeal on efficiency grounds. However, some people view it as a way of reducing carbon dioxide emissions at no net cost to society. The economic costs of a

carbon tax can be fully offset by taking advantage of its efficiency value and using the revenues to cut the most distortionary pre-existing taxes, those on new capital formation,"[15] write the authors of a carbon tax proposal.

But the existing tax regime is the result of many political battles, private and public. While revenues from a carbon tax could in theory substitute for distortionary taxes, those taxes are in place for a reason. Economists have long known that there are other, more efficient taxes. But Congress did not adopt them. What would lead Congress to do that now? Also, if large new revenues were given to the Congress through the carbon tax, it's not clear that the members of Congress would reduce another tax to match, and if they did, would they choose the most distortionary tax? Or would they spend the added money instead? Many loud and powerful constituents continually call for added spending. It is appropriate to be skeptical about whether carbon tax revenues would really be allocated to reducing the tax burden on investors, as this scheme calls for.

The Problem of Aid To Help Poorer Countries Reduce Their Emissions

Much of the future CO_2 emission growth is expected to come from poor countries with growing populations, such as China and India. This raises the question of how such nations can afford to curtail their use of cheap energy, which is often carbon-based. One answer often heard is that the developed nations could send aid to the poorer countries, helping them to invest in cleaner, more efficient energy sources to replace the use of carbon-based fuels.

Such aid would have to be large. It would also have to flow through the existing governments of the poor nations. Massive aid to the governments of poor countries, however, often has unfortunate side effects in the recipient nations. Peter Bauer, the eminent development economist, catalogs the many reasons that foreign aid from richer countries usually harms, rather than helps, citizens of poor nations.[16] For one thing, foreign aid slows the changes needed to bring about healthy economic growth (and the environmental benefits that will come with increased prosperity). The reason is that recipient governments, like all governments wishing to survive, allocate the resources to benefit the politically powerful, not to maximize growth or environmental benefits. Even when projects funded by outside foreign aid are intended to be economically sound, they tend to fail; evidence of this is the huge debt burden of many very poor countries. The soft loans they obtained did not yield the promised benefits. Why would we expect environmentally targeted funds to be handled more effectively?

Conclusion

If policy action to reduce CO_2 emissions by influencing market choices is to be undertaken, timing is critical, but that doesn't mean that precipitate action is the right policy. It is an elementary fact of economic life that quick responses nearly always entail much larger costs than less hurried responses. It is even more true when we consider the

possibility of substantial increases over time in technical knowledge, which will enable responses in the future to be more effective in dealing with a problem. Fast action is much more costly than the same action taken at more deliberate speed. In the case of global warming, scientific uncertainties abound, but these uncertainties will be reduced as research progresses. As economist William Nordhaus points out, "The best investment today may be in learning about climatic change, rather than in preventing it."[47]

ENDNOTES

1. John M. Reilly, "Agriculture in a Comprehensive Trace-Gas Strategy," in John M. Reilly and Margot Anderson, *Economic Issues in Global Climate Change*, (Boulder: Westview Press, 1992, p. 80

2. J. Goudriaan and M. H. Unsworth, "Implications of Increasing Carbon Dioxide and Climate Change for Agricultural Productivity and Water Resources," in *Impact of Carbon Dioxide, Trace Gases, and Climate Change on Global Agriculture*, Symposium Proceedings (Madison: American Society of Agronomy, ASA Special Publication No. 53, 1990), p. 11.

3. Sherwood B. Idso, *Carbon Dioxide and Global Change: Earth in Transition* (Tempe: IBR Press, 1989), p. 69.

4. Stephen H. Schneider, "Will Sea Levels Rise or Fall?" *Nature*, Vol. 356, 5 March 1992, pp. 11-12.

5. On February 19, 1992, the U.S. Court of Appeals in Washington, D.C., upheld a challenge to CAFE standards on grounds that they kill drivers and passengers. See Jonathan Marshall, "Challenge to Fuel Standards Upheld," *San Francisco Chronicle*, Feb. 20, 1992.

6. See World Bank economist Marian Radetzke's, "Economic Growth and Environment," presented at a World Bank Symposium November 21-22, 1991, for a review of the evidence and reasons why the relationship between economic growth and environmental quality tends to be positive.

7. Preliminary results reported by Donald Coursey, economist at Washington University, St. Louis, in private conversations in June, 1991.

8. A 1986 survey of readers of the Sierra Club magazine indicated that the median household income was $46,100, compared with median household income in the U.S. of $23,618. A full 83% had graduated from college, while among Americans as a whole, 19.4% had completed four or more years of college in 1985. (Sierra Club magazine data provided by the Sierra Club, 530 Bush St., San Francisco, CA 94108.)

9. Perhaps the best comprehensive treatment of this general topic is presented in Aaron Wildavsky, *Searching for Safety* (New Brunswick: Transaction Press, 1988), especially in Ch. 3.

10. See, for example, "America's Energy Choices," published by the Union of Concerned Scientists, which recommends using policy to override choices by energy users, on the grounds that enough efficiency could be gained to more than pay for cutting CO_2 emissions up to 70% (from 1988 levels) by 2030.

11. See Mikhail Bernstam, *The Wealth of Nations and the Environment* (London: Institute for Economic Affairs, 1991) for comparisons using official data.

12. For a summary of how and why this has happened, and why the policy process is unlikely to improve soon, see Robert Crandall, "Why is the Cost of Environmental Regulation So High?" Policy Study No. 110 (St. Louis: Center for the Study of American Business, Feb. 1992). See also *The Environmental Protection Agency: Asking the Wrong Questions* by Marc K. Landy, Marc J. Roberts, and Stephen R. Thomas (New York: Oxford University Press, 1990.)

13. Robert W. Crandall, *Controlling Air Pollution: The Economics and Politics of Clean Air* (Washington, D.C.: The Brookings Institution, 1983), p. 19.

14. Alan S. Manne and Richard G. Richels, "The Costs of Reducing U.S. CO_2 Emissions–Further Sensitivity Testing," *The Energy Journal*, Vol. 11, No. 4.

15. Robert Shackleton, et al., "The Efficiency Value of Carbon Tax Revenues," (December 16, 1991 draft of a paper submitted to the Stanford Energy Modeling Forum Report 12).

16. Peter Bauer, *Equality, the Third World, and Economic Delusion*, (Cambridge: Harvard University Press, 1981).

17. William Nordhaus, "Global Warming: Slowing the Greenhouse Express," in Henry J. Aaron, ed., *Setting National Priorities: Policy for the Nineties*, (Washington: Brookings Institution, 1990) p. 207.

SENATOR GORE. Thank you very much. We certainly appreciate you making the journey to testify here today.

I can't resist asking just a couple of brief questions about your statement and then more general questions for the panel as a whole.

You refer to the agricultural benefits of doubling CO_2 emissions and the work of Sherwood Idso. You specifically say that the doubling of atmospheric CO_2 increases the water efficiency of almost all plants, in fact, doubles the water-use efficiency of nearly all plants.

You're not a professor of agriculture or agronomy or botany, are you?

MR. STROUP. No. I'm a professor of agricultural economics. I'm not a botanist, that's true.

SENATOR GORE. In your capacity as a professor of agricultural economics, have you reviewed the literature on this point?

MR. STROUP. I reviewed some of the articles. There are hundreds. I reviewed some of the articles.

SENATOR GORE. There are. We had on the Science Subcommittee and the Commerce Committee a four-hour intensive review of these points. We had the leading experts in the scientific community from throughout the United States. Mr. Idso was also there.

Are you familiar with vehement disagreement with his conclusions about this?

MR. STROUP. I know that there was a recent article in the Scientific American where two writers took that result to task.

SENATOR GORE. Yes. About 99 percent of the scientific community thinks that Mr. Idso's work is utter nonsense.

MR. STROUP. I respectfully disagree. I don't believe that that 99 percent figure would hold, sir.

SENATOR GORE. Do you know about the studies in the real world outside of the controlled greenhouse study by Mr. Idso, where he gives these sour orange trees all the fertilizer they want, all the water they want, etc., and in the real world, just on this point of water efficiency, just quickly, increased CO_2 increases total leaf surface area. So that even though the tiny openings in the leaves are constricted, the total surface area is larger, so more water ends up being lost than if the plant had not been subjected to the increased CO_2.

MR. STROUP. I think that that would be quite a controversial statement, sir.

SENATOR GORE. Well, the testimony by Walter Oechel, who is the leading expert in this particular area, is the source of that statement. I'm not sure that it's useful to go into it in much more detail here, but I will simply, as a courtesy, send you a copy of the transcript of that hearing. I would urge you really to not take what Sherwood Idso says about this as being valid.

MR. STROUP. I'd appreciate receiving that.

SENATOR GORE. Thank you. Now, on the point you make, and here, I want to ask the other panelists to join in as well, you make the point that

the effort by foreign countries to reduce CO_2 emissions will be a tremendous burden for the industrial world.

Don't you think there might be an opportunity there? If there is a market for new and more efficient energy-producing capacity, isn't that an opportunity instead of a burden?

MR. STROUP. There are terrific opportunities there. If we keep it in the realm of the voluntary and market responses, then I think there are terrific opportunities for fuel efficiency, which has a side effect of reducing CO_2 emissions. And I know that people at Oak Ridge and lots of other places are working on introducing appropriate technologies to those countries that will help them dramatically reduce their fuel use.

I think you're exactly right, Mr. Chairman, that there are big opportunities there. The question, then, is going beyond what can benefit those people directly, what's economical for them and their situations, on the one hand, where there are huge opportunities, and then going beyond that, to force them by regulation or even purchase them by subsidy, to go beyond that.

Beyond that, I think we get into problems. But there are big opportunities. You're absolutely right about that.

SENATOR GORE. Do you know anything about the ozone problem, incidentally?

MR. STROUP. I have made some study of that problem.

SENATOR GORE. Do you think depletion of the stratospheric ozone is a problem?

MR. STROUP. I think the uncertainties are nearly as great there as they are currently—what effect have CFCs had, for example, on the global warming problem? For quite a long time, I read as though it was absolutely certain that they was a warming gas, a greenhouse gas.

The most recent things I've been reading——

SENATOR GORE. No, no, no. I'm not asking about global warming here. I'm asking whether you, specifically, do you think chlorofluorocarbons destroy stratospheric ozone?

This is an aside, but I'm just trying to get a fix on where you are.

MR. STROUP. I think that the chemistry is quite clear that CFCs can destroy ozone.

SENATOR GORE. Can destroy ozone?

MR. STROUP. Can destroy ozone.

SENATOR GORE. Do destroy ozone? Do you think they do?

MR. STROUP. My reading of the situation is that they do. How much and with what result is another question. But I believe that the science clearly shows that they can and I believe that they do, yes.

SENATOR GORE. And do you think it was a good idea to have this treaty that bans chlorofluorocarbons?

MR. STROUP. That may be a case of forcing people ahead of our knowledge. I don't know of any reliable data on UVBs reaching the earth

and the effects of stratospheric ozone depletion on UVB reaching the earth.

In fact, the little data that I know about—and it's not very good—suggests that at the time the stratospheric ozone was declining, there were declines in UVB reaching the earth. But those were questionable data. I wouldn't want to go on them, either.

SENATOR GORE. So, you think that we may have made a mistake in signing this treaty?

MR. STROUP. I think that's possible, yes. I wouldn't want to make a judgment one way or the other, but I would not be surprised if it turned out ten years from now that we learn it's an error, just as we've learned that global warming seems more likely than global cooling over the past ten or 20 years.

SENATOR GORE. Okay. Do any of the other witnesses have a view as to whether or not there might be opportunities for the United States in this shift by the developing countries toward reductions in CO_2?

Mr. Sutcliffe?

MR. SUTCLIFFE. Mr. Chairman, I would bring to your attention that our industry definitely believes there is opportunity offshore, so much so that through our trade association, we have created an export trading company, and we are in a position to exploit those opportunities as they arise in concert as an industry, bringing to bear not only our energy services, but U.S. suppliers of goods and services.

And I believe that you will be seeing this very new industry going offshore in the United States in the not too distant future, with both the technique of energy service and U.S. products and goods, and U.S. financing to make it possible to have capital formation in those countries that need the energy resource, but would like to have an energy resource that is less polluting than the traditional method of meeting energy budgets.

SENATOR GORE. You know, when the world signed this treaty on chlorofluorocarbons, the market for new technologies that avoided chlorofluorocarbons began to open up and became a tremendous business opportunity. And the United States has been moving aggressively to try to take advantage of that.

If we have a world treaty limiting CO_2 emissions, then businesses like yours would see new opportunities.

Correct, Mr. Sutcliffe? You just testified as much.

MR. SUTCLIFFE. That is correct. The treaty establishes a certainty of opportunity and commitment because a treaty is less likely to change than certain budget agreements, for example.

SENATOR GORE. Yes. Do either of you have a statement on this?

Mr. Fox?

MR. FOX. I'd just add that much of the efficient equipment that we see in the marketplace is American-produced. And therefore, given the fact that we see efficiency delivering a kilowatt-hour saved at a third to half

the cost of a kilowatt hour produced, suggests that there is a tremendous market opportunity in efficiency offshore.

SENATOR GORE. So, if other countries, say, Japan and the EC countries, establish CO_2 limits and drive the market for new technologies that produce less CO_2, then they're going to have a set of incentives that will drive businesses toward greater efficiencies in attempting to supply that market than would be the case in a country where the sky is the limit—no extra incentive to reduce CO_2.

Is that a fair assumption?

MR. FOX. I'd agree with that.

SENATOR GORE. Mr. Moskovitz, do you want to comment on that or on the earlier part of it?

MR. MOSKOVITZ. I do agree with your statement. I do believe that if other countries adopt strategies that certainly encourage their manufacturers to develop energy-efficiency products, we'll find those leading states in this country buying those products. It also extends to renewable energy production facilities as well.

SENATOR GORE. I'd like to explore why ... this might sound like an elementary question, but they're the kind that I learn the most from.

How could it be that the effort to eliminate pollution, whether it be CO_2 or SO_2, or whatever, also increases profits frequently?

Some people have reacted to this reality as if it was counterintuitive. But in order to make pollution, you have to buy raw materials before you can make the pollution. Correct?

MR. SUTCLIFFE. I think the problem is that we have looked at a command and control strategy in this country for reducing pollution, which has usually led to retrofits that are more expensive than the business as usual.

What we're starting to evolve to is an understanding that more efficient production of goods and services and more efficient uses of energy can accomplish the environmental goal, as was the case in the refinery that I cited, at positive cost to the goods-maker. And that realization is, as you say, within many corporate boards, still counterintuitive.

But I think that probably the greatest contribution that programs can make, such as Green Lights and the other green programs that EPA is promoting, is that they can point out the economic advantage of being energy efficient and meeting goals for the environment with no net costs.

But that's, I think, where you are with the elemental problem, that we're in a transition period of our understanding of pollution control.

SENATOR GORE. Mr. Moskovitz?

MR. MOSKOVITZ. That's exactly the case with all of the activities that are going on in the states pursuing energy efficiency opportunities and are being done really without regard to the environmental improvement. The environmental improvement is largely just a free lunch.

SENATOR GORE. That's the free lunch. Mr. Fox?

Well, let me just say, to use what may be perhaps an awkward analogy, if you're trying to hunt a bear, you look for the tracks. If you're trying to hunt inefficiency, you can look for the pollution.

Pollution is often a marker for inefficiency, which is difficult to see in its own right because it's in the sometimes invisible operations of the system itself. It is not always embodied in a clearly visible form.

But by tracking the pollution, you can sometimes follow that trail to the inefficiency which results in the pollution.

Yes, Mr. Stroup?

MR. STROUP. That sounds exactly like what I tell my classes all the time. I think, in most cases of pollution, you're exactly right. The awkward thing about carbon dioxide is that if you're perfectly efficient in using a fuel—a fossil fuel—you're going to get carbon dioxide and water. And so, in the conventional sense, those two things are not waste, in the conventional sense. They may still be pollution if they cause harm to others.

SENATOR GORE. Carbon dioxide is the biggest pollution problem we have in the world today.

MR. STROUP. Maybe so. But it's almost unique in the usual sense of not being a sign of waste. If CFCs escape, that is, in some sense, waste. We don't want them out there because they're costly. But when CO_2 escapes, that's what we want. We want CO_2 and water with perfect combustion.

Again, it limits the analogy. That's all.

SENATOR GORE. I understand the qualifier that you're trying to add. But we disagree on the underlying assumption. I think the point is still demonstrably valid, with respect to CO_2, if you look at the experience companies have had in attempting to reduce CO_2.

We now have the case of the Keidanren in Japan beginning to set much tougher standards for CO_2 emissions and the other emissions of pollution than those embodied in U.S. law.

There are two possible explanations. Number one, Japan may simply be soft-headed about international economic competition, or it could be that they think there's some economic benefit to be found in pursuing that strategy.

Number two, it seems to be that they have identified. This market, these new opportunities that you yourself talked about a moment ago, Mr. Stroup, and you, Mr. Sutcliffe, are "fairly lickin' yer chops over" with your business—in Japan, they want to be in a position to exploit what some in Japan have said is the biggest new market in the history of world business.

In Mexico City right now, they're shutting down factories, not because of the economy, but because people are choking to death on the pollution. And if they can reopen those factories and put people back to work, they're anxious to find the new processes and machinery that will allow them to do so. Japan is eager to sell it to them. That's an opportunity that we ought to be pursuing.

In the modern world economy, a classic strategy for success is to gain economies of scale in the domestic market, levels of quality and price effectiveness—and then penetrate the world market. The requirement for greater levels of efficiency and lower CO_2 emissions in the domestic market will confer an advantage in the competition in this world market, I believe.

Let me ask you, Mr. Fox, whether or not PG&E really views integrated resource planning and aggressive conservation as a regional development strategy? What do you mean by that? Isn't this really the same thing? Do you really see this approach to conserving energy as a rational strategy for regional economic development?

MR. FOX. You can look at this in a number of ways. If you look at it solely through the lens of economics, this is the least-cost plan. This is going to ensure that we can continue to provide our services to our customers existing in the future at the lowest possible cost.

The fact that, as somebody just described, the environmental benefits are free-riders, in California, we're actually monetizing those now.

So, we see this absolutely as the foundation of a corporate strategy that we feel is necessary, not just desired, but necessary to keep us competitive in our market, which, in turn, will hopefully keep our customers competitive.

SENATOR GORE. You're not government run, are you? These aren't the views of the government bureaucracy, are they?

MR. FOX. We're an investor-owned utility. At least we were when I left.

[Laughter.]

SENATOR GORE. All right. Given your experience in a state that already has one of the lowest per-capita energy use in the country, and which has one of the fastest-growing populations in the country, where you, as an investor-owned utility living with these realities, project a sizable reduction in your CO_2 emissions between now and the year 2000, do you think it's possible for the United States, as a whole, to stabilize CO_2 emissions at a profit?

MR. FOX. Well, I don't think I'm qualified to comment on the entire country, but certainly we see the plan that we have in place as stabilizing our emissions, reducing our costs and, therefore, our prices below what they would have been, and providing an economic stimulus to the service territory.

MR. MOSKOVITZ. Senator Gore, if I might just add. My work really takes me to states all around the country, not just California. I'm certainly unqualified to speak about the nation's CO_2 budget in its totality. But with respect to the electric utility industry, I can certainly tell you that the capability is there for the rest of the country to at least match what PG&E is doing now.

Remember, PG&E didn't get to their current level of activity, even though they started a long time ago—there was a long period at which

PG&E's own activities in this regard were relatively modest—until a little over a year and a half ago when the public utilities commission in California changed the rules.

And from that point forward, PG&E dramatically, and I think very successfully, increased their level of activity. That same pattern has been the case in the other states that have followed that same pattern. I don't have any reason to believe that the industry, in the aggregate, can't stabilize, if not even reduce, their CO_2 emissions to match PG&E's.

What I think is very unlikely, absent some federal leadership, is actually spreading to all of the other states. There will be a few good examples out there that we'll all be very proud of, and the rest of us will continue to work very hard trying to, in effect, conquer one state at a time.

SENATOR GORE. How's TVA doing?

MR. MOSKOVITZ. Not very well. Neither TVA nor Tennessee are yet doing very well in this regard. They're probably at the bottom half of the class.

SENATOR GORE. TVA used to be a leader in energy conservation and efficiency. What happened?

MR. MOSKOVITZ. I'm really not sure.

SENATOR GORE. Are they missing economic opportunities?

MR. MOSKOVITZ. I have absolutely no doubts about that. I have absolutely no doubts that there are many cost-effective energy efficiency opportunities in TVA's territory and the rest of Tennessee, and in the rest of that region.

We have spent some substantial amount of time in the Southeast, generally—Georgia and Florida—so I'm quite familiar with the untapped opportunities there. Things are turning around quickly in Georgia. They haven't yet in Tennessee.

SENATOR GORE. They're coming up on a decision to build new capacity, or figure out some way to manage demand. I guess you'd recommend that they should take a hard new look at demand-side management?

MR. MOSKOVITZ. Absolutely.

SENATOR GORE. Mr. Sutcliffe, are you prepared to go to the Tennessee Valley and make a killing if TVA can't figure out how to do it on their own?

MR. SUTCLIFFE. We visited a large plant two days ago in Chattanooga that has substantial energy conservation opportunities.

If you teamed the ratepayer interest in finding saved units of energy at a lower cost with the billpayer interest so that you really got the economic incentives correct, we'd be there within the next month.

The problem is that you can only go where the utilities have recognized that it's in their self-interest to pursue least-cost planning. BPA is starting to do that. We are hopeful that TVA would return to that path.

SENATOR GORE. Well, on the federal level—I used the phrase earlier—we have the leadership gap. It seems to me that these policy options are so attractive and the opportunities are so great that we really should move in that direction.

I think that the experience that all three of you on this part of the panel have had really demonstrates that.

Let me say that I have a number of other questions for the record. I know that my colleagues will as well. If you would be willing to answer other questions—it won't be a burden and there won't be too many of them—in writing for the record, we would appreciate that.

Because the hour is running late and we have another panel, I'm going to truncate the Q&A on this panel. But please know how much the Committee appreciates your testimony here today. It's been extremely enlightening and I want to thank you very much, all four of you.

Thank you very much.

Our final panel has only two witnesses—William Chandler and Florentin Krause. If you two would come toward the witness table, I will introduce you as you are coming.

William U. Chandler is senior research scientist with the Battelle Institute here in Washington, D.C. Florentin Krause is with the International Project for Sustainable Energy Paths in El Cerrito, California.

May I begin by thanking you for your patience and forebearance. It has been a long hearing and you have remained throughout, and I appreciate that. The Committee appreciates it.

Mr. Chandler, we'll begin with you.

STATEMENT OF WILLIAM U. CHANDLER, SENIOR RESEARCH SCIENTIST, BATTELLE INSTITUTE, WASHINGTON, D.C.

MR. CHANDLER. I've been searching my testimony to find something, a point that hasn't been made today, or at least isn't in your book, which I like very much, by the way.

Am I allowed to say that on the record?

SENATOR GORE. You are certainly allowed to make reference to "Earth in the Balance."

[Laughter.]

MR. CHANDLER. With regard to the work on estimating the cost on stabilizing emissions, you referenced the National Laboratories' report earlier that I was involved in, which suggested that through the year 2010, we could hold emissions constant in this country at no net cost to the economy.

I wanted to point out that if you dig into the Department of Energy report, you will find some interesting scenarios that suggest similar conclusions. If you simply take the scenario that suggests that if you cap emissions at 1990 levels and use a carbon tax to achieve it, then you get a cost to the GDP in the year 2005, or so, of about 1.4 percent in that year.

If you take that scenario and then rebate the funds to utilities for them to sequester the carbon that they emit in trees through reforestation, you get the cost down to about 0.2 percent of GDP.

And then if you also do something, such as DOE did in one scenario, which was to take the cap and reduce the implicit discount rate to 5 percent, you bring the cost down to the level that we arrived at, which was zero cost through the period, even though they have a higher level of total energy demand in that period because of the higher growth rates that they assumed.

In my testimony, I touched on market barriers, but we've talked a lot about that today. So, I will just make one point about policies for overcoming market barriers. And that is to point out that policies such as the corporate average fuel economy standards really did work. Over the last 15 years, we've had these oscillating fuel prices. But despite that, because of the fuel economy standards, fuel economy in new cars has been increasing steadily over this period, as has the fuel economy of the entire fleet.

So, carefully targeted policies can work. And, in fact, to reference something Mr. Stroup said, the safety of cars has actually improved by about 20 percent, in terms of serious injury per vehicle mile over that period, while fuel economy was doubling.

One other main point I wanted to make is that the United States has an historic opportunity to go beyond its own borders in promoting energy efficiency to cut carbon emissions. And I'm referring specifically to the opportunity of providing technical and economic assistance to Russia for restructuring its energy economy, reforming its energy prices, and cutting carbon emissions.

If we took this $3 billion to $5 billion that the United States is going to provide for economic reform stabilization in Russia, and if we took a billion dollars of that and targeted it to restructuring the energy sector and energy efficiency, in the year 2000, we could reduce carbon emissions by 50 to 100 million tons per year—a very, very low cost and a very effective means of cutting the burden to the global climate.

And finally, I wanted to point out something with regard to jobs and business that I picked up in an airplane last week. It's an advertisement on the back of "L'Express," which shows a couple of color photographs of an incandescent bulb throwing off lots of heat and a compact fluorescent bulb that's a lot colder.

In French, it says, you can double your money by investing in our compact fluorescent.

I just wanted to point out that this is a German company advertising in France. This illustrates that there are real business opportunities out there.

Thank you.

[The prepared statement of Mr. Chandler follows:]

PREPARED STATEMENT OF WILLIAM U. CHANDLER

SUMMARY

Thank you, Mr. Chairman, for the opportunity to comment on carbon dioxide emissions reduction costs and strategies. My testimony focuses on three general conclusions suggested by recent research:

1. U.S. carbon dioxide emissions could be held constant through the year 2005, according to our research, at no net cost to the U.S. economy.

2. U.S. carbon emissions could be cut by 20 percent in the year 2005 at a relatively small cost to the economy—probably less than 0.5 percent of GDP.

3. International assistance Russia and Eastern Europe—depending on the level of funds available—could cut the region's carbon emissions by 50-200 million tons of carbon per year in the year 2000.

Energy efficiency is without question the top emissions reduction policy priority at home and abroad. It is the only approach that can simultaneously improve both economic and environmental conditions. Recent studies indicate that the United States could hold carbon dioxide emissions constant over the next 10-20 years for a cost of $0-60 dollars per ton of carbon emissions reduction. These studies also suggest that the nation could cut carbon dioxide emissions by 20 percent over the same period for $22-220 per ton—for a cost of 0.2-1.4 percent of GDP in 2005. The variation in these estimates derives from modeling methodology, modeling assumptions, and interpretation. Measures including carbon or energy taxes, efficiency standards, and research and development efforts will be necessary to cut emissions by 20 percent.

Carbon emissions can also be cut dramatically with energy assistance to Russia and Eastern Europe. The United States has much to offer that region in cutting emissions: the United States leads the world in developing policies for least-cost utility services and U.S. manufacturers build efficient industrial motors, controls, and high-efficiency gas turbines, all high priorities for the region. Assisting energy-efficiency and economic reform efforts in the region could thus help cut greenhouse gas emissions by an amount equal to 4-15 percent of current U.S. carbon emissions.

59-626 O - 92 - 6

CURBING CARBON DIOXIDE EMISSIONS IN THE UNITED STATES

The cost of controlling greenhouse gas emissions in the United States will depend mainly on how effectively we remove barriers to energy efficiency. These barriers include price distortion, lack of infrastructure, disparity between private and social discount rates, promotional practices among energy suppliers, split incentives, lack of markets in saved energy, and inadequate consumer information. A vast literature has identified and described these difficulties, but has been less successful in prescribing solutions. Solutions have nevertheless been documented in successful regulatory, incentive, and information programs. The central question is whether these opportunities can be captured in the United States. Answering this question requires difficult and controversial application of energy and economic models.

Modelling Issues

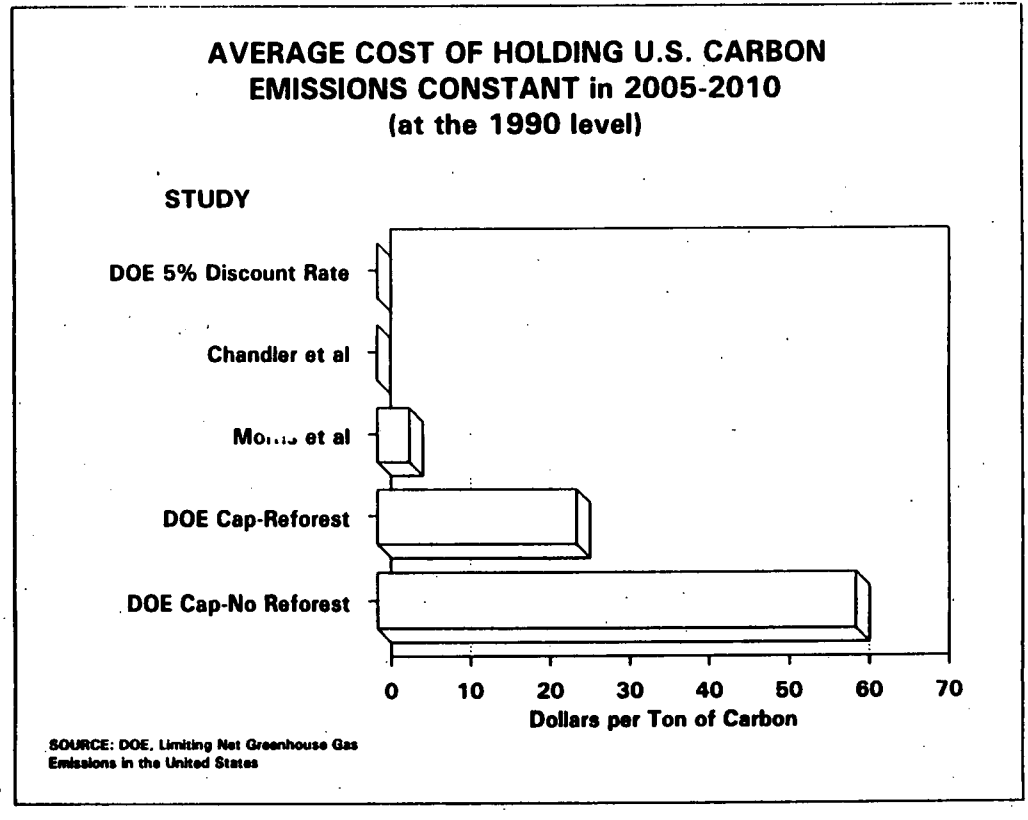
Valid models must be reproducible, transparent, and based on valid principles and assumptions. Strikingly different projections of future energy demand--and carbon dioxide emissions--can result from the modeler's choice of both models and inputs. Confusion can arise from differences in modelling tools, particularly between the "top down" and the "bottom up" approaches. The former type of model is driven primarily by economic growth, modified by econometrically estimated income- and price-elasticities of energy demand. These models may also include parameters that modify energy demand projections based on estimates of technological change, but they typically have very little detail on end-use activities or technologies.

End-use or bottom-up modelling efforts also are driven by economic growth, but they permit more detailed investigation of non-price-induced technical and policy changes. For example, automobile fuel economy or appliance efficiency standards can be assumed in an end-use or bottom-up model, while such a change can only be crudely approximated in a top-down, principally economic model. End-use models can thus reveal additional detail for understanding past and future energy demand.

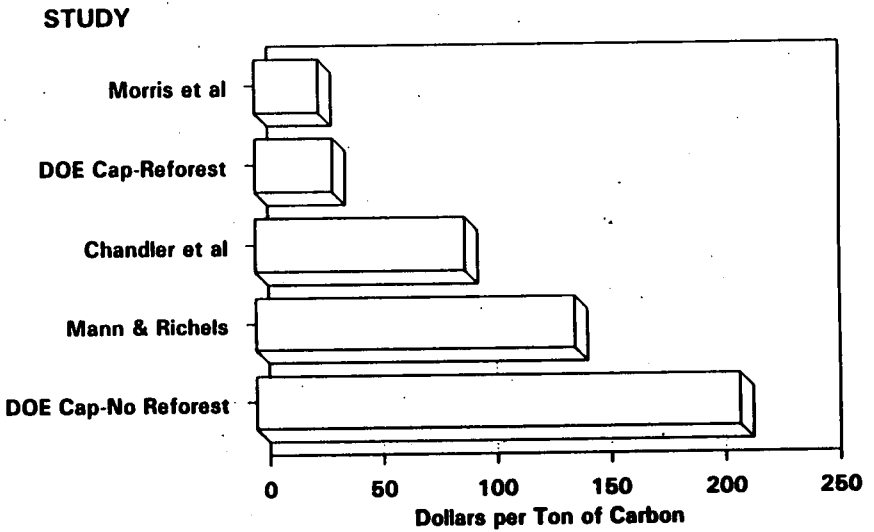
End-use or "bottom-up" models are handicapped, however, by their inability to provide equilibrium solutions. That is, economic theory suggests that reducing energy demand through regulatory policy should also lower energy prices somewhat. Depending on the magnitude of the price reduction, energy demand could be stimulated and thus offset some of the savings. Similarly, energy savings could have the effect of increasing the net income of consumers, and thus increase energy demand. A macroeconomic model would capture this effect, but the energy end-use models in use today often do not. On the other hand, the end-use models may better represent saturation of energy services. The strengths of the two approaches, top-down and bottom-up, can be merged, and efforts are underway to do so at Pacific Northwest Laboratory.

Comparison of Selected Studies

The cost of emissions control as estimated by various studies depends on many factors: the choice of modeling tools, scenario type, and assumptions. (See figures below.) The results, however, may differ more in perception of their results than in reality. A study by *Manne*


AVERAGE COST OF HOLDING U.S. CARBON EMISSIONS CONSTANT in 2005-2010
(at the 1990 level)
STUDY
DOE 5% Discount Rate
Chandler et al
Mo... et al
DOE Cap-Reforest
DOE Cap-No Reforest
0
10
20
30
40
50
60
70
Dollars per Ton of Carbon
SOURCE: DOE, Limiting Net Greenhouse Gas Emissions in the United States

AVERAGE COST OF CUTTING U.S. CARBON EMISSIONS by 20 PERCENT in 2005-2010 (at the 1990 level)



SOURCE: DOE, Limiting Net Greenhouse Gas Emissions in the United States; Manne and Richels, 1991.

and Richels[1] estimated carbon emissions control costs at about 1.25 percent of U.S. GDP in the year 2005, or $95 billion per year (average of ~$140 per ton). This cost may strike the reader as being surprisingly low compared to perceptions about Manne and Richels' work which is perhaps best known for high costs--about 2.5 percent of GDP--in the year 2030 and after. The short term costs do reflect technical energy-efficiency improvement, although the study has been criticized for underestimating the potential for energy efficiency. The average of energy intensity reduction over the last century in the United States has been 1 percent per year, and reached 2.5 percent per year during the energy crises of the mid-seventies to mid-eighties. Manne and Richels, however, allow only 0.5 percent per year.

In contrast, a study by *Morris et al.*[2] estimates the cost of emissions reduction by modeling the optimum use of cost-effective energy alternatives, including efficiency.[3] The model used was a linear programming model, which does not reflect consumer behavior but optimizes inputs as efficiently as possible. The costs estimated in this study appear modest. The authors estimated that cutting carbon emissions by 20 percent by the year 2005 would reduce GDP in that year by only 0.3 percent. Control costs would total $21 billion per year in 2005, or an average of $28 per ton of carbon reduced.

Critics of the study have argued that consumers do not optimize consumption in the way implied by the model. One problem is that the model assumes social discount rates, while consumers have much shorter time horizons. They will typically demand shorter payback times and do not value money in the way that long-term bond markets do. The critics also note that policy instruments for implementing energy-efficiency and renewable energy options remain to be defined.

A study performed for the National Energy Strategy exercise by four national energy laboratories estimated the cost of implementing existing cost-effective energy-efficiency potential by modeling a variety of efficiency standards and taxes.[4] A modified version (Chandler et al.[5]) estimated that holding emissions constant would incur essentially no net cost to the economy. Cutting carbon emissions by 20 percent by the year 2005 (compared to 1990) might cost as much as 0.5 percent of GDP in that year. Costs would total $69 billion, an average of $92 per ton of carbon. The study did not consider greenhouse gases other than carbon dioxide.

This study has been criticized for lacking a market equilibrium solution--that is, it does not incorporate the "takeback" effect--and for underestimating the energy-efficiency potential. The latter problem is, in my opinion, the more serious of the two criticisms. The take-back effect is not likely to result in more than a few percent increase in energy demand.[6] Supply-side energy-efficiency options, however, were not emphasized in the analysis, and these could provide large improvements in the efficiency of electric power generation. In general, the conservative approach taken in this report underestimated the energy efficiency potential of the United States, and overestimated the cost of cutting greenhouse gas emissions.

The Department of Energy report *Limiting Net Greenhouse Gas Emissions in the United States* is much more complicated because it presents a large number of options to reduce greenhouse gases, and it also examines all the major anthropogenic greenhouse gases, not just carbon dioxide. Carbon emissions, according to that study, could be held constant in

2000 with a $100 per ton carbon tax, and could be cut by 20 percent with a $500 tax. The cost to the economy of these tax levels would be 0.1 percent and 1.4 percent of GDP, respectively. In comparing this study to the Chandler report, it should be noted that DOE assumed a 3.0 percent rate of economic growth while Chandler et al. assumed 2.5 percent per year through 2010. However, the Chandler study achieves an 8 percent higher level of energy efficiency in the year 2005, equal to about 440 million tons of carbon per year.

One scenario in the DOE report both imposes taxes on carbon use and gives credits for reforestation. *This scenario yields an estimate of only 0.2 percent of GDP in 2005*, even lower than Morris et al. The report cautions, however, that the institutional aspects in a reforestation policy, which would use one-seventh of the U.S. land area for tree-planting, remain to be described. Other analysis suggests that the effect on land and food prices would not present serious difficulties. The price of lumber, on the other hand, would be dramatically reduced.[7]

The DOE report also addresses the question of discount rates. In one scenario, it examines the cost of emissions control if the consumer discount rate were reduced. ***The DOE report found that emissions could essentially be held constant through the year 2000 if the consumer discount rate were cut to 5 percent.*** The costs estimated by Chandler et al. and Morris et al. for holding carbon emissions constant through the year 2005 were also at or near zero.

Energy-Efficiency Potential

The NES Laboratories White Paper study (Chandler et al.) asked *How far can we go?* in applying energy efficiency. The authors assumed that energy consuming equipment is purchased to minimize total costs on a life-cycle basis, using a 7 percent real discount rate. The following discussion presents highlights from the analysis.

In Chandler et al., the efficiency case produced carbon emissions some 20 percent lower in the year 2010 than, for example, the DOE report. Half of this difference was due to the higher economic growth rate assumed by DOE, and almost half due to higher efficiency levels in Chandler et al.

Energy demand in the laboratories paper for the buildings sector in 2010 was reduced 14 percent below the base case. Households would in 2010 pay an additional $5 billion for efficiency measures, while realizing savings of $21 billion in reduced energy bills in the same year. Seven percent of the cumulative savings in buildings through 2010 was estimated to derive from new building shell measures, 23 percent from building retrofits, and 70 percent from new appliance equipment.[25] Additional savings are potentially available if faster turnover of existing equipment were considered.

The share of savings in commercial buildings from retrofits and new buildings measures were estimated at 47 and 53 percent, respectively. (Note that Fossil2, the model used by the Department of Energy for its report to Congress, does not effectively implement energy-efficiency options in retrofit applications. Also, capital stocks are not retired before their useful lifetimes, even if energy prices become extremely high.) The largest savings overall in the residential sector were projected for more efficient refrigerators. Necessary design changes involve more efficient compressors and fans, and significantly increased insulation.

Other important savings were projected by retrofit measures to existing buildings, such as additional wall and ceiling insulation.

In the commercial sector, large reductions in energy consumption occur for adjustable speed fan motors in building ventilation and in more-efficient lighting. Several technologies can be used to improve the efficiency of a motor when less than its full capacity is required. One technology, electronic variable-speed drives, adjusts the speed of motors by electronically varying the input voltage and frequency to the motor. These drives can reduce energy consumption in systems with varying loads, including fans in variable air volume systems, water pumping, and air-conditioning chillers.[24] Lighting efficiency can be improved by 25-75 percent, which in turn reduces air conditioning loads.

Many technological options now introduced in the new vehicle market can be used to improve future fuel efficiency.[27] These technologies include overhead camshafts, friction-reducing cylinder materials, ceramics to reduce heat rejection, compression ratio increases through more sophisticated electronic controls and better combustion chamber design, multipoint fuel injection, more valves per cylinder, turbocharging, supercharging, intercooling, electronic transmission control, four- and five-speed automatic transmissions, torque converter lock-ups, continuously variable transmissions, front-wheel drive, better aerodynamics, and improved accessory designs. *Carlsmith et al* suggested that a 38.5 mpg car will be cost-effective in 2000. (Although the DOE report suggests high energy efficiency gains through the use of alternative fuels in automobiles, the fuel economy of gasoline powered cars does not reach 23 mpg (actual on-the-road) over the next four decades. Gasoline powered cars nevertheless represent more than 40 percent the auto fleet in 2030 in the DOE report.)

Significant industrial efficiency potential also exists.[28] Improvements were taken only if they were both technically possible and economically justifiable and could be phased in as capital stocks were retired. For example, opportunities were found for cutting energy requirements throughout the *steelmaking process*.[29] The electric arc furnace uses virtually 100 percent scrap and requires only about 10.6 GJ per ton of steel produced. Only 36 percent of U.S. steel is made with the arc furnace, and this could probably be increased to 60 percent.[30] Similarly, energy use in making iron and steel from virgin ore could be cut dramatically by direct reduction or smelting of ores. We found that existing technology in cokemaking, blast furnace operation, steelmaking, and casting could, by 2010, save up to 42 percent of the total energy required to make steel, and at a cost below that of energy supply. The status quo would merely bring the U.S. down to the current level of Japanese energy efficiency in steelmaking--after 20 years.[32] In the *chemical industry*, both chemical processes and generic energy uses--distilling, separation--can be made more efficient. For example, the new Unipol process for making polyethylene uses only 35 percent as much energy per kilogram of output as conventional processes.[34] Generic opportunities include upgrading electric motor efficiency, cogeneration, thermal recompression in evaporation, and automated process control.[35] In the *paper industry*, promising technologies include continuous digesters, oxygen bleaching, upgraded evaporators, mechanical dewatering, boiler efficiency improvement, increased biomass use, and cogeneration. Various studies estimate that specific energy intensity in this industry could be reduced by one-third to two-fifths by 2010.[36] In *cement making*, the inefficient wet process still accounts for almost one-third of production, though the dry process uses 26 percent less energy per ton.[40] One hundred percent penetration for

the dry process by 2010, complete with heat recovery and optimum efficiency opportunities including more efficient motors for grinding, could reduce the energy required for cement making at least 20 percent.

The utilization of cost-effective energy efficiency opportunities will depend heavily on the rate of replacement or upgrading of existing industrial plant and equipment. This rate is not the same for all industries, as illustrated by the fact that the average age of the U.S. paper industry's plant and equipment is estimated to be 20 years, while that of the chemical industry is probably less than 10 years.[44] Studies which ignore the potential for early retirement of equipment made obsolete by changing energy conditions ignore considerable potential for emissions reduction.

Energy Supply Options

Demand for natural gas in *Chandler et al.* would total about 14 quadrillion BTU (quads) in 2010. This total would leave nearly 13 quads of potential gas supply which could be used for reducing coal consumption. Imposing constraints--taxes or regulations--on coal use to encourage maximum use of gas would reduce carbon emissions by almost 130 million tons per year in 2010. The cost--without any change in capital or technology--would be high, but with new gas-fired combustion turbines and combined cycle electric generation, the total cost could be cut to $7-8 billion per year.[49] New technology developed over the period might reduce this cost even further. (See figure below.)

U.S. Policy Considerations

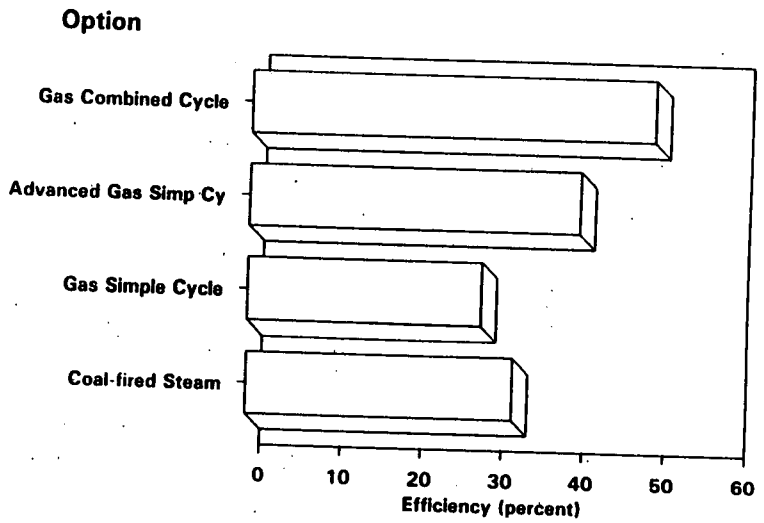
The constraint on short term efficiency improvements is not primarily technological, as the above discussion indicates. The primary barrier is insufficient implementation of existing cost-effective measures. Pursuit of additional opportunities through research, development, and demonstration is important in the long run, but significant efficiency improvements are technologically and economically feasible today.

Many imperfections in energy markets impede the implementation of energy efficiency. For example, prices should include all costs in order to promote energy efficiency. But the prices that consumers pay for fuels do not reflect fully all the environmental and social costs associated with fuels production, conversion, transportation, and use. For example, the costs of acid rain and of global warming are not now reflected in the prices of fossil fuels and electricity. Similarly, the national security and foreign balance-of-payments implications of oil imports are not incorporated in fuel oil and gasoline prices.

The price incentive for efficiency is further reduced in the electric sector because state public utility commissions generally set electricity prices at levels below the marginal cost of supply. Traditionally, prices are set so they reflect the average cost of producing electricity.[54] If, however, the costs to build and operate future power plants are greater than the current average, then consumers face inappropriate price signals. A similar, although less dramatic, situation occurs for natural gas.

Financing for efficiency investment is also a barrier. Energy-efficient systems are generally more expensive than their less efficient counterparts. Obtaining the additional money to

Power Plant Efficiencies



SOURCE: Johansson, Kelly, Reddy, Williams, RENEWABLES (UNCED Report)

pay the incremental capital costs of efficiency improvements is often a problem. Financing for energy efficiency is a major barrier for low-income households and cash-constrained industries. Theses barriers translate into very high implicit discount rates associated with residential investments in efficient refrigerators, air conditioners, other appliances, space heating equipment, automobiles, and retrofit measures, ranging up to 100 percent.[56]

Lack of information on the performance of energy-efficient technologies is often lacking. Such information is critical to those who decide on the commercial deployment and market penetration of new technologies, including investors, regulators, consumers, and others. In addition, energy end users are not adequately informed about the energy they consume. Evidence of this is provided by a recent study of gas furnace purchases which found that the energy efficiency rating is a poorly understood characteristic of furnaces.[68] The importance of this information gap is provided by studies that have shown that households will reduce their energy consumption when provided with detailed information feedback on the energy consumed by their appliances, heating equipment, and air conditioners.[69]

Consumers often must use the energy technologies selected by others. Industrial buyers select the technologies that are used in the production process. Specialists write product specifications for military purchases that limit access to alternatives. Architects, engineers, and builders, without direction from the ultimate owners and occupants, typically decide the energy efficiency of buildings and their equipment. Builders select and purchase large numbers of furnaces, water heaters, and other appliances for new homes. Used-vehicle buyers must choose from those vehicles purchased by generally more affluent, new-vehicle purchasers who may have placed a low value on fuel efficiency.

Overcoming these barriers would permit both economic and environmental benefits. ***Studies suggest that the United States could hold emissions constant until 2010 and save several tens of billions of dollars in energy costs, if it captured most of the energy efficiency potential available at the point of end use.*** The nation could cut emissions by 20 percent by 2010 at a cost of 0.2-0.9 percent of GNP if it not only revived energy efficiency efforts, but developed available natural gas supplies and added 10 quads of alternative energy supply. This is a formidable task and will require serious policy efforts. The key policy levers to accomplish this task include carbon taxes, appliance efficiency standards, and information. Tax credits and other incentives do not work particularly well, and in any case, the United States faces financial constraints which foreclose such policies.

ASSISTING RUSSIA AND EASTERN EUROPE MAKE LARGE EMISSIONS REDUCTIONS

The United States can reduce carbon emissions in an important new way: ***assisting the former Soviet Union and Eastern Europe.*** Existing technologies could reduce carbon dioxide emissions in the former Soviet Union, for example, by almost 370 million tons per year--an amount equal to 28 percent of total U.S. carbon emissions. This potential can be captured very inexpensively.

Assistance to Russia and other nations of the region can help both their economies as well as the global environment. The region has experienced a collapse comparable to the

American Great Depression, wiping out 20 years of income growth. What does the United States have to offer the former Soviet Union in energy policy? The United States is half as energy-intensive as Russia, and has the technology, policy experience, and motivation to cooperate. The United States would benefit strategically, environmentally, and economically by helping the new nations of the former Soviet Union survive their energy crises by applying energy-efficiency measures.

Energy Efficiency

The nations of the Former Soviet Union and Eastern Europe rank among the least energy-efficient countries in the world. Per capita energy use in Czechoslovakia, for example, exceeds that of Austria, yet Czechoslovakian GNP per capita is only one-third as high as Austria's.[8] The former Soviet Union overall consumes three-fourths as much energy as the United States, yet produces only 30-50 percent as much economic value. The region has about 12 percent of the world's population but produces 25 percent of global energy-related greenhouse gas emissions, more than the United States.

Unfortunately, the recent economic crisis in the region has not yet produced energy efficiency improvements: energy intensity in Russia, for example, has increased. This problem is explained by the fact that the light manufacturing sector has been hit hard by the reduction of imports, which provided spare parts and other essential inputs, while the energy-intensive heavy materials sector has not been affected as much.

Economic and environmental goals can be made to converge in post-planned economies. U.S. assistance is already helping--and can do more to help--the region make this difficult transition. Energy-efficiency opportunities in Eastern Europe include the use of better electric motors, motor speed controls, automation of industrial processes, combined cycle power cogeneration, more-sophisticated cars, improved lighting and refrigeration technologies, and thermal insulation in buildings. In the district heating and electric power sector, transmission and distribution losses remain high, and new combined cycle technologies could eventually cut heat rates by 15 percent or more.

Major opportunities also exist in the residential sector, including installation of heat meters and valves for controlling radiators, as well as more-efficient appliances. In the transportation sector, fuel economy remains low. The regional average is only 27 mpg in the typically small and low-power cars used in the region. Comparable vehicles used in the United States average more than 35 mpg. Increasing automobile fuel economy to cost-effective levels and converting the truck fleet from gasoline to diesel-powered engines can help reduce growth in transportation energy demand.

The commercial opportunities for selling, installing, and producing these products is large. This potential is reduced by constraints on available technology and capital. The extent to which savings are actually captured depends to a large extent on getting price signals and energy policies right, interesting western firms in making investments in Eastern Europe, and overcoming the failures that plague all market economies.

Providing consumers with access to capital is an important policy option. Energy-efficiency loan funds can be created for use by utilities and major industries through revenues from

fuels taxes or loans from multi-lateral development banks. In the buildings sector, blocks of financing could be channeled to utilities for distribution to consumers through least-cost planning programs. In the industrial sector, loans can be made available to enterprises for investments increasing energy efficiency in addition to output or productivity. Experience has shown that disbursing such loans requires technical assistance, including:

- Energy audits for industry and buildings;
- Least-cost planning specialists to advise utilities;
- Loan processing training for banking, utility, and industrial organizations.

Providing such assistance to the economies of the former Soviet Union and Easter Europe would have major benefits for energy conservation, the economies of those nations, and the global environment.

Natural Gas Alternatives

Russia's immense natural gas resource offers an attractive energy strategy: a gas bridge in the future. Gas production could grow from 29 exajoules in 1988 to as much as 35 exajoules by the year 2000 and 38 exajoules by 2010. There may be major potential for the U.S. private sector to become involved with the expanded use of gas. The United States makes some of the most efficient gas turbine power plants--adapted from high-efficiency jet engines--and these have a number of attractive characteristics. First, they approach 50 percent in energy-to-power conversion compared with only 33 percent for conventional power plants burning gas. Second, they are low-cost items in terms of capital. Conventional coal-fired steam plants in the United States cost two to three times as much per unit of power. And third, they are flexible because they do not benefit from economies of scale and therefore can be installed in small blocks of power as needed without loss of efficiency.

This strategy can be extended to Eastern Europe. Russian natural gas pipelines already serve Eastern Europe. Creative joint ventures between Russian and Eastern European enterprises, Western gas-steam turbine manufacturers, and Russian gas producers to finance the production of gas-using equipment and the delivery of gas to Eastern European consumers would help solve both economic and environmental problems. Eastern Europe would gain a cleaner, more productive energy system, the Soviets would gain a market for their gas, and the Western countries would gain export markets and reduced carbon dioxide and sulfur dioxide emissions from Eastern Europe.

Targeting Assistance to Curb Carbon Emissions

The cost-effective energy-efficiency potential in Russia is over 8 quads[9] per year in the year 2000--assuming a 50 percent discount rate. This amount is equal to 20 percent of 1990 primary energy consumption.[10] Only 3 quads of the energy-efficiency potential is likely to be captured *with Russian resources alone*, due primarily to lack of institutional infrastructure. Similarly, approximately 2 million tons of methane losses from natural gas pipelines could be prevented by relatively simple measures.[11]

If the United States were to provide, for example, a $1 billion one-time U.S. investment in energy-efficiency and methane leak reduction in Russia, emissions could be reduced an

estimated 50-100 million tons of carbon equivalent per year in the year 2000.[12] (See figure below.) Priorities for restructuring and institution building would require 10 percent of total emissions-reduction assistance, and should include:

1. Support for local experts to develop transition policies that emphasize energy efficiency.

2. Support for local and foreign experts in developing Integrated Resources Planning measures for electric, gas, and district heating utilities, including installation of meters and controls.[13]

3. Improving operations and maintenance in energy-using facilities through the use and implementation of audits.

Priorities for direct investment and joint venture development include both supply and demand side technologies, especially introducing efficient gas turbines for power generation; methane leak prevention measures for natural gas pipelines[14]; efficient electric motors and variable speed drives; meters, valves, and energy-conserving materials in the buildings sector; and industrial controls and meters.

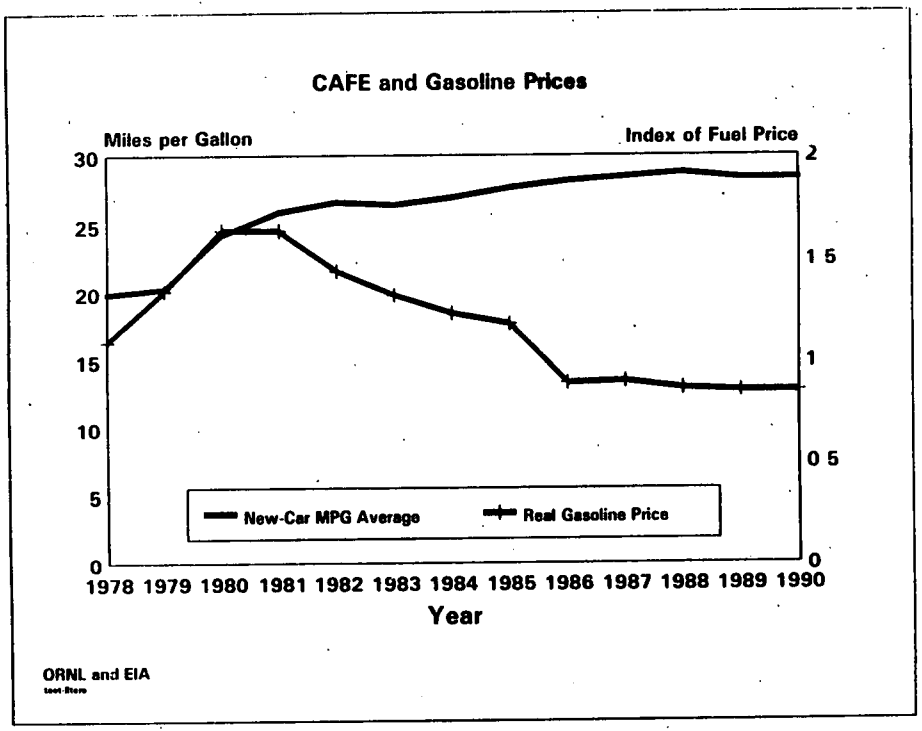
CONCLUSION: SELECTING AN EMISSIONS CONTROL STRATEGY

Many energy analysts believe that changes in ***energy prices*** were responsible for at least two-thirds of the energy-efficiency improvements attained in the United States in the period following the oil shocks of the seventies and early eighties. Price mechanisms, including taxes, are thus prerequisites for effective greenhouse emissions control policy.

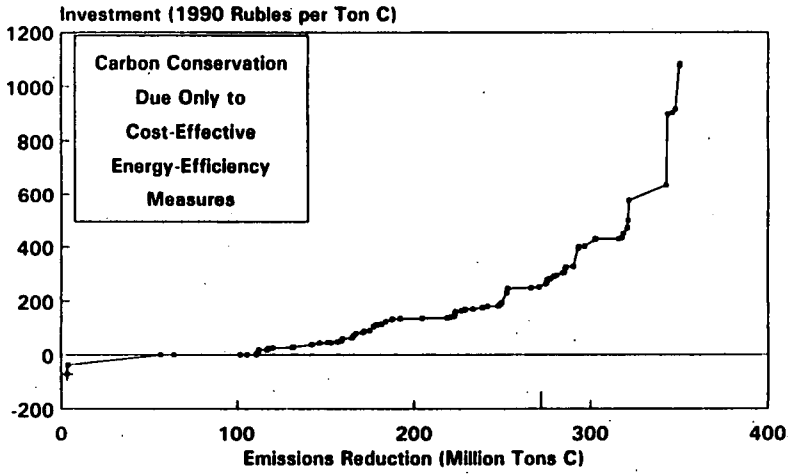
Tax incentives have sometimes been proposed as a means to overcome investment barriers, but there is no evidence that tax credits for home or industrial energy-efficiency investment in the United States have been worth their cost. However, some U.S. utilities have sponsored ***incentive plans*** and ***integrated resource planning*** and have saved energy quickly and inexpensively.[15]

Regulatory standards can effectively promote energy efficiency where there are clear market failures or where discount rates are unusually high. The level of fuel economy in private automobiles illustrates the effectiveness of this approach. Research and experience suggest that car-buyers will be indifferent to fuel economy over a broad range. While levels even twice the current new car average would yield net savings to consumers, the savings would be quite small and can be ignored from the buyer's point of view. Evidence of the constant increase in average U.S. fuel economy over the last 15 years (despite wildly fluctuating gasoline prices) presents a strong case for the effectiveness of standards. (See figure below.)

Regulatory policy, however, can fail unless continually evaluated and revised. For example, the fleet of light trucks in the United States has grown rapidly in part because they were treated differently from cars in the corporate average fuel economy standards. These vehicles today are generally used not as trucks per se, but as automobiles. They generally


CAFE and Gasoline Prices
Miles per Gallon
Index of Fuel Price
30
25
20
15
10
5
0
2
1 5
1
0 5
0
New-Car MPG Average
Real Gasoline Price
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990
Year
ORNL and EIA

Carbon Conservation Curve
Former Soviet Union, 1990-2005



SOURCE: I. Bashmakov and V. Chuplatov
(NOTE: 1990 Rubles = 5 Rubles per $US

are more powerful than cars, use far more fuel per unit of distance, and remain in use longer.

This fact suggests that a combination of policies might be required to accomplish a given objective. For example, U.S. appliance policy was crafted from a combination of efficiency labelling, regulatory standards, utility incentive programs for the purchase of efficiency models, and rising energy prices. A hypothetical example of such as policy in the transport sector combines fuel economy regulation with meaningful gasoline taxes and information programs designed to appeal to consumer self-interest. In fact, helping consumers reduce their effective discount rates would go far toward reducing the risk of climatic change.

The United States can also help the former Soviet Union and Eastern Europe reduce carbon dioxide emissions by carefully targeting technical assistance. Because energy inefficiency constrains economic growth and threatens the success of the vital experiments in democracy in the region, and because the opportunities for environmental protection through energy efficiency improvement can prove to be good business for American firms, there is ample justification for the United States to assist the region significantly reduce its carbon dioxide emissions.

NOTES AND REFERENCES

1. A.S. Manne, and R.G. Richels, ***Buying Greenhouse Insurance: The Economic Costs of CO_2 Emissions Limits*** (Cambridge, MA: MIT Press, 1991).

2. S.C. Morris, B.D. Solomon, D. Hill, J. Lee, and G. Goldstein, "A Least Cost Energy Analysis of U.S. CO_2 Reduction Options," in ***Energy and the Environment in the Twenty-first Century*** (Cambridge, MA: MIT Press, 1990.

3. Three terms must be clearly defined for comparing emissions control estimates: marginal, total, and average costs. The *marginal cost* is the cost of reducing the last--and usually most expensive--increment of greenhouse gas emissions and is relative to a reference case. The *total cost* of emissions reduction is the sum of incremental costs taken at each step in reducing emissions, with the last step taken at the marginal cost. It is computed for an individual year and is also relative to a reference case. The *average cost* is calculated as the total cost of emissions reduction, again relative to a reference case, divided by total emissions reduction. The value varies both with the year in which it is calculated and policies imposed. This testimony cites average and total costs in terms of dollars per ton of carbon reduced and total GDP change, both for a given year.

4. R.S. Carlsmith, W.U. Chandler, J.E. McMahon, and D.J. Santini, ***Energy Efficiency: How Far Can We Go?***, Oak Ridge National Laboratory ORNL/TM-11441, Oak Ridge, TN, 1990.

5. R.S. Carlsmith, W.U. Chandler, J.E. McMahon, D.J. Santini, J.A. Edmonds, and S. Kolar, "The United States: Carbon Emissions Control: Scenarios and Strategies for the Year 2030," in W.U. Chandler (ed.), ***Carbon Emissions Control Strategies*** (Washington: Conservation Foundation, 1991).

6. Edward Vine and Drury Crawley, editors, *State of the Art of Energy Efficiency: Future Directions* (Washington: American Council for an Energy-Efficient Economy, 1991). See also, Alden Myers et al., *America's Energy Choices: Investing in a Strong Economy and a Clean Environment: Technical Appendixes* (Cambridge, MA: Union of Concerned Scientists, 1992).

7. D. Adams, R.M. Adams, J.M. Callaway, C.C. Chang and B.A. McCarl, *The Economics of Sequestering Carbon on Agricultural Land in the U.S.: A Preliminary Analysis of Social Cost and Impacts on Timber Markets.* Mimeo.

8. Marie Kostalova, Jiri Suk, and Stanislav Kolar, *Reducing Greenhouse Gas Emissions in Czechoslovakia*, Battelle, Pacific Northwest Laboratory, Advanced International Studies Unit, January 1992.

9. An exajoule (EJ) is .95 quadrillion BTU, or roughly equal to 500,000 barrels of oil per day.

10. Cost-effectiveness assumes world energy prices and price liberalization. Savings includes only direct savings, thus excluding indirect savings. The latter equal as much as 70 percent of direct savings. Transfer of technology through stimulation of joint ventures could increase the direct savings potential.

11. See V. Rabchuk, N. Ilkevich, and Y. Kononov, "A Study of Methane Leakage in the Soviet Natural Gas Supply System," background paper prepared by the Siberian Energy Institute and presented at the Soviet-American Energy Workshop, 8 June 1991, Washington, D.C.

12. This estimate assumes that the most cost-effective measures are taken first, including a $300 million investment in leak reduction for pipelines and $700 million investment in energy-efficiency measures. The greenhouse warming potential (GWP) in carbon-equivalent assumed for methane is a factor of 20 times the number of tons of methane.

    The lower value in this range represents the amount of emissions reduction that would be achieved if only half of all options that are cost-effective at a 50 percent discount rate were actually implemented. This possibility could stem from a number of constraints, including lack of consumer information. The upper value in the range reflects 100 percent penetration of these attractive investments.

13. Note that price reforms in such sectors will not necessarily translate into energy savings if utilities are unable to meter consumer energy bills and if consumers are unable to turn down or turn off heat, for example.

14. This measure is not counted in the above totals, but could reduce methane emissions by 2 million tons, or the equivalent of 40 million tons of carbon. The cost of this reduction--and we might assume again that only half could actually be attained--would be an estimated $300 million.

15. Vine and Crawley, *State of the Art of Energy Efficiency*.

SENATOR GORE. Thank you very much. I have appreciated your work over the years, incidentally, and I appreciate the assistance that you have given on other occasions.

I'll hold questions until after our last witness.

Mr. Florentin Krause, I've made reference to your work already here today. Thank you very much.

Please proceed with your statement.

STATEMENT OF FLORENTIN KRAUSE, INTERNATIONAL PROJECT FOR SUSTAINABLE ENERGY PATHS, EL CERRITO, CALIFORNIA

MR. KRAUSE. Mr. Chairman, I would like to just briefly introduce myself and explain the capacity in which I speak here today.

I wear two hats, but I'm only here with one hat, so to speak. I'm the director of a private energy policy analysis firm called IPSEP. I'm also a staff scientist at Lawrence Berkeley Laboratories' Energy and Environment Division. And I hold a doctorate in physical chemistry from the University of California at Berkeley.

I have over the last 12 years been the lead author of several U.S. and European studies on the economic costs of low-emission energy futures and the policy options for implementing them.

You mentioned the National Association of Regulatory Utility Commissioners' handbook, which I co-authored. I was recently commissioned by the Dutch Government to complete two major assessments in the field of greenhouse policies. Our first report was released in 1989 and it developed the concept of buying insurance and developed greenhouse gas emission targets for industrialized countries based on warming limits, which was a novel concept at that time.

Our second report, which is now being readied for distribution, examines the cost of carbon reductions in the EC5 region in Western Europe—the core countries of the European community. This work is relevant to this hearing for two reasons, which I want to restate.

One of them is that in our analysis, we analyze generically the methods, their strengths and their weaknesses, with which the crucial question of costs can be analyzed and has been analyzed in the past. And we examine the viability for answering the questions that you posed today in this hearing. Namely, will it hurt the economy? Will it be a burden, or will it be a boon to the economy to reduce emissions?

And second, our study looks at one of America's competitors—Western Europe. It is an analysis for the competition. It is advice given to the competition. And I would like to emphasize that far from being the only kind of advice of the kind that we have found in our work, there were several other research reports by agencies of the European Economic Commission itself; namely, DG-17 and DG-12— including the various scenario analyses for individual countries and national studies within Western Europe, including, perhaps, foremost among them, the economic assessment of the Western German Enquête Commission on

Climate Protection, which involved 60 institutes in West Germany in a joint effort that we have not seen in this country to analyze the cost of carbon reductions.

So, the claim of some Administration officials that Western Europe is naive, they have not done their homework, and is out of some environmental do-gooderism, proposing the stabilization of emissions at 1990 levels, I think, is patently false, and just portrays lack of knowledge of how the policy process works in Europe.

I think the surprising, or perhaps not so surprising, findings of our study are basically well summarized in the written testimony. They indicate that for Western Europe, there is a very large potential over the next 30 years. We had a somewhat longer time horizon than other studies discussed here today. There is a large potential for emission reductions at zero or negative net cost of up to 60 percent, relative to base year levels.

What I would like to emphasize is, maybe, two aspects. One of them is a methodology aspect and the other one goes back to the question of international competitiveness.

One thing that hasn't been addressed in the testimony so far is the repeated statement by some witnesses that top-down analyses are somehow superior to bottom-up analyses and are inherently more capable or the best we have for answering the question that you posed today for the hearing.

I would like to take issue with this. And I would like to summarize this for the record briefly, what I see fundamentally at fault and the reasoning.

I quote a couple of statements here.

Richard Morganstern of the EPA testified before Henry Waxman's committee a month ago: "Top-down approaches realistically simulate the dispersed, heterogenous decision-making characteristic of a market economy." One justification for using the current top-down studies for policy development.

The second one: "Bottom-up approaches are technology-driven and thus do not predict actual marketplace use of new technologies well." Again from the same source.

And finally, "The assumptions, methodologies and conclusions of top-down and bottom-up models have not been reconciled because a full set for doing so has not been developed," quote from DOE's study, page 23, executive summary, "and would require substantial empirical and modelling research," quote from Charles Rivers Associates.

So, here I synopsized the key statements that justify the analytical approach that has been used in trying to address the congressional question posed to the Administration: What would it cost America to reduce emissions.

Now, in our research, we came to the following conclusions. And I want to emphasize the empirical aspects of our review.

First of all, the claim that carbon emissions reductions will be inherently costly is, according to our review, a predictable outcome of an

assumption made in all top-down econometric modelling calculations to date. Namely, that status quo energy-service markets function reasonably efficiently, i.e., that energy, capital and other production factors have historically been and are currently being employed in a welfare-maximizing manner.

If one makes this assumption, it is inescapable that one would conclude carbon reductions will cost something, as you pointed out earlier in the hearing.

Now, careful examination of this assumption shows that econometric, top-down approaches do not realistically simulate efficient markets. What they do is they realistically simulate and perpetuate into the future a politically-formed status quo in which the functioning of markets is riddled by pervasive barriers, distortions and regulatory failures.

Actions envisioned under the U.S. National Energy Strategy or under voluntary programs by other agencies to achieve stable emissions are far from sufficient to eliminate the majority of these barriers.

Recognizing these fundamental deficits of the econometric perfect-market paradigm, the majority of the U.S. utility industry has, in recent years, made bottom-up approaches the primary, not the exclusive, basis for its resource investment planning. Integrated resource planning, which is now adopted by two-thirds of the states in the United States, is primarily a bottom-up type of approach.

Integrated resource planning, as is now practiced by the states, also is living proof that combining bottom-up and top-down approaches—again, combining them, not rejecting one or the other, but combining them—is already analytically feasible and practically done, and does not have to await future intensive research and development of analytical modelling techniques, even though there is an urgent need to improve those integration approaches.

And most importantly, what we are seeing today, the way econometric and bottom-up approaches are being combined in planning investments in the utilities sector is a sufficient basis for getting to the qualitative question that you posed in this hearing, which is, does the economic impact go in a good direction or in a bad direction?

For this question to be answered, we already have the necessary integration and I think the statement in the DOE study that the tools weren't available for really integrating bottom-up analyses is to be faulted and is also directly contradicted by the 5 percent discount rate case, as we heard in the hearing today.

SENATOR GORE. If I could just interject. To clarify that point for the record, how extensively do you feel DOE integrated bottom-up opportunities in the report to the Congress?

MR. KRAUSE. Among the major studies justifying the current Administration, the DOE report went the furthest. And so far, the DOE's modellers did at least consider, in a nominal fashion, the demand-side resources and gave it the treatment on the basis of different discount rates.

Those kinds of analyses were not even done in some of the other macroeconometric studies. Of course, your earlier questioning had already shown that the analysis of the bottom-up inputs left much to be desired and, certainly, cannot be held out as complete.

Now, the other point I wanted to make here that regards the international competitiveness situation, I believe it is worthwhile restating what the view—carbon reductions can be done at a profit—means for the question of international competitiveness.

We have to ask ourselves, does the United States have comparable opportunities to avail itself of these benefits, if they are benefits rather than burdens, to the competitors in Europe and Japan? And if we do or if we don't, what is our course of action to be?

I would suggest that international comparative analytic research on energy use in the OECD countries, done at LBL and elsewhere, shows conclusively that if it is market barriers and failures in the economy and opportunities for removing them that drives the beneficiality of carbon reduction policies, the United States is in an excellent position to compete because it will have plenty of those to remove. And I think we can restate that contrary to the intent of the Administration to protect the country's economic interests in the international climate negotiations, what the current stance really does is it misses an opportunity. It misses an opportunity and it opens the United States up to a further loss in international competitiveness, precisely what the stance is intended to prevent.

So, I think the fundamental flip-flop that occurs if one goes from a view that carbon emissions are a burden to a view that carbon emission reductions are an opportunity for economic benefit has not been sufficiently recognized in the public dialogue about this problem.

And I think your hearing was an excellent and very important contribution to changing this state of affairs.

[The prepared statement of Mr. Krause follows:]

A U.N. sanctioned report by the Intergovernmental Panel on Climate Change (IPCC) recently found that global carbon emissions will need to be cut by at least sixty percent below present levels in order to stabilize the concentration of carbon dioxide in the Earth's atmosphere. As an initial response, Western Europe's governments have proposed an international agreement to return OECD fossil carbon emissions to 1990 levels by the year 2000, and some European governments have established national targets to cut carbon emissions by 20 percent or more soon thereafter.

Meanwhile, the U.S. government has so far resisted the adoption of similar policy goals. Its key objection is the potential economic cost of such targets. Indeed, U.S. officials have predicted that European governments will back away from their "ambitious" proposals once their economic implications are studied more carefully.

These assertions are challenged by a major analysis of the cost and potential of carbon reductions in Western Europe that is soon to be released. The study, which includes a review and critique of other recent studies in the U.S. and Europe on that topic, was prepared by the International Project for Sustainable Energy Paths (IPSEP), a private research organization with affiliates in Europe and the U.S. The 500 page report represents a two-year research effort by experts from academic institutions and energy efficiency centers on both continents, and was funded by the Dutch Ministry of Environment.*

Challenging conventional wisdom

The IPSEP study throws into question the basis of the current U.S. policy stance in the international climate treaty negotiations. It finds that

- Contrary to a widespread belief, significant cuts in carbon emissions are feasible while saving nations and consumers money.
- Studies showing that reduction goals would require high carbon taxes and would slow the growth of the economy are conceptually flawed and ignore important options for recycling carbon taxes.
- Corrections of these analytic shortcomings yield the opposite result: Programs aimed at cost-effective but unrealized efficiency improvements can cut emissions while reducing national energy bills and enhance

---

* The author was the principal investigator for this research project. The opinions expressed in this testimony are those of the author and not of the Dutch government.

growth in employment and GNP. Even without such programs, the effects of carbon reduction targets on GNP would be neutral to positive if the revenues from carbon taxes are properly recycled.

- Carbon taxes in the range of hundreds of dollars per ton are not needed. Emission reductions can be implemented most effectively by heavily relying on instruments other than carbon taxes. In such an approach, carbon taxes play a supplementary role and are an order of magnitude lower than conventionally calculated.
- Conventional econometric modeling assessments of the cost of carbon reduction strategies are ill-suited as the principal basis for public policy. Much greater emphasis should be placed on incorporating into these models data from bottom-up analyses, notably market research, program evaluation, and engineering-economic studies that identify market barriers and unrealized efficiency potentials by technology, end-use, and sector.

Why carbon cuts make good economic sense

The key to lowering carbon emissions while making money are the pervasive market barriers, regulatory failures, and other market distortions that inflate business-as-usual energy use and make it less efficient than economically desirable. Eliminating these market inefficiencies and regulatory failures will save money and reduce carbon emissions at the same time, i.e., carbon emissions are reduced at negative net cost.

If the money saved from such a least-cost approach is invested in renewables and further efficiency improvements that are currently somewhat more expensive than conventional supplies, carbon emissions are decreased even further. At the same time, the total expenditure for energy services is still no higher than in the business-as-usual case, i.e., carbon emissions are reduced at zero net cost.

Why macroeconomic studies don't prove high costs

The fundamental flaw of macroeconomic calculations is that status quo patterns of energy use are treated as though they reflect efficiently functioning markets. As a result, any deviation from business-as-usual scenarios leads to higher energy expenditures. This assumption is in conflict with the findings of detailed engineering-economic investigations by IPSEP and many other research groups, which find large technical opportunities in both Europe and the U.S. to increase energy efficiency while reducing costs.. It also conflicts with the extensive body of experience with successful utility incentive and other conservation programs.

Even if such opportunities did not exist, carbon reduction strategies could still be used to boost economic growth. Contrary to widely quoted conclusions from studies by the U.S. Department of Commerce (U.S. DOC), the U.S. Department of Energy (U.S. DOE), the Congressional Budget Office (CBO), and the Electric Power Research Institute (EPRI), carbon taxes and carbon constraints do not necessarily result in losses in GNP. Studies by the European Economic Commission (EC), by the New York State Energy Office (NYSEO), and by the U.S. Environmental Protection Agency (EPA) show that the impact on GNP depends on the manner in which revenues are recycled into the economy.

If revenues are rebated in the form of income tax, payroll tax, or corporate tax reductions, or if they are used to reduce the budget deficit, macroeconomic modeling studies do typically find a reduction in GNP. But when revenues are recycled into investment tax credits or directly into subsidies for energy efficiency investments by consumers and industries, the same econometric models yield the opposite effect: GNP growth is either the same as in the business-as-usual case, or is enhanced by up to several percent because carbon taxes now directly support productive capacity investments or investments that reduce fossil fuel needs.

The IPSEP study thus concludes:

- Carbon taxes can enhance economic growth if revenues are used to stimulate investments, i.e., if they improve the macroeconomic efficiency of existing tax structures. This recycling option is not considered in the analyses on which current U.S. concerns over GNP losses are based.

Several of the studies quoted in support of the current U.S. government position do not even identify their failure to investigate the recycling of carbon taxes into investments as pertinent to their findings.

The GNP stimulating effect of least-cost carbon reduction strategies

The above outcome of neutral to positive impacts on GNP growth is obtained before considering the option of reducing energy expenditures through least-cost policy reforms. Because least-cost energy investments will free capital for investment in other sectors, they will enhance the growth of GNP. Thus, macroeconomic effects can move from neutral to positive, or can become more strongly positive, when optimized carbon tax recycling is combined with least-cost market reforms, since the two would reinforce each other. The IPSEP analysis concludes:

- When carbon taxes are directly used to finance cost-effective energy efficiency investments and are accompanied by other programs to overcome market and regulatory barriers, the result is a stimulus for GNP growth and employment.

Why high carbon taxes are not necessary

The studies quoted in support of current U.S. government positions calculate that very high carbon taxes (several hundred dollars per ton) would be needed to induce significant reductions in carbon emissions, leading to as much as a doubling of coal and oil prices. These findings are an artifact of conventional macroeconomic modeling studies.

The implementation of carbon reduction targets cannot be achieved through macroeconomic instruments alone. While carbon or energy taxes are an important and desirable price signal, such price signals are a blunt sword without specific regulatory policies and incentives programs aimed at overcoming pervasive market and regulatory barriers, since these barriers will continue to make price signals ineffective.

The IPSEP study therefore proposes a different approach, consisting of several policy instruments that complement each other:

1) Legally binding reduction targets and timetables, coupled with market mechanisms for carbon emission trading;

2) Strict energy efficiency standards for buildings, appliances, lighting systems, vehicles, and other suitable end-uses.

3) Extension services and incentive programs to help industries and consumers invest in already cost-effective equipment, vehicles, homes, appliances, etc. whose efficiencies exceed standards.

4) Financial incentives (golden carrots) for manufacturers that increase the energy efficiency of their products beyond best available levels.

5) If needed, transitional conversion incentives (golden parachutes) for industries and regions that will lose assets and markets as a result of reduced fossil fuel consumption.

6) Federal carbon taxes or combined carbon/energy taxes set at levels needed to fund the above carbon substitution programs.

The funding of these programs and the associated incentives or investments would partly come from recycling carbon tax revenues, but would also rely on other options, such as:

- Least-cost planning reforms in the utility sector, including incentive programs for demand-side efficiency investments by customers.
- Fee/rebate (feebate) programs that finance rebates on purchases of energy-efficient vehicles or other products by fees on inefficient ones.

In IPSEP's approach, a major portion of carbon-reducing investments are thus directly financed by the savings generated from least-cost utility planning reforms and other programs. As a result, carbon taxes have only a supplementary role; low tax levels are sufficient to finance requisite programs.

Why bottom-up analyses should be a primary basis of public policy

The IPSEP analysis concludes that macroeconomic modeling assessments of the cost of carbon reduction strategies are ill-suited as the principal basis for public policy: they result in opposite conclusions depending on the tax policies assumed, and they do not capture the cost-reducing effects of policy options for correcting existing market and regulatory failures in the energy sector.

A more reliable approach for estimating the cost of carbon reduction strategies is available through detailed engineering-economic and market research analyses that examine each major energy application separately and calculate the least-cost level of aggregate energy demand "from the bottom up." Several recent U.S. and European studies have made use of this approach, including studies by the Office of Technology Assessment (OTA) and by the National Academy of Sciences (NAS). This bottom-up approach is also used in IPSEP's study of Western Europe.

A case study of Western Europe: major findings

In IPSEP's assessment, Western Europe's proposal to return fossil carbon emissions to 1990 levels by the year 2000 is not audacious or reckless, but modest when compared with the region's economic opportunities for cutting emissions.

Looking thirty years ahead to the year 2020, the study concludes:

- Under business-as-usual plans, Western Europe is likely to spend 15-35 percent more for energy services than it would under a least cost strategy. In absolute terms, these excess costs would amount to $40 to $70 billion in real (1990) dollars per year by 2020, or about $ 400-650 per household per year.
- Significant (up to 40 percent) carbon reductions below 1985 levels will result from strategies that merely eliminate these excess costs by providing energy services in a least-cost manner.
- Such a least-cost strategy will reduce year 2020 oil and coal consumption below present levels while the use of natural gas grows about as much as it would under business-as-usual projections.
- Western Europe has ample resource options for cutting its carbon emissions further. Using higher-cost efficiency, renewables and cogeneration resources, the region could reduce its carbon emissions by up to 60 percent below present levels even if nuclear power is phased out and gross national product continues to rise as projected.
- Under favorable but not unrealistic assumptions (moderate gas prices and good progress in reducing the cost of renewables), even this 60 percent cut in carbon emissions could save these nations a significant portion of their future energy bill when compared to business-as-usual plans. With unfavorable assumptions (i.e., with high gas prices and more expensive renewables), the net effect on Western Europe's total bill for energy services would be about zero.

Implementing the full cost-effective resource potential of efficiency improvements and low carbon supplies requires strong and persistent policy action and may not be politically feasible. The IPSEP study therefore calculates percentage carbon reductions and costs for cases where policies are less than 100 percent effective in mobilizing low-carbon resource potentials. It finds that:

- Major carbon reductions can be achieved in Western Europe even when efficiency and renewable resources are not fully utilized. If only 50 percent of the EC-5 resource potentials are mobilized, carbon reductions of 27 percent relative to 1985 levels can be achieved. For a 75 percent mobilization, carbon emissions drop by 43 percent. As in the 100 percent case, the costs over business-as-usual energy strategies are zero at worst, with the potential for pronounced savings.

These estimates measure only direct expenditures for energy services. They do not yet take into account the economic benefits of avoided environmental externalities and military costs for securing oil supplies.

Nor do they measure the potential macroeconomic benefits from a carbon reduction strategy. The IPSEP study finds that with proper implementation, a carbon reduction strategy is likely to strengthen, not weaken, Western Europe's economic competitiveness:

- Industries and consumers will spend the same or significantly less on energy services;

- Expenditures for controlling acid rain emissions and other externalities of current energy use will be greatly reduced.
- Western Europe's dependence on fossil fuel imports will be stabilized at the present level of about 50 percent even as domestic fossil fuel production declines, compared to an inexorable rise in import dependence under business-as-usual scenarios.
- Western Europe's fossil fuel imports will decrease in absolute terms. Less money will flow out of the region to pay for imported fuels.
- Lower imports will put downward pressures on prices for coal and oil, and possibly on rises in the price of gas.
- Unilateral action ahead of or beyond international agreements could give Western Europe a head start in technological innovations that will have world-wide markets once least-cost and low carbon policies gain broad international acceptance.

These advantages suggest that a strategy to reduce carbon emissions swiftly is good industrial policy for Western Europe, irrespective of whether other countries follow suit or not.

While carbon reductions in Western Europe could be robustly advantageous in economic terms, realizing this potential requires a suitable mix of pricing policies, regulatory adjustments, and market-oriented incentive programs:

- Macroeconomic pricing instruments such as carbon or energy taxes are important, but revenues will need to be effectively recycled so as not to impede economic growth. Suitable recycling methods are investment tax credits and/or energy efficiency and other carbon-reducing investments.
- Even with proper recycling, carbon taxes will still need to be accompanied by sector- and application-specific regulatory policies and incentive programs to overcome persistent market and institutional barriers.

Findings of other bottom-up analyses

IPSEP's report reviews six other recent bottom-up scenario analyses covering, respectively, Canada, Germany, Sweden, and the U.S over a 20 to 40 year period. Though these countries differ significantly, the studies consistently find that significant reductions in carbon emissions are available at net savings in costs.

Summary

In summary, IPSEP's analysis suggests that even in a very cautious approach, Western Europe could adopt targets aiming at substantial cuts in carbon emissions for the years beyond 2000 while boosting economic growth, saving large sums of money, and enhancing its international competitiveness.

SENATOR GORE. Well, I appreciate those kind words. I appreciate even more your excellent statement. I want to say the same about both statements.

I only have a few questions because the hour is late.

When I said earlier that pollution can be a marker for inefficiency, do you all agree with that? And has that been the experience of companies that have eliminated inefficiency and pollution simultaneously?

MR. KRAUSE. Can I just make one example that speaks directly to this?

In the 1970s, in Germany, there was a push by public interest groups and political parties to take measures on SO_2 emissions in power plants. And at the time, we had a dialogue very similar to the one we have about global warming now: It will ruin the country if we proceed to take measures that are going to be very costly.

Because of the political situation and the leadership that was provided, in part, by the public itself, Germany proceeded to unilaterally adopt very stringent emission standards that its European competitors were not following.

Ten years later, West Germany was in the position to be the world leader in scrubber technology—better than the Japanese, better than the United States. And it took the United States about a decade to catch up with this technological lead.

Today, Eastern Europe is not only ravaged by a depression, but it is ravaged by the environmental effects of the long rule of communism. And we find that the population is demanding the best environmental technologies, even as they are building themselves up from a depression, and want nothing less.

What products do they want? Preferably German ones when it comes to power plant technology, on account of the reputation that they have better clean-up equipment.

This is just one minute example, but it goes in the general direction of what you said, that pollution does lead to opportunities, not just to burdensome costs, if one follows it.

SENATOR GORE. Thank you. Mr. Chandler, could you describe how receptive the Bush Administration is to some of your suggestions, which I find exciting, regarding potential conservation gains in the emerging economies in Eastern Europe and the former Soviet Union?

MR. CHANDLER. Well, I can't say because some of these ideas are very new, such as targeting the assistance to Russia. I know the ideas are on the table.

Let me add on this point about whether pollution is a marker or not. I've worked a lot in Eastern Europe, Russia and China in the last few years. I think your analogy or parallel is right on target.

If you look at the Anchon steel mill and you see the smoke billowing out, or the red oxide billowing out, of the open-hearth furnace and look right beside it at the basic oxygen furnace and you see the difference and you hear the Chinese asking for assistance in developing and investing in

that kind of technology, you see right away that pollution is in fact a marker for energy efficiency.

I hope that the Bush Administration will adopt this idea. I don't know.

SENATOR GORE. In fact, China, just yesterday, announced a major new government initiative of its own to target, as a national priority, the development of environmentally benign and energy-efficient new production technologies.

MR. CHANDLER. China has done something no other developing country has done, which is over the last ten years, is cut energy demand growth to half the rate of economic growth.

SENATOR GORE. Wouldn't you agree that it would be important for us to be a leader in the CO_2 negotiations, calling, for example, for a joint implementation framework so that we can take advantage of these opportunities?

MR. CHANDLER. I think U.S. industry has a lot to benefit if the U.S. does play such a leadership role.

We make some of the most efficient gas turbines in the world. Motor-speed controls, efficient electric motors—things that are high priority in Russia and Eastern Europe—are potentially big markets for this country.

So, both in terms of our position and in terms of our moral and business leadership, I think it's a worthy idea.

SENATOR GORE. I have some other questions, but I'm going to have to ask them for the record because we have gone so long. But I hope that you will answer these questions for the record because I want to get the further benefit of your testimony.

You've both been extremely helpful and major additions to this hearing. I want to thank you very, very much.

I think it's been an interesting day. I've learned a great deal, and I think the record of this hearing is going to be an extremely interesting one.

I want to thank all the witnesses and, again, to our final two, who have waited throughout the day, a special word of thanks.

This hearing will stand adjourned.

[Whereupon, at 5:47 p.m., the Committee adjourned, subject to the call of the Chair.]

O

59-626 (182)