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This is still pretty rough, but I should have a clean version to you tommorrow early.

bc

**Testimony of**

**William U. Chandler**
**Senior Scientist**
**Battelle Memorial Institute**
**Pacific Northwest Laboratory**

**before the**

**JOINT ECONOMIC COMMITTEE**
**U.S. CONGRESS**

**on**

# ECONOMIC IMPLICATIONS OF CARBON DIOXIDE EMISSION REDUCTION STRATEGIES

**28 April 1992**

# ECONOMIC IMPLICATIONS OF CARBON DIOXIDE EMISSION REDUCTION STRATEGIES JOINT ECONOMIC COMMITTEE, U.S. CONGRESS

**William U. Chandler**
**Battelle, Pacific Northwest Laboratory**

## 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 could--depending on the level of funds available--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.**

need taxes to cut

***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: for example, the United States leads the world in developing policies for least-cost utility services, and U.S. manufacturers build efficient industrial motors, electronic controls, and high-efficiency gas turbines, 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.**

implication to goal implementation

## 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.

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### 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. The results, however, may differ more in perception of their results than in reality. A study by *Manne and Richels*[1]

DOE

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.

Do we know this for DOE?

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 $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 cutting carbon emissions by 20 percent by the year 2005 (compared to 1990) would cost about 0.5 percent of GDP in that year. Costs would total $69 billion, an average of $90 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 5 percent increase in energy demand. 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.

? documented AFEs was only 90%

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. One option, a carbon tax, suggests costs of 1.4 percent of GDP in the year 2005. 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.

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.[6]

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 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 the buildings sector, seven percent of the cumulative savings 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. 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. Energy demand in 2010 would fall 14 percent below that of 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. Note that the DOE report to Congress was unable to fully account for retrofit measures due to model limitations.

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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, roller cam followers, 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.

reduction from this?

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.

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**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 total around $73 billion in 2010. This cost should be considered a worst case because it assumes optimistically low and pessimistically high prices for coal and natural gas, respectively. Also, the estimates ignore the potential for new conversion technologies to reduce the cost of supply electric power. New gas-fired combustion turbines and combined cycle electric generation systems could reduce the overall costs. Using advanced systems such as steam injected gas turbines would cut this cost to $7-8 billion per year.[49]

**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.

Prices should include all costs in order to promote energy efficiency. However, 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 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 pay the incremental capital costs of efficiency improvements is often a problem. Obviously, money is a major barrier for low-income households and cash-constrained industries. Many studies found 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. The nation would benefit strategically, environmentally, and economically by helping the new nations of the former Soviet Union survive their energy crises.

### 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.[7] 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 overall--with about 12 percent of the world's population--produces 25 percent of global energy-related greenhouse gas emissions, more than the United States.

USSR?
E. Europe

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.

Restructuring the economies of the former Soviet Union and Easter Europe would have major benefits for energy conservation. Materials use per capita is very high compared to other nations, and market reforms would have two effects. First, less scrap and unnecessary material would be produced. Second, materials would be used more efficiently in manufacturing, construction, and packaging as manufacturers compete for price-sensitive markets. Structural reform could save 11 exajoules by 2010, or almost one-sixth of current total former Soviet energy demand.

**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. 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.

In the long term, gas can serve as a bridge to a renewable future. A fundamental reorientation of the utility sector would see natural gas supplies stretched by general use of efficient combined cycle systems producing electricity and steam for space heating or industrial processes. This technology would reduce the environmental problems in the former Soviet Union associated with coal and nuclear power, and would save gas for export.

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[8] per year in the year 2000--assuming a 50 percent discount rate. This amount is equal to 20 percent of 1990 primary energy consumption.[9] 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.[10]

The emissions reduction due to a $1 billion one-time U.S. investment in energy-efficiency and methane leak reduction in Russia is estimated to total 50-100 million tons of carbon equivalent per year in the year 2000.[11] The carbon emissions reduction due to a $5 billion one-time U.S. investment in energy-efficiency in Russia is estimated to total 100-190 million tons of carbon per year in the year 2000.[12] 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 natural options for 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.

*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 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.

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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.

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6. 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.

7. Marie Kostalova, Jiri Suk, and Stanislav Kolar, *Reducing Greenhouse Gas Emissions in Czechoslovakia*, Battelle, Pacific Northwest Laboratory, Advanced International Studies Unit, January 1992.

8. An exajoule (EJ) is .95 quadrillion BTU, or roughly equal to 500,000 barrels of oil per day.

9. 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.

10. 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.

11. 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.

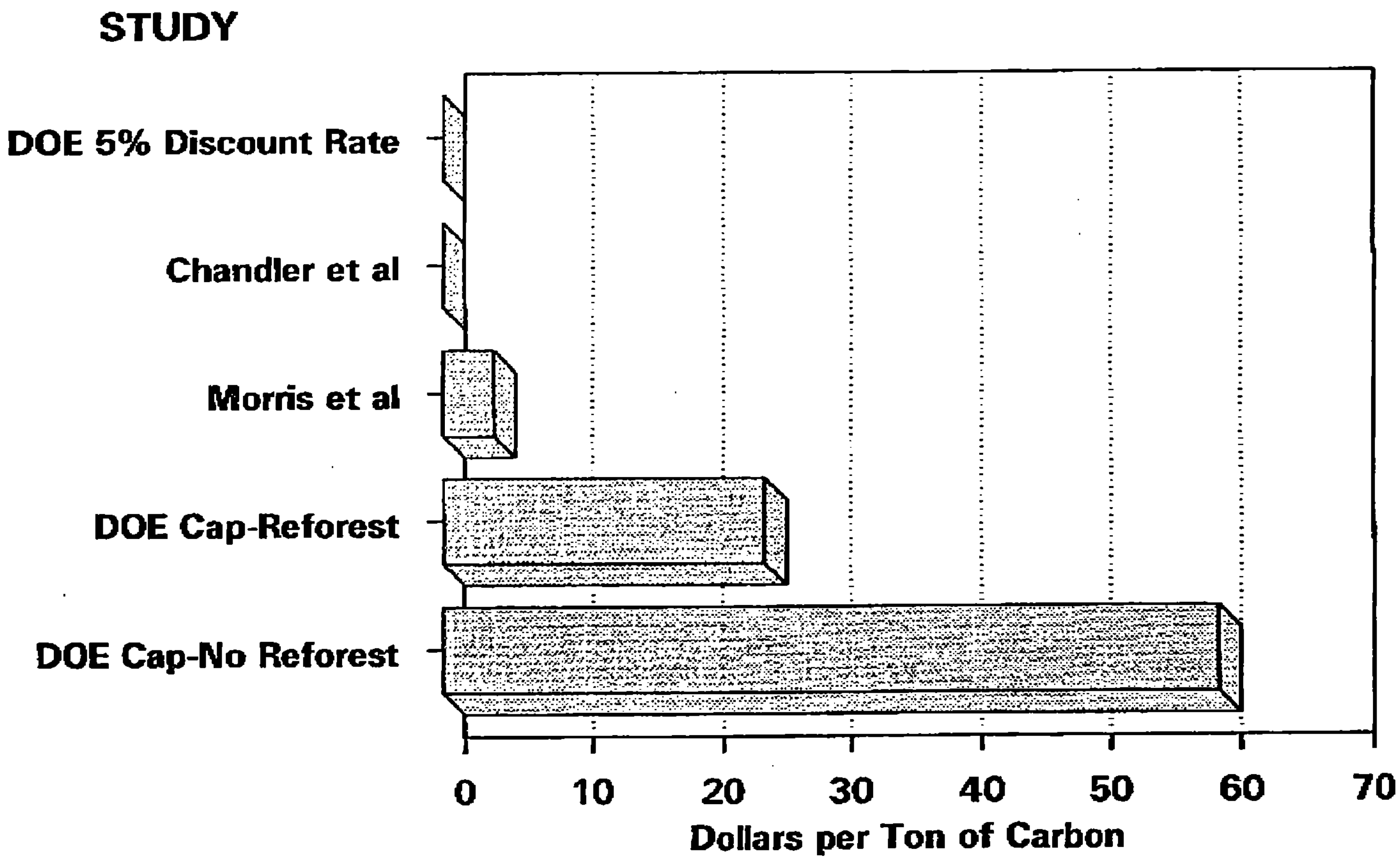
12. This estimate assumes $300 million is spent on methane leak reduction and $4.7 million on energy-efficiency measures.

    For an explanation of the range, see the previous note.

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.

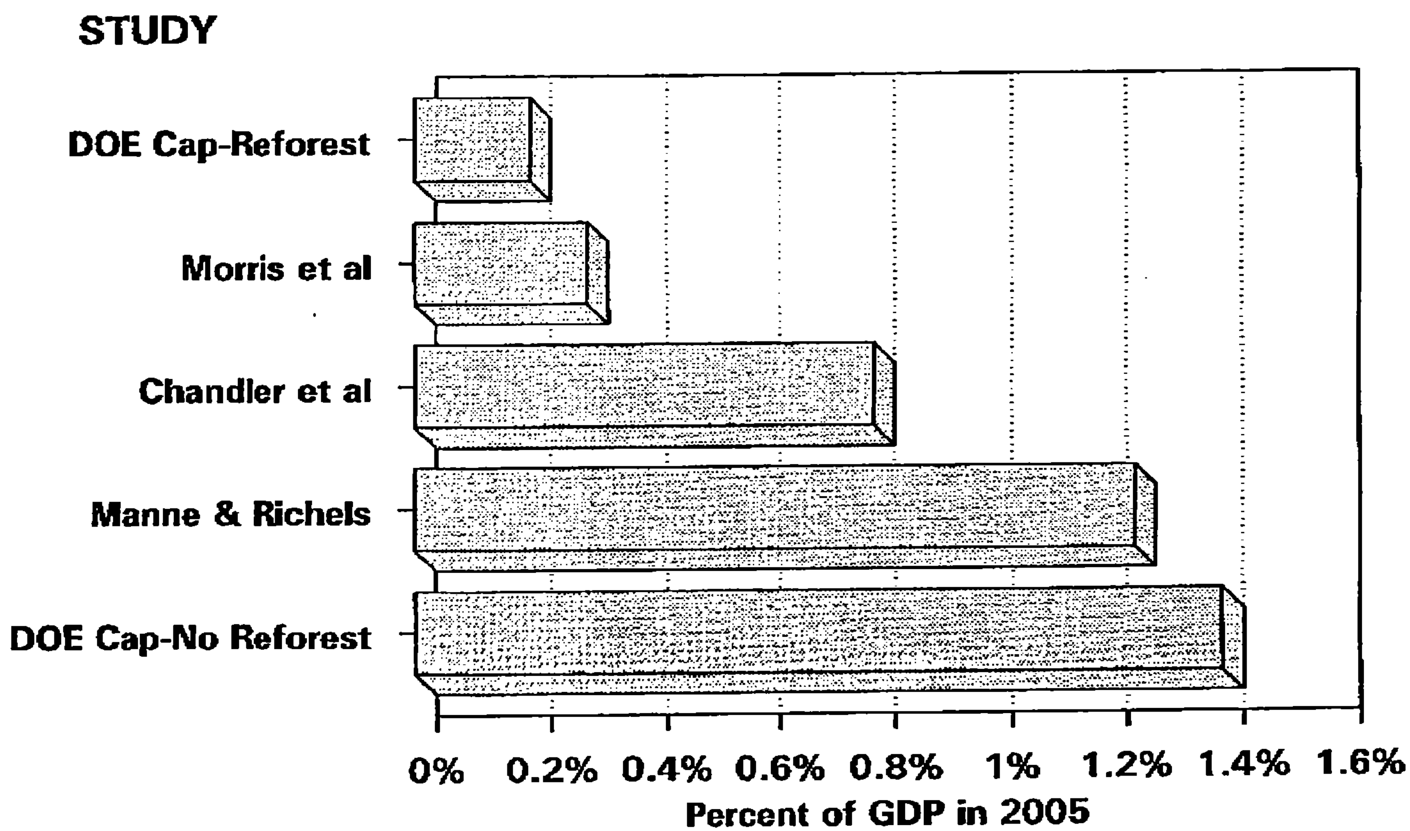
14. This measure is not counted in the above totals, but could reduce methane emissions by 2 million tons, or the equivalent of 40 million tons of carbon. The cost of this reduction--and we might assume again that only half could actually be attained--would be an estimated $300 million.

# AVERAGE COST OF HOLDING U.S. CARBON EMISSIONS CONSTANT in 2005-2010 (at the 1990 level)



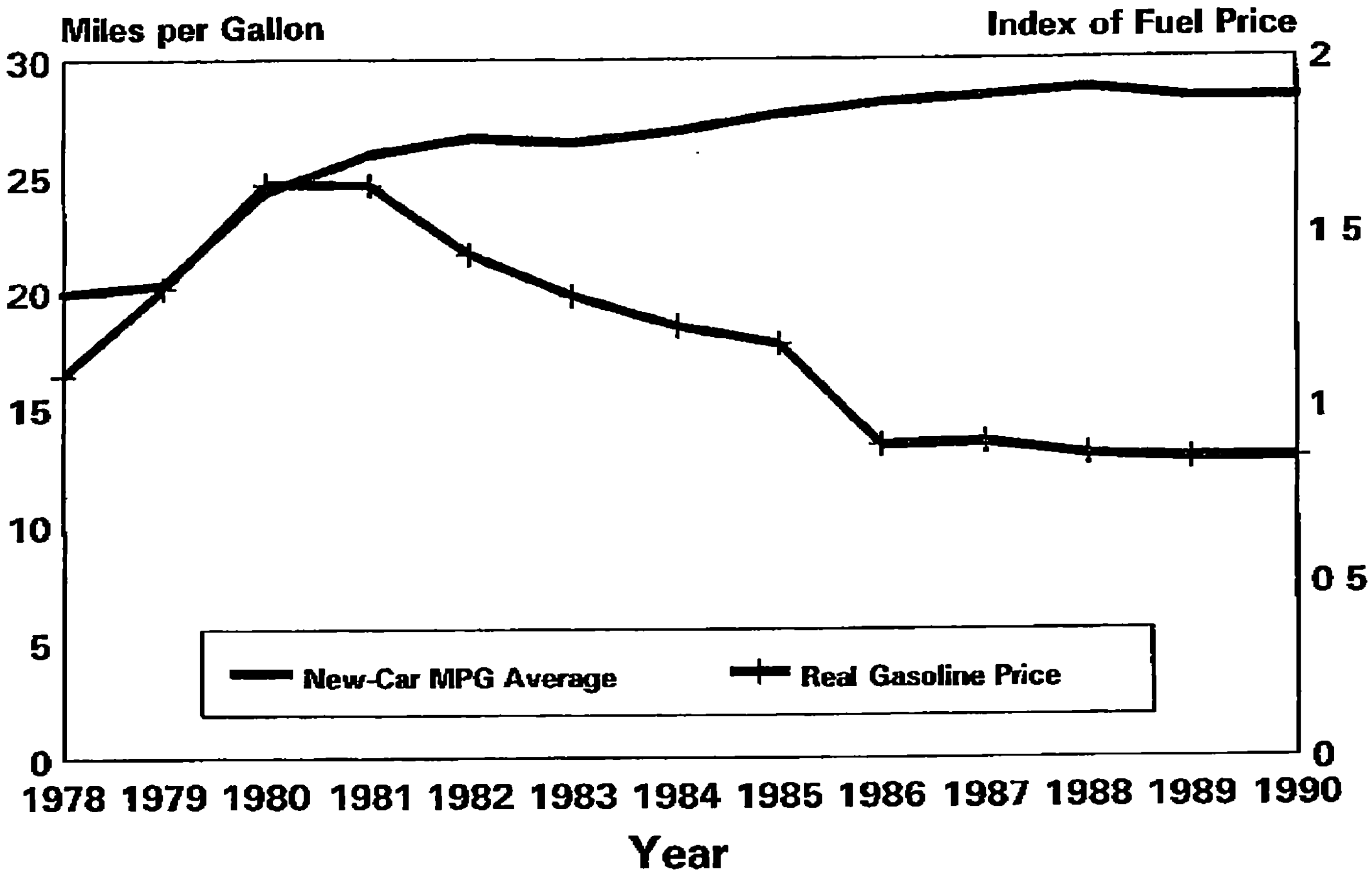

SOURCE: DOE, Limiting Net Greenhouse Gas Emissions in the United States

## TOTAL COST OF CUTTING U.S. CARBON EMISSIONS by 20 PERCENT in 2005-2010 (at the 1990 level)



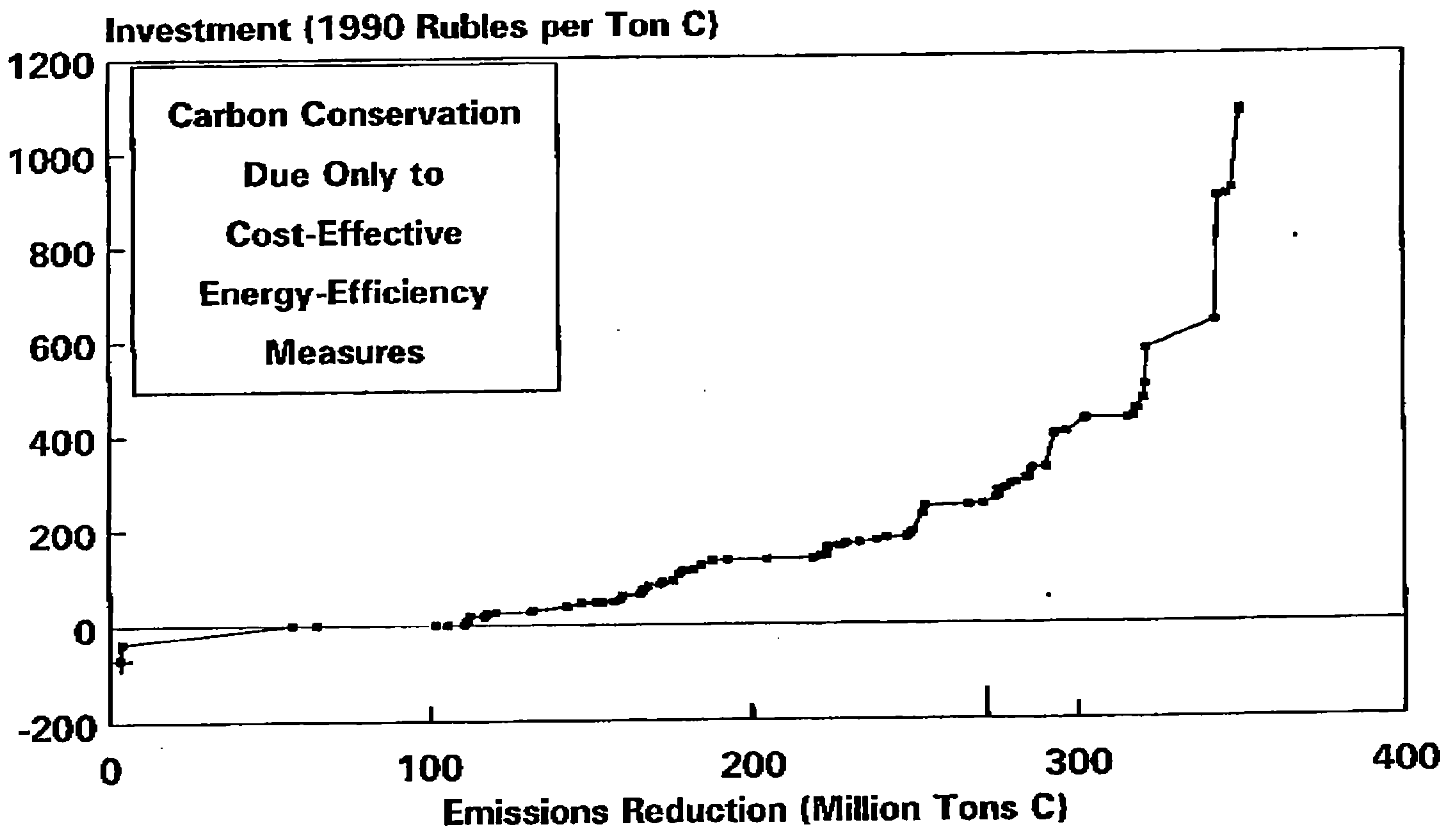

SOURCE: Derived from US DOE, Limiting Net Greenhouse Gas Emissions in the United States; Manne and Richels, 1991

## CAFE and Gasoline Prices




ORNL and EIA
test-liters

# Carbon Conservation Curve
# Former Soviet Union, 1990-2005




SOURCE: I. Bashmakov and V. Chupiatov

(NOTE: 1990 Rubles = 5 Rubles per $US

May 13, 1992

*MEMORANDUM*

To: Senator Gore

From: Marc Chupka

cc: Katie McGinty

Subject: Labor and $CO_2$ reduction

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You are apparently meeting tomorrow with labor leaders concerned about the impact of $CO_2$ reductions and jobs. They have probably been fed a steady diet of propoganda from Department of Commerce, Global Climate Coalition, Western Fuels Association, etc. A study was released yesterday (by Wilbur Steger) showing big job losses -- I haven't seen it but I understand that it is an extension of the gloom and doom carbon tax scenarios so it is not a suprise. You may wish to emphasise that the jury is still out on the economic impacts and that many analyses point to improved employment from modest $CO_2$ emission strategies.

You may want to point out that in many industries, there will be opportunities for labor. Conservation activities are more labor intensive than energy production (see attached Worldwatch paper discussion). In fact, electricity sector is very capital intensive, and demand-side programs are more labor intensive. Gas industry will benefit (cite American Gas Association study). Building more fuel-efficient cars may be just as labor intensive as gas-guzzlers.

However, $CO_2$ stabilization will probably continue to limit coal employment. But they are in sad shape under any scenario -- shifts to western strip mined coal (which is capital intensive and non-union) and technological changes (longwall mining methods) have really hurt coal employment. If Richard Trumka (United Mine Workers) is there, you will have to deal with transitional issues. UMW may have learned a lesson from the acid rain debate, however: get to the bargaining table early or risk getting shut out of the process when deals are struck. UMW may want to hear more about what could be done for them under a $CO_2$ stabilization policy rather than absolutely refusing to hear about it.

# Beyond the Petroleum Age: Designing a Solar Economy

Christopher Flavin
and
Nicholas Lenssen

Worldwatch Paper 100
December 1990

"Only about 3 percent of the World Bank's energy and industry loans in 1989 went to improving the efficiency of energy use."

example, nuclear power is the only energy source with a United Nations body dedicated to its advancement. This organization, the International Atomic Energy Agency (IAEA), has a 1991 budget of $179 million, with additional voluntary contributions of $70 million expected. While the IAEA has one essential role—monitoring nuclear proliferation—it also actively promotes the export of nuclear power to developing nations. A similar organization, the Nuclear Energy Agency, exists to facilitate atomic cooperation between industrial countries.[80]

It is time to reconsider the IAEA's promotional role, which does not reflect the positions of many of the governments that fund it. The agency's programs are aimed principally at developing countries, which get 40 percent of their energy from renewables and less than 1 percent from nuclear energy. In recent years, many of these poor nations have slowed nuclear expansion, while stepping up their commitment to renewable energy sources. International institutions need to catch up with this shift in priorities.[81]

Broader reforms are also needed, such as more concerted efforts to assist developing countries improve energy efficiency and harness renewable energy resources. One way of doing this is to increase funding of energy projects by the United Nations Development Program, an organization with a $900-million annual budget. Former West German Chancellor Willy Brandt has suggested the further step of creating an International Solar Energy Agency (ISEA). This body would provide developing countries with support for research, advice on how to build production facilities, and exchanges of information and personnel on renewable technologies.[82]

The problem facing developing countries is in part a shortage of capital and in part a misallocation of funds. Multilateral lending organizations, including the World Bank and the regional development banks, provide developing countries with huge sums for energy projects—more than for any sector except agriculture. Energy accounted for 16 percent ($3.3 billion) of the World Bank's $21 billion in loans in 1990. These loans attract even more money by encouraging parallel lending by commercial banks and other development institutions. In China in particular, the failure to invest adequately in improved energy efficiency will cause carbon dioxide emissions from coal plants to soar in the years ahead.[83]



Despite the World Bank's supposed new environmental awareness, only about 3 percent of its energy and industry loans in 1989 went to improving the efficiency of energy use. Renewables (other than hydropower) received virtually nothing. Significantly increasing multilateral lending for renewables and efficiency is essential if these energy sources are to expand rapidly in developing countries during the nineties.[84]

Current lending programs also encourage energy-intensive industries and products, something that is not helpful to most poor countries. By instead promoting domestic production of efficient refrigerators, air conditioners, electric motors, and other energy-consuming devices, poor countries could cut the expected growth in their power sectors by 30 percent or more, with large economic savings. In India, for example, instead of building a factory to produce standard incandescent light bulbs, the World Bank could fund the construction of plants to make energy-efficient fluorescent light bulbs. A single $7-million factory could produce 12.3 million bulbs over seven years, enough to save India the equivalent of more than 1,500 megawatts of coal-burning electrical capacity. That translates into $2.4 billion in savings, mostly from not having to build new power plants.[85]

The process of transforming energy institutions is no less challenging than the development of new energy technologies. The transformation will take many years to accomplish, but is likely to accelerate as policy makers awaken to the environmental and economic challenges they face.

## Energy and Jobs

Political leaders tend to guard the status quo, neglecting the fact that successful economies are dynamic, changing constantly over time. The evolution of technologies and of society itself naturally reshapes the economy, including the job market. With the automobile's advent, for example, service station attendants and mechanics replaced blacksmiths and wainwrights. Although this can be a painful process, it also creates new employment opportunities.

Defenders of the status quo contend that reduced energy consumption will lead to massive layoffs in energy-producing industries. To the contrary, a sustainable energy economy would likely have more jobs than one based on fossil fuels—primarily because improving energy efficiency creates more employment than supplying energy. In the future, the number of jobs in energy will probably grow, and the skills in demand shift dramatically.

Energy industries are not currently a major source of employment. In Poland, Canada, and India, for example, 4.4, 2.5, and 1 percent of jobs, respectively, are in energy and mining. Some 1.5 million Americans—1.4 percent of the labor force—worked in energy production and conversion in 1988. This includes jobs in coal mining, the oil and gas industry, and electric and gas utilities.[86]

The trend in industrial countries is toward fewer such jobs. Coal mining employment in the United States fell nearly 40 percent between 1980 and 1988, from 246,000 to 151,000, despite a 14-percent increase in coal production. The number of employees in the nation's oil and gas industry shrank from 715,000 to 528,000 over the same period. One minor exception to this trend is in electric utilities, where the number of employees, primarily service workers, rose 10 percent, to 648,000 workers. However, most of this increase likely has been offset by a loss of construction jobs as spending on new power plants declined 40 percent in the eighties.[87]

Most energy industries are capital-intensive and create relatively few jobs. The oil and gas industry in Alberta, Canada, for instance, generates 1.4 jobs for $1 million worth of capital investment, while other sectors of the economy average more than 10 jobs. Manufacturing, by comparison, yields 9.2 jobs per $1 million; agriculture, 13; and services, more than 32. The electric power industry is also capital-intensive. One-quarter of the foreign debts of Costa Rica and Brazil are from borrowing for the construction of power plants and transmission lines. Similarly, in the Soviet Union, energy accounted for nearly one-fifth of all capital expenditures in the late eighties, and Poland poured almost 40 percent of its industrial investment into energy in 1986, 21 percent in coal alone.[88]

**"Each dollar invested in efficiency improvements generates more jobs than a dollar invested in new energy supplies."**



Employment in coal mining is likely to continue decreasing, especially as societies seek to limit emissions of carbon dioxide. Governments will need to compensate workers, ensure that they learn new skills, and cooperate with businesses to form new industries in the affected areas. Countries such as the United Kingdom and Germany have experience with this problem, since the number of coal miners is already falling as automation increases. Now, hundreds of thousands of Polish, Czech, and east German coal miners may lose their jobs as energy prices are deregulated. Even in China, with more than 4 million coal miners, increased automation and worker productivity ensure a leveling off of employment.[89]

There is a way, however, to meet energy needs in the future while creating jobs. Numerous studies have concluded that each dollar invested in efficiency improvements generates more jobs than a dollar invested in new energy supplies. A 1979 Council on Economic Priorities report found that investments in energy conservation and solar technologies created twice as many jobs as those in traditional energy industries such as oil, natural gas, or electric power generation. At the local level, a dollar spent on energy efficiency produces four times as many jobs as one invested in a new power plant, mainly because reduced energy bills allow investments in other job-creating businesses.[90]

Similar conclusions were reached by a 1985 European Community study of Denmark, France, the United Kingdom, and West Germany. Investments in district heating, building insulation, and biogas plants, for example, were found to save money and produce more jobs than traditional energy investments. A study in Alaska found that home weatherization created more jobs and personal income per dollar than any other investment, including the construction of hospitals, highways, or hydroelectric projects. Evaluations of existing energy-saving programs in Connecticut and Iowa found that they were less expensive and created more work than energy-supply alternatives such as electric power stations.[91]

As communities invest in energy efficiency and tap local renewable energy resources, economic benefits will ripple through the economy. An energy plan drafted by city officials in San Jose, California, for example, would create about 175 jobs during its 10-year span, with an initial city investment of just $645,000. The program includes education campaigns to show consumers how to save energy, and technical assistance such as energy audits and a home energy rating system. The plan also includes initiatives to reduce energy use in government buildings and transportation, setting an example for the community. The city investment, which would spur nearly $20 million in private spending, is expected to pay for itself in two-and-a-half years, and result in reduced carbon dioxide emissions.[92]

Even among electricity-generating technologies, there is a wide gap in employment levels. For the amount of energy produced, traditional fossil fuel and nuclear power plants employ fewer people than today's solar power systems, even when coal mining is included. (See Table 8.) As the technologies are refined and companies cut costs, however, the difference between renewable and conventional technologies may narrow. Photovoltaic companies, for example, are now reducing costs by opening fully-automated manufacturing lines, as Maryland-based Solarex did in 1990. Biomass energy also generates more jobs than fossil fuel alternatives—particularly because of the labor required for maintaining tree farms and handling fuel. A recent Canadian study found that increasing wood use in the province of New Brunswick over the next 20 years would create more income, jobs, and tax revenue than oil or coal development. Studies in the northeastern United States came to similar conclusions.[93]

In the move away from a fossil fuel economy, some of the largest employment opportunities would be in home insulation, carpentry, and sheet-metal work. Wind prospectors, photovoltaic engineers, and solar architects are among the new professions that might expand rapidly. Numbering in the thousands today, jobs in these fields may total in the millions within a few decades. Some of the skills now used in a fossil-fuel-based energy system would still be valuable. Petroleum geologists and oil-well crews, for example, could find jobs in the geothermal industry. But most of the jobs in a renewable-energy-based economy



**Table 8: Direct Employment in Electricity Generation, Various Technologies, United States**

| Technology | Jobs (per thousand gigawatt-hours a year) |
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| Nuclear | 100 |
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[1]Includes coal mining.

Source: Worldwatch Institute, based on DOE, EIA, *Electric Plant Cost and Power Production Expenses 1988* (Washington, D.C.: 1990); DOE, EIA, *Coal Production Statistics 1988* (Washington, D.C.: 1989), and other sources.

would be cleaner and safer. No one would be required to clean up radioactive spills or decommission "hot" nuclear plants. Nor would workers have to toil deep underground or dispose of toxic ash.

The most profound adjustments will come in those few nations that now rely heavily on fossil fuel industries. The Persian Gulf nations, for example, have built their entire economies on oil, and Saudi Arabia in particular has worked actively to weaken international commitments to limit carbon dioxide emissions. But most of these countries eventually will have to move away from petroleum dependence. Even in the Persian Gulf, the oil will not last forever, so these nations would do well to begin diversifying their economies.[94]

Oil-importing developing countries, particularly those burdened with foreign debt, have a further incentive to follow a labor-intensive, improved-efficiency energy strategy. Most Third World nations have far more labor to spare than capital; indeed, underemployment and unemployment are creating major social problems in many developing countries. By following a more diversified energy strategy, these countries would provide more jobs while reducing expenditures on imported oil and other fossil fuels.

As energy supplies become more diverse and less dependent on conventional fuels, local economies can begin to free themselves from disruptive boom-and-bust cycles. The Iraqi invasion of Kuwait, for example, did not significantly affect the cost of solar hot-water equipment in Jordan, of sugarcane ethanol in Brazil, or of wind turbines in Denmark. Indeed, the unquantifiable benefits of a sustainable energy economy could offer stability in an otherwise volatile world.

## Toward a Solar Economy

In 1976, *Foreign Affairs* journal published an article that challenged the comfortable assumptions of energy planners. In "Energy Strategy: The Road Not Taken?" physicist Amory Lovins offered a vision of a future world that relied on improved energy efficiency and renewable technologies instead of fossil fuels and nuclear power. Long before conventional energy planners were taking these new technologies seriously, Lovins was plotting the shape of a sustainable energy economy.[95]

The experience of the past 15 years has proven Lovins' vision prophetic. In the mid-seventies, conventional energy planners predicted that the United States would be using around 135 quadrillion Btus (quads) of energy in 1990, while Lovins projected just under 100 quads. However, the estimated figure for 1990 is just 83 quads, only 10 percent higher than in 1973. Once portrayed as a wild-eyed advocate of "soft energy," Lovins actually underestimated the rapidity of efficiency's gains.[96]

The world has taken the first step toward the future Lovins foresaw. However, the next step—harnessing renewable energy—has been slower in coming because of technological lag-times, government neglect, and the 70-percent decline in oil prices between 1980 and 1986. Still, renewable energy technologies are now far more mature than in the mid-seventies. Rapid commercial development of several of these technologies is expected during the next decade, driven not only by technical advances but by world oil and climate trends.[97]

**"Solar, wind, and cogeneration facilities can be built at less than one-thousandth the size of a typical nuclear- or coal-fired plant."**

A new energy system is beginning to emerge and, as Lovins predicted, decentralization may be its hallmark. In contrast to the huge coal and nuclear plants of today, renewable electricity sources—whether photovoltaic cells, wood-fired plants, or wind generators—can be developed economically in various sizes. Solar, wind, and cogeneration facilities can be built at less than one-thousandth the size of a typical nuclear- or coal-fired plant. Some renewable energy systems can be installed, literally, at the household level.[98]



Even larger-scale renewable energy projects—such as commercial wind farms—are more modular than today's energy sources. Today, wind farms are typically composed of 100-kilowatt turbines that are less than 20 meters in diameter and cost roughly $100,000 to build and install. The manufacturing processes are more akin to today's automobile factories than to central power plants. A wind-power developer can install 10, 100, or 1,000 machines, depending on how much power is needed. The same machine could also be used by itself to supply power for a Third World village.

Given the diversity and decentralization of renewable resources, transmission and distribution losses can be minimized. Smaller scale, more decentralized energy technologies, particularly if developed at the household level, reduce the need for moving energy about. However, some larger-scale distribution systems will still be needed. If hydrogen is used as a carrier, for example, energy can be moved long distances with virtually no losses. Hydrogen can also be used to power automobiles, buses, and other modes of transportation.[99]

Areas where renewable sources are abundant, and the need for energy great, will likely see the arrival of a range of new technologies. Solar thermal power systems may be deployed extensively in deserts, while wind turbines proliferate in windy regions. Photovoltaics can be used virtually everywhere. No matter the energy technology, however, environmental and land use considerations need careful attention. Although many areas will remain off-limits for energy production due

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# Union of Concerned Scientists * National Wildlife Federation
# Sierra Club * Environmental Defense Fund

May 7, 1992

Dear Senator:

The undersigned national environmental organizations urge you to cosponsor Global Climate Protection Act to be introduced by Senators Gore and Mitchell on the Senate floor May 7, 1992. The bill would require the United States to stabilize its emissions of carbon dioxide, the principle greenhouse gas, by the year 2000 at or below 1990 emissions levels. Enactment of the bill would be good for both the global environment and the U.S. economy and its passage could help break the current logjam in global warming negotiations.

As you are probably aware, the Bush Administration is pushing text at the current negotiations that would lead us towards a meaningless convention on global warming. In light of the Administration's recent report that lists voluntary measures whose full implementation would nearly achieve stabilization, its refusal to be held accountable to the international community is unconscionable. Virtually every other industrial nation has committed itself to at least stabilize carbon dioxide emissions and developing countries have made it clear that these commitments to limit emissions are a precondition for their participation in a climate treaty.

A number of studies have demonstrated that the United States could greatly reduce its CO2 emissions through increases in energy efficiency and more rapid commercialization of renewable energy sources like solar and wind energy which produce no greenhouse gas emissions. A study by UCS and three other organizations, entitled <u>America's Energy Choices</u>, concluded that increased investment in efficiency and renewables could reduce U.S. CO2 emissions by 25% by 2005 and 70% by 2030, while producing net savings to energy consumers of <u>more than $2 trillion</u> over the next 40 years. Unfortunately, the Bush Administration has thus far been unwilling to promote the policy changes needed to fully realize our nation's tremendous efficiency and renewable energy potential.

In the midst of the final round of negotiations at the United Nations in New York this week, the Administration remains opposed to international treaty language that will ensure stabilization of emissions. We urge you to cosponsor this legislation to ensure that the U.S. sends a message to the international community that targets and deadlines are the only true way to protect the global environment.

Sincerely,

Alden Meyer
Director, Climate Change and
Energy Program
Union of Concerned Scientists

Sharon L. Newsome
Vice President, Resources
Conservation Division
National Wildlife Federation

332-0705

David Gardiner
Legislative Director
Sierra Club

William J. Roberts
Legislative Director
Environmental Defense Fund

## $CO_2$ Stabilization, Economic Growth, and Jobs

Many recent studies conclude that cost-effective energy efficiency investments abound in the U.S. economy, and that $CO_2$ emissions could be stabilized at a profit. Even the recent analysis conducted by the Administration implies this, since their voluntary (and profitable) programs nearly stabilize $CO_2$ emissions. This flatly contradicts previous Administration analysis that suggest that any action taken to reduce $CO_2$ emissions from projected levels will hurt the economy. But that was a foregone conclusion based on their methodology -- which simply assumed that energy markets operate perfectly. More detailed analysis suggests otherwise:

- The National Academy of Sciences report concludes that the U.S. could "reduce of offset its greenhouse gas emissions by between 10 and 40 percent of 1990 levels at low cost or some net savings;"

- The Office of Technology Assessment has testified that $CO_2$ emissions could be held at 1987 levels through 2005 at no cost to the economy;

- The Alliance to Save Energy and other organizations concluded in America's Energy Choices that $CO_2$ emissions could be cut by as much as 70% below 1988 levels by 2030 at a net savings to the economy of $2.3 trillion. Under a less aggressive scenario, $CO_2$ emissions could be reduced by 25% at a net savings of $1.9 trillion.

While the administration cites jobs as a reason not to stabilize $CO_2$ emissions, the weight of economic studies suggest that energy conservation and renewable energy investments create jobs.

Energy efficiency investments and conservation management practices are far more labor intensive than the capital intensive energy production industries. Therefore, shifting investments away from fuel production and into conservation will produce additional jobs in the economy. According to a variety of studies, a dollar spent on energy efficiency produces between two to four times as many jobs as a dollar invested in a new power plant.

- For example, a recent study performed by Economic Research Associates found that investing in conservation would create an additional 12,600 more jobs in Louisiana compared to conventional powerplant expansion. Similar results were obtained for Virginia.

- The recent American Gas Association study indicates that reducing $CO_2$ emissions to 10% below current levels would create 80,000 new jobs nationally.

- Worldwatch Institute has calculated that investments in renewable electric generating options create between two to five times the number of jobs as investments in conventional coal-fired capacity, even accounting for coal mining employment.

In addition to being profitable throughout the economy, energy efficiency and renewable energy investments create a range of good jobs in construction, manufacturing, and in the service sectors. From the insulation installer to the financial planner, these jobs substitute labor and brainpower for fossil fuel energy. A commitment to $CO_2$ stabilization would be a commitment to expanded job opportunities for many Americans.

Katie - Sent to Al @ 7:00 pm 4/25. I talked briefly w/ Al, he seems eager to do this hearing. Talk to you tomorrow

— Marc

April 25, 1992

***MEMORANDUM***

To: Senator Gore

From: Marc Chupka

Subject: JEC Hearing

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Here is a very detailed version of how we might engage Gruenspecht and Claussen. It is preliminary (I will get specific questions for Claussen later). See what works for you -- all of the documentation is here to support your position. When we make final decisions on what to pursue on this panel, I will radically condense the material into bullet points for the hearing. I won't get Gruenspecht' testimony until Monday, and it may necessitate major changes. Claussen testimony is a rehash of previous testimony to Sharp's Subcommittee (describes the EPA programs) PLUS the numerical estimates of $CO_2$ reductions contained in the *U.S. Views on Global Climate Change*.

I will begin to draft questions for the other panels tomorrow. If you need to contact me to discuss the material, call me at work (202) 224-0375, or at home (202) 232-3212.

PANEL 1. Howard Gruenspecht and Eileen Claussen

We will show that the NES analysis, and the subsequent DOE report to Congress <u>Limiting Net Greenhouse Gas Emissions in the United States</u> (1) rely on questionable methodology (2) are based on out of date assumptions (3) have significant biases toward $CO_2$ emissions growth.

<u>Round 1: The NES/Report to Congress Methodology</u>

First, note that

- DOE $CO_2$ report is predicated on the National Energy Strategy analysis, and therefore an examination of the NES analysis is warranted given its primacy in the DOE study.

- Many people have criticized the NES analysis.

First question will be a blind quote.

**Dr. Gruenspecht, do you agree with the following quote referring to 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, which may lead to undue reliance being placed on modeling results."**

If he does **not** agree, or presumes that the quote comes from some alternative environmental advocacy study, point out the fact that this came from a **National Research Council** study commissioned by Secretary Watkins to study the NES development process.

[This is a little-known report produced for energy modeling nerds like myself -- see endnote for additional information on the report. In all likelihood, Gruenspecht has not had to defend the NES analysis against the critique. It demonstrates impressive staff work.]

Turn up the heat and further quote the NRC report:

> **"Much of the energy data pertaining to the NES modeling 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."**

Any changes in other models that will be needed?

**"...the aggregate modeling structure has major limitations relative to the analytical results being obtained by the models."**

**" It is important for decisionmakers to appreciate the limited power of the existing analyses uses for making policy choices. It would be misleading to assign too much precision to the results of model runs, or to presume that the models incorporate sufficient information to judge the future impact of policy choices, particularly impacts beyond a decade or two."**

[if Gruenspecht is on his toes, he will respond that the NES document was influenced by the critique -- they put probability ranges around some of the post-2000 model outcomes. Concede the point if he makes it. If he doesn't pick up on it, even better.]

Any other changes in model.

**"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 <u>a priori</u> assumptions and simplifications, and the off-line contributions made by the NES modeling subgroups in shaping the scenarios. To a great extent, such assumptions and off-line analyses, rather than the model <u>per se</u>, dictated the results of model runs.."**

more informed prices incorporated?

[Off-line analysis refers to an <u>ad hoc</u> supplementary analysis of a specific issue conducted outside of the main integrating model, which is called FOSSIL2. Off-line analysis isn't bad <u>per se</u>, just somewhat prone to manipulation and inconsistent underlying assumptions.]

**"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."**

Any subsequent changes to these critiques

[We may pick up on the coal bias later, but probably not. The NES analysis is very tilted toward coal use in electricity, but for pretty hairy technical reasons that would not be easy to deal with in the hearing. We should stick to the demand side.]

Score for round 1: mostly jabs, Gore wins on points.

## Round 2: Baseline Emissions Growth

Gore starts to connect with some combination punches with criticisms of the baseline emissions estimate.

(1) **GNP growth estimate** is now out of date -- it averages 3.5% between 1990 and 1995, and 2.9% between 1995 and 2000 (for an average of 3.2% over the decade 1990-2000. This is much higher than current estimates. For example, the economic forecast from the current Annual Energy Outlook (from DRI Incorporated) has 2.3% annual growth. Over a decade, a 3.2% annual growth rate will produce an economy about 9 percent larger than a 2.3% growth rate. This is an enormous difference.

**Dr. Gruenspecht, has DOE revised its modeling results to reflect more realistic economic growth assumptions? What impact does this have on baseline $CO_2$ emission growth?**

[Don't make too much of this, since Howard has several counterpunches that he has already used in the Waxman hearing, and will readily concede the point. First, we all want economic growth, and DOE took a reasonable circa 1990 projection. We still hope it happens. Second, he can legitimately point out that the projection for GNP in 2000 will still occur by, say 2003. Therefore, estimated costs associated with stabilization will still occur, only later. Just stick to the point that the 2000 estimate is off and move on -- we'll take care of longer term stabilization in Eileen's testimony.]

(2) Related to the GNP growth, **electricity demand growth** is overstated: the NES has over 2.5% annually between 1990 and 2000, while the most recent EIA Annual Energy Outlook projects a growth rate of 1.9%. He will concede this point too, but keep punching.

**Dr. Gruenspecht, how does a revised GNP growth assumption translate into reduced demand for electricity?**

(3) In addition to GNP as driver of electricity demand, DOE severely understated **the impact of increased utility demand side management programs** in reducing electricity demand in the basecase.

* claim old was used of more recent study why wasn't this done

Display Table A-23: Demand Side Management Savings Assumptions in the NES Technical Annex 2, which cites (indirectly) a 1986 Electric Power Research Institute (EPRI) study that concludes that a total of 57 billion killowatthours (bkWh) will be avoided by utility DSM programs by the year 2000. The 1990 EPRI version, Impact of Demand-Side Management on Future Customer Electricity Demand: An Update concludes that almost twice that amount -- 106 bkWh -- will be saved by 2000. Thus the baseline is very conservative about current utility estimates for



* EIA & EPRI agree re: projected electricity demand growth → 1.9%

DSM savings. This analysis, <u>which is an EPRI and Edison Electric Institute forecast that was available when the NES analysis was conducted</u>, concluded that electricity demand will only rise by 1.8% annually between 1990 and 2000.

**In addition to the reduction in electricity demand from smaller GNP growth rates, have you reestimated baseline emissions to correct for your outdated demand side management assumption?**

[You will score most by referring directly to the EPRI analysis. This criticism was echoed by the NRC study: "parameter values used in the models are based on very limited data and aggregated information about energy consumption and <u>demand side management</u>."]

You may wish to prefigure later testimony by saying that DOE has never given innovative electric utility conservation programs much support, and that their analysis reflects that bias. We have a utility (PG&E) who has committed to obtaining 75% of new service demand from conservation investments. Why can't DOE shift analytical attention to where the action is? Too slow to respond, or just uncomfortable with ideas that collide with the supply side bias?

TWO ADDITIONAL CRITICISMS: Optional, use only if we need them.

(4) **Commercial floor space** estimate are high, especially between 2000 and 2010, but it is hard to find clear support for alternative views: floorspace projection models are simply driven by employment or GNP growth, ~~making no effort~~ to account for near term ~~financial distress~~ in the building sector or sectoral ~~shifts~~ in economic activity. <u>Annual Energy Outlook for 1992</u> assumes 5% less commercial floorspace compared to NES in 2000, and 9.5% in 2010. According to the NES Technical document:

> "The single most important input to [the residential and commercial] sectors is the forecast of future building stock."

[According to off-the record analysis at EPA, the huge growth from 1995-2000 results in an extra 20 MMT of carbon -- a large impact. Howard will now know that we are being fed information by EPA, and that he is in for a very long afternoon.]

(5) **Residential appliance saturation** assumptions are too high. Appliances per home are assumed to rise by 50% between 1990 and 2000. This also seems overstated -- do we assume that everyone with a washer & dryer now owns a washer and two driers?

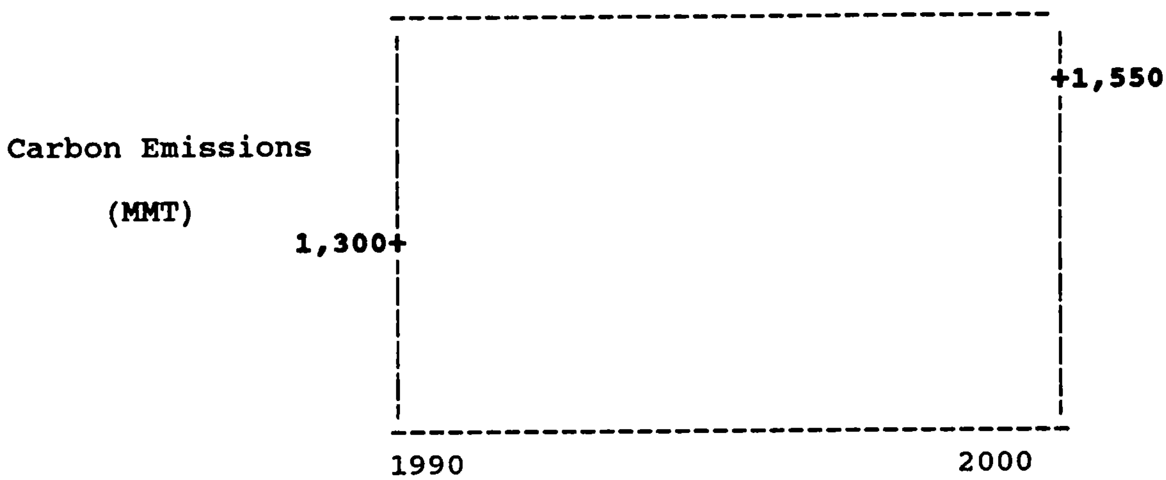
[Don't make too much of this -- some additional residential appliance intensity is probably reasonable. But 50% seems out of line.]

any support? assumptions in other analyses?

Score for round 2: Gore lands major body blows; Gruenspect's knees wobble.

Round 3: Charting Future Emissions

We will prepare a chart that looks like




There will be a red ribbon tacked at 1,300 on the left, 1,550 on the right. During the hearing, you can adjust the ribbon as new information comes. By the end, the ribbon will be flat or downward sloping.

According to the NES, U.S. Carbon emissions were 1,300 million metric tons (MMT) in 1990; DRI says 1,350, Oak Ridge says 1,330 for 1989. So first move is to move the LEFT pin upward to 1,350. [Stabilization is easier when the target is higher.]

Will he have?

Next, get from Gruenspect the revised $CO_2$ emission results from revised GNP assumptions. Move the RIGHT pin down to ___(?). If it is higher than 1,440, refer to the Department of Commerce/DRI study. In the DRI study, basecase emissions grow to 1,437 by 2000. <u>This is a 90 MMT increase over the decade</u> Put the pin there. Now refer to Eileen Claussen's testimony: The programs contained there are estimated to <u>save between 87-121 MMT of Carbon from projected 2000 levels</u>. Thus, if you buy the DRI baseline and the program estimate, we're there. But we will go beyond that in subsequent testimony (Additional programs, things in the energy bill, conservative estimates).

Might also want to add here the results of an analysis that Katie has from NRDC, which estimated the $CO_2$ emissions from John Sununu's military air travel. They calculated 844,000 lbs of $CO_2$ over a two year period. Clearly, the NES assumed that such travel would occur throughout the decade, and was part of the basecase emissions growth. At 422,000 lb. of $CO_2$ per year, this yields about 50 metric tons of carbon, or 0.00005 Million Metric



1437
67
1370

tons of carbon. You may wish to point out that you hope that Sununu's departure will have more dramatic impacts on $CO_2$ emissions, if only indirectly.

+ establish that it was stipulated that NES had the entire suite of cost-effective options

Round 4: The NES and the Report to Congress did not include all cost-effective options.

Here we will establish that DOE ignores analysis in its own backyard (EIA and the National Labs) that demonstrates that NES Action Scenario excludes cost-effective conservation.

(1) The Energy Information Administration conducted supporting analysis for the NES process. In Energy Consumption and Conservation Potential: Supporting Analysis for the National Energy Strategy, two conservation scenarios were examined: the High Conservation Case and Very High Conservation Case. They find the High Conservation case "cost effective" in a cost-benefit framework. The Very High Conservation case was not subjected to cost-benefit analysis. But several interesting things emerge:

Both the High Conservation and Very High Conservation case increase GNP relative to the baseline "reference case." The reference case has lower GNP growth than the inflated NES baseline (2.8% annual between 1990-2000, compared with 3.2%) but actually higher electricity growth than the NES, at 2.7% annually. When the conservation scenarios were run in the FOSSIL2 model, both scenarios increased GNP compared to the basecase. The Very High Conservation case also approaches $CO_2$ stabilization, and this is relative to the inflated NES baseline. (TABLES 1-6, 1-7, 1-8)

+ evidence that these did not make it into final analysis.

need to establish that these conservation measures not in NES!

**Dr. Gruenspect, don't these analyses suggest that conservation options not included in the NES would reduce $CO_2$ emissions and have positive economic benefit?**

(2) DOE's perception of consumer discount rates. The DOE spiked the conservation analysis in the NES and the Report to Congress with high discount rates (displayed in Technical Annex II Table A-4). As discussed in a previous memo, this may be a fair view of economic behavior. But we can make two points:

(a) The rates chosen were not well documented or supported. The consultant's report has a page that you will quote, where they basically throw up their hands. [I will furnish the supporting documentation.]

(b) Even if the high discount rates reflect market realities, we should hammer away at the discount rates as a symptom of severe energy efficiency sickness -- first cost disease. DOE is supposed to monitor the health of the energy economy, diagnose ills, and recommend solutions.

These high discount rates are like a 106 degree fever -- a "code blue" that should galvanize DOE into remedial action.

Further quote the Department of Energy Organization Act (P.L. 95-91) that mandates that DOE

> **"create and implement a comprehensive energy conservation strategy that will receive the highest priority in the national energy program" (42 USC 7112 [4]).**

Instead, the DOE report to Congress ran a "sensitivity analysis" where discount rates were held to 5% from 20%-60% It basically showed that we could stabilize at zero cost, and then presents a lot of hand-wringing about how tough it is to lower discount rates in the market.

In order to really rub Gruenspecht's face in it, you should quote the precise language in the DOE report to Congress (Page 7.55):

> **"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."**

analyses in their own back yard, from their own models showed different; authors also said were conservative.

~~As to not~~ being able to identify any measures, the question is obvious: **How hard did they look?** Secondly, the "future date" is today: about seven months from the DOE study release and one year after the NES. Why did they ignore the evidence that cost-effective conservation exists in abundance in the U.S. economy?

> **"..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 DOE couldn't stomach the result, so they emphasized:

> **"<u>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.</u> 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."**

are they right on this?

[the emphasis is DOE's]

Could DOE be ignoring its own research in the area? DOE does support research into conservation analysis and integrated resource planning. Are the implications of the analyses taken seriously by the DOE upper echelon? They are taken seriously by the energy policy community and by utilities. Utility demand-side management analysis is bottom-up in nature. The whole point of the programs is to change behavior -- effectively lowering the customer ~~rate of return~~ on efficiency investments. The analysis techniques are good enough for private utilities but not for DOE?

discount rates

For example, "Energy Efficiency: How Far Can We Go?" was produced by researchers at DOE national labs (Oak Ridge, Argonne, Lawrence Berkeley, Pacific Northwest, & Idaho National Engineering Laboratory). It was published in January 1990, and used a 7 percent discount rate to evaluate conservation investments. It 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 (0.64%). The researchers did not assume any efficiency gains in energy conversion (e.g. more efficient power plants) to estimate energy savings. From the introduction:

read this part

> **"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. A ground rule for the review was that changes in government policy were not to be considered, since later phases of the national energy strategy process will examine these issues."**

x need to identify options they concluded were cost effective that ultimately were ignored

[Amazingly, the client was Gruespecht's office (before he arrived). But the study was basically ignored in formulating the NES options or in the analysis of the NES and Report to Congress. One of the co-authors of the report was William Chandler (a JEC witness) we will ask him about the study and his subsequent participation in the DOE Report to Congress. He will disavow the chapter to which he contributed analysis.]

**Dr. Gruenspecht, why was the Oak Ridge study of conservation potential ignored? Wasn't it supposed to be part of the NES process, where DOE was ostensibly looking for options?**

For another example, cite a story in Electric Power Alert, a biweekly trade publication, March 18 1992 issue. The article is titled "$CO_2$ Emissions: New ~~England Cuts~~ of 20% Would Save Money, Researcher Reports" and describes a presentation by Dr. Florentin Krause of LBL (and a witness at the JEC hearing).

> "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% with no

increase in the overall cost of power. In a briefing to state regulators, Dr. Florentin Krause of the Dept. of Energy's Lawrence Berkeley Laboratory said a "moderate goal" of freezing $CO_2$ emissions at current levels can be achieved at a 'robustly negative cost.'"

"The findings assume that only 50% 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 Dept. of Energy and the Environmental Protection Agency, and is currently under review by those agencies."

[We have to be careful and not get Krause into trouble with DOE/EPA. The clients are in the Conservation and Renewables Program at DOE (Mike Davis shop) and the Office of Policy Planning and Evaluation at EPA (Dick Morganstern's shop).

why has it not yet been released → gotta march from getting it the Pres. → stabilizing N. Eng. [illegible]

**Dr. Gruenspect, will the New England $CO_2$ study will have any influence on DOE's thinking about the economics of $CO_2$ stabilization? If not, why not?**

Round 4: with a dazzling display of combinations, Gore puts Gruenspect on the canvas. Saved by the bell.

Round 5: Summing Up

Force Gruenspect to say for the record:

**(1) the NES baseline is too high -- underlying drivers of energy use are out of line.**

**(2) Current efficiency trends -- like DSM -- are underestimated and existing analyses (EIA, labs) indicate high economic value for additional conservation.**

**(3) Given that (1) the EPA programs are designed to increase cost-effective conservation investments, (2) that the Administration agrees that they will reduce $CO_2$ emissions and increase economic efficiency, (3) that these measures go beyond the NES Actions, then the NES <u>does not</u> include all cost effective options for energy conservation. But this is the basis upon which the DOE report to Congress was predicated. Thus, the NES analysis and the DOE report to Congress are no longer adequate assessments of the economic impacts of $CO_2$ stabilization. All subsequent debate should ignore these analyses. To borrow a wonderful euphemism from the Watergate era, the DOE analyses are "no longer operative."** [You might want to put the Commerce Department Study into this group, too.]

If he agrees to the statements, great. If not, we will simply point out that they are true, and turn to Eileen. Other witnesses will continue to trash DOE throughout the hearing.

Round 5: TKO for Gore, the referee stops the fight.

EILEEN CLAUSSEN:

We need several additional statements from Eileen.

- First, that by construction, **EPA voluntary programs are market-based and increase economic efficiency**, not just energy efficiency. Because they harness market forces and help remove barriers, they are **pro-growth** and **pro-jobs**. This is the future of environmentalism, and one which is win-win. Perhaps she can provide examples and secondhand corporate endorsements.

also some programs not there - for example - CAFE - cite NAS study.

- Second, that the **EPA considers the estimates of savings very conservative.** (we will get corroboration from later witnesses) After all, EPA compromised many of the numbers under the guidance of OMB, not usually known for its pro-environmental biases.

- Third, that **additional programs** may be on the drawing board. We may not get quantification, but must establish the point.

For example, two elements of the House and Senate energy bills that go beyond the NES are: (1) Commercial building standards that bring heating, ventilating, and air conditioning (HVAC) and other energy consuming equipment up to ASHRAE 90.1 standards. This could reduce maybe another 20 MMT carbon. (2) Industrial motor standard that increases efficiency about 10%. There may be some overlap with EPA Green Motors program, but not much.

CAFE //

- Fourth -- and perhaps most importantly -- that the estimated impact in 2000 does not exhaust EPA program gains. Many programs are just getting started (as displayed in assumed penetration rates) and thus more savings will roll in post-2000. The **cost-effective stabilization of U.S. $CO_2$ emissions is sustainable beyond 2000.** We can't expect quantification, but Eileen can probably state that stabilization could continue for perhaps another decade. This point goes directly to the political debate, as DOE (we'll see how Gruenspecht reacts to this) is likely to fall back on the defense that it just can't hold up. We will get other witnesses to back the sustainability claim.

ENDNOTE: BACKGROUND ON THE NRC REPORT

The National Research Council (NRC) is composed of members of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. In 1990, Secretary Watkins asked the NRC to establish the Committee on the National Energy Modeling System (NEMS) to advise DOE and the Energy Information Administration (EIA) on the development and application of models to support national energy policy. EIA is the quasi-independent agency (under Congress, not DOE) that supplies objective and unbiased information, forecasts, and analysis to DOE and to Congress. The Committee's main report, published in February 1992, contained recommendations for future energy modeling analysis.

Prior to the main NEMS report, the First Advisory Report of the Committee on the National Energy Modeling System was released on January 30, 1991 (roughly the same time as the NES analysis release). It was a general critique of the NES analysis. 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." In other words, DOE did OK given the time and the resources available.

However, the advisory report had some fairly direct criticisms of the NES effort. In particular, it found that the modeling approach was not well understood and that many conservation options appeared to be ignored.

You should be aware that the guy who performed the analysis is OK by everyone's estimation: he was given an impossible task and incredibly tight deadlines. He also had a gun to his head -- it has been reported that most DOE people though the electricity forecast was on the high side, except for John Sununu, who alone thought it was too low! Maybe an apocryphal tale, but a good one. Some of the errors in the analysis reflect inadequate time to reflect on the assumptions and results. The NEMS report contains many recommendations to strengthen the institutional support and modeling groups in DOE/EIA.

TESTIMONY OF

HOWARD GRUENSPECHT
ASSOCIATE DEPUTY UNDER SECRETARY FOR PROGRAM ANALYSIS
OFFICE OF DOMESTIC AND INTERNATIONAL ENERGY POLICY
U.S. DEPARTMENT OF ENERGY

BEFORE THE
JOINT ECONOMIC COMMITTEE

April 28, 1992

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 similar, 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%

Barbara Barnes 586-6341

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.

Another type of overlap occurs when impacts of policy actions to increase conservation and introduce of low- or no- emission electricity generation technology are considered together, because conservation directly reduces the amount of new generating capacity required. The purpose of analyzing actions in combination, or "integrating" them, is to provide an understanding of these effects, and to avoid serious errors in projecting their total 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.

disparaging — but yet Admin just translated this analysis to world.

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. Consumers often purchase their vehicles based on family size rather than fuel efficiency.

do the models assume this or do they take these kinds of product attributes into account?

- opportunity costs -- There are opportunity costs to consider. 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" that makes some energy-efficiency improvement investments desirable.

? – what is this rate?

- rebound effects -- We've all heard examples of the rebound effect, where someone buys a more energy-efficient furnace and then turns up the thermostat -- a natural response following a decrease in the "cost of comfort" using the more energy-efficient equipment. Consumers seem to 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. The recent NAS study of CAFE cites "take back" estimates ranging from 5 to 90 percent of the projected fuel savings under a constant travel assumption.

true? (if even 5 to 80, this analysis figures [illegible]

- average vs. actual use -- Often the engineering efficiency frontier is appropriate for the average situation, but not for the specific application. While compact fluorescent bulbs might make sense in an application where they are used about 3,000 hours, such as in a busy hallway, they would not be a cost-effective investment if your actual need was for lighting in a seldom-opened closet.

why — assuming unit cost & as mass production

- 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.

? — what DOE doing about this?

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.

Furthermore, since new opportunities continually emerge from the process of technical innovation, the best conservation strategy is inherently an evolving one. The Administration envisions continued progress in increasing energy efficiency through additional investment over time as energy prices, technical opportunity, and capital availability warrant. We also fully support voluntary information-oriented initiatives such as EPA's Green Lights Program.

? - Action oriented

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, my testimony will concentrate on carbon dioxide and short-term stabilization of carbon dioxide emissions.

A scenario that has been the subject of substantial attention in recent months is the stabilization of carbon dioxide emissions at 1990 levels in the year 2000. One policy option examined to meet this target was a carbon tax. A charge would be assessed on each tonne of carbon emitted into the atmosphere. The DOE study found that stabilization of U.S. carbon dioxide emissions at 1990 levels would require a carbon charge of $140 per metric ton in the year 2000, rising to a charge of $200 per metric ton in 2010.

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 marginal and total costs incurred in 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 the long-term rate of 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. Many of the assumptions are subject to much uncertainty, and hence, the results are uncertain.

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 tree 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 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

4, 8,40t
$200??

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 have assumed a constant 40-year uptake of carbon by the trees. However, the carbon uptake of trees planted in the early years of the program would decline sharply after 40 years. In addition, the trees could not be harvested without releasing carbon to the atmosphere. Afforestation is not a long-term option for achieving net carbon emissions reductions.

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 Federal government reduced its borrowing from capital markets and therefore decreased

GNP over the short-term, but eventually raised GNP via a fundamental shift toward lower personal consumption and higher savings. Tax revenues recycled to consumers tended to reduce short-term GNP losses but increase long-term GNP losses. Finally, it should be noted that these 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 we may all know is possible, is better served by a comprehensive review of available reform options then as an afterthought linked solely to greenhouse policy concerns.

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 compared 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. These and other recent studies will be examined closely as DOE updates the NES and its analyses of policy options to reduce net greenhouse gas emissions. We are committed to examining other promising actions that could reduce greenhouse 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 Alan 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. We are working with other International Energy Agency countries to improve the characterization of energy technologies in models such as MARKAL.

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.

QUESTIONS FOR EILEEN CLAUSSEN:

**The centerpiece of your efforts thus far has been GREEN LIGHTS, and it accounts for a large portion of the projected carbon reductions. The successes that you have already cited are impressive.**

[LEAD RIGHT INTO...]

**So you must be pretty confident that the GREEN LIGHTS program will at least achieve the potential estimated in your testimony, am I right?**

[SHE IS OPTIMISTIC -- TENDING TOWARD THE HIGH SIDE (but will not go beyond that)]

**Are there provisions in the House and Senate energy bills that were not considered in the interagency analysis?**

[YES]

**Will some of these provisions produce additional carbon dioxide emissions reductions?**

[YES]

KATIE'S ADDITIONAL Q & A HERE

**So it seems to me that there are additional opportunities for greenhouse gas reductions beyond those programs outlined in the Administration, including increased penetration of green technologies. Would you agree?**

[SURE, WHY NOT?]

**Do these programs going to carry us beyond the year 2000? Do we anticipate additional program impacts after 2000?**

[LONG STORY -- SOAK IT UP]

BUILDING THE BASELINE:

Lacking a definitive estimate of annual carbon dioxide emissions in the year 2000, I had to grow my own.

If we look at the $CO_2$ projection in the National Energy Strategy Base Case, we see that it starts at 1,300 million metric tons of carbon in 1990, and grows to about 1,550 million metric tons in 2000. Therefore, if that describes the path of the energy economy over the next 10 years, we would have to obtain large savings from the new programs and the NES in order to stabilize emissions at 1990 levels.

But its not so hard. Using the Energy Information Administration Annual Energy Outlook - 1992 projections of energy use in the economy, we can get the picture

First, the National Energy Strategy Base case. Note that annual U.S. fossil fuel use increases by 14 quads between 1990 and 2000. Thats a big overestimate compared with the more recent Annual Energy Outlook, which shows an increase of only 7.4 quads of fossil fuels. Looking at individual fuels, the Annual Energy Outlook growth is 50 percent of the NES forcast -- 2.6 compared to 5.2, while the coal use doesn't rise nearly as fast. The Annual Energy Outlook growth forcast is only 37 percent of the NES. .

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

Well, what does our Annual Energy Outlook projection say about $CO_2$ emissions growth. If we took a naive approach, they would be 53 percent of the projected NES growth. But notice that coal and oil growth is significantly lower. When you adjust for the fuel shares (using commonly assumed relative carbon factors) you can see that the Annual Energy Outlook projects only about 125 million metric tons of growth.

So according to the Annual Energy Outlook Case, we need only 125 million metric tons of carbon reductions in the year 2000 to stabilize emissions.

The New Actions combined with the NES Actions yeild 89 - 121 million metric tons of carbon reductions -- tantalizingly close to the needed 125 stabilization goal.

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 |

- Renewables
-

productivity of pollution prevention – p. 7 Center for Standards

~~1440~~ 1440 45
$$\begin{array}{r} 1440 \\ -45 \\ \hline 1395 \end{array}$$

**15** MMT
equipment **standards**

* legislation is not included in their analysis

American Council for an Energy-Efficient Economy
WASHINGTON, DC / BERKELEY, CA

April 27, 1992

TO: Katie McGinty and Marc Chupka
FROM: Howard Geller

RE: Comments on carbon emissions reductions estimates

I have reviewed the new memo from the Administration titled "U.S. Views on Global Climate Change" and I have the following comments which you might find helpful at your hearing and thereafter.

1. The actions to curb carbon emissions analyzed by the Administration and included in Tables 1 and 2 of the memo are actions either now being pursued by the Administration, planned but not yet started, or proprosed in the NES. All of these initiatives are not contingent on the adoption of new legislation. Likewise, the tables do not include the energy efficiency provisions in S. 2166 or the House legislation.

2. While there is some overlap between the Administration's initiatives and those in the legislation, they are different and additive for the most part. Furthermore, sensible implementation of the two sets of policies would minimize overlap and ensure maximum complementarity. For example, the legislation includes minimum efficiency standards on some types of lamps and motors. EPA can complement this policy through its Green Lights and Green Motors programs by promoting efficient products not covered by the standards (such as variable speed motor drives, compact fluorescent lamps, and high efficiency light fixtures).

3. ACEEE and the Alliance to Save Energy estimate that the energy efficiency provisions in the legislation ("best of both bills") will reduce carbon emissions in 2000 by about 45 million metric tons. Building codes, equipment standards, and utility regulatory reform are the most important provisions. Our savings estimates are conservative in that they assume there would be substantial implementation of cost-effective conservation measures in the absence of the legislation due to market forces and other programs (state, utility, and federal). We only account for the incremental benefits resulting from the legislative initiatives.

Do we want this in US views?

4. The renewable energy provisions in the legislation will result in additional reductions in carbon emissions. According to both DOE and the Energy and Power Subcommittee, the renewables incentives and other provisions should cut emissions in 2000 by about 16 million tons.

5. In combining the emissions reductions from the Administration's initiatives with those from the legislation, it would be reasonable

to discount the direct savings estimates for the legislative proposals slightly (say 10-20%) to avoid overlap and double-counting of savings. Using the 20% adjustment value, the adjusted reduction in 2000 due to the efficiency and renewables provisions in the legislation is 49 MMTC. Combining this with the 75-108 MMTC of reduction specified in the memo, a total carbon reduction of 124-157 MMTC is obtained. Since the projected growth in carbon emissions during 1990-2010 is about 140 MMTC given a reasonable base case (such as the 1992 Annual Energy Outlook recently issued by the EIA), the combination of executive and legislative initiatives appears to be adequate to achieve the stabilization goal.

6. It should be noted that automobile efficiency improvements are virtually ignored in both the executive and legislative initiatives. Adopting strong but feasible new CAFE standards (e.g., the Bryan bill) would yield an additional roughly 42 MMTC of avoided carbon emissions in 2000 relative to the EIA base case (which assumes cars reach about 32 MPG in 2000 without new standards). Weaker standards -- say only 37 MPG by 2000 -- would still lead to about 26 MMTC of additional emissions reductions in 2000. Even if stronger CAFE standards are not adopted, other initiatives such as feebates or expansion of the gas guzzler tax could lead to vehicle efficiency improvements.

per Chandler p. 7

7. Accept for policy initiatives that are cooperative efforts of the federal government and states, utilities, or other partners, the initiatives do not account for emissions reduction efforts that have been (or will soon be) adopted at the state or local level. Such efforts are proliferating and in some cases are very substantial. For example, a few utilities (e.g., SoCal Edison and PG&E) have commited to reducing their carbon emissions by 20%; states such as Oregon and California have made or are in the process of making commitments for reducing their overall carbon emissions as well. These efforts will contribute to a goal of stabilizing or reducing emissions at the national level.

# California Energy Commission

## Summary of Staff Recommendations on Whether or Not California Should Establish A Carbon Dioxide Reduction Goal

Staff recommends that the state establish a quantitative carbon dioxide reduction goal.

The committee will consider staff testimony and testimony by other interested parties in a series of public hearings. These hearings will result in a report to the Governor, which will recommend whether or not California should adopt a carbon dioxide reduction goal, and if so, what that goal should be. If reduction goals are adopted by the full Energy Commission, legislation supporting those goals would probably have to be enacted.

Staff says establishing greenhouse gas reduction goals would provide significant contribution to minimizing the risk from global climate change not only in terms of total emissions reduced but also in terms of providing policy and technological leadership for the United States and other countries.

Such goals could create a more favorable economic environment for the development of low emission technologies. California businesses could benefit from trade with other countries that have adopted emission reduction policies. This has been the market strategy of Japanese and German business interests.

- ❑ Staff recommends a 10 percent carbon dioxide reduction from 1988 levels by 1998, with a 1 percent reduction thereafter — equal to a goal of 20 percent reduction by the year 2010. This goal should be revisited and potentially updated to account for new scientific, economic or political trends. The percentage can easily be translated into tons per year in reduction.
- ❑ Staff recommends that the base year for calculating a carbon reduction goal should be 1988 because of the Energy Commission's *1988 California Inventory of Greenhouse Gases*. This inventory presents an analytically sound base-year from which to measure reductions.
- ❑ Staff recommends that the net carbon dioxide reduction goal of 10 percent and 1 percent thereafter should be disaggregated by sector — transportation, electrical generation, etc. These separate goals should be established within two years by developing a net emission reduction strategy for the state. The strategy should establish and balance the cost of meeting the goal with the potential emission reduction amounts that can be achieved through various measures.

- Staff recommends setting a quantitative goal for carbon dioxide. Because it is difficult to inventory methane, nitrous oxide and chlorofluorocarbons (CFCs) by source, staff recommends a policy statement to encourage reduction of these other gases to the extent possible and cost-effective. Staff does not, at this time, recommend setting goals for non-carbon dioxide emissions.

- Staff recommends that other non-carbon dioxide greenhouse gases — methane, nitrous oxide and CFCs — should be included in the greenhouse gas reduction policy because these gases contribute about 50 percent of the potential greenhouse gas problem and their relative contribution is increasing.

- Staff recommends that separate goals be established at a later time for each non-carbon dioxide greenhouse gas, as opposed to expressing a greenhouse gas reduction goal in terms of carbon equivalency factors.

- Staff recommends that a two-year time table be set to establish quantitative goals for these other non-carbon dioxide greenhouse gases.

- Trading between sources of carbon dioxide is viewed by staff as a good option for reducing total carbon dioxide emissions because it introduces flexibility in meeting the overall state goal. Without quantitative goals for each gas, however, trading between carbon dioxide and other non-carbon dioxide greenhouse gases is not possible.

- The reduction goal for carbon dioxide that staff is recommending is similar to the ones established voluntarily by Southern California Edison Company, the Los Angeles Department of Water and Power, and the South Coast Air Quality Management District. It is also consistent with the goal proposed by staff when preparing the Energy Commission's *Global Climate Change Report.*

- Staff recommends that the state establish "carbon sinks" in estimating the California Carbon Budget. Measures to increase "carbon sinks" could include tree planting or reforestation programs. Tree planting can be viewed as a means of offsetting carbon dioxide emissions from combustion sources.

# # #

Gruenspecht Testimony: Main Points and Criticisms

Page 1

*Limiting Net Greenhouse Gas Emissions in the United States* analyzed 20% reduction in ten years and 50 reduction in 20 years.

Page 2

Used NES as starting point: Language re: could not identify cost-effective options beyond NES. We'll get him on that one.

Because of forcast error, "no fixed set of actions can assure attainment of absolute energy use or emissions targets in the future."

Page 3

Overlap and synergies hard to estimate -- need integrated approach

Page 4

Top-down is more real world because its based on actual market observations: bottom up is more "theoretical" because it focuses on what is economically achievable "in a frictionless world where the only consideration is the tradeoff between first cost and eneryg use over time.

**Bottom up analyses do identify ultimate economic/technical potential. However, they ususally account for friction by holding penetration rates of new technologies to fractions of their absolute maximums.**

**Dr. Gruenspecht, bottom-up technology models don't assume a frictionless world. It depends on the discount rates and the penetration rates. Don't researchers often limit economic penetration rates to account for friction? Don't utility demand-side managers assume less than perfect response?**

Pages 4 - 6:

BULLETS:

1) Other Attributes - fine

2) Opportunity Costs - there is opportunity costs of energy savings foregone, too.

3) Rebound - U.S. Views 12-20 percent, Chandler believes 5 percent is best figure.

4) Average vs. actual: he cites lights used infrequently -- but some lights are used more than average and will obtain bigger savings, while infrequently used lights are usually not part of analyses and don't consume much energy anyway.

5) Market Penetration: DOE is supposed to help in this regard: they have a mandate to speed penetration of efficient devices in the market.

GRUENSPECHT CONCLUSION: Technological frontier in engineering models may not be attainable or even approachable in the real world.

But most bottom-up studies do not assume full penetration or that the limits are reached. Also, top-down studies can miss technological developments: they are based on historical relationships between energy use and prices, and rarely account for new technology.

**Dr. Gruespecht, your testimony indicates a deep suspicion of market barriers in energy markets. But Mr. Fox indicates that his experience in Integrated Resource Planning is that pervasive barriers exist.**

**Now, is Mr. Fox wrong?**

**Don't Integrated Resource Planning models use a bottom-up approach to estimate consevation potential?**
**Are these demand-side management people kidding themselves?**

**Why does DOE support Integrated Resource Planning efforts when they use analytical methods that DOE does not appreciate?**

**Is this type of analysis good enough for the private sector but not good enough for DOE?**

**Do you think that the DOE bias against bottom-up engineering analysis leads to underestimates of future potential?**

<u>Page 7</u>

NES supports broader use of Integrated Resource Planning for utilities.
But their baseline misses underlying trends.

He calls GREEN LIGHTS an information-oriented initiative. But GREEN LIGHTS is a voluntary <u>action-oriented</u> initiative.

**FROM TESTIMONY: "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 use"**

**Dr Gruenspecht, how does DOE justify the multi-billion dollar clean coal technolgoy initiative by this criteria?**

Page 8

*Limiting Net Greenhouse Gas Emissions in the United States* analyzes policy options that go beyond NES actions.

But it did not evaluate the EPA programs that they now concede will reduce the same or larger amounts of $CO_2$ than the NES actions.

Page 9

$140/Metric Ton Carbon tax needed to stabilize at 1990 levels by 2000, rising to $200/ton by 2010.

Highest cost emission reductions between 2000 and 2015, falling thereafter as better energy supply technologies (nuclear, renewables) emerged as cost-effective.

Page 10
Carbon tax and afforestation: $CO_2$ sequestration helps lower costs (because less reductions needed from energy ) Tax rates fell to the $12 - $27 ton range.

Page 11

But DOE has major doubts about the afforestation costs and feasibility. It does buy time, however.

Page 12

Recycling options: different impacts. They like to deal with the recycling issue seperately, since we can always improve the tax code -- doesn't require carbon tax reveneus. WE WILL EXAMINE THIS IN JUNE HEARING.

Selected references to other studies -- DOE in the middle. This is legitimate, although Jorgenson work has shown taxes in the $10/ton - $20/ton to be effective at stabilization, as does more recent Nordhaus work.

Page 13

"You will hear today from researchers involved in several studies that were not available during the 1989-1991 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? What about the EPRI 1990 update on DSM impacts in electricity demand? They were available but ignored.**

"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 commited to examining other promising actions that could reduce net greenhouse gas emissions. DOE is casting a wide net..."

**DOE casts a wide blanket, not a net: Cite New England $CO_2$ study (article on Krause Paper)**

"..the NES was always intended to be an evolving strategy...."

**Evolution implies extinction: a more realistic baseline and the new actions in "U.S. Views on Global Climate Change undermines NES and DOE greenhouse gas report results. They are "analytical fossils." Evolution has been rapid: in the year after NES and seven months after the Greenhouse Gas Report, the Adminstration discovers actions which dwarf the original nes actions to reduce greenhouse gases.**

Rest of Testimony: We're working on better stuff, ala the National Research Council recommendations

Round 2: Baseline Emissions Growth

(1) **GNP growth estimate** is now out of date -- it averages 3.5% between 1990 and 1995, and 2.9% between 1995 and 2000 (for an average of 3.2% over the decade 1990-2000. This is much higher than current estimates. For example, the economic forecast from the current *Annual Energy Outlook - 1992* (Energy Information Administration) has 2.3% annual growth. Over a decade, a 3.2% annual growth rate will produce an economy about 9 percent larger than a 2.3% growth rate. This is an enormous difference.

**Dr. Gruenspecht, has DOE revised its modeling results to reflect more realistic economic growth assumptions? What impact does this have on baseline $CO_2$ emission growth?**

be prepared w/ some correlation studies? testimony?

(2) Related to the GNP growth, **electricity demand growth** is overstated: the NES has over 2.5% annually between 1990 and 2000, while the most recent EIA *Annual Energy Outlook* projects a growth rate of 1.9%.

**Dr. Gruenspecht, how does a revised GNP growth assumption translate into reduced demand for electricity?**

?: how about EPRI analysis → 1.8% — add this here

Phytoplankton productivity decreased

36.7

• State & Local Actions.

Allen Miller - Center for Global Δ -
~~Patty~~ Pamela Heeler

CA → 20% reductions
8% Cut by 2002 ] Conversion
population & economic growth → CA
ahead rest of nation.

→ Howard Geller → 37 MPG in 2000 → 26 MMTC
* Chandler p. 7 → 38.5 cost effective

+NAS CAFE - 2000 mpg tech feasible

* Energy Eff from bills. < commercial equip / ~~motors~~ → ~30
* Renewables?? ACE³ → another approx 19 MMTC
49 net of the approx 30 MMTC in eff.

* State Programs.

NY State - over 20 yrs → ↓ 241 MT ⇒ 59 MMTC / 20 yrs.
p. 9 Washington State → 3 MMTC -- just from residential energy codes.
p. 10 * Connecticut → 30% ↓ energy use by 2010 → 11 MMTC = ↓3.3 MM
also dealing auto eff.
p. 11 Iowa
VT - 12% ↓ emissions by 2000

call M Smith re: breakdown of emissions reductions in 2000?
call Darling re: state inventories?

Creation of jobs. p. 9

John Fox re: annual MMTC  1300 / 550

NAS → $\boxed{130}$ = 10% of 1990 levels. } ⇒ conservative
[illegible] upto 40% ⇒ 520 MMTC. & possible.

5 CO2 eqv.

DOE/EPA →

24.2
5 / 121.7
8
37
36
10

1. Idso -- doubling of atmospheric CO2 doubles the water use efficiency of nearly all plants. Not true. Studies in the real world -- outside of Idso's controlled greenhouses shows that increased CO2 increases total leaf surface area -- so more water ends up being lost than if the plant had not been subjected to the increased CO2 (Walter Oeschel testimony).

2. Increased agricultural productivity -- only shown in highly controlled environments where plants spiked with fertilizers. And even then, the nutritional value of the plants were diminshed because they contained less nutrients (nitrogen and phosphorous) relative to carbon than plants that had not been so stressed.

3. "In order to gain some insurance against greater global warming it will be necessary to sacrifice income and economic efficiency."

allow fox and other panel members to respond to this!!

disagrees with the admin then that the programs they have outlined in the US Views report are in fact cost-effective??

disagrees with the National Academy of Science: "the United States can reduce its greenhouse gas emissions by between 10 and 40 percent of the 1990 level at very low cost. Some reductions may even be at a net savings if the proper policies are implemented."????

OTA concluded same thing -- significant reductions at no cost or net savings...

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CONGRESS OF THE UNITED STATES
JOINT ECONOMIC COMMITTEE

If there are
other [illegible]

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~~Follow up here~~

will ~~be~~

Was there any
evidence ~~of~~
~~the~~ before you
finished the
NES that there
may be other →

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Options out there?
go to NAS
guide

CONGRESS OF THE UNITED STATES
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How is it
given this
mandate

We went
over this before
DOE was at
2.5% growth.
Other Studies
were 1-8% growth.
We showed this before
-- difference was a 1990
study as opposed to a 1986
study. —

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The difference
is between
2.5% (1986)
and 1.8%
(1990).

Question rem

March 1992 — Schneider
Nature, Will Sea Levels Rise or Fall?

Chandler —
4 dig wts

tax. 1.4% cut in GDP
recycle funds 0.2%

pollution prevention / productivity of profits

1970's Germany — effort to cut $SO_2$ emissions
→ [illegible] adopted v. stringent stds
10 yrs. later — world leader in scrubber techs.

China →
cut energy demand to half of production growth??
no other developing country has done this.

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Your 5:30
has cancelled

Finally, on page 13 we hear:

"..the NES was always intended to be an evolving strategy...."

**Evolution implies extinction: a more realistic baseline and the new actions in "U.S. Views on Global Climate Change undermines NES and DOE greenhouse gas report results. They are "analytical fossils." Evolution has been rapid: in the year after NES and seven months after the Greenhouse Gas Report, the Adminstration discovers actions which dwarf the original NES actions to reduce greenhouse gases. This renders the previous analysis incapable of informing Congress or the Administration.**

As further evidence that NES ignored good analysis, cite "Energy Efficiency: How Far Can We Go?" produced by researchers at DOE national labs led by Oak Ridge. It was published in January 1990, and used a 7 percent discount rate to evaluate conservation investments.

From the introduction:

> **"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."**

It appears to have been ignored, although DOE acknowledges that it received "public review" (Page B-4 NES)

The analysis 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 (0.64%). The researchers did not assume any efficiency gains in energy conversion (e.g. more efficient power plants) to estimate energy savings.

ORNL/TM-11441

Conservation and Renewable Energy Program

# ENERGY EFFICIENCY: HOW FAR CAN WE GO?

A Study By The Staffs Of


The Oak Ridge National Laboratory
The Argonne National Laboratory
The Lawrence Berkeley Laboratory
The Pacific Northwest Laboratories
The Idaho National Engineering Laboratory

Roger S. Carlsmith
William U. Chandler
James E. McMahon
Danilo J. Santini



DATE PUBLISHED - JANUARY 1990

Prepared for
Office of Policy, Planning and Analysis

Prepared by the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6285
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

## II. INTRODUCTION

The United States has made remarkable progress in efficient energy use since the 1973 oil crisis. In 15 years energy use increased only 8 percent, while gross national product increased 46 percent.[1] Thus we are now using 26 percent less energy to produce one dollar's worth of goods and services. Some of this reduction came from structural changes in the economy, but most of it resulted from increases in energy efficiency.[2] The experience shows that threats of shortages, rising prices, and government policies can make major changes in the operation of the economy.

The questions we now face are the extent to which these trends in energy efficiency are likely to continue, and the factors that will influence them. On the one hand, overall energy efficiency has hardly changed since oil prices dropped precipitously in 1986. On the other hand, detailed studies of energy technologies all point to large opportunities for more efficient energy use, even at current fuel prices.[3] Furthermore, it is frequently noted that other industrialized nations (with generally higher energy prices) use energy more efficiently than the United States.[4]

A review of these questions was undertaken by the staffs of five national laboratories during the summer of 1989. 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. A ground rule of the review was that changes in government policy were not to be considered, since later phases of the national energy strategy process will examine these issues. Our review covered only end-use consumption of energy (residential, commercial, transportation, and industrial sectors), and thus omitted the significant efficiency improvements that can be made in the generation, transmission, and distribution of electricity. This report summarizes the results of the review.

First, we asked how much end-use efficiency improvement is likely to occur between 1990 and 2010. In this part of the analysis we assumed continuation of present trends in construction, equipment manufacture, and personal lifestyles. We assumed that fuel prices, population, and economic activity will follow the paths forecast by the Energy Information Administration[5] (EIA) as of mid-1989. We also assumed no changes in the governmental regulations, tax policy, and incentive programs that affect energy use. Although we do not expect all (or even most) of these assumptions to be realized, the conditions of this scenario should give a reasonable indication of energy consumption over the next 20 years if there are no unexpected changes in economic factors and no changes in government policy. Results of this "business as usual" scenario are given in Chapter III, "Where We Are Headed."

Next, we estimated the technical potential for cost-effective improvements in energy efficiency between 1990 and 2010 (that is, those that cost less money than they save). The computations for this scenario were made as if purchasers of energy-related equipment consider life-cycle cost with a discount rate of 7 percent real. The 7 percent discount rate was chosen as an approximation of a socially optimal allocation of resources. One would expect this scenario to yield considerably

Eskimos, farmers, residential consumers, large industrial consumers, conservationists, auto manufacturers, truckers, railroads, alternative fuel advocates, and others.

In addition, more than 2,000 written comments were submitted directly to DOE for review. Whether submitted in person at a public hearing or sent directly to DOE, every written suggestion on what DOE should do to develop a National Energy Strategy was reviewed. In total, DOE reviewed more than 29,000 pages of written material, covering virtually every aspect of energy policy.

### Laboratory White Paper Workshops—More Public Review

In late June 1989, DOE invited the National Laboratories to Washington, D.C., to discuss plans for the development of a National Energy Strategy. The Department asked the National Laboratories to provide advice and counsel on a range of issues that were deemed to be of special importance to the development of the Strategy. The labs subsequently sent to DOE a series of white papers on the subjects of energy efficiency, renewable energy, global climate change, and technology transfer.

* In June and July 1990, DOE held three workshops on the following laboratory white papers: *Energy Efficiency, How Far Can We Go?*, *The Potential of Renewable Energy*, and *Energy Technology for Developing Countries*. These workshops differed from the public hearings in format and focus. Where the hearings had been largely formal, the workshops were free flowing and open to the public on a first-come-first-serve basis.

Since each white paper represented the best thinking of a team of National Laboratory analysts familiar with the particular issue, the purpose of the workshops was to review the papers chapter by chapter with the public. Were the assumptions about the economic, technological, and behavioral factors made by the analysts relating to these issues consistent with the assumptions made by others outside of government?

The commitment by DOE to a public review of the analytical work of the National Laboratories reflects DOE's insistence that the development of the Strategy be as open a process as possible.

## *Analyzing the Issues and Options*

The information gathered through the public hearing process and the workshops served as a key resource for several sets of analytical activities. These activities were designed to measure, evaluate, and select from the broad range of potential Strategy options a discrete set of options to be analyzed. An overall picture of what energy we need, where it could come from, and what the consequences of energy supply and demand choices are, was the objective of the analytical effort.

The analytical goals for the Strategy were to identify market inefficiencies and security and environmental vulnerabilities. Where market inefficiencies, failures, and vulnerabilities were found to exist, their effects were to be, to the maximum extent possible, quantitatively analyzed.

### Areas of Options Analyses

There were three areas of analysis. The first area dealt with interagency concerns, the second area dealt with DOE concerns, and the third area dealt with modeling efforts, including developing a National Energy Strategy Current Policy Base case.

#### *Interagency Analysis: Economic Policy Council*

DOE worked closely with other Federal agencies to analyze selected options identified in the public record. The box at right identifies those agencies that participated in the interagency analysis process. The Economic Policy Council (EPC) Working Group (Assistant Secretary level) was chaired by the Deputy Secretary of Energy and directed its efforts at options having broad national policy implications and significant interagency effects. Three areas of focus were the following:

- **Energy Security**. This group focused on petroleum supply and demand options; the goal is to reduce U.S. vulnerability to oil market disruptions.

(3) In addition to GNP as driver of electricity demand, DOE severely understated **the impact of increased utility demand side management programs** in reducing electricity demand in the NES basecase. They project 57 billion kilowatthours (bkW) savings from DSM while an updated study available to the NES modeling team showed 106 bkWh.

How much does this matter? It is about 10 MMT of Carbon in the year 2000 baseline. **

Display Table A-23: Demand Side Management Savings Assumptions in the *NES Technical Annex 2*, p. 93 which indirectly cites a <u>1986</u> Electric Power Research Institute (EPRI) study that concludes that a total of 57 billion killowatthours (bkWh) will be avoided by utility DSM programs by the year 2000. The <u>1990</u> EPRI version, *Impact of Demand-Side Management on Future Customer Electricity Demand: An Update* concludes that almost twice that amount -- 106 bkWh -- will be saved by 2000. Thus the baseline is very conservative about current utility estimates for DSM savings. This EPRI analysis concluded that electricity demand will only rise by 1.8% annually between 1990 and 2000. <u>This forecast that was available when the NES analysis was conducted</u>.

**In addition to the reduction in electricity demand from smaller GNP growth rates, have you reestimated baseline emissions to correct for your outdated demand side management assumption?**

** based on their assumed rate of impact: 106 bkWh -57 bkWh = 49 bkwh underestimate. They assume 24 MMT of carbon reduction from 116 bkWh. 49 X (24/116) = 10 MMT.

You may wish to prefigure later testimony by saying that DOE has never given innovative electric utility conservation programs much support, and that their analysis reflects that bias. We have a utility (PG&E) who has committed to obtaining 75% of new service demand from conservation investments. Why can't DOE shift analytical attention to where the action is? Too slow to respond, or just uncomfortable with ideas that collide with the supply side bias?

**Table A-20. Life-Extension Costs and Construction Times[1]**

| Technology | Capital Cost[2] ($1989/Kw) | O&M Cost (M/kWh) | Commer Year | Heat Rate (Btu/kWh) | Construct. Time (Years) |
|---|---|---|---|---|---|
| Coal Steam | $235 | 4.3 | 1990 | 10400 | 3 |
| Oil/Gas Steam | $155 | 5.0 | 1990 | 9500 | 3 |
| Nuclear | $580 | 11.2 | 1990 | 10200 | 3 |

[1]Full life extension is assumed for all fossil plants in excess of 200 MW capability; life extended capacity equals 340 GW by 2010.
[2]Costs do not include costs of compliance with new source performance standards.
Sources: Coal, oil, gas: EIA 1990b;
Nuclear: Oak Ridge National Laboratory;

**Table A-21. Electricity Generation Fuel Prices ($1989 per MMBtu)**

| | Liquid Fuels | Natural Gas | Coal | Nuclear fuel |
|---|---|---|---|---|
| 1990 | 3.43 | 2.23 | 1.51 | 0.81 |
| 2000 | 5.13 | 4.64 | 1.78 | 0.64 |
| 2010 | 6.88 | 6.27 | 2.02 | 0.62 |
| 2020 | 7.87 | 7.78 | 2.17 | 0.62 |
| 2030 | 8.57 | 8.86 | 2.39 | 0.62 |

Source: National Energy Strategy Current Policy Base case

**Table A-22. Electricity Generation Miscellaneous Assumptions**

| | Imports (BKWH) | T & D Losses | Plant Reserve Margin | Life[1] (years) |
|---|---|---|---|---|
| 1990 | 27 | 7.5% | 17% | 40 |
| 2000 | 59 | 7.5% | 17% | 40 |
| 2010 | 68 | 7.5% | 17% | 40 |
| 2020 | 85 | 7.5% | 17% | 40 |
| 2030 | 107 | 7.5% | 17% | 40 |

[1]Base Load

Source: 1990–2010 imports: EIA 1990a; 2010–2030 imports: EIA; office of Coal, Nuclear, Electric and Alternate Fuels; other: EIA 1990b.

**Table A-23. Demand Side Management Savings Assumptions (Billion kWh per year)**

| | 2000 | 2010 | 2020 | 2030 |
|---|---|---|---|---|
| Residential | 20 | 59 | 65 | 70 |
| Commercial | 17 | 53 | 66 | 78 |
| Industrial | 20 | 59 | 69 | 81 |
| Total | 57 | 171 | 200 | 229 |

Source: 1990–2010: EIA 1990b; 2010–2030: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels.

## Renewables

Two categories of renewable-energy consumption are projected in the model: centralized, or grid-connected, and dispersed. As discussed previously, utility and non-utility renewable-electricity generation technologies compete with fossil and nuclear technologies to satisfy demand. Renewable-technologies characteristics used in the model are given in Table A–24.

Large hydroelectric capacity is assumed to remain relatively constant due to lack of new construction. Dispersed renewables are projected in each end-use sector. The largest dispersed renewables uses are residential wood for space heating, industrial biomass for steam and cogeneration, and alcohol fuels for vehicles. Residential wood-consumption assumptions are given in Table A–6. Biomass competes with fossil fuels on a marginal cost basis to produce steam and electricity in the industrial sector. As discussed previously, alcohol fuel for personal travel is assumed to continue at the current levels used in gasoline additives through 2010. Consumption rises modestly thereafter, reaching 0.5 quads by 2030.

Small amounts of additional dispersed renewables are consumed in the residential, commercial, and industrial sectors. The amounts are given in Table A–6 and Appendix B Table B–13.

# Impact of Demand-Side Management on Future Customer Electricity Demand: An Update

CU-6953
Research Project 2863-8

Final Report, September 1990

Prepared by

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# SUMMARY

*More utilities than ever before are using demand-side management (DSM) to help meet their needs and the needs of their customers. Forecasts presented in this report indicate that by the year 2000, these programs are likely to reduce the U.S. summer peak electricity demand by 6.7% and annual electricity consumption by 3%. These reductions will improve utility load factors, and could grow larger than the "most likely" estimates if DSM program performance and participation by utilities and customers increase beyond currently-planned levels.*

These are the main conclusions of this report, which presents estimates of the impact of demand-side management (DSM) programs on the U.S. demand for electricity. This report completes a trilogy of recent EPRI studies that, combined, bracket the likely range of impacts of energy-efficient technologies. The first of these studies (EPRI report CU-6746)[1] concludes that the maximum technical potential for energy savings if all efficient technologies were implemented on an overnight replacement basis ranges from 24% to 44% of a base case forecast of energy consumption in the year 2000. The second report (EPRI CU-6925)[2] indicates that the base case forecast of electric energy consumption in the year 2000 is already 8.5% lower than it would have been in the absence of efficiency improvements due to efficiency standards, customer response to rising energy prices, and improved technologies. The present study completes the picture by quantifying the contribution of the electric utility industry to reducing peak demand and energy consumption through its DSM efforts.

DSM encompasses the planning, implementation, and monitoring of *utility* activities that encourage customers to modify their pattern of electricity usage, including the timing and level of electricity demand. Typical DSM objectives include lowering customer cost, increasing customer value, and improving the utility's financial performance. Using 1988 as the base year, this study developed projections for the impacts of DSM programs on summer and winter peak and off-peak demand, and total annual energy consumption, for the years 1990, 2000, and 2010. Key findings and other important details follow.

Compared with a reference ("no-DSM") forecast of electricity demand and consumption for the year 2000, the most likely impacts of DSM programs are a 6.7% reduction in summer peak demand and a 5.3% reduction in winter peak demand. The associated most likely reduction in U.S. energy consumption in the year 2000 is estimated at 3.0%.

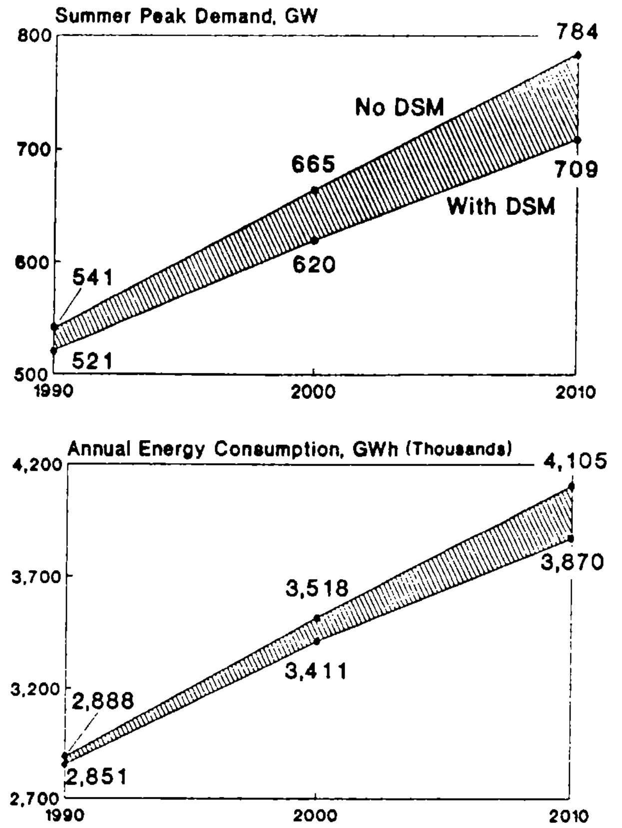
- As shown in Figure S-1, the reference forecast indicates that in the absence of DSM programs, the U.S. summer peak demand would reach 665 gigawatts (GW) in the year 2000, reflecting a rise of about 2% per year during the 1990s. The corresponding forecast of annual U.S. electricity consumption is 3,518 thousand gigawatthours (GWh) in the year 2000, also reflecting a rise of about 2% per year. This consumption forecast includes both actual end-use consumption and transmission and distribution losses.

---

[1] *Efficient Electricity Use: Estimates of Maximum Energy Savings*. EPRI CU-6746.

[2] *Estimating Efficiency Savings Embedded in Electric Utility Forecasts*. EPRI CU-6925.

Figure S-1
Estimated DSM Impacts




- In absolute amounts, DSM is most likely to reduce summer peak demand in 2000 by about 45 GW (roughly the capacity of 450 100-MW combustion turbines). The most likely DSM-induced reduction by that year in winter peak demand is 32 GW, and in annual U.S. energy consumption, about 106,000 GWh.

=106 bkWh

- The resulting forecast, with DSM, is 620 GW for summer peak demand in 2000 (an average annual increase of 1.75% from 1990), and 3,411 thousand GWh for annual energy consumption (an average annual increase of 1.8% from 1990).

- Relative to the forecasted growth in electricity usage, new DSM programs over the 1990–2000 period are expected to reduce the growth in summer peak demand by about 20%. The growth of U.S. annual energy consumption will be reduced by an estimated 11%. This indicates that average electric utility load factors will increase.

(4) **Commercial floor space** estimate are high, especially between 2000 and 2010, but it is hard to find clear support for alternative views: floorspace projection models are simply driven by employment or GNP growth, making no effort to account for near term financial distress in the building sector or sectoral shifts in economic activity. The Energy Information Administration *Annual Energy Outlook for 1992* assumes 5% less commercial floorspace compared to NES in 2000, and 9.5% in 2010. According to the NES Technical document (p.72):

> "The single most important input to the buildings sectors is the forecast of future building stock."

[According to off-the record analysis at EPA, the huge growth from 1995-2000 results in an extra 20 MMT of carbon -- a large impact. Howard will now know that we are being fed information by EPA, and that he is in for a very long afternoon.]

(5) **Residential appliance saturation** assumptions are too high. Appliances per home are assumed to rise by 50% between 1990 and 2000. This also seems overstated -- do we assume that everyone with a washer & dryer now owns a washer and two driers?

[Don't make too much of this -- some additional residential appliance intensity is probably reasonable. But 50% seems out of line.]

Cite a story in *Electric Power Alert*, a biweekly trade publication, March 18 1992 issue. The article is titled "$CO_2$ Emissions: New England Cuts of 20% Would Save Money, Researcher Reports" and describes a presentation by Dr. Florentin Krause of Lawrence Berkeley Lab:

> "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% with no increase in the overall cost of power. In a briefing to state regulators, Dr. Florentin Krause of the Dept. of Energy's Lawrence Berkeley Laboratory said a "moderate goal" of freezing $CO_2$ emissions at current levels can be achieved at a 'robustly negative cost.'"
>
> "The findings assume that only 50% 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 Dept. of Energy and the Environmental Protection Agency, and is currently under review by those agencies."

**Dr. Gruenspect, will the New England $CO_2$ study will have any influence on DOE's thinking about the economics of $CO_2$ stabilization? If not, why not?**

?.= evidence this study while the DOE study being completed?
evidence is unreasonably delayed?

# Electric Power Alert

From the publishers of Inside EPA. An exclusive biweekly providing timely news on the electric power industry and the issues that are radically changing it.

Vol. II No. 6 — March 18, 1992


## Making PUHCA reform a near-certainty
## SWEEPING PRO-COMPETITION CHANGES CLEAR KEY HOUSE COMMITTEE

Dramatic reform of PUHCA moved a major step closer to reality last week, in a rapid-fire markup of a comprehensive energy bill by the House Energy & Commerce Committee. The package, approved under the watchful eye of committee chairman Rep. John Dingell (D-MI), left largely intact the PUHCA revisions authored and promoted by Rep. Philip Sharp (D-IN), including controversial language that could force FERC to open up the nation's transmission system to independent power producers. Several important changes were made, however, including the addition of language intended to protect native-load customers, and a tightened ban on retail wheeling. But several anticipated amendments did not make the final package: a proposed global warming amendment was dropped by Rep. Henry Waxman (D-CA), who complained that the swiftness of the markup left him no time to drum up support for his proposal. Another amendment that didn't make the final cut was a proposal to allow the creation of voluntary regional associations to handle transmission access disputes. Stories begin on page 3.

### Transmission Access
### FERC ENDORSES OPPORTUNITY COSTS FOR FIRM SERVICE

FERC for the first time has approved a transmission tariff that allows a utility to charge for lost opportunities under a firm-service contract, in an order that marks the first application by the commission of the opportunity-cost principles laid out a month ago in its approval of the Northeast Utilities merger (p7). In the PacifiCorp merger, supporters of transmission access by qualifying facilities have returned to a federal court of appeals, arguing that FERC is continuing to unfairly discriminate against QFs in violation of the court's clear instructions (p9). And the city of Vernon, CA, is appealing the decision of a federal court, which ruled earlier that Southern California Edison can refuse the city's transmission access request if the utility shows it needs the capacity for its own customers (p11).

### State Action
### CALIFORNIA ALJ DECISION STRESSES CLEAN AIR COSTS IN CAPACITY PLANNING

A California Public Utilities Commission hearing examiner's report, developed in anticipation of first-time competitive bidding for statewide generation capacity, finds that the costs of clean air compliance should be considered as part of increased capacity plans (p25).

In Massachusetts, Boston Edison, fighting a battle with conservationists and consumer advocates over whether its proposed 306-Mw Edgar Electric plant is needed, has gone back to the siting council with a significantly lower estimate of future demand, a projection that is more conservative than the council's own calculation of future need (p26).

And in the Northwest, a Spokane utility serving Washington and Idaho has requested that the Idaho commission formally issue for the first time a conservation incentive to the company (p37).

### Utility Emissions
### NEW ENGLAND REGULATORS EYE CO2 REDUCTION GOALS

State utility regulators from New England last week took a first, albeit tentative, step toward the adoption of a target for reducing $CO_2$ emissions. At the same time, the New England regulators seemed to move away from the concept of monetized adders as a way of incorporating environmental externalities into power planning decisions (p8). In the Midwest, state regulators are developing a first-of-its-kind, system-wide acid rain emissions trading program for American Electric Power (p10). And the Internal Revenue Service has ruled that $SO_2$ emission allowances allocated by EPA are not taxable income for utilities. But the IRS left a number of key issues unresolved (p17).

### Presidential Candidate Profile
### CLINTON REJECTS TRADITIONAL RESOURCES; STRESSES CONSERVATION, RENEWABLES

If Democratic presidential candidate Gov. Bill Clinton (D-AR) had his way, oil and nuclear power would be largely displaced by alternative fuels, stepped-up conservation, cleaner coal technologies and natural gas. The candidate argues that such a strategy would heighten national competitiveness, as well as promote national security and environmental protection. Unlike his principal Democratic rival, former Massachusetts Sen. Paul Tsongas, Clinton does not see nuclear power as an option. In the second of a series of profiles of the candidates, Electric Power Alert examines Clinton's views on the best means of securing the nation's energy future (story begins on back page).

of PURPA . . . ' It would be difficult to find a more straightforward attempt to administratively repeal statutory rights than this," according to the API petition.

An attorney for API acknowledged that petitions for mandamus are rarely granted by the courts, but said she believes such action is justified in this case. The attorney said the next step may be a request from the court for a response from FERC. (Environmental Action, Inc., et al v. FERC, Nos. 89-1333, et al, U.S. Court of Appeals for the District of Columbia)

## Regional Emissions Trading

## MIDWEST STATE REGULATORS REVIEW FIRST SYSTEM-WIDE ACID RAIN PLAN

An Ohio utility commissioner is spearheading the development of an unprecedented least-cost, system-wide acid rain emissions trading program encompassing all of American Electric Power's operations. An AEP source explains that since the utility operates in so many states, it makes sense to develop a comprehensive plan that encompasses all AEP subsidiaries and operations. The move represents the first formal effort to develop a multi-state approach to Clean Air Act compliance.

An AEP source explains that, for the purposes of the acid rain trading program, it is important that the company operate according to the same ground rules in all states. The goal is to "come up with an agreement on the allocation of costs of acid rain controls and allowances," this source says. For example, if AEP decides to scrub emissions at the 2,600 Mw Gavin plant, owned by subsidiary Ohio Power Co., and receives excess "bonus" allowances, it may want to transfer some of those credits to facilities in other states. AEP believes that ratepayers would be best served by this type of system-wide, "least-cost" compliance plan that would ultimately allow lower costs at every power plant. The alternative -- to develop separate plans for each state -- would result in higher costs, the source says. AEP would prefer a "master" compliance plan for all seven states within which it operates, spreading costs equally across the system.

Ohio PUC commissioner Ashley Brown is leading the effort toward a regional agreement and has been meeting with state regulators for the past year, having set up the "AEP regional coordinating committee." A future meeting schedule still has not been set. General reaction to a system-wide plan has been favorable, but EPA's long-awaited decision on how bonus allowances will be distributed has been a major sticking point. Regulators have a difficult time assessing the effectiveness of a regional trading program without knowing how utilities plan to meet the requirements of the Clean Air Act. AEP has held off a decision on whether to scrub emissions at the Gavin plant until EPA sets down its distribution scheme.

"We want to understand the utility's compliance intention and coordinate a commission-wide response," says one source. Another says the purpose is for AEP to provide a compliance plan up front and ensure states are "in sync." Most say that the group has been in a fact-finding mode and has not yet delved into the trading issues. One says that the benefit to date has been exchanging information on AEP.

Many regulators are unsure whether the group will ultimately develop a system-wide plan, with one regulator explaining that AEP tends to operate on a system-wide basis already. Another agrees with the premise of a comprehensive plan, but explains that most states do not have a process for approving any plan outside the PUC. "We don't know if multi-state regulation is appropriate," this source says. A state regulator counters that though each state has a different method for approving plans, any agreement would still pass through required public review procedures. This source believes it will be in the states' best interest in any event, since they will stand to benefit from lower costs that a comprehensive plan would bring.

Most participants to the effort believe it will be productive. One official says that AEP's attempt at communicating with state regulators to minimize regulatory risk has prompted a "unique attempt at regional cooperation," which will be much needed in coming years.

## CO2 Emissions

## NEW ENGLAND CUTS OF 20% WOULD SAVE MONEY, RESEARCHER REPORTS

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% with no increase in the overall cost of power. In a briefing to state regulators, Dr. Florentin Krause of the Dept. of Energy's Lawrence Berkeley Laboratory said a "moderate goal" of freezing CO2 emissions at current levels can be achieved at a "actually negative cost."

Krause spoke at a meeting of state regulators, utility executives and researchers convened by the

Massachusetts Dept. of Public Utilities with funding from the federal Environmental Protection Agency. The purpose of the meeting was to look at issues affecting regional coordination and environmental externalities (see related story).

Krause's briefing reviewed the results of research he has conducted, with two LBL colleagues, on how global warming risks can be incorporated into power sector planning, focusing on the New England region. Krause reports that $CO_2$ emissions can be frozen or reduced by 15-20% while simultaneously lowering the overall cost of power. Those findings assume that only 50% 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.

While Krause reports that overall cost of power would decline, he notes that actual electric rates would rise somewhat. Freezing $CO_2$ gives a 1-5% rise in rates, while a 15-20% $CO_2$ reduction would result in a 8-15% rise in rates. Rate increases do not necessarily translate into higher electric bills for customers, because DSM measures may have lowered demand enough to offset the higher price of energy.

Another finding reported by Krause was that freezing or cutting $CO_2$ emissions would have no major effect on the need for natural gas. Krause reports that in his most aggressive case, the requirement for gas was only 15% higher than is currently projected by the New England Power Pool. NEPOOL is already projecting that gas consumption will double, Krause says. In remarks related to his research, Krause said he does not believe that the use of adders in decisions about new resources will have much effect on $CO_2$ emissions; Krause concurred with another researcher at the conference, Steve Connors from the Massachusetts Institute of Technology, that to get real reductions in $CO_2$ in New England, existing oil and coal plants need to be closed down. Krause also noted that using adders in dispatch decisions would have little effect on $CO_2$, but said adders were more effective in cutting emissions that produce acid rain.

Krause's research was jointly funded by the Dept. of Energy and the Environmental Protection Agency, and is currently under review by those agencies.

## Limited Transmission Access

## CALIFORNIA CITY CHALLENGES COURT SUPPORT FOR SOUTHERN CAL EDISON

A California city is challenging a landmark appeals court decision denying the city transmission access to Southern California Edison's power grid. Attorneys following the case say it is the first lawsuit to force a federal court ruling on transmission access. The case was brought by the city of Vernon against Southern Cal Edison, with Vernon arguing that the utility has engaged in anti-trust behavior. The U.S. Court of Appeals for the Ninth Circuit, upholding a district court decision, ruled on Feb. 7 that the utility is not obliged to provide access if it can prove that it needs the line to serve its own customers. The city on Feb. 21 filed its petition for an en banc review, a ruling by all the ninth circuit judges.

The city of Vernon argues that the utility was engaging in anticompetitive conduct by denying it access to power transmission lines and preventing the city from obtaining bulk power from other suppliers. Vernon's Municipal Light Dept. generates about 30 Mw but buys additional power over Edison's transmission lines for resale within city limits. The city argues that Edison has refused to enter into "reasonable" agreements to integrate Vernon's "firm" power purchases from other sources.

The appeals court ruled that Vernon failed to show why Edison was required to stop using its own facility so that Vernon could begin using it. The court also said that the city lacked evidence to demonstrate that Edison was conspiring to boycott Vernon's attempt to purchase power. The court says the city failed to refute the "legitimate business justification" that Southern Cal Edison gave for not providing requested access. Vernon also failed to demonstrate that Edison discriminated in its rate treatment, the court says.

The city, in asking for its en banc review, says the decision conflicts with judicial precedent on the issue. In its petition, the city explains that the issues are important because they affect the "competitive vitality" of cities and regions, arguing that as utilities expand, safeguards against monopolies are particularly important. "If the panel opinion is permitted to stand, the impact is an implied repeal of the antitrust laws in the wholesale and bulk power markets" which would allow monopolies to prevail.

The petition takes issue with the court's finding that Edison is justified in denying access if it has a legitimate business reason. The decision was made without any evidence from Edison that providing access to Vernon would have caused rates to increase, the petition argues. The city cites the case of *Otter Tail and Terminal R.R.*, which places the burden on Edison as the owner of a "crucial" facility to allow for reasonable access. The city also challenges the court's interpretation that it challenged Edison because it did not provide all the access the city wanted. "Vernon was not required to define the amount of access that would have been reasonable . . . it was only required to show that the access that it had actually

Much has been made of the Discount Rate Sensitivity Case, where they drop the discount rates from the 20 - 60 percent range to 5 percent.

> **"..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..."** (PAGE 7.55)

But DOE could not handle the implications, so they emphasised:

> **"*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."** (Page 7.55)

Lets note here that the GREEN LIGHTS program is explicitly targets the discount rate for commercial lighting upgrades: Compared with the NES assumption of 60 percent real discount rate, a GREEN LIGHTS partner invests in conservation at the rate of the prime plus six points -- currently about 12%, or a real discount rate of about 8% accounting for inflation.

reductions are achievable, and if such potential gains exist, to identify policy instruments capable of accessing these gains without incurring greater real social costs.

With regard to computing the extent of apparently available gains that are potentially available, only the extent of items 2 and 3 are at issue. Item 1 is not available because it is included in the reference case. Items 4, 5, and 6 are not available because they represent real, irreducible net costs. The NES Actions have identified a great number of individual actions that, without raising taxes, improve overall energy system efficiency. As we discuss in Chapter 11, the NES Actions Case is not inconsistent with the results of the NAS (1991) bottom-up analysis. how hard did they look?

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.

### 7.6.1 Sensitivity of the Results to the Apparent Consumer Discount Rate

One of the contributions of the bottom-up approach has been to identify the fact that there is a possibility of providing the same energy services with greater capital inputs and lower energy inputs than are reflected in average practice.[a] We attempt to bound the value of emissions reduction potential by conducting a sensitivity analysis. To do this we compare two cases. The first is the NES Actions Case; the second is the NES Actions Case with the required internal rate of return on capital by end-use activities reduced to 5%. We shall refer to this latter case as the "Discount Rate Sensitivity Case."

(a) We note that the fact that while individual end-use energy applications may be more capital intensive than the technologies they replace, the full energy system capital intensity may either increase or decrease, depending on the specific energy technology under consideration and relevant prices and interest rates.

By reducing the apparent consumer discount rate to 5%, we act as if all of the difference between the observed values and 5% can be attributed to market imperfections. This assumption is extreme. In fact, all of the difference between the observed apparent consumer discount rate and the 5% rate we have chosen may reflect real, irreducible costs included in items 5 and 6 above. We note, however, that by embedding the analysis in the Fossil2 modeling structure, the effects of the takeback phenomenon are explicitly considered.[b]

**This analysis does not argue that the computed reduction in the cost of greenhouse gas emissions reductions is either potentially available 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 a top-down analysis structure. We further note that one of the effects of the successful implementation of the NES Actions is to capture potentially available gains from efficient energy technologies.**

The effect on GWP of reducing the internal rate of return in the Fossil2 Model to 5% on the effectiveness of various carbon tax rates and the associated total cost of carbon emissions reductions can be seen in Figures 7.7 through 7.15. In general, in terms of GWP-weighted energy-related emissions, both the total and marginal cost of emissions reductions are lower in the Discount Rate Sensitivity Case than in the NES Actions Case, but the amount by which costs are lower varies considerably. The lower costs reflect the fact that at lower internal rates of return, investments in energy-efficient end-use technologies are greater at any carbon tax rate.

As shown in Table 7.61, the Discount Rate Sensitivity Case reduces the tax rate necessary to hold carbon emissions constant through the year 2000, relative to 1990, from approximately $140/mtC to zero, and the tax rate necessary to reduce emissions by 20%, relative to 1990, from approximately $500/mtC to approximately $350/mtC.

(b) We note that Fossil2 takes the demand for energy services as given. Therefore, no accounting is made for the feedback effect on the demand for energy services.

DOE's perception of consumer discount rates. The DOE spiked the conservation analysis in the NES and the Report to Congress with high discount rates (displayed in *Technical Annex II* Table A-4). As discussed in a previous memo, this may be a fair view of economic behavior. But we can make two points:

(a) The rates chosen were not well documented or supported. The Applied Energy Services rationale for commercial discount rates is that they don't know what they are so they just guessed. See Attachment.

(b) Even if the high discount rates reflect market realities, high discount rates are a symptom of severe energy efficiency sickness -- "first cost disease." DOE is supposed to monitor the health of the energy economy, diagnose ills, and recommend solutions. These high discount rates are like a 106 degree fever -- a "code blue" that should galvanize DOE into remedial action.

Further quote the Department of Energy Organization Act (P.L. 95-91) that mandates that DOE

> **"create and implement a comprehensive energy conservation strategy that will receive the highest priority in the national energy program" (42 USC 7112 [4]).**

**Does DOE worry about the high discount rates it observes in the market? Does that indicate cost effective conservation potential?**

**Table A-4. Capital Stock Lifetime and Discount Rate Assumptions**

| Sector and End-Use Category | Capital Lifetime (years) | Consumer Hurdle Rate |
|---|---|---|
| Residential Sector: | | |
| Space heating[1] | 20 | .20 |
| Space cooling | 15 | .25 |
| Thermal | 10 | .25 |
| Lighting and appliances | 10 | .25 |
| Commercial Sector: | | |
| Space heating | 20 | .25 |
| Space cooling | 15 | .35 |
| Thermal | 10 | .60 |
| Lighting and appliances | 10 | .60 |

[1] Buildings are assumed to have 50-year lives.

Sources: EIA 1990b, Energy Information Administration, Office of Energy Markets and End Use (residential, commercial heating); AES 1986 (other commercial).

Consumer investment in conservation technologies is based on the fuel-cost portion of the energy-service cost. It is assumed that consumers will invest in conservation measures that are less expensive than the fuel cost on an equivalent annual-cost basis. Such investment is sometimes referred to as price-induced conservation. Conservation measures can be added either when the building is first built or retrofitted later, and the cost of the measures is correspondingly different. The effect of conservation is to satisfy energy-service demand at a lower fuel use (or, in other words, to increase the total efficiency of the technologies).

**Table A-5. Residential and Commercial Fuel Prices ($1990 per MMBtu)**

| | Residential Sector | | | Commercial Sector | | |
|---|---|---|---|---|---|---|
| | Distillate | Natural gas | Electricity | Distillate | Natural gas | Electricity |
| 1990 | 7.64 | 5.69 | 23.74 | 5.65 | 4.77 | 22.49 |
| 2000 | 8.87 | 8.04 | 23.57 | 7.41 | 7.12 | 21.77 |
| 2010 | 10.72 | 9.74 | 25.50 | 9.40 | 8.76 | 23.55 |
| 2020 | 11.78 | 11.21 | 26.26 | 10.54 | 10.18 | 24.26 |
| 2030 | 12.52 | 12.22 | 26.85 | 11.33 | 11.15 | 24.81 |

Source: National Energy Strategy Current Policy Base case

Conservation investment for each end-use is calculated on the basis of fuel prices, the consumer hurdle rate, existing stock efficiencies, and characteristics of new conservation technologies. Fuel prices are generated within the model and are given in Table A-5. (These prices are based on resource and average electricity prices, which are discussed later.) Consumer hurdle rates for each end-use are given in Table A-4. Conservation characteristics for each end-use are represented by two curves in the model—the conservation marginal-cost curve and the conservation total-cost curve. The conservation marginal-cost curves represent the total savings from technology measures that fall below a given marginal capital cost (in dollars per MMBtu); the conservation total-cost curves represent the total cost of these measures on a unit basis (per home or 1,000 square feet of commercial space).

The residential and commercial conservation marginal-cost curves are shown in Figures A-3 through A-13. They represent the additional efficiency gains available as of 1988. The conservation total-cost curves can be derived from marginal-cost curves and are therefore not shown. Each curve is an aggregation of individual conservation measures and end-use technologies ordered by marginal capital cost in dollars per MMBtu of savings. As additional conservation investments are made in an end-use category, additional conservation measures are purchased. As the cost of measures are specific to regions, and building types, measures are given for different regions and buildings. The specific technologies, regions, and building types are given in the figures. Although the Strategy integrating energy model is not a regional model, regional differences in technology performances are captured in these curves in order to more closely replicate regional effects.

Short-term level-of-use adjustments are made using an assumed relationship between the total fuel bill and disposable income. Short-term level-of-use drops as the fuel bill rises relative to disposable income, and rises as the fuel bill drops relative to disposable income, through a behavioral-factors demand-multiplier curve. This curve adjusts level-of-use by as much as 20-percent up or down, although separate curves are input for each end-use category. The disposable income assumptions are given in Table A-2.

# FOSSIL2 ENERGY POLICY MODEL
# DEMAND SECTOR DOCUMENTATION
# VOLUME 2 - VARIABLE DOCUMENTATION

prepared for

U.S. Department of Energy
Office of Planning, Policy and Analysis

by

Applied Energy Services, Inc.
1925 North Lynn Street
Suite 1200
Arlington, VA 22209

September 1986

**Variable (s):** CSXDRH
CCXDRH
CTXDRH
CAXDRH

**Variable Name (s):** Commercial Space Heat Discount Rate
Commercial Cooling Discount Rate
Commercial Thermal Discount Rate
Commercial Appliances Discount Rate

**Variable Type:** Constants

**Derivation:**

Numerous studies on discount rates and consumer behavior have been conducted that focus on residential purchases, but not on those in the commercial sector. Without any further evidence we have used the same discount rates for the commercial heating and cooling as those that had been estimated for the residential sector, and slightly higher rates for thermal and appliances.

CSXDRH = .35 (fraction/year)
CCXDRH = .35 (fraction/year)
CTXDRH = .60 (fractipn/year)
CAXDRH = .60 (fraction/year)

Q: When did Green Lights get started?

On Friday the Administration found dozens of additional policy options <u>beyond NES Actions</u> that would reduce $CO_2$ at a profit. But as late as September 1991, they couldn't find any beyond NES action.s

> **"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."**
>
> **(Page 7.55, Report to Congress *Limiting Net Greenhouse***

As to not being able to identify any measures, the question is obvious: **How hard did they look?** Secondly, **the "future date" is today: about seven months from the DOE study release and one year after the NES.** Why did they ignore the evidence that cost-effective conservation exists in abundance in the U.S. economy?

Make the point that in seven months they found options beyond NES that would reduce carbon emissions by between 43 and 76 million metric tons in the year 2000. At the current rate, the Administration should be able to identify many more opportunities. If we're this close to stabilization, another couple of months will put us over the top.

bring in the

bring in National Academy campaign here

reductions are achievable, and if such potential gains exist, to identify policy instruments capable of accessing these gains without incurring greater real social costs.

With regard to computing the extent of apparently available gains that are potentially available, only the extent of items 2 and 3 are at issue. Item 1 is not available because it is included in the reference case. Items 4, 5, and 6 are not available because they represent real, irreducible net costs. The NES Actions have identified a great number of individual actions that, without raising taxes, improve overall energy system efficiency. As we discuss in Chapter 11, the NES Actions Case is not inconsistent with the results of the NAS (1991) bottom-up analysis. how hard did they look?

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(a) We note that the fact that while individual end-use energy applications may be more capital intensive than the technologies they replace, the full energy system capital intensity may either increase or decrease, depending on the specific energy technology under consideration and relevant prices and interest rates.

(b) We note that Fossil2 takes the demand for energy services as given. Therefore, no accounting is made for the feedback effect on the demand for energy services.

Round 1: The NES/Report to Congress Methodology

The DOE report *Limiting Net Greenhouse Gas Emissions in the United States* is predicated on the assumption that the *National Energy Strategy* analysis accounted for ALL of the cost effective efficiency opportunities in the U.S., a claim that we will examine later in the hearing.

Many people have criticized the NES analysis.

**Dr. Gruenspecht, do you agree with the following quote referring to 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..**

This came from a **National Research Council** study commissioned by Secretary Watkins to study the NES development process. (PAGE 108, Appendix B)

Move to quote identifying NES as sum of cost-effective.
* Start w/ dire quote re: harsh econ impact.
* Start w/ GAP & IRP & electricity pricing problems.

Turn up the heat and further quote the NRC report:

**"Much of the energy data pertaining to the NES modeling 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."** (PAGE 108)

**"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 modeling 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.."** (PAGE 106)

**"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."** (PAGE 107)

# The National Energy Modeling System

Committee on the National Energy Modeling System
Energy Engineering Board
Commission on Engineering and Technical Systems

*in cooperation with the*

Committee on National Statistics
Commission on Behavioral and Social Sciences and Education

NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS

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model does solve for an energy market equilibrium (both prices and quantities), the excursion analyses entailed no reexamination by DOE of the macroeconomic consequences of the technology changes and other changes assumed. Under these circumstances, the Committee questions the outcomes of the excursions (especially for instance those involving high levels of energy conservation) as being potentially inconsistent with reference case economic assumptions. (See also Adequacy of Data, below.)

The Committee sought but did not obtain clear justification from DOE for the selective use of the FOSSIL2 model for virtually all time horizons considered in the NES analysis i.e, to the exclusion of other available integrating models such as the Intermediate Future Forecasting System (IFFS) used by EIA to generate mid-term forecasts.

3. Adequacy of Data

2 **Much of the energy data pertaining to the NES modeling 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.**

Parameter values used in the models are based on very limited data and aggregated information about energy consumption and demand side management. For example, there is little information (at DOE and elsewhere) of the potentials for energy efficiency improvements in the industrial sector. The feasibility of new or alternative energy supply and some end-use technologies appear to rely on estimates made by DOE that are based on limited experience and have a documented history of over-optimism. For instance, specifications made by DOE of technology-derived gains associated with clean coal technologies and methanol are important influences in the analysis, but appear to be speculative.

1 **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**, and may lead to undue reliance being placed on modeling results.

4. Dealing with Uncertainty

In the analyses to date, it is the Committee's view that little attention has been given to dealing with uncertainties regarding assumptions, input data and results, and to risks posed by an uncertain future. More direct treatment of uncertainties will strengthen the NES analyses.

Ignoring uncertainties could lead to undue reliance on "model outputs" and a tendency to overlook the speculative nature of the projections, particularly over long-term time horizons. In context it is worth emphasizing that, for the models considered in the NES analysis, the Committee is not aware of any basis to assign a greater level of certainty to the differences ("deltas") in outcomes among various excursions than to the outcomes of the individual excursions themselves.

was made of other models, such as the ARGUS (Argonne Utility Simulation) model of the Argonne National Laboratory.

Ad hoc interagency staff organizations, particularly the NES Modeling Subgroups, were created to assist in developing assumptions and off-line parameters for the modeling effort (See Figure 1). The cooperation involving the DOE policy and program offices, the EIA, the national laboratories and ad hoc inter-agency staff organizations in developing assumptions and conducting off-line estimations for the NES exercise is to be commended.

In the Committee's view, the foregoing process was constructive. The working group format served to pull together and synthesize information. The interactions and the pooling of expertise were commendable uses of personnel resources.

**B. General Observations**

There is no comprehensive model or group of integrated models existing within DOE, or probably within the federal government, that has the analytical capability to respond to the long time horizon needs imposed by the NES effort. 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 analyses that DOE accomplished through the calibration of the FOSSIL2 model has been a useful way to maintain consistent accounting and reporting of results. (See Note in Figure 1 on the calibration of FOSSIL2.)

The aggregate structure of the models used, however, has significant limitations relative to the analytical results reported by DOE and presented to the Committee. Thus, it is important for the decisionmakers who will be using the results of the NES analyses to appreciate the limited power of the existing set of models used for evaluating policy choices. It would be misleading to assign too much quantitative precision to the results of the model runs or to presume that the models incorporate a great deal of relevant detailed information that can enhance judgments about the future impact of policy choices, particularly impacts beyond a decade or two. **In the presentations that were made to the committee, little reference was made per se to the validation of the models used in the current national energy strategy analysis exercise. Policymakers should appreciate the important role of the a priori assumptions and simplifications, and the off-line contributions made by the NES Modeling Subgroups in shaping the excursions or scenarios, which to a great extent dictated the results of model runs.** In instances where such working groups play such an important role, DOE ought to consider enhancing the working group format with greater outside participation.

As the Committee understands it, the NES analysis and the development of a National Energy Modeling System were initiated by the DOE Office of Policy, Planning and Analysis, which was also responsible for the choice of excursions or scenarios to be analyzed and for the selection and application of the FOSSIL2 integrating model. EIA has provided extensive analytical support in these activities, but not in its customary role of generating, independently, energy information and forecasts such as the Annual Energy Outlook.

**C. Specific Comments**

1. Long-Run Modeling and Forecasting

None of the current models used in the NES analysis was developed to generate 40 year projections. It would be misleading to presume that the models incorporate a great deal of information relevant to the long-term implications of the excursions or scenarios analyzed.

The models are deterministic, and are based either on historical data and relationships that may or may not have relevance to situations anticipated in the future, or on external judgments about the course of technological and institutional changes. The variances can be high in the relevant parameters as well as in the structure of relationships within the models. It may well be that uncertainties are so great for forecasts over a 30 to 40 year period that deterministic forecasts cease to be useful over such time frames.

There are issues still to be resolved concerning the internal consistency of the models within the two-tier hierarchy of which they are part. (See The FOSSIL2 Model, below.)

2. The FOSSIL2 Model

In the current NES exercise, the FOSSIL2 model is the integrating vehicle used by DOE to yield long-term forecasts. While the calibration and application of FOSSIL2 may be a useful way to (a) achieve rough integration of the analysis performed with other models, and (b) maintain consistent accounting and reporting of results, the aggregate modeling structure (as depicted in Figure 1) has major limitations relative to the analytical results being obtained from the models.

The FOSSIL2 model itself, according to DOE, is not well understood in the department except by a few people in the Office of Policy, Planning and Analysis. And, the staff at EIA indicated that they too did not have in-depth knowledge of the characteristics and workings of the FOSSIL2 model.

9 **The compatibility of the FOSSIL2 model with the other models is also not well understood by DOE. The influence of 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 future fuel choices for electric power production in the FOSSIL2 model could be important and perhaps overly restrictive.**

Many of the excursions (from the reference cases) analyzed by DOE with the FOSSIL2 model involved substantial changes in the use of energy technologies, and assumptions on technology availabilities, efficiencies and costs. While the FOSSIL2

The DOE Report to Congress used the FOSSIL2 model. This produced the result that a carbon tax would have to be $140/metric ton in order to stabilize $CO_2$ emissions in 2000 at 1990 levels.

But the model has one especially severe limitation:

> **"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/metric tons of carbon, this behavior may not reflect the full extent of economic response and may therefore tend to underestimate the impact of the modeled policies."**

**(Page xiii, Executive Summary of the Report to Congress *Limiting Net Greenhouse Gas Emissions in the United States***

Note that the model begins to underestimate responses to the tax at the $140/ton level, and thus the tax rate required to achieve stabilization is therefore artificially high.

* Confirm w/ quote from Chandler.

It is worth noting that the Fossil2 Model may tend to underestimate the responsiveness of the energy system in extreme cases. This is because the model has no mechanism for prematurely retiring existing 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/mtC, this behavior may not reflect the full extent of economic response and may therefore tend to underestimate the impact of the modeled policies. The assumption that only fossil fuel carbon emissions are taxed is also limiting. A more general analysis would consider taxation of carbon from other potential net sources including, for example, cement manufacture and forest practices, as well as the effect of taxes on other activities that produce greenhouse gas emissions.

The output from Fossil2 provided inputs to two other modeling systems used for analyzing the impacts of policies to mitigate greenhouse gas emissions. The first of these models is the Edmonds-Reilly Model of long-term, global energy-economy interactions. This model is an energy market equilibrium model, with supply and demand equated only for the energy sector. The Edmonds-Reilly Model calculates base Gross National Product (GNP) directly as a product of labor force and labor productivity. This model was used to assess the global energy and greenhouse gas emission implications of U.S. actions that go beyond those implemented by the NES (Chapter 10).

The Data Resources, Inc. (DRI) Quarterly Macroeconomic Model was used to estimate the impact of greenhouse gas emission mitigation policies on investment, GNP growth, and other aspects of the U.S. economy. Two examples of policy instruments were selected for detailed examination (Chapter 9). The DRI Model uses energy demand as an input to generate estimates of economic growth. When the DRI Model is used in this study, the energy component is represented by estimates of total demand at full employment, obtained through Fossil2 simulations.

In the analysis of costs, we have sought to calculate estimates of reductions in the dollar value of new, final goods and services produced in a given year (GNP). We have used the tools of economic analysis to construct these estimates. Reductions relative to the NES Actions Case are reported in the year in which they occur. There are obvious differences in the burden of costs incurred in the present and in the future. The discount rate is a tool frequently used to enable a comparison between costs incurred at different points in time. But great uncertainty exists as to the proper rate of comparison. Problems in determining the correct rate occur for a variety of reasons, including the fact that the beneficiaries of possible changes in the rate of emissions of greenhouse gases will be, to a large extent, future generations, while costs may be incurred to a greater extent by those currently alive (see, for example, NAS 1991). Rather than attempt to deal with uncertainties associated with comparing costs across time, we have chosen to report costs in the year in which they occur only. We provide perspective by comparing these costs to the then-current GNP. In addition, we have made no attempt to assess the demographic, geographic, or sectoral distribution of the costs of emissions reductions policies. While important, these issues are beyond the scope of the present study and remain to be addressed in future research.

**Analysis of Current Policies**

Three sets of policies were examined with regard to their impact on greenhouse gas emissions: Current Policies, NES Actions, and Policy Instruments Beyond the NES Actions.

The first set consists of the Current Policies Base Case. This is also the reference case used in the NES analysis. It is examined in Chapter 5. Three general assumptions guide the development of this case, modeled in Fossil2: that there are no major changes in current laws and energy policies

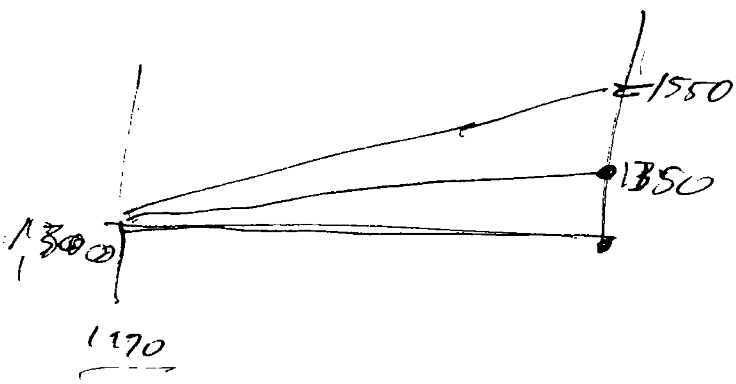
Comparison between NES "Current Policy"
and Annual Energy Outlook 1992

| Annual Energy Cons. (quads) | Increase 1990 - 2000 NES | AEO 92 | Percent ~~Reduction~~ ~~In Growth~~ AEO of NES |
|---|---|---|---|
| Petroleum | 5.2 | 2.6 | 50% |
| Natural Gas | 4.4 | 3.2 | ~~28%~~ 72 |
| Coal | 4.4 | 1.6 | ~~63%~~ 37 |
| Total Fossil | 14.0 | 7.4 | ~~42%~~ 53% |

| Annual Carbon Emissions (MMT Carbon) | Increase 1990 - 2000 NES | AEO 92 | |
|---|---|---|---|
| → Reduction Needed for Stabilization: | 250 | $\boxed{132}$ 125 | $\boxed{50\%}$ |

| Carbon Weights | |
|---|---|
| Petroleum | 0.32 |
| Natural Gas | 0.25 |
| Coal | 0.43 |

3.5 - 2.7




I can take Al through the analysis. Its really simple, based only on growth in AEO compared with NES. This is our

Pre NES BASELINE (see page from AEO)

+125

U.S. VIEWS: $\boxed{87-121}$

We're there, baby

# 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 | 13.3 | 11.7 | 8.8 |
| Natural Gas | 18.1 | 19.2 | 21.8 | 20.4 | 20.2 | 19.9 | 17.8 |
| 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 | 89.3 | 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 | 0.2 | 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 | 39.6 |
| Primary Consumption (quads) | | | | | | | |
| Petroleum | 33.5 | 36.6 | 38.7 | 41.5 | 44.8 | 49.6 | 52.0 |
| Natural Gas | 19.2 | 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 | 0.2 | 0.2 | 0.2 | 0.2 | 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 | 35.3 | 39.9 | 44.4 | 48.8 | 57.3 | 64.8 |
| Energy Prices | | | | | | | |
| World crude oil ($1990/bbl) | 22.00 | 21.21 | 29.26 | 34.94 | 39.29 | 45.02 | 49.02 |
| Wellhead natural gas ($1990/mcf) | 1.77 | 2.43 | 3.82 | 4.55 | 5.55 | 7.04 | 7.99 |
| Minemouth Coal ($1990/ton) | 22.18 | 24.65 | 26.62 | 27.30 | 30.59 | 33.05 | 36.63 |
| 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 | 24.8 | 26.5 | 27.9 | 25.1 | 22.2 |
| NOx (mill. tons/year) | 22.7 | 22.2 | 23.3 | 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 | 7388 | 7255 | 7789 | 8425 | 9668 | 10523 |
| Gross National Product (bill. $1990) | 5463 | 6474 | 7472 | 8600 | 9756 | 11831 | 13931 |

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# 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 | 6.09 | 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 | 8.98 | 10.08 | 11.02 | 2.6 |
| **Total** | 85.02 | 90.49 | 95.61 | 101.20 | 106.10 | 1.1 |
| **Net Imports - Petroleum** | 15.18 | 18.05 | 20.81 | 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.D0923913.

March '91 — NES released
< Jan. '91 — NRC review
Sept '91 — DOE Greenhouse Gas Report

$CO_2$ STABILIZATION: AN OPPORTUNITY FOR ECONOMIC GROWTH

Joint Economic Committee Hearing
April 28, 1992

## OVERVIEW

This hearing examines the economic impact of stabilizing $CO_2$ emissions at 1990 levels by the year 2000. Persuasive evidence will be presented that (1) $CO_2$ stabilization is achievable at a profit (2) $CO_2$ stabilization will create jobs and make the U.S. more competitive (3) $CO_2$ stabilization will require federal leadership. The evidence will not come from environmental advocates; but from EPA, independent analysts who work for DOE/National Labs, and from the private sector.

The hearing will also deliver other important political messages: that DOE systematically ignores energy efficiency analysis; that DOE misallocates taxpayer money toward energy supply technologies; and that DOE gives the President poor advice regarding the economic impacts of $CO_2$ stabilization. By misleading the President on energy issues, DOE thwarts effective policymaking and serves to isolate the U.S. in the international diplomatic arena. Thus, the President should reevaluate the U.S. position on stabilization, and seize a historic opportunity to promote economic growth and to address the global warming threat.

The hearing has three panels: Administration witnesses, government energy efficiency experts, and the private sector. This hearing will establish the consensus of independent experts and the private sector that the market is ready to respond to the stabilization challenge by exploiting profitable opportunities for $CO_2$ emission reductions. All that is necessary is national leadership.

## ADMINISTRATION PANEL ON COST OF STABILIZATION

This panel will play out the DOE vs. EPA analytical debate regarding stabilization options. We will discredit DOE analysis and philosophy, while supporting EPA's innovative programs. We do not know whether DOE will deliver more positive testimony regarding the opportunities for cost-effective conservation, given the internal debate at this time. Barring more cooperative testimony, however, we will undermine DOE credibility on the issue.

**Howard Gruenspecht, DOE**

He will discuss the much debated DOE analysis Limiting Net Greenhouse Gas Emissions in the United States. Although the study is much maligned by environmental groups, many enviro-oriented analysts privately concede that it is not so bad; contains some interesting results; makes some questionable but defensible analytical assumptions; and suffers primarily from the pessimistic Executive Summary.

Beyond the DOE study, we will examine the general claim that the National Energy Strategy analysis has identified all of the cost-effective $CO_2$ emission reduction opportunities. DOE made a half-hearted attempt to find some efficiency gains in the analysis, but now the analysis has become codified into Administration ideology. Since the $CO_2$ reduction analysis is based on the premise that the NES is the final word on cost-effective emission reduction opportunities, it is fundamentally flawed to the extent that other profitable options exist. For example, the EPA Green lights program is not included. While DOE officially supports EPA programs, they still have not changed their analytical stance. This is where the duplicity enters in: they stand by their analysis that they admit has major shortcomings.

**Eileen Claussen, EPA/Office of Air and Radiation (OAR)**

Eileen can brief us on the analysis of OAR $CO_2$ reduction options and describe the EPA approach to addressing market barriers. This will contradict the DOE position that the NES has exploited all of the cost-effective options. They use bottom-up models to identify cost-effective opportunities and to motivate programs to reduce market barriers to conservation investments.

The EPA takes a marketing approach to energy efficiency. There are two goals: to increase market penetration of the most efficient equipment and to accelerate manufacturing cost reductions which normally accompany expanding markets.

We don't know how far Eileen can go in confronting Howard on the analysis and the estimates of $CO_2$ emission reductions. But we can use the ammunition that her testimony supplies to turn on DOE.

**PRIVATE SECTOR PANEL ON STABILIZATION BENEFITS: THE CASE OF ELECTRICITY**

We are going to directly dispute the DOE analysis by examining real world conservation potential. This panel will focus on the electricity generation sector; it includes a utility executive, a consultant (and ex public utility Commissioner), and an entrepreneur selling energy efficiency services. All three witnesses will state that, given the right regulatory environment and federal leadership, that the market can stabilize U.S. $CO_2$ emissions at a profit.

**John C. Fox, Pacific Gas & Electric**

John heads PG&E's demand-side management programs. He will talk about PG&E's commitment to energy efficiency, reduced $CO_2$ emissions, increased customer value, and regional economic development. We can take his testimony and generalize to the rest of the country.

PG&E regards demand-side management and other utility programs as regional development tools. Fox will provide an analysis of the economic benefits that PG&E has calculated from their efficiency programs.

PG&E also promotes renewables. They have committed to satisfying all new load growth with efficiency and renewables. (This is not exactly the same as $CO_2$ stabilization, but pretty close). Given that they (1) are one of the "cleanest" utilities around now and (2) they are in a fast-growing region of the U.S, their program suggests that the entire U.S. could easily adopt the same goals.

**David Moskovitz, The Regulatory Assistance Project**

David is a former Maine Public Utility Commissioner who now directs a consulting practice that helps PUCs and utilities develop conservation and renewable energy programs. He is an expert on state (public utility commissions) and federal policy options to enhance efficiency and promote renewables. An innovative and engaging thinker, David will discuss the regulatory situation and the role of federal intervention. He has also analyzed the U.S. potential for energy efficiency, and will indicate how much can be done, given adequate federal leadership.

**S. Lynn Sutcliffe, President and CEO, SYCOM Enterprises**

Lynn runs SYCOM, an energy service company (ESCo) that markets energy efficiency. In his words, "I am a least-cost doer, not a least-cost planner." He will outline how his firms and others like him are prepared to expand their efforts when policies dictate. His firm provides energy efficiency services, through split-savings agreements and other contractual arrangements. SYCOM has entered into innovative joint ventures to supply electricity and efficiency bundles specifically designed to have zero net emissions or pollution reductions. Thus, his experience is literally a microcosm of the economy-wide opportunities for entrepreneurial emission reductions.

## INDEPENDENT PANEL ON THE COST OF $CO_2$ REDUCTION OPTIONS

This panel will offer additional views regarding the costs of stabilization and the opportunities for cost-effective conservation investments. The two national lab witnesses will also provide evidence that DOE ignores its own analysis when it conflicts with administration policy.

**Florentin Krause, International Project for Sustainable Energy Paths (IPSEP), and Lawrence Berkeley Laboratory**

He will describe his analysis of European Community options. The EC seems to accept the results of bottom-up analysis more than the Administration does. There is an additional message here: to the extent that the EC countries adopt cost-effective measures, they will become more competitive. Thus, we are in danger of losing competitive advantage.

Moreover, in his position at Lawrence Berkeley Laboratory, Florentin will describe how other countries actively acquire the U.S. developed expertise in designing energy efficiency programs. This "technology transfer" is beneficial, but it seems that DOE is less interested than other countries in applying the knowledge to U.S. utility markets.

Also, DOE is squelching completed analyses that directly contradicts the administration position. I am trying to develop independent confirmation of this claim, in order to keep Florentin's fingerprints off. We have a good opportunity to find a "smoking gun" here regarding DOE misinformation.

**William Chandler, Battelle Memorial Institute - Pacific Northwest Laboratories**

Chandler can discuss the state of economic modeling, and how useful models are in evaluating policy options. In addition to experience in evaluating U.S. energy strategies, he can give an international perspective (he has edited a volume of comparative $CO_2$ reduction studies) with emphasis on eastern Europe and the former Soviet Union.

Chandler participated in the DOE $CO_2$ emission reduction study. However, he claims that he would have taken his name off of the final document, as DOE editing distorted his analysis. Although we must protect Chandler's position, we can probably elicit some testimony that reflects his frustration with the Administration on this issue.

**Richard Stroup, (Minority Witness) Montana State University and National Center for Policy Analysis**

I really don't know what Stroup is going to say. Given his background -- affiliations with ultra-conservative think tanks, very doctrinaire writings -- I have a few hunches. He will probably claim that energy markets work real well in the absence of government-induced distortions. He may point out that the engineering analysts are not economists (and therefore miss part of the "truth" received only by the adherents to neoclassical theory). He could bring out the scientific uncertainties surrounding climate change. He might talk about the virtues of property rights and free-market resource pricing.

Both Chandler and Krause know more about energy markets and energy analysis than Stroup, who is a generalist as far as I can tell. They have both confronted the neoclassical critique before, and can help us refute Stroup's testimony. On the other hand, it may be just as easy to ignore and marginalize his views.

? - suggestions underlying Krause in IPSEP T f. → what in/out of NES.
? - actual $'s for $CO_2$ & $ cost to U.S. economy.
? - Moskovitz article re: federal incentives — how much in NES; how much in S2166? ground for criticism?

* all need to get fed back to shortcomings in DOE study of key implication to ~~supp~~ identify strengths of EPA analysis.

*'s need to tease out shortcomings of DOE study.

April 22, 1992

***MEMORANDUM***

To: Senator Gore

From: Marc Chupka

cc: Katie McGinty

Subject: Background Materials for JEC Hearing

---

Attached are four readings:

- A background memo on conservation investment analysis and utility economics. I was unsure how much exposure you had to the economics of energy investments, and you need to know the basic story.

- A chapter from a least-cost utility planning handbook. Worth a brief scan. I have highlighted the sections that may be useful; in particular the discussion of market barriers on pp. II-7 to II-9 is important.

- "Cutting the Nation's Electric Bill" by David Moskovitz. Browse it if you feel up to it.

- "Least-cost Insurance Against Greenhouse Risks: The Cost of Cutting Carbon Emissions" briefing document by Florentin Krause. This is a broad view of conservation options, and gives highlights of Krause's Western Europe study.

I will happily answer questions that you have as you read these. Call me at work 4-0375 or at home (202) 232-3212. You should read the background memo and the Krause "Least-cost Insurance" piece. The others are more optional, but will enhance your appreciation of the economic issues surrounding energy use and $CO_2$ emissions.

TESTIMONY OF
EILEEN CLAUSSEN
DIRECTOR
OFFICE OF ATMOSPHERIC AND INDOOR AIR PROGRAMS
OFFICE OF AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON ENERGY AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
U. S. HOUSE OF REPRESENTATIVES

MARCH 3, 1992

It is a pleasure to appear before you this morning to present a number of voluntary Environmental Protection Agency (EPA) initiatives relating to climate change that would reduce greenhouse gas emissions and air pollutants associated with the production of electricity by promoting private investment in energy efficiency. Greenhouse gases and air pollutants that would be affected include carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), nitrogen oxide (NOx) and sulfur dioxide ($SO_2$).

## Strategy for Increasing the Adoption of New Energy-Saving 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 productive use of energy and lead to increased 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 cost-effective technologies, for a range of applications, for preventing, controlling, and mitigating greenhouse gas emissions and, wherever possible, for also 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.

We believe that these measures can have substantial effects. To address energy efficiency objectives, EPA has developed a five-part strategy: (1) corporate and government purchasing; (2) enhanced product markets; (3) regulatory and legal reforms; (4) development and demonstration of prevention, control, and mitigation technologies which, wherever possible, also recover energy; and (5) expanded international markets. EPA believes that this strategy of efficiently using energy resources can cost-effectively achieve reductions in emissions of greenhouse gases below the levels which they would otherwise reach in future years, while at the same time promote economic growth.

In the last two decades, U.S. energy consumption per unit of GNP has fallen by 30%, mostly as a result of the normal functioning of the market. "Green Lights" and related EPA programs targeted at electricity consumption are part of an overall movement to improve the efficiency of energy use, including the Administration's National Energy Strategy, as well as utilities' integrated resource planning and demand-side management programs. We are coordinating closely with the Department of Energy on all of these efforts. The best way to explain how this strategy would work is to place it in the context of programs that EPA has already developed, or is currently developing, in each of these strategic areas.

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.

EPA believes this program will be successful, since over 400 participants already signed up--nearly two billion square feet committed--which is 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 preliminary installations look quite promising: reports received indicate that savings of 40-75% in lighting electricity consumption have been realized, exceeding some previously published technical estimates. Preliminary analyses indicate that investment in energy efficient lighting resulting from utility including integral resource planning and demand-side management, as well as Green Lights--could lower greenhouse gas emissions from electricity production by millions of tons.

Why have these lighting upgrades not happened earlier, given that the investments in efficient lighting products are all profitable? There are a variety of reasons. The facilities manager is responsible for lighting--and usually also charged with making the elevators run and ensuring that the building temperature is comfortable. Even when this manager is educated that opportunities 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.

EPA's Green Lights program requires participants to establish efficient lighting as a strategic corporate decision undertaken at a high level within the corporation and it also 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 helps 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. At the same time, 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.

EPA is currently developing several other programs that could operate similarly to the Green Lights model with regard to corporate and government purchasing; green commercial buildings; and, green energy corporations.

The Green Buildings program would focus primarily on building-shell improvements. 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 stimulate corporate energy efficiency across the board--in other words, a green energy corporation program that would require participants to ensure that all equipment purchases are consistent with the principles of life-cycle profitability.

EPA's Green Lights--and similar "green" programs--demonstrate that significant pollution prevention may be achieved by providing information and technical advice to corporations and government offices.

Enhanced Product Markets

A second aspect of EPA's approach is to provide signals to manufacturers that markets exist for the most efficient technologies that manufacturers can produce. 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 after 1994 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 (or 1995).

Under present law, the Department of Energy (DOE) standard is applied to all refrigerators as a minimum standard. The winning refrigerator model is required to be 25 percent more efficient than the 1993 DOE appliance standard, and may be as much as 50 percent more efficient. The draft request for proposals (RFP) is currently being reviewed by the public and will be offered in June of this year. The first super-efficient refrigerators will be shipped as early as 1994. The rebates will be awarded directly to the manufacturers.

Opportunities for many other "Golden Carrot" programs 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 and will 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 super efficient equipment.

EPA has identified a large number of opportunities for future "Golden Carrots", including heat pumps, clothes washers, clothes dryers and solar water heaters.

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-using 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 indicating that this equipment uses less electricity. Manufacturers can use this label 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-using consumer products. By amplifying market signals for efficient products, these programs can stimulate real savings both in terms of energy and reduced greenhouse gas emissions.

**Regulatory and Legal Reforms**

Step three of EPA's strategy is to help ensure that corporations are not penalized for efficient use of energy. The programs I have just outlined will not function effectively if utilities lose money as their customers become more energy-efficient. As long as utilities have a regulatory structure which provides incentives to <u>sell</u> kilowatt hours and disincentives to <u>save</u> kilowatt hours, national efforts toward energy efficiency will be at odds with the shareholder objectives currently in place in most utility jurisdictions. For federal policies to be effective, they must not be inconsistent with the objectives of utilities around the country.

Since the mid-1980's, the Department of Energy 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 sea change in State regulatory treatment of energy efficiency investments by utilities.

During the past eight months, EPA has engaged in a widespread outreach effort that complements what is already underway. 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 Initiative**

While not based on products or corporate purchasing per se, profitable options identified by EPA for reducing emissions of methane to the atmosphere also fit into the strategy. Methane is an attractive focus for reducing greenhouse gas emissions because it is more effective at trapping heat than carbon dioxide ($CO_2$) and because it has energy value--so profitable systems can be designed to recover or better utilize this methane. This is possible with methane from landfills, methane from the management of animals (dairy and swine farming) and methane from coal mining. EPA is working to enhance market opportunities for methane recovery in these areas. This includes demonstrating profitable "on-site" energy generation for farms (while solving non-point source runoff problems) and working to remove barriers to energy recovery at landfills and coal mines. For example, property rights issues 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.

**Development and Demonstration**

EPA is 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 on anaerobic digester gas. A third demonstration is directed toward advanced pregasification for deep coal mines.

## Expanded International Markets

Finally, EPA is helping 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). These technology cooperation projects will contribute significantly to global environmental improvement, and potentially create large markets for domestic goods and services and will thereby decrease prices for these goods and services, both abroad and within our own borders.

## Conclusion

Voluntary programs--following the model of EPA's green lights program--have demonstrated that they can reduce greenhouse gas emissions in a cost-effective way. We believe that by improving information dissemination about efficiency and continuing technology development and demonstration, cost-effective reductions in emissions of greenhouse gases can be achieved while promoting economic growth.

* * *

## BACKGROUND MEMO ON ENERGY INVESTMENT, UTILITY ECONOMICS, AND OPPORTUNITIES FOR CARBON DIOXIDE REDUCTIONS IN ELECTRICITY

Testimony and questions at the JEC hearing on April 28 will revolve around economic discounting principles, technology investment analysis, and electric utility economics. This is a soup-to-nuts primer on the issues; a little long-winded perhaps but the story is difficult to condense into bullets.

### Discounting

All economic discounting involves making comparisons of value through time (intertemporal analysis). The basic idea is familiar: costs and benefits now are more important than those experienced in the future. Economists like to frame the issue in terms of opportunity cost. A promise to give you $100 one year from now is worth less than $100 today, since the $100 today could be invested to give a return, yielding for example, $105 in one year. (See endnote on real vs. nominal interest rates.)

### Investment Analysis and Conservation

Energy efficient equipment can be viewed as an investment, if alternatives exist with different efficiency and cost characteristics. For example, which refrigerator is cheaper: a relatively efficient model that consumes 600 kilowatthours (kWh) per year and costs $750, or a model that consumes 900 kWh but only costs $600? The investment choice depends on whether the energy costs saved over time from the efficient model will compensate for the extra initial cost of $150. The question can now be framed: is the extra $150 a good investment now if it saves $15 per year on your electric bill? What is the return on the investment? Is it a good investment compared with alternative investments? If a consumer has to borrow on his credit card to finance the investment at 20%, can he still make money on the deal? In simple terms, the energy savings will pay back the initial investment in about 10 years; do consumers normally require a quicker "payback" period to commit to an investment?

Another example is a commercial building tenant who pays $10,000 per year in electricity for lighting. Would a lighting efficiency upgrade investment be worthwhile if it costs $20,000 but saves $6,000 per year over 10 years? The life-cycle cost of the upgrade depends on the up-front investment cost, the value of energy saved through the useful life of the investment, and the discount rate applied to savings in the future.

An undiscounted analysis of the lighting option would show that the $20,000 investment would save $60,000 over 10 years. However, a lot of the savings occur far in the future. The present value of the savings stream, discounted at 10% annually, would only be $36,867, while if the future savings were discounted at 20% annually the present value would only be $25,155 (See Attachment: Lighting Upgrade Financial Analysis). Under a 20% discount rate, the $6,000 saved in year 10 is only worth $969 today, in present value terms. The present value of savings exactly equals $20,000 at a discount rate of 27.3%. If the company had a policy that said that investments must return at least 30%, they would not perform the lighting upgrade. An observer would conclude that the "hurdle" rate or the "implicit discount rate" for the company was at least 27.3% since it did not make the investment.

There is abundant evidence that consumers and firms routinely forego profitable investments in energy efficiency. This is often expressed in a consumer "discount rate" or "hurdle" rate, where energy efficient investments must provide returns in the range of 20% to 60% for consumers or firms to get off the dime and invest in conservation. This observation leads to several questions.

- First of all, **why?** I have attached a full chapter from a least-cost utility planning handbook (co-authored by Florentin Krause, a JEC witness). You may wish to browse through the highlighted sections. The bullet points on **page II-9** are an excellent description of why efficiency does not do well in the marketplace.

- Secondly, **what are the implications?** If electricity demands rise rapidly because consumers are not making profitable conservation investments, then the utility must make investments in generation capacity. Utilities have their own investment criteria, for example, they will invest in powerplants if they have a financial return of 12% or so. The discrepancy in discount rates (20% to 80% for consumers vs. 12% for utilities) means that society would be better off if more were invested in conservation and less into new electric generating capacity.

- Thirdly, **how could we accomplish an investment shift?** Emerging utility programs -- called demand-side management (DSM) least cost utility planning (LCUP) and integrated resource planning (IRP) are methods that utilities use to try to identify, quantify, and ultimately exploit the conservation potential on the demand side.

## Utility Regulation and Economics

Investor-owned utilities (IOUs) are regulated, profit seeking firms that supply electric power and gas. They accept the obligation to provide reliable electric power at reasonable rates, as set by the state Public Utility Commission (PUC). In return, the PUC sets rates high enough for utilities (1) to cover operating costs and (2) to provide an adequate return on investment for the shareholders. This return is usually about 12% to 15% in most states.

The traditional regulatory story starts with utilities forecasting "load growth" (increase in electricity demand). They then decide what kinds of new generating capacity would be economically best to serve the new load, given the current mix of generating plants in their service territory. They build the plant, and ask the PUC to raise electricity rates to cover the new capital investment. If the investment is deemed "prudent" then the new plant is incorporated into the "rate base" and the PUC sets rates high enough for the utility to earn a profit.

The ratesetting rules vary by state, but usually include a full pass-through of fuel and operating costs. The rate base is determined by looking at the invested capital. The "allowed rate of return" is calculated as a fraction of the rate base. The PUC then calculates the electricity rates for different customer classes -- residential, commercial and industrial -- sufficient to achieve the target rate of return.

This cozy system broke down in the 1970s as fuel prices spiked up, demands fell far short of expectations, and half-built nuclear plants were abandoned. PUCs reacted by allowing "automatic fuel adjustment clauses" to reflect fuel price changes into rates without formal regulatory proceedings. They also disallowed a lot of "imprudent" investments by not allowing the costs of failed plants into the rate base. In effect, they refused to let rates rise to cover the expenses, and thus took it out of the shareholders' hides.

PUCs and utilities also began to recognize that once-predictable demand forecasts were a huge source of financial risks when they didn't pan out. Thus, they began to examine ways that they could actually affect future demand growth--and demand side management (DSM) was born.

As it became obvious to utilities that many customers were using electricity inefficiently, they began trying to increase end-use efficiency as a way to avoid commitments to build risky new capacity. In effect, they began to view the inefficiency of end-use as a potential source of power supply. In a typical early program, utilities would subsidize (through planning assistance, energy audits, interest-free loans, or equipment giveaways) more efficient electricity-using devices. These devices could deliver the same level of electricity services -- heat, light, refrigeration, mechanical power--while using less electricity. If enough customers purchase efficient equipment in response to the incentives, then demands for electricity will fall, or at least not rise as rapidly. The efficiency gains become a source of "supply" that can be exploited in lieu of building new generating capacity.

A variety of approaches and programs have emerged, which all depend on the incentives that the utility faces with respect to the PUC treatment of their programs. Ratesetting formulas partition the gains between shareholders and ratepayers (both participants and non-participants) For participants, <u>rates</u> can rise, but their <u>bills</u> can be lower if they use electricty more efficiently. Non-participants can be harmed if their rates <u>and</u> bills rise; this can conflict with PUC mandates for fairness, which inhibits DSM programs. For shareholders, three options have emerged since the mid-1970s:

- **Expensing DSM** as an operating cost, i.e. rates can rise only to the extent that utilities incur ongoing costs. This gives utilities limited incentive to pursue DSM programs, except to the extent that they fear the alternative--risky supply side investments.

- **Rate-basing DSM.** If the program costs are counted as "investments" and the PUC allows rate increases to more than cover program costs, this makes DSM more attractive for utilities. Thus, the $100 rebate for a more efficient refrigerator becomes a "little power plant" on which the utility can earn a return. This is sometimes called "investing on the customer side of the meter."

- **Decoupling profits from sales.** This is the idea that David Moskovitz pioneered, and gives utilities maximum incentive to treat conservation and supply side investments on equal footing. (See attached article "Cutting the Nation's Electric Bill.)

The terms "least cost utility planning" (LCUP) and "integrated resource planning" (IRP) refer to the complex planning and economic analysis of competing utility investments on both the demand and supply side. The financial and technical models used for LCUP and IRP can examine every aspect of utility operation and economic impacts. Some states are now requiring that the models incorporate externalities as explicit costs when evaluating the relative economics of various supply and demand side options in their "resource selection plans". This gives demand-side options and renewables an advantage in the planning process.

Investment Economics, Utility Regulation, and the JEC Hearing

Because most of the increase in $CO_2$ between 1990 and 2000 is projected to come from electricity generation, coal-fired in particular, the short-run stabilization debate focuses on this sector. The questions are: how much conservation potential is out there, and how can we exploit it? Other topics are: what has DOE done to promote conservation, and how does their analysis reflect the potential for expanded conservation programs?

Investment Economics and GREEN LIGHTS

how know the rate of return — who decides the discount rate?

The lighting upgrade example was important because it shows how the EPA Green Lights program works. A Green Lights "Partner" agrees to survey their office space, and invest in lighting efficiency if the return is at least the prime rate (about 6.5 percent) + 6 points. Big corporations can usually borrow at the prime, so that any efficiency investment yielding over 13% return will yield a profit, and will be undertaken by a partner. Thus, the program explicitly addresses the discount rate issue. (EILEEN CLAUSSEN TESTIMONY)

If can borrow @ the prime then a hurdle return above 6.5% would yield a profit ??

Green Lights partners are also encouraged to avail themselves of utility DSM programs. Utility rebates for certain lighting equipment lowers the cost of investment and thus provides another economic incentive lever to promote efficiency investments. Green lights, therefore, can increase the effectiveness of utility DSM efforts, and if the utility is earning a return on DSM investments, can help utility profits as well. (JOHN FOX - PG&E, DAVID MOSKOVITZ, TESTIMONY)

Another option is for a Green lights partner to hire an Energy Services Company (ESCo), which performs the work, monitors the results, and splits the savings with the corporation in order to make a profit. If the ESCo industry takes off, they will provide more "discount-rate lowering" incentives to corporations. (H. LYNN SUTCLIFFE TESTIMONY).

The market for energy efficiency in the electricity sector is evolving and dynamic. The question remains however: how much potential can be realized in the next decade, and what is the opportunity for federal leadership? EPA voluntary programs look promising, and DOE supports some efforts for technical assistance for utilities and PUCs in developing LCUP and DSM programs. This assistance is about $4 million per year, a pittance compared with fossil and nuclear hardware development programs. It is legitimate to cast LCUP into an "emerging technology" paradigm and ask why major demonstration projects, etc. could not be pursued in order to spread these programs to other states. However, major advances would only come from state PUC changes. DAVID MOSKOVITZ will discuss federal policy options that could encourage the spread of LCUP into more states.

Any way to show that N is bogus? — any way to demonstrate that this is high or accurate or the ... ballpark?

## Investment Economics and DOE Analysis

Where does DOE go wrong in their $CO_2$ analysis? They observe very high consumer discount rates and factor them into the analysis (60% on commercial lighting upgrades) This is not bogus *per se*, but does beg the question of whether or not they conducted any detailed analysis of programs that could lower consumer discount rates.

such as?

Another issue is whether DOE included a reasonable estimate of utility DSM impacts in the baseline, since their electricity demand forecast would be too high if they assumed a conservative penetration of efficiency programs.

optimism

Finally, DOE has questioned whether or not EPA's estimated impacts for their programs are valid. They view the EPA analysis as little more than a "counting the lightbulbs" approach that employs an optimistic assessment of program impacts and does not adequately address other estimation issues, such as "snap-back." Snap-back refers to the behavioral response to efficiency investments, where lower energy costs lead to increased usage. This phenomena can erase as much as 10% to 20% of estimated energy savings for appliances such as hot water heaters (people take longer showers when energy costs are lower). However, it is not clear whether any snap-back occurs in commercial lighting, since usage is not much affected by costs.

who has the upper hand?

(how much of this actually in the DOE report?)

## Other Aspects of DOE Baseline and Analysis

The DOE baseline from the National Energy Strategy (NES) analysis is now pretty out of whack in any case. Projections of GNP growth in general are now out of date. DOE concedes this point. But other data only loosely associated with overall GNP growth is also questionable, such as commercial floor space (a big driver of electricity demand), and residential appliance saturation.

Finally, and this is the real issue: DOE insists that the NES strategy has identified all cost-effective conservation investments and therefore anything beyond those programs will incur economic costs. First of all, it is impossible to figure out what the NES conservation investments are -- they appear to be very conservative. Secondly, the NES claims to encourage utility Integrated Resource Planning (and thus demand-side programs) but the assumptions are not clear. Third, they did not analyze any EPA programs explicitly (they claim some overlap but don't defend it well). This observation calls into question the assertion that NES found all of the profitable conservation investment opportunities. Finally, the supporting analysis for the NES appears to cover more conservation options, but these were not picked by the NES even though they appear to be cost-effective.

how do we know? we need something more solid here.

?

were considered & adopted, rejected, why? can we learn on this?

ENDNOTE: Nominal vs. real interest rates.

At a 10% annual (simple) interest rate, a $100 dollar investment made on January 1 is worth $110 dollars on January 1 the following year. (see endnote on compounding). The stated rate is a nominal rate of interest, not adjusted for inflation. The real interest rate accounts for the loss in purchasing power due to inflation. If inflation is 5% over that year, the real interest rate is only 5%. This is because you need $105 dollars just to buy the same amount of goods, and your $110 doesn't look quite as attractive.

Virtually all energy market analysis is conducted in real terms, and this is indicated by the phase "constant dollars." or "constant 1989 dollars," or any other benchmark year. (The alternative is "current" dollars, which are not adjusted for inflation and therefore just taken at face value in the "current" year.)

All of the investment and technology choice analysis discussed in the hearing will be expressed in constant dollars. Therefore, the interest rate used in the financial or investment analysis is a real rate.

## Lighting Upgrade Financial Analysis

Here is a simplified spreadsheet analysis of the lighting upgrade described in the memo. It costs $20,000 and saves $6,000 per year for 10 years. The spreadsheet analyzes the upgrade for four discount rates: zero (undiscounted), 10 percent, 20 percent, and 27.3 percent (break-even rate).

The key to the analysis is to bring the entire 10-year stream of savings into the present. Under a 10 percent discount rate, the year 1 savings is only worth $5,455, which is $6,000 divided by 1.10 (1+discount rate). What about the second year savings? It is farther out in the future, so must be discounted more heavily - in fact it is discounted by 10 percent twice. The exact formula is

$$\frac{\$6,000}{(1+0.1)*(1+0.1)} = \frac{\$6,000}{(1+0.1)^2} = \$4,959$$

The third year stream is discounted thrice:

$$\frac{\$6,000}{(1+0.1)^3} = \$4,508$$

and so forth.

The NET PRESENT VALUE of the stream of savings is the sum of the discounted savings: $5,455 + $4,959 + 4,508 +....+ $2,313 which equals $36,876. Notice that a $6,000 savings ten years from now is only currently worth $2,313 under a 10 percent discount rate. In other words, if I can get 10 percent real return on an alternative investment, I would only pay (up to) $2,313 now for a promise of $6,000 in ten years. If I had to pay more for such a promise, I would be better off investing the $2,313 in a 10 year bond offering a 10 percent return (non-compounded yield).

LIGHTING UPGRADE FINANCIAL ANALYSIS
Year "0" investment; 10 years of
energy savings (year 1-10)

| YEAR: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INITIAL COST: | $20,000 | | | | | | | | | | |
| ANNUAL SAVINGS: | | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 |

PRESENT VALUE OF ANNUAL SAVINGS

| Sum PV: (1..10) | @Discount Rate: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $60,000 | 0.0% | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 | $6,000 |
| $36,867 | 10.0% | $5,455 | $4,959 | $4,508 | $4,098 | $3,726 | $3,387 | $3,079 | $2,799 | $2,545 | $2,313 |
| $25,155 | 20.0% | $5,000 | $4,167 | $3,472 | $2,894 | $2,411 | $2,009 | $1,674 | $1,395 | $1,163 | $969 |
| $20,000 | 27.3% | $4,713 | $3,701 | $2,907 | $2,283 | $1,793 | $1,409 | $1,106 | $869 | $682 | $536 |

Net Present Value of Investment
(Sum of PV Savings - Initial Cost)

| NPV | @ Discount Rate: |
|---|---|
| $40,000 | 0.0% |
| $16,867 | 10.0% |
| $5,155 | 20.0% |
| ($0) | 27.3% |

# *LEAST-COST INSURANCE AGAINST GREENHOUSE RISKS:*

# *THE COST OF CUTTING CARBON EMISSIONS*

by

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Presented at a
Briefing for Congressional Staff
in cooperation with the
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# BRIEFING SUMMARY

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. Besides an original analysis of carbon reduction costs in France, Germany, Italy, and the United Kingdom, the report includes a review of other recent studies in the U.S. and Europe on that topic. It 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 on their energy bills.
- Macroeconomic 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: With proper carbon tax recycling, the effects of carbon reduction targets on GNP will be neutral in the worst case, and could be strongly positive.
- Emission reductions can be implemented most effectively by combining modest carbon taxes with other policy instruments. In such a hybrid

approach, carbon taxes are an order of magnitude lower than conventionally calculated.

- Macroeconomic modeling assessments of the cost of carbon reduction strategies are ill-suited to be the principal basis for public policy in this area. Greater reliance should be placed on engineering-economic bottom-up studies.

*Why carbon cuts make good economic sense*

The key to lowering carbon emissions while making money is the set of 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 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.

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) and research sponsored 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 consistently 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 at least the same as in the business-as-usual case, and could be boosted by 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 boost 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.

Most 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 boost the growth of GNP. Thus, macroeconomic effects can be 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 further stimulus for GNP growth.

*Why high carbon taxes are not necessary*

The macroeconomic 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 macroeconomic modeling studies, which are ill-suited to simulate implementation options other than carbon taxes.

The implementation of carbon reduction targets cannot be achieved through macroeconomic pricing instruments alone. While carbon or energy taxes provide an important and desirable price signal, such price signals are a blunt instrument without specific regulatory policies and incentives programs aimed at overcoming pervasive market and regulatory barriers. So long as these barriers remain unaddressed, they will continue to make price signals ineffective.

The IPSEP study proposes a potentially more effective and cheaper 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) Transitional conversion incentives (golden parachutes) for industries and regions that will lose major 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 that benefit ratepayers as a whole.
- 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 self-financed by the savings generated from least-cost utility planning reforms and other programs. Furthermore, because the price signal of carbon taxes is no longer attenuated by market and regulatory barriers and because measures other than carbon taxes play a major role, tax levels can be up to an order of magnitude lower than calculated in conventional macroeconomic studies while still being 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 to be 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 that can correct existing market and regulatory failures in the energy sector.

A more reliable approach for estimating the cost of carbon reduction strategies is available through engineering-economic 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 at best 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 will spend at least 15 percent and as much as 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 $ 500-750 per household per year. When environmental externalities and military costs for securing oil supplies are considered, these excess payments rise further.

- Significant (17 to 40 percent) carbon reductions below 1985 levels will result already 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 only 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 (low gas prices and good progress in reducing the cost of renewables), even this 60 percent cut in carbon emissions would save these nations 65 billion dollars per year by 2020, or 25 percent of their future energy bill when compared to business-as-usual plans. At worst (i.e., with high gas prices and expensive renewables), it would have a zero net effect on Western Europe's total bill for energy services.

These cost estimates do not yet take into account the economic benefits of avoided environmental and security externalities. 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 will strengthen, not weaken, Western Europe's economic competitiveness:

- Industries and consumers will spend the same or 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.

- 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 the prices of coal and oil, and possibly even on 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, 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.

why?

- 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.

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:

are costs higher when don't have 100% implementation?

- 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.

## Findings of other bottom-up analyses

IPSEP's report reviews several other recent bottom-up scenario analyses covering, respectively, Canada, Germany, Sweden, and the U.S over a 10 to 40 year period. Though both the countries and the details of the analyses differ significantly, the studies consistently find that significant reductions in carbon emissions below present levels are available at net savings in costs.

actual figures for the US

## 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.

FYI: Economics!



## RMI-Inspired Retrofit Saves Big $

RMI recently heard from Steedman Bass, Energy Action Coordinator at Hamilton College in New York. After reading two of our publications ("Abating Air Pollution at Negative Cost via Energy Efficiency" and "How a Compact Fluorescent Lamp Saves a Ton of $CO_2$"), Bass wrote to tell us that they were "instrumental in breaking down the inertia of $1.4 million annual utility bills at Hamilton."

The college hired Bass in July 1991 to reduce electricity consumption by 15% and cut $200,000 from the annual utility bill. He and a crew of students began by installing 2,832 compact fluorescents in dorms, classrooms and a dining hall. (Bass says the task required "a ladder, a dish towel (for hot bulbs) and an aptitude for staring at the ceiling.") The results have been, well, illuminating. The new lamps are saving $4,000—every *month.* "Since our total investment, after the $10 per lamp rebate we received from the local utility, was $22,656," says Bass, "the school is reaping a 211% annual return."

This leaves us wondering how much money is presently being squandered by inefficient lighting, heating and cooling equipment on other campuses. If, as Bass says, "energy efficiency represents the best investment any institution can make," why doesn't every college have a program like this?

*For a report about Hamilton's efficiency program contact Bass, c/o Physical Plant, Hamilton College, Clinton NY 13323; (315) 859-4503; FAX 859-4407.*



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DAVID H. MOSKOVITZ

# Cutting the Nation's Electric Bill

*New regulatory systems are needed to make energy conservation more profitable than production for utilities.*

Up to 75 percent of the electricity produced in the United States each year is wasted through the use of inefficient motors, lights, and appliances. Customers—residential, commercial, and industrial alike—are failing to take full advantage of many conservation opportunities. But much of the blame for the nation's massive waste of electricity rests squarely on the electric utilities themselves and on the public regulatory systems that govern their operation.

Electric utilities generally resist investing in energy conservation measures, preferring to build new power plants to meet increased demand. Nor do utilities do enough to encourage customers to make their own energy-efficiency improvements. This is because utilities are controlled by regulatory systems that strongly, if unintentionally, encourage the production and sale of as much electricity as possible. Indeed, the way that utility rates are set imposes two facts of life on utility managers: Selling more electricity always adds to a utility's profits, regardless of the cost of producing the extra power or the price at which it is sold; and investments in conservation measures always hurt a utility's bottom line, regardless of their cost-effectiveness.

This sure-fire recipe for increased consumption means more than just higher electric bills for the nation. The electric utility industry now produces 68 percent of the sulfur dioxide emissions that cause acid rain, 20 percent of the gases linked to the atmospheric greenhouse effect, and more than 50 percent of all nuclear waste. Utility construction projects also consume 19 percent of the nation's private capital. These are burdens that should be going down, not up.

Eager to enlist utilities in the battle against these problems, a growing number of policymakers and utility regulators are seeking ways to align the utility industry's financial interests with the society's broader goals of a clean environment and an efficient economy. One promising approach is to reform the regulatory system to reflect the principles of "least-cost planning"—a process for examining all electricity-producing and electricity-saving options and selecting the mix that minimizes total consumer

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costs. Since energy conservation investments often cost considerably less than what a utility would otherwise have had to spend in order to produce electricity, utilities practicing least-cost planning would be likely to favor options that reduce demand—and thus the undesirable side effects of power production.

## The quest for profit

As regulated monopolies, utilities are entitled to have the price they can charge for electricity set at a level that will allow recovery of all operating expenses and fixed costs. The fixed costs include such things as taxes, interest, and a reasonable rate of return, or profit, on their rate base (their capital investment in power plants and components of the electrical distribution system, minus depreciation).

But actual profit levels aren't cast in stone. Instead, state public utility commissions examine utilities' historical and forecasted expenses and set the price of electricity at levels expected to allow specified rates of return. Once the price is set, however, utilities have an incentive to sell more electricity to increase profits.

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. And even when rates are lowered, the utility isn't required to give rebates or credits to customers to make up for past excess profits. Thus, a utility can keep all the profit it can manage to make.

In its quest to maximize profits, a utility's most powerful incentive for selling more electricity is hidden in its regulatory "fuel adjustment clause." Some 40 to 50 percent of the price of electricity is determined by the cost of fuel. This cost is subject to considerable volatility, especially for oil and gas. To insulate utility shareholders from the impact that fluctuating fuel prices would have on earnings, nearly all states allow utilities to adjust customer prices periodically so that changing fuel costs do not affect profits.

This protection operates regardless of whether a utility's total fuel bill increases because of rising prices or because it consumes more fuel to produce more electricity. A utility that spends more than projected on fuel can raise the price of all electricity to spread the extra cost among its customers. If it spends less than projected, the utility must pass on the savings to consumers through lower rates. Thus the utility has no incentive to conserve fuel or to purchase the lowest cost fuel.

Utilities can even make money by selling power for less than it costs to produce—indeed, they are the only businesses that can sell their product at a loss and still come out ahead. 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 1 kilowatt-hour of electricity. The regulated price of power might be 7 cents per kilowatt-hour, which represents 5 cents in fixed costs and 2 cents allotted for the utility's "average" fuel costs. But the utility recovers the extra 8 cents in fuel costs—that is, the generator's 10-cent fuel cost minus the 2-cent average fuel cost—by invoking the adjustment clause to raise rates.

## Tilting the balance

The regulatory system must be changed so that it is profitable for utilities to make decisions that are in the public interest. Various approaches to regulatory reform have been tried, but they have generally proved inadequate. A number of states, including Wisconsin and Washington, have sought to provide utilities with financial incentives to pursue conservation investments by allowing utilities to "rate-base" those investments. That is, they can earn a reasonable rate of return on energy-efficiency investments just as they earn a return on investments in power plants, poles, and wires. Some states even try to tilt the balance in favor of conservation by allowing a higher rate of return on such investments.

This approach, however, simply doesn't provide utilities with adequate incentive to pursue conservation vigorously. Most energy-efficiency measures are fairly inexpensive to implement, which means the investments don't add much to the utility's rate base. Thus, the added profit per kilowatt hour will not even offset the revenue lost from decreased sales, never mind compare with the profits promised by increased sales.

Rate-basing also raises the potential for an even more perverse problem. Since investments in conservation help determine a utility's profit, its earnings will be increased the most by the most expensive energy-efficiency measures. The least expensive investments—at the extreme, zero-cost conservation—add little to the rate base, and hence produce little income. Meanwhile, conservation means lower sales, lower revenues, and lower profits. Ironically, a utility could maximize its profits by pursuing the most expensive types of conservation programs designed to produce little or no energy savings.

While utilities apparently haven't embraced this most blatant form of profiteering, neither have there been significant reductions in energy use in the states that allow conservation rate-basing. However, although this strategy won't by itself promote major reductions in energy consumption, it could be successfully incorporated into more comprehensive plans for state regulatoryreform.

*Under Maine's new plan, utilities may even find that investing in energy conservation measures on behalf of their customers proves financially beneficial.*

California has taken another approach that avoids some of these economic disincentives. In the mid-1970s the state's public utility commission instituted the Electric Revenue Adjustment Mechanism (ERAM), which effectively decouples sales from profits. The program allows a utility to be reimbursed for revenues lost for any reason, including decreased sales caused by conservation. Conversely, if a utility's sales are higher than expected, ERAM takes away the extra profits and returns the proceeds to customers. There is therefore no incentive to promote increased consumption of electricity.

The ERAM program is not without drawbacks. In particular, it doesn't fully satisfy the requirements of least-cost planning. That is, ERAM addresses only conservation measures that reduce demand, but does nothing to ensure that utilities strive to reduce their cost of producing electricity. Whether power costs 2 cents or 10 cents per kilowatt-hour to produce doesn't change their profit, because higher fuel costs are passed on to customers via the fuel adjustment clause. Still, this is an important regulatory improvement, which could bring major economic and environmental benefits to other states as well.

## Cutting customer bills

In Maine, the public utilities commission has proposed a fairly simple addition to the state's regulatory system that will allow society's broader goals to be met while also benefiting utilities. Our proposal should work in most other states as well. We plan to periodically adjust a utility's allowed rate of return based on its success, or lack of success, in controlling its customers' average monthly electric bills. Since the objective of least-cost planning is to minimize the overall cost to consumers, it makes sense that regulatory attention should focus on how much they pay each month, not on the amount of electricity consumed or the price charged per kilowatt-hour. Thus, utilities would be encouraged to look for economic savings for their customers both by reducing consumption and by reducing production costs.

Under our plan, the commission's regular rate-setting process will proceed as usual, with utility operations being examined on an as-needed basis in response to changing conditions that increase or decrease costs. This process will be supplemented, however, with annual performance reviews. Each spring, when data on utility performance during the previous year are available, we will adjust each utility's allowed rate of return to provide a reward or punishment. To make it attractive for utilities to promote and invest in conservation, an upward adjustment will more than offset revenue losses from reduced sales. For a typical Maine utility, a 1 percent improvement in its average customer bills will require a 0.7 percent increase in its rate of return, from 12 to 12.7 percent.

Of course, customer electric bills are influenced by numerous factors, many of them well beyond a utility's control. To ensure that extrinsic factors do not result in windfall profits or undeserved losses, our proposal calls for identifying a group of utilities in New England that can serve as an index against which individual utilities in Maine can be measured. Selecting the right index utilities will be crucial. For example, they must serve similar numbers and types of customers. They must use roughly the same mix of fuels, so changes in fuel prices won't skew comparisons. And they must be subject to the same general economic and weather conditions, which can greatly influence customer demand for electricity.

Comparisons won't be made on actual dollar amounts, but on the percent increase or decrease in customer bills from year to year. For instance, if the average residential bill of the index utilities increases by 10 percent, this will be the benchmark for judging Maine's utilities.

Given this competitive situation, utilities would find that even investing in energy conservation measures on behalf of their customers would often prove financially beneficial. For example, lighting consumes roughly a quarter of the electricity produced in a typical utility system, and incandescent lighting accounts for about 60 percent of the total. A utility might offer to supply its customers with screw-in, color-corrected, high-efficiency fluorescent bulbs that provide the same amount and quality of light while using a fifth of the electricity of ordinary bulbs. Even if only 20 to 30 percent of all its customers accepted the more efficient bulbs, overall electricity consumption and average customer bills would both decline by about 2 percent.

A utility that succeeds in beating the index and is granted an increased rate of return may have to raise its price of electricity. But the bills for the great majority of customers will still be lower because of their reduced consumption. And we believe that most people will readily understand and accept the explanation that the utility's price hike is actually a regulatory reward for outperforming other utilities in the region in controlling customer bills—a reward that will encourage the utility to cut bills even more in the future.

Although most customers will pay less each month, we recognize that the bills of those who did not conserve energy may increase slightly. This is not a trivial concern, but it is greatly outweighed by the many benefits of long-overdue regulatory reform. Still, regulators and utilities must take care that energy-efficiency programs are targeted at the widest possible spectrum of customers. Special efforts may be needed to assist people with low or no income: They often can't afford to invest in conservation measures and generally live in the least energy-efficient buildings equipped with hand-me-down appliances. Renters may also need extra attention, since they usually pay the electric bills but don't control many of the factors that influence their energy consumption, such as the amount of insulation and type of appliances in their buildings. Ways may have to be found to encourage landlords to upgrade the energy efficiency of their buildings.

Some critics might also fault our plan for not doing enough to directly promote energy conservation. They may argue, for example, that it doesn't take into account the substantial environmental costs associated with utility-related problems such as acid rain. And it's true that if these costs were reflected in the price of electricity, then conservation measures that cost 3 cents per kilowatt-hour to implement might be preferred over 2-cent supply options—the reverse of what least-cost planning would dictate. Utilities may also be reluctant to spend money for pollution-control equipment beyond what they are required to install, since the result might be higher bills that would lead to lower profits.

But although the Maine commission, like those in most states, lacks the statutory authority to reflect environmental cleanup costs not borne by the utility in the regulated price of electricity, our system could be easily modified if state lawmakers were to grant such authority. For example, utilities might be allowed an economic "buffer" when being compared with the index utilities. Say average customer bills of the index utilities increased by 5 percent: The target utility's benchmark could be set several percent higher, providing that the utility spent the difference on upgrading pollution-control equipment.

Because this new rate-making procedure with its comparison index is such a dramatic departure from past practice, the Maine Public Utilities Commission is not imposing it on utilities. The commission requires only that rates be set in such a way that least-cost planning is no less profitable than any other manner of utility planning. Each utility has the option of proposing its own method of achieving the same goal.

Response among utilities to our call for reform has been positive. For example, the state's largest utility, Central Maine Power Company, recently filed a rate-making plan that combines something similar to California's method for adjusting revenues with rewards targeted at realized conservation savings. We will hold hearings on the plan this spring. If it turns out to meet our general guidelines—and it very well may—the first annual rate adjustments could occur next spring, based on the utility's performance during 1989.

## Help wanted

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-costplanning can prove an important catalyst.

*Federal legislation endorsing least-cost planning can be an important catalyst for regulatory reform.*

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.-R.I.) Global Warming Prevention Act (H.R. 1078) would, among other things, provide $10 million "to assist states in addressing the various issues related to removing incentives against least-cost planning, 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 home energy-efficiency improvements that save electricity for less than it would cost to produce it. 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 (S. 324), proposed by Senator Tim Wirth (D.-Colo.) and cosigned by more than a dozen lawmakers, has similar features. But it would go a step further in fostering least-cost planning 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."

Potent federal action was also outlined in a bill introduced into the House of Representatives last year, which was aimed at reducing acid rain damage. Developed by the staff of the so-called "Group of Nine," made up of key members of the House Energy and Commerce Committee, it was sponsored by John Bonker, a retiring congressman from Washington. The bill called for limiting government funds for acid rain cleanup to states that reformed their utility rate-setting system to encourage least-cost planning. Although never voted on, some of its provisions are likely to find their way into new acid rain legislation this year. After all, the conservation measures that would be fostered by least-cost planning 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 rate-making 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 least-cost planning. 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 the National Association of Regulatory Utility Commissioners (NARUC).

Of course, the buck always stops with the public utility commissions. Fortunately, progress has been good as regulators have gradually warmed to the idea of reform. For example, the chairman of New York's commission recently challenged his state's utilities to develop innovative rate-making procedures, and some of them have begun to respond. Regulators in Wisconsin, Nevada, Ohio, and several other states have taken similar action. And NARUC's energy conservation committee, which includes regulators from 22 states, has endorsed a statement that commissions should "require their utilities to engage in least-cost planning [and] seek to make the least-cost plan a utility's most profitable resource plan."

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.

*Recommended reading*

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Please say the Pledge of Allegiance before reading this.

4/28 — AM

Today we are at a historic crossroad. Last Friday, the Adminstration released a document titled "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, Administration 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. But the final estimates indicate that the U.S. can nearly achieve stabilization of $CO_2$ emissions at 1990 levels by the year 2000, with no economic losses and probable economic gains. Stabilization is precisely the target that other countries have adopted as a reasonable goal toward meeting the climate change threat.

This Thursday, the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change will convene in New York. This is the final negotiating session before the Earth Summit in Brazil that begins on June 4. Yet, although the Administration's own analysis indicates that we could commit to a stabilization agreement while preserving economic growth, the Bush administration resists the logic of its own analysis. In the past, the Administration has claimed that we could not stabilize emissions without imperiling growth. Now, it seems, we can do it. The Bush Administration just doesn't want to.

So, for reasons unknown, the Administration is poised at the juncture between logical thought and appropriate action. This may be due to a lingering suspicion that the economic analysis is somehow flawed. This hearing will examine that issue directly. Perhaps the Administration has legitimate concerns regarding how $CO_2$ reductions might affect economic growth. 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 in our diverse economy. Exploiting the conservation resource can create <u>more</u> jobs than would occur from expanding energy production.

Or maybe the Administration does not believe that other industrialized nations are bargaining in good faith -- and that they will renege when they understand the economic consequences of a stabilization committment. This hearing will also consider how other nations could enhance economic growth from a $CO_2$ stabilization committment. It will be in our competitive self-interest to embark on a similar energy path.

INTRODUCE PANELS NOW & BEGIN

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[ALTERNATIVE BEGINING]

The future of the U.S. energy system, in all of its complex dimensions, is one of the pressing economic issues of our time. That fact was certainly brought to the forefront during the Gulf

# NEW YORK STATE ENERGY PLAN

Volume I: Executive Summary


**William D. Cotter**
**Commissioner**
**New York State**
**Energy Office**

**Thomas C. Jorling**
**Commissioner**
**NYS Department of**
**Environmental Conservation**

**Peter A. Bradford**
**Chairman**
**NYS Department of**
**Public Service**



**February 1992**

## PLAN OVERVIEW

The 1991 SEP sets forth a strategy for achieving a sustainable energy future while improving both the competitiveness of New York's economy and the quality of the State's environment. The 1991 SEP recognizes the fundamental link between energy policy and environmental quality.

Since release of the 1989 SEP, New York's energy situation and outlook has improved as a result of efficiency advancements and the beginning of a historic expansion of natural gas deliverability. The electricity supply situation has increased as a result of the implementation of broad-based utility demand-side management (DSM) programs, new independent power capacity that has come on line and the near completion of an initial round of utility competitive bidding programs. New capacity in excess of 1,400 megawatts is expected to come on line in 1992 from both independent power facilities and utility DSM programs, and there is expected to be a supply surplus throughout the 1990s.

A major challenge confronting New York, in the face of a national recession and the need for fiscal restraint, is to sustain the recent progress and implement policies that promote the wise and efficient use of resources and protect the environment.

New York's energy strategy for the 1990s recognizes that a state which is more efficient will be more competitive in a global economy; that a state which encourages competition among energy fuels and services will further economic development objectives; and that a state which protects the environment through prudent regulation will help assure sustainable long-term economic growth.

The 1991 SEP demand forecast and supply assessment findings show that concerted action is necessary to achieve a sustainable energy future consistent with the 1991 SEP goals and planning objectives. Projections of a growing State economy -- once a national economic recovery begins -- result in rising energy demand, especially for transportation fuels and electricity, increased air emissions and greater dependence upon imported petroleum.

New York is implementing an integrated strategy for achieving a sound and sustainable energy future. The strategy relies on:

- promoting energy efficiency improvements in all sectors to reduce consumer energy bills, moderate significantly the rate of energy demand growth and improve economic competitiveness.

- encouraging competition among all fuel forms to further improve economic competitiveness and diversify New York's fuel mix.

- pursuing aggressive conservation, expanded use of natural gas, and strengthening of regulatory programs for mobile emissions and power plants consistent with the Clean Air Act Amendments of 1990 to reduce air emissions.

State action in pursuit of opportunities for cost-effective improvements in energy efficiency remains the cornerstone of this integrated strategy. Energy efficiency improvements result in multiple benefits: reduced energy bills; reduced sulfur dioxide ($SO_2$), nitrogen oxide ($NO_x$) carbon dioxide ($CO_2$) and other emissions, reduced need for new energy facilities and improved energy security. The 1991 SEP recommends, as a planning objective, that New York initiate and encourage action to achieve a 2.5 percent per year average annual reduction in energy intensity, as measured by primary energy consumption per dollar of gross State product.

Building upon the cornerstone of energy efficiency, the State's integrated strategy requires State action to assure that all energy forms compete fairly in the energy marketplace. Enhanced competition among fuels, reflecting environmental externalities in an appropriate manner, will result in the lowest reasonable energy costs for consumers over the long-term. Competition among energy forms in this manner should result in expanded use of natural gas and renewables, as well as improved energy efficiency, thus contributing to increased fuel diversity and an attendant reduction in risk. The 1991 SEP recommends, as planning objectives, that the State accelerate the development and use of renewable resource technologies, and support actions to increase the cost-effective and efficient use of natural gas by at least 50 percent by 2008.

The integrated strategy also requires federal and State actions, as necessary, to reduce emissions from the combustion of fossil fuels in buildings, transportation and electricity generation. The 1991 SEP recommends, as planning objectives, that New York continue to take State action and participate fully in federal programs designed to achieve dramatic reductions in $SO_2$ and $NO_x$ by the year 2000 and also recommends that the State seek as an interim target to stabilize $CO_2$ and greenhouse gas emissions by the year 2000 at the 1990 level.

The 1991 SEP recommends the further integration of energy planning with environmental policy objectives, as follows:

- integrate transportation decision-making with energy and environmental decision-making; and emphasize transportation programs that improve efficiency of existing systems and promote the use of more efficient modes;

- place renewed emphasis on the promotion and demonstration of renewable resources;

- consider the use of, and account for, environmental externality costs, to the extent practicable, in all aspects of State energy decision-making; and implement actions consistent with SEP objectives to help reduce emissions of greenhouse gases; and

- support the search for and investigation of federal actions to assure that energy prices reflect the real environmental and security costs of energy.

Highlights of key 1991 SEP recommendations follow:

- New York must increase fuel efficiency in all phases of energy production and every sector of energy use: buildings, transportation, natural gas efficiency, and electricity DSM, as well as in the generation and transmission of electricity.

- Renewable resource use must be expanded over the next decade. New York must promote the demonstration and use of new renewable resource technologies.

- Transportation decisions must be integrated with energy and environmental decision-making. New York must support increasing the efficiency of vehicles and vehicle use, reduction of emissions, and development and use of alternative fuels in order to achieve an energy efficient and environmentally sound transportation system.

- New York must continue to pursue increased supplies of natural gas by supporting the development of additional natural gas transmission facilities into the state, as well as expanding the natural gas distribution system within New York's borders.

- Future electricity requirements should be met through cost-effective DSM programs and the competitive procurement of new capacity. Electricity resource decisions and choices must reflect the characteristics (e.g., efficient, economic, clean, secure and diverse) of the type of electricity generation desired for the 21st century. New York must improve the efficiency of electricity generation and use, reduce the emissions associated with electricity production, and maintain the diversity of the electricity generation resource base.

- Energy prices should reflect more fully the costs of energy production and use, by accounting for environmental and security externalities in energy decision-making.

- National energy policy must foster State initiatives and innovation, and focus on policies most appropriately implemented at the federal level. A balanced national energy policy must assure energy availability, enhance environmental quality, improve economic competitiveness and protect national security.

**Figure 1**

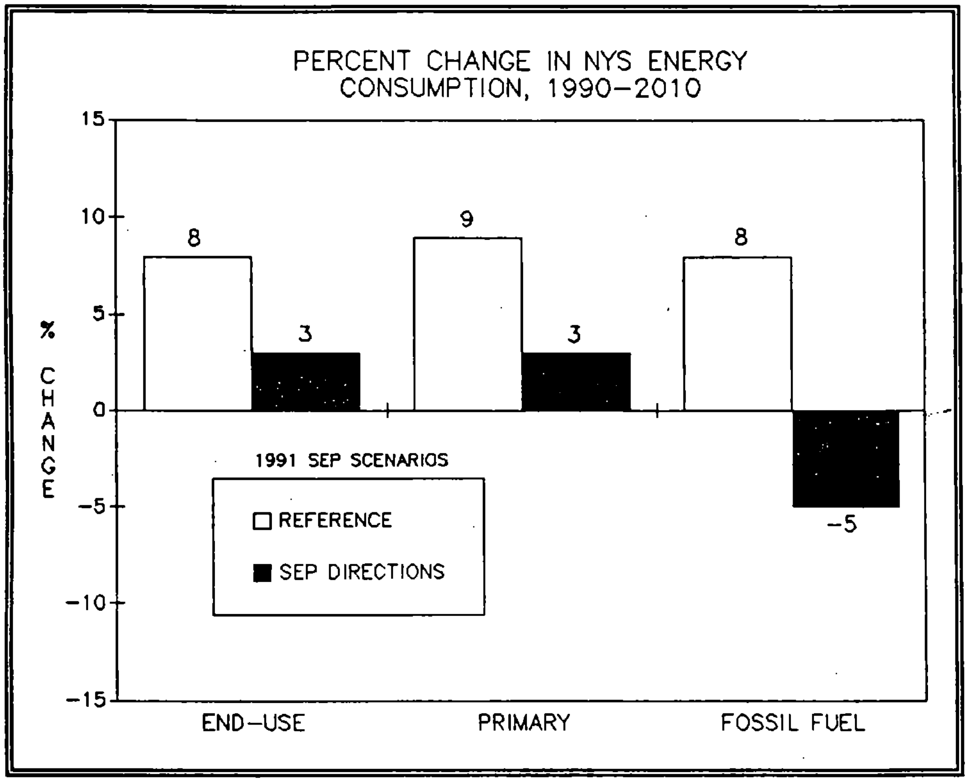
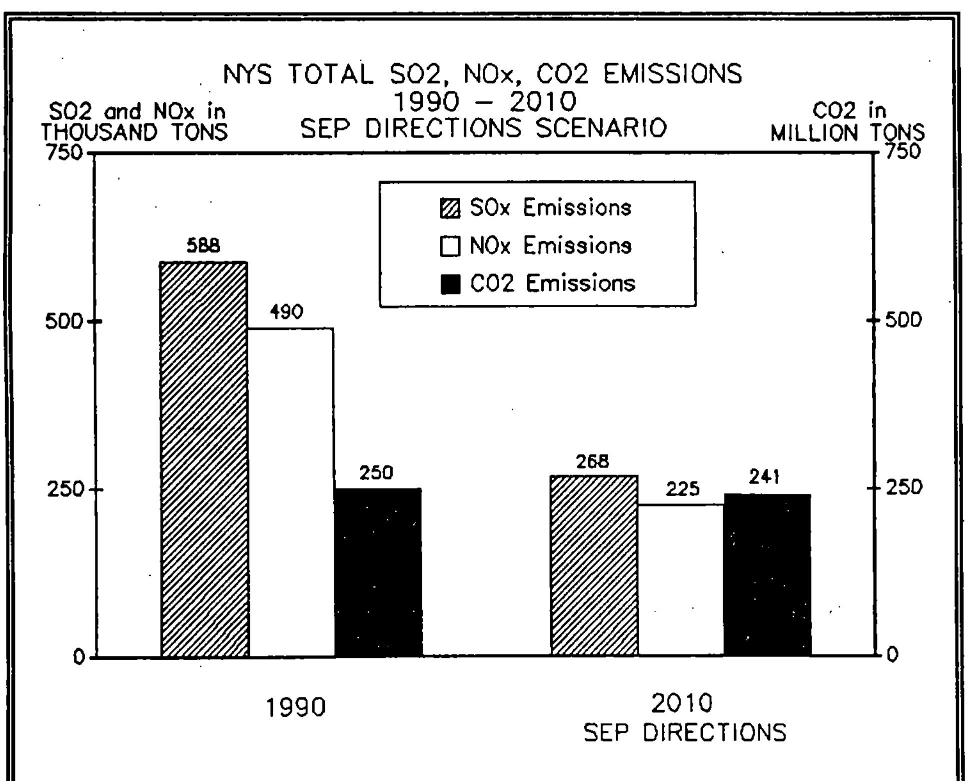



**Figure 2**



# Calculations Cooked on Carbon Cut Costs

*By William Nitze, Alliance to Save Energy*

The long- overdue US Department of Energy (DOE) report, *Limiting Net Greenhouse Gas Emissions in the United States*, says, in its executive summary, that to reduce carbon emissions from fossil fuels by 20% by 2000 would require a tax of almost $500 per metric ton of carbon released. This would cost approximately $95 billion per year by the year 2000, according to the DOE. The report also concludes that even much higher tax levels are insufficient to achieve a 50% reduction in carbon emissions from fossil fuels.

The conclusions are in sharp contrast to other studies that highlight substantial opportunities for reducing US carbon emissions at little net cost to the U.S. economy. *America's Energy Choices*, for example, a two-year study undertaken by the Alliance to Save Energy, the American Council for an Energy Efficient Economy, the Natural Resources Defense Council, and the Union of Concerned Scientists, concludes that US carbon emissions could be cut by 25% in 2005 and 70% in 2030 through investments in energy efficiency and renewable technologies. Taken together these actions would generate net cost savings for energy consumers of $US 2.3 trillion over the next 40 years. Similar, if less dramatic, conclusions were reached in major studies conducted by the US Office of Technology Assessment and the National Research Council.

Discrepancies between DOE conclusions and other studies result from key differences in their approach to analysing the problem.

The DOE carbon tax numbers cited above, for example, represent the most costly of a range of policy options for reducing energy-related greenhouse gas emissions analyzed in the main DOE report. The report analyzes a number of different combinations of fiscal and regulatory strategies, which, in combination with the Administration's National Energy Strategy proposals, could achieve the 20% reduction in 2000 at a far lower cost to the economy than a tax on fossil fuels alone. A combined strategy of taxing all greenhouse gas emissions from the energy sector based on their global warming potential, and rebates for planting trees, for example, could achieve the same result for $3 to $9 billion per year, rather than the $95 billion highlighted.

The DOE's calculations are also based on a number of controversial assumptions, such as the US economy growing by more than 3% per year between 1990 and 2000. This is questionable given overall growth of less than 2% in 1990-1991 and the likelihood of very little growth in 1992. If the DOE had assumed a more realistic 2.5% growth rate, carbon emissions could be substantially less and the costs of reducing them correspondingly lower. They also assumed that capital stock, such as coal fired power stations, will not be retired until the end of their useful life. The *America's Energy Choices* analysis shows that achieving large reductions in emissions in a least-cost manner would require the replacement of a significant number of operating coal plants with natural gas generators. The DOE also assumes that end-use energy efficiency standards beyond the Administration's National Energy Strategy are not cost-effective.

The DOE does acknowledge, however, that the long-term macro-economic impacts of a $100 per ton carbon tax could be positive if the proceeds were properly reinvested in the US economy. But it makes no effort to explore possible recycling alternatives.

The DOE report fails to provide the Bush Administration with an analysis of emissions abatement costs in the US. A careful reading suggests that the DOE recognizes cost-effective policy options for reducing carbon emissions that it has chosen not to explore in the report.

# US Utilities Move to Cut $CO_2$

*By Daniel Lashof*

While the Bush Administration continues to insist that $CO_2$ targets are unacceptable in theory, US electric utilities are taking action to cut $CO_2$ emissions in practice. The most recent action came last Tuesday when the Bonneville Power Administration (BPA) announced that when negotiating contracts for new power supplies it will seek assurances that sponsors are prepared to absorb costs should their plants be subject to future regulations on greenhouse and other gases. This is the first recognition of the financial risks from building $CO_2$-emitting power plants by a federal power marketing authority (BPA was established by the US government and is associated with the DOE).

*20% Cut*

The action by BPA builds on recent $CO_2$ reduction commitments by privately owned utilities. Last month the New England Electric System announced plans to cut $CO_2$ emissions 20% by the year 2000 as part of their overall strategy for complying with the 1990 Clean Air Act requirements to cut $SO_2$ and $NO_x$ emissions. Southern California Edison, the largest US electric utility, and the Los Angeles Department of Water and Power had plans to cut their $CO_2$ emissions 10% by 2000 and 20% by 2010. PG&E, California's other utility giant, has stated that through at least the year 2000 it will meet 75% of its projected growth in service demand with energy efficiency improvements, meeting the remaining capacity requirements with renewable resources.

BPA announced its innovative approach, which shifts the risk of future $CO_2$ control costs to power plant builders, in conjunction with its preliminary selection of energy conservation and power generating projects that it may buy to meet growing needs. BPA selected 27 out of 100 projects for further consideration in response to a competitive bidding procedure for securing 300 average MW of power. The proposals passing the initial screen include almost 60 MW in efficiency projects as well as 1000 MW in generation projects.

Notably, the generation proposals are primarily cogeneration and combustion turbine projects, and do not include any conventional coal or nuclear power plants. Included are 39 MW of renewable energy projects, which won't have to worry about future $CO_2$ control costs.

The National Association of State Utility Consumer Advocates and major environmental groups have previously put the utility industry on notice that they must consider the financial risks of building $CO_2$-emitting facilities. The industry would not be allowed to pass on to customers added costs to meet future $CO_2$ reduction requirements if utility commissions conclude that power plant investments imprudently ignored these risks.

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