NATIONAL ENERGY EFFICIENCY PLATFORM: DESCRIPTION AND POTENTIAL IMPACTS

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I. Introduction

After over a decade of increasing national energy productivity, the overall energy efficiency of our nation has stalled and energy use is climbing rapidly. Energy use rose 8 percent in the past two years, in tandem with GNP growth [1]. This surge in energy use costs consumers tens of billions of dollars annually, contributes to rising oil imports, worsens acid rain and urban smog, and accelerates climate change due to the greenhouse effect.

Increasing emissions of carbon dioxide and other "greenhouse gases" are especially troubling given the possibility that, if current trends continue, the earth could heat up by around 2-5^{o}C by the middle of the next century. Even warming at the low end of this range could dramatically alter rainfall patterns, reduce crop and forest productivity, and damage coastal areas [2]. A consensus is growing that reductions in greenhouse gases are urgently needed in order to minimize the risks associated with climate change [3]. Since the U.S. is responsible for about 21% of worldwide carbon dioxide emissions resulting from burning of fossil fuels, it must play a primary role in controlling CO2 emissions.

Unfortunately, U.S. energy use and CO2 emissions will continue to rise if new initiatives to promote greater energy efficiency are not adopted. The most recent base forecast by the Energy Department shows energy use increasing by 14% and CO2 emissions by 13% between 1988 and 2000 [4]. However, rising energy use is not preordained. President Bush and the Congress should set a <u>goal of eliminating growth in energy demand and reducing absolute CO2 emissions during the next decade.</u> This goal is technically feasible, it will save money, and it does not require personal sacrifice or economic stagnation. It will start the U.S. on a path whereby we substantially reduce our contribution to greenhouse warming over the long run, and it will set a positive example for other nations.

Achieving this goal requires a renewed commitment to energy efficiency, the most significant strategy for limiting climate change in the near-term [5]. As part of this commitment, new policies for improving the energy efficiency of our buildings, appliances, vehicles, and factories are needed. Comprehensive policies are called for given the challenge of limiting climate change as well as the federal government's failure to support greater energy efficiency in recent years.

This paper presents ten major energy efficiency initiatives that, taken together, can get our country back on the "energy efficiency track" and begin to reduce our CO_2 emissions. The policies are broad-based -- some have multiple components -- in order to provide maximum energy and carbon savings. All of the policies can be adopted by the federal government either through legislation or administrative action. The ten policy proposals address the major energy uses and opportunities for energy savings. However, the list of ten initiatives is not exhaustive. Other policies such as a carbon-based fuels tax or additional efficiency standards could be adopted in order to achieve even further savings.

The ten initiatives are briefly described in the next section. Section III presents an analysis of the potential energy, economic, and carbon dioxide savings in the year 2000. The proposals are evaluated on a consistent basis with care not to "double count" savings from overlapping proposals. The methodology and basic assumptions used to evaluate savings are explained in Section III and in the Appendix.

The energy efficiency platform presented below draws from and builds on other energy conservation policy agendas prepared recently, such as Energy Efficiency: A New Agenda [6], and the energy efficiency sections of legislation introduced in Congress to reduce climate change [7]. This report goes further by indicating the benefits that could result from adopting each major energy efficiency initiative.

II. Energy Efficiency Platform

1. Raise car and light truck fuel economy standards, expand the gas guzzler tax, and establish gas sipper rebates so that new cars average 45 mpg and new light trucks average 35 mpg by 2000.

The fuel economy of new cars and light trucks is now stagnating after increasing by two-thirds between 1975 and 1986. The fuel economy goals of 45 miles per gallon (mpg) for new cars and 35 mpg for new light trucks are about 60% greater than the fuel economy of today's new vehicle fleet. These goals are technically and economically feasible [8]. However, many technologies that are now available for raising vehicle fuel economy are not being adopted due to low gasoline prices, lack of interest in fuel economy, and lack of effective policies.

New fuel economy standards are essential for significantly raising vehicle efficiencies. The standards could either require each manufacturer to achieve a specified average efficiency (i.e., an extension of the current CAFE approach), or require equal percentage efficiency improvements from all manufacturers, or require specified average efficiency levels for each size class. New fuel economy standards should be complemented by expanded gas guzzler taxes, gas sipper rebates, and a new gasoline tax.

The gas guzzler tax was enacted by Congress in 1978. The tax now applies to vehicles with a fuel economy less than 22.5 mpg. Relatively few vehicles are affected. We propose increasing the amount of the tax and the mpg threshold steadily over the next 15 years to encourage further fuel economy improvements. Also, the tax should be applied to light trucks since they are relatively inefficient vehicles and their sales have been growing rapidly.

Finally, using revenue generated by the expanded gas guzzler tax, rebates on the order of $500-2000 should be provided to buyers of highly efficient new vehicles. These "gas sipper" rebates would help establish the market for vehicles that are at least 20% more efficient than the average in any vehicle size class. The rebate amount should increase in proportion with vehicle efficiency.

2. Raise the federal gasoline tax by 50 cents per gallon within five years and spend part of the revenue on mass transit and energy efficiency programs.

The market price for gasoline does not reflect its real cost to the nation (i.e., considering costs associated with environmental damage, the trade deficit, and national security). Furthermore, the gasoline tax in the U.S. is far below that in most other industrialized nations. Substantially raising the gasoline tax while the world oil price is low would rekindle consumer interest in fuel economy, complement new fuel economy standards, and help to limit growth in vehicle usage.

We suggest a new tax of 50 cents per gallon phased in within five years (if not sooner). It would be desirable to use the tax revenue for a variety of purposes including: 1) providing rebates to low-income households to offset the regressive effects of the tax, and 2) supporting the construction of mass transit systems and high-occupancy vehicle lanes on commuter highways. The latter complements the gasoline tax as a means of encouraging less automobile driving. We also recommend that part of the revenue be dedicated to federal energy conservation programs, including R&D, demonstration, and implementation programs.

3. Adopt acid rain legislation that encourages energy efficiency as a means for lowering emissions and reducing emission control costs.

Electricity conservation can reduce utility acid rain emissions and cut the costs of acid rain control. Furthermore, states that are very dependent on high-sulfur coal can more than offset the cost of a major SO_2 emissions reduction program by aggressively pursuing conservation [9]. Economic savings result from deferring the need for costly new power plants, avoiding fuel purchases, and avoiding some pollution control devices. However, not all legislative approaches to acid rain control encourage conservation or provide full credit for emissions reductions due to conservation.

Revisions to the Clean Air Act should encourage states and utilities to pursue conservation along with pollution control and give full credit for emissions reductions achieved through conservation. This can be accomplished by:

1) using emissions ceilings rather than emissions rate limits and providing states with maximum flexibility;

2) permitting conservation investments to qualify for any pollution clean-up subsidies;

3) urging (or requiring) states and utilities to develop least-cost electricity supply and emissions reduction plans;

4) urging (or requiring) states to reform utility ratemaking so that utilities have

a financial incentive for pursuing conservation;

5) requiring utilities to offset any additional CO_2 emissions caused by new acid rain legislation.

4. Reform federal utility regulation to foster investment in end-use energy efficiency and cogeneration systems.

Most utilities do not allow energy-saving options to compete on a "level playing field" with energy-supply options when they are acquiring new power resources. Also, most utilities are financially penalized when they operate successful energy efficiency programs because the loss of sales revenue exceeds the short-run operating cost savings [10]. In addition, utility policy concerning buy back of electricity can greatly limit the viability of industrial cogeneration projects. To help remedy these problems, the Congress should amend the Public Utility Regulatory Policies Act (PURPA) so that:

1) Energy-efficiency investments are allowed to compete fairly with supply options when utilities acquire resources under the qualifying facility provisions of PURPA or through competitive bidding, with environmental costs internalized to the extent possible.

2) State utility commissions are encouraged to provide utilities with financial incentives for pursuing energy efficiency and least-cost energy services.

3) States and utilities are encouraged to offer standard long-term contracts to qualifying cogeneration facilities and are allowed to set electricity buy back rates above avoided costs if considered appropriate (e.g., based on environmental benefits).

In addition to legislative action, the Federal Energy Regulatory Commission should affirm these principles in its regulations and guidelines.

Based on experience in states such as California, Maine, and Wisconsin, making these regulatory reforms can greatly expand utility-supported energy efficiency and cogeneration efforts. Utilities in these states are purchasing electricity savings and cogenerated power on a large scale. Even though a few states and utilities are moving ahead on their own, federal action is needed to ensure prompt regulatory reform throughout the U.S.

5. Increase the efficiency of electricity supply through development, demonstration, and promotion of advanced generating technologies.

New energy-efficient power generating technologies could substantially lower fuel use for electricity generation. For example, an intercooled steam-injected gas turbine burning gasified coal could have an overall electrical generating efficiency of 42% compared to 35% for a conventional coal-fired steam-electric plant [11]. Advanced combined cycle power plants also could provide significant efficiency gains especially if they burn natural gas. The technical and economic viability of these technologies could be proven within a few years.

This proposal calls for placing much greater emphasis on technologies that increase the efficiency of power generation in the Clean Coal Technology Program managed by DOE and in related efforts. In particular, the development, demonstration, and commercialization of efficient generating technologies such as intercooled steam-injected gas turbines or advanced combined-cycle power plants should be given highest priority. Technologies that do not offer the possibility of reducing CO_2 emissions (compared to conventional generating technologies) should not be funded under the Clean Coal Program.

Likewise, substantial efficiency increases should be required if regulatory or tax incentives are used to promote the adoption of new generating technologies. For example, it has been proposed that utilities be given a time extension for meeting acid rain reduction requirements if power plants are retrofit with so-called clean coal technologies. Offering financial incentives to utilities that adopt these technologies also has been proposed. In order to receive a time extension and/or financial incentive, a utility should be required to increase generating efficiency significantly. This will ensure that certain environmental benefits occur in return for the incentive.

6. Strengthen federal appliance efficiency standards and adopt new efficiency standards on lamps and plumbing fixtures.

National appliance efficiency standards were adopted as federal law in 1987. The Energy Department is required to review the appliance efficiency standards on a regular basis and promulgate more stringent standards if deemed technically and economically feasible. A rulemaking for refrigerators and freezers as well as televisions is presently underway. DOE should tighten the refrigerator and freezer standards by at least one-third and set meaningful standards on televisions. Also, the standards on water heaters and lighting ballasts should be upgraded in the early 1990s.

The appliance standards legislation can be amended to include additional products. Incandescent and fluorescent lamps are prime candidates for inclusion under the standards. Efficiency standards on these products should have the effect of phasing out "standard" lamps in favor of lamps containing better gases, improved phosphors, and other energy-saving features. Standards along these lines are being established in Massachusetts [12].

Plumbing fixtures (i.e., showerheads and faucets) are also good candidates to include under the national standards. For showerheads and faucets, flow rate limits should be adopted. This would reduce hot water use, thereby saving energy and water. A few states including California and New York have already adopted showerhead flow rate regulations.

7. Promote the adoption of building standards and retrofit programs to reduce energy use in residential and commercial buildings.

Major opportunities exist for increasing the energy efficiency and affordability of homes and commercial buildings [13]. In addition to expanding and strengthening national appliance efficiency standards, four federal initiatives could help to reduce the energy use and cost for heating, cooling, and lighting buildings.

1) DOE should encourage widespread adoption of its commercial building standards and forthcoming residential building standards among states. These standards are mandatory for federal buildings but voluntary for non-federal buildings. Also, new homes financed by FHA, VA, and FmHA mortgages should be required to meet the standards.

2) Energy efficiency ratings and labels should be required for all new homes. This will encourage builders to exceed minimum efficiency requirements and make it easier for Fannie Mae and Freddie Mac to offer larger mortgages to buyers of very efficient homes.

3) Energy efficiency improvements in existing homes should be encouraged by streamlining and promoting the Energy Efficiency Mortgage Programs available through Fannie Mae, Freddie Mac, FHA, FmHA, and the VA.

4) Utilities should be allowed to sell conservation measures and should be encouraged to operate full-service home weatherization programs. The latter involves a utility arranging audits, financing, installation, and inspection, thereby making home weatherization as easy as possible for the resident. Also, utilities should be encouraged to provide similar services for commercial buildings.

8. Reduce federal energy use through life-cycle cost-based purchasing.

Some steps already have been taken to reduce energy use by the federal government. The Federal Energy Management Improvement Act (FEMIA) of 1988 mandates a 10% reduction in energy use in federal facilities by 1995. Recently enacted commercial building standards (and forthcoming residential building standards) are mandatory for new federally-owned buildings. Also, federal agencies are supposed to select equipment and products on the basis of minimum life-cycle cost.

Unfortunately, GSA and other agencies rarely purchase equipment with minimum life-cycle cost when it involves an additional capital outlay. We propose stricter adherence to the life-cycle cost requirements. Without exception, the federal government should purchase energy-efficient lighting products, motors, heating and cooling equipment when justified on a life-cycle cost basis. Also, the most fuel-efficient, cost-effective motor vehicles should be selected that meet size and other requirements.

9. Reduce industrial energy use through research and demonstration programs, promotion of cogeneration, and further data collection.

According to projections by DOE, the industrial sector will experience the largest absolute increase in energy use between 1988 and 2000 (5.4 Quads). While studies show that it is technically and economically feasible to reduce projected industrial energy use by 25% or more, many cost-effective conservation measures are not being widely implemented by industries [14].

This multi-faceted proposal calls for:

1) Demonstrating and promoting commercially available energy-saving technologies and processes that have not been widely adopted. DOE's

conservation R&D program has not included this type of activity in recent years.

2) Establishing joint government-industry research centers for energy-intensive industrial processes. The centers would conduct basic and applied research, striving for advances that provide energy savings along with other benefits.

3) Promoting greater adoption of industrial cogeneration. This would reduce fuel use by industries and utilities combined.

4) Conducting the Energy Information Administration's survey of manufacturers annually. This will provide better data and focus more attention on industrial energy intensity trends.

Other initiatives such as reform of utility regulation should also lead to industrial efficiency gains.

10. Increase federal conservation R&D funding and reinstitute demonstration programs.

Federal funding for conservation R&D was cut by two-thirds between 1980 and 1989. Conservation R&D accounted for only 5% of the Energy Department's total energy R&D effort in 1989. These drastic cuts occurred in spite of the success of many conservation R&D projects. For example, DOE helped to develop low-emissivity windows, electronic lighting ballasts, flame-retention oil burners, and ceramic heat recuperators. These and other technologies advanced by DOE's R&D program will save the nation hundreds of billions of dollars [15].

This proposal calls for approximately doubling DOE's conservation R&D program within four years. Recommended funding levels are $220 million in FY90, $260 million in FY91, $300 million in FY92, and $350 million by FY93. These funding increases will enable the Energy Department to support additional conservation R&D projects. Also, DOE should reinstitute demonstration of prototype and newly commercialized energy-conserving technologies, as well as expand efforts to transfer new energy-efficient technologies to the private sector.

III. Potential Impacts

This section presents the analysis of the policy proposals with respect to potential energy savings, economic benefits, and reduction in carbon emissions by the year 2000. The energy savings analysis makes use of the 1989 base case forecast by the Energy Information Administration as a point of reference [4]. This forecast shows primary energy use growing to 90.6 Quads by 2000, a 1.1%/yr average growth rate during 1988-2000. The estimated energy savings from the efficiency proposals are relative to the projected energy use levels in the EIA forecast. An attempt was made to exclude energy savings from efficiency improvements already assumed in the forecast, as well as to avoid double counting of savings from related policy initiatives. Also, it should be recognized that some of the proposals are very broad and therefore difficult to evaluate. In some cases, energy savings estimates are based primarily on assumed savings targets rather than projected efficiency levels.

The economic savings estimates are expressed in 1988 dollars and are based on the energy price projections in the EIA base case forecast. The savings are from the consumer perspective, with the estimated cost of saved energy deducted from the value of saved energy for each proposal. Cost of saved energy is estimated where appropriate using a 6% real discount rate. Further details of the energy and economic impacts analyses are given in the Appendix.

Table 1 summarizes the estimated savings in the year 2000 from the ten policy proposals. The impacts from each proposal are briefly described below.

1. Raise car and light truck fuel economy standards, expand the gas guzzler tax, and establish gas sipper rebates so that new cars average 45 mpg and new light trucks average 35 mpg by 2000.

Adopting tough new fuel economy standards, expanding the gas guzzler tax, and offering gas sipper rebates could cut gasoline use in 2000 by 1.0 MBPD (2.0 Quads) relative to current DOE projections. Even larger annual reductions will result during the following decade. Saving 1.0 MBPD in 2000 is equivalent to avoiding about 26% of the projected growth in oil imports between 1988 and 2000. Achieving this savings could cut our trade deficit in 2000 by $10 billion and save consumers $12 billion that year. Carbon emissions in 2000 would drop by about 41 Megatons and emissions of other air pollutants (e.g., CO, NOx, and HC) would fall as well.

2. Raise the gasoline tax by 50 cents per gallon within five years and spend part of the revenue on mass transit and energy efficiency programs.

Regarding impacts on energy use as a consequence of increasing the gasoline tax, it is assumed that there are no improvements in vehicle fuel economy beyond those assumed for the fuel economy standards, gas guzzler tax, and gas sipper rebates. This avoids double-counting of savings, but is a conservatism. It is assumed that the tax reduces vehicle-miles travelled based on a price elasticity of -0.20 [16]. This results in a reduction in gasoline use in 2000 of 0.9 Quads (8%) after savings from the previous proposal are accounted for. The direct fuel savings are worth about $10 billion in 2000. Tax revenue and expenditures are ignored in the economic analysis since these represent transfer payments within the economy.

3. Adopt acid rain legislation that encourages energy efficiency as a means for lowering emissions and reducing emission control costs.

Aggressive electricity conservation efforts in Eastern states targeted for acid rain clean-up are assumed to result in an 8% reduction in electricity demand in these states by 2000 (in addition to savings from other proposals). This represents a savings of about 176 billion kWh per year. The corresponding net economic savings in 2000 would be about $7 billion and the reduction in carbon emissions would be about 48 Megatons. In addition, the total bill for acid rain clean-up could fall by about $2 billion per year.

4. Reform federal utility regulation to foster investment in end-use energy efficiency and cogeneration systems.

If utility regulations are fully revised along the lines suggested here by the early 1990s, it is reasonable to expect a reduction in electricity demand growth of 1.0–1.5%/yr as a result. This level of performance is typical of the most aggressive and successful utility conservation efforts in recent years, in some cases where reforms along the lines proposed here have been partially implemented. Assuming a 10% total reduction in national electricity demand by 2000 from this proposal alone, annual savings by 2000 could equal approximately 347 billion kWh (3.8 Quads on a primary basis). If electricity savings of this magnitude are realized, net economic savings of $14 billion per year and carbon avoidance of 94 Megatons per year could result by 2000.

5. Increase the efficiency of electricity supply through development, demonstration, and promotion of advanced generating technologies.

Advanced generating technologies could affect fuel use for electricity supply within 10 years, although much larger impacts are likely in the next century. Regarding impacts by 2000, it is first assumed that half of gas–fired or oil–fired steam turbines are replaced with high efficiency gas turbines or combined–cycle plants that use 25% less fuel on average. Second, it is assumed that one quarter of coal-fired steam turbines are repowered with fluidized bed combustors or other technologies that provide 10% fuel savings on average. Taking into account the savings from other utility–related initiatives, these actions result in 0.9 Quads of fuel savings and 20 Megatons of carbon avoidance by 2000. No economic benefits are assumed since the capital cost for these actions is uncertain. However, all of the actions are expected to be cost effective on a life–cycle basis.

6. Strengthen federal appliance efficiency standards and adopt new efficiency standards on lamps and plumbing fixtures.

Upgrading the refrigerator and freezer standards could reduce electricity use in 2000 by approximately 18 billion kWh and save about 0.2 Quads of primary energy. Raising the water heater and lamp ballast standards could add close to 0.3 Quads of savings in 2000, while lamp standards could result in 0.4 Quads of savings and showerhead and faucet standards about 0.2 Quads of savings. Taken together, these new appliance standards could lower energy use in 2000 by 1.1 Quads. Consumers could realize a net savings of over $5 billion per year by 2000, and annual carbon emissions in 2000 would fall by about 25 Megatons.

In addition to the savings from new appliance standards, Table 1 includes savings estimates for the national appliance standards adopted in 1987 and 1988. The impacts of these standards were not incorporated into the 1989 EIA forecast [17]. The savings in 2000 from standards already adopted are similar in magnitude to the savings from the proposed new standards.

7. Promote the adoption of building standards and retrofit programs to reduce energy use in residential and commercial buildings.

Promoting tougher residential building codes and increasing the use of home energy rating systems is estimated to reduce space conditioning energy use by about one–third in 11 million affected homes. This saves about 0.2 Quads of primary energy by 2000. Promoting tougher commercial building codes could save about 0.3 Quads of primary energy that year. The initiatives for existing residential and commercial buildings could save an additional 0.6–0.7 Quads by the turn of the century. These estimates are based primarily on reducing energy use for space conditioning since other proposals address appliances and lighting. Assuming the energy savings are worth 2.5 times the cost of saved energy, consumers would realize a net benefit of over $5 billion per year by 2000. Achieving this savings would prevent the release of close to 22 Megatons of carbon in 2000.

8. Reduce federal energy use through life-cycle cost-based purchasing.

Purchasing equipment based on minimum life-cycle cost along with the new building standards for federal buildings and the provisions in the Federal Energy Management Improvement Act of 1988 could reduce energy use in federal buildings by 20%. This represents an annual savings of 0.2 Quads of primary energy by 2000. Net energy service costs would drop by nearly $1 billion/yr, and annual carbon emissions would fall by about 4 Megatons.

9. Reduce industrial energy use through research and demonstration programs, promotion of cogeneration, and further data collection.

The goal of this proposal is to work cooperatively with industry in order to lower energy use in 2000 by 8% relative to the level projected by EIA. This implies eliminating half of the projected increase in industrial energy use during 1988–2000. If the overall goal is achieved, industrial energy use in 2000 would drop by about 2.7 Quads. Industries could realize a net economic savings of around $13 billion per year by 2000, and carbon emissions in 2000 would fall by about 53 Megatons.

10. Increase federal conservation R&D funding and reinstitute demonstration programs.

Many energy-efficient technologies now commercially available originated in R&D programs begun in the 1970s. Increasing R&D in the near future is not likely to have much impact on energy demand by 2000, but the long-term savings and other benefits could be significant. Development and commercialization of a new generation of energy-efficient technologies is essential if the U.S. is to return to rapidly improving energy productivity and effectively limit greenhouse warming over the long run. In addition, certain R&D projects conducted by DOE, such as technology transfer activities and the least-cost utility planning project, do have near-term impacts which are accounted for through other policy proposals. No energy savings are directly attributed to this initiative.

Overall Savings

As indicated in Table 1, adopting the entire energy efficiency platform could save nearly 16 Quads of energy in the year 2000 relative to the EIA base case forecast. Consumers could save about $75 billion per year, and carbon emissions in 2000 could fall by over 350 million metric tons relative to the EIA forecast.

Table 2 compares energy use, energy services cost, and carbon emissions in 1988 with the respective values in 2000 from a frozen efficiency scenario, the EIA forecast and the high efficiency scenario represented by implementing this platform. Without any efficiency improvement, energy use will increase 34% (the projected increase in GNP) between 1988 and 2000. However, this scenario is unlikely to occur since ongoing structural and technological changes are reducing national energy intensity to some extent. In fact, the EIA base forecast shows energy use growing 1.1%/yr on average compared to 2.5%/yr in the frozen efficiency case.

If the energy efficiency initiatives have the impacts estimated here, than energy use in 2000 would fall by 30% relative to frozen efficiency and 18% relative to the EIA forecast. There would be a modest drop in absolute energy use between 1988 and 2000. Based on the 2.5%/yr GNP growth rate implicit in the EIA forecast, national energy intensity (E/GNP) falls 3.0%/yr on average during 1988-2000 in the high efficiency scenario, compared to a 1.4%/yr reduction on average in the EIA forecast. For reference, national energy intensity declined 2.3%/yr on average during 1973-86.

A rough estimate can be made of the energy savings by fuel type as a result of implementing the energy efficiency platform. Coal use in 2000 could fall by 7.1 Quads, oil use by 4.9 Quads, and natural gas use by 3.9 Quads. The oil savings, equivalent to 2.3 million barrels per day, would cut petroleum imports in 2000 by about 23% (relative to the EIA base forecast). This represents eliminating nearly 60% of the growth in imports otherwise projected to occur between 1988 and 2000. Cutting oil imports to this extent would reduce pressure on world oil markets, thereby lowering the risk of another world oil price shock and enhancing national security.

Adding up the electricity savings estimates from relevant policy proposals (i.e., appliance and lighting standards, promotion of conservation in acid rain legislation, reduction of industrial energy use, etc.) results in a total electricity savings of 20-25% in 2000 relative to the EIA base forecast. Although this degree of savings is substantial, it does not exhaust the full electricity savings potential from currently available, cost-effective conservation technologies. For example, a recent study conducted by ACEEE indicates 38% electricity savings potential in New York State [20].

Carbon emissions in 2000 in the high efficiency scenario are 33% less than with frozen efficiencies and 21% less than emissions associated with the EIA base case forecast. Furthermore, in the high efficiency scenario, carbon emissions in 2000 would be 11% less than actual emissions in 1988. The relative reduction in carbon emissions is slightly greater than the relative reduction in energy use because the efficiency proposals are targeted on cutting fossil fuel use (as opposed to non-fossil energy use).

The potential reduction in carbon emissions from the proposed set of energy efficiency initiatives is consistent with the goal of achieving a 20% reduction in CO_2 emissions from 1988 levels by 2000, as recommended in global warming legislation introduced by Representative Schneider and Senator Wirth in 1989 [7]. Meeting the goal in these bills implies emitting no more than 1200 Megatons of carbon by 2000. Compared to the frozen efficiency scenario, this represents reducing carbon emissions in 2000 by about 810 Megatons. The efficiency initiatives in this platform together with the efficiency improvements already accounted for by EIA provide a reduction in carbon emissions of nearly 670 Megatons in 2000 (relative to frozen efficiency). Thus, energy efficiency improvements are providing about 82% of the carbon avoidance necessary to meet the Schneider-Wirth goal.

To actually meet the Schneider-Wirth goal, a further reduction in carbon emissions of about 140 Megatons would be necessary. This additional reduction can be achieved by some combination of increasing non-fossil fuel-based energy sources (e.g., solar power or biomass-derived fuels), afforestation, or shifting from more carbon-intensive fuels to natural gas [5]. The potential for carbon reductions from such options is beyond the scope of this study.

IV. Conclusion

This analysis indicates that a comprehensive set of energy efficiency policy initiatives can have a large, near-term impact on U.S. energy use and carbon emissions. Given widespread but realistic energy efficiency improvements, it is possible to cut energy demand back to the levels of the mid-1980s and to realize an 11% reduction in absolute carbon emissions between now and 2000. These reductions can be achieved while population, economic output, and living standards are increasing.

Considered from the perspective of potential carbon emissions without further efficiency improvements, the energy efficiency platform can provide the lion's share of the reductions necessary to meet the challenge of 20% fewer carbon emissions by 2000. Furthermore, adopting these policies should enable the U.S. to achieve even greater energy and carbon savings over the longer term. However, further policy initiatives (e.g., expanding the use of renewable energy sources or natural gas) appear to be needed in order to cut carbon emissions by 20% in the short run.

Obtaining the energy savings indicated here will not be easy. Energy prices are expected to remain relatively stable in the near future [5]. A very broad and aggressive set of policies are needed; the policies must be adopted promptly; the policies must be implemented effectively; and the response to the policies must be substantial. Moreover, the Bush Administration and the Congress must commit to eliminating energy demand growth and reducing carbon emissions. The savings described here will not be achieved without commitment and leadership.

On the positive side, the economic and environmental benefits from greatly increasing our nation's energy efficiency are massive. Consumers would save hundreds of billions of dollars, industries would become more competitive, oil imports would drop substantially, all forms of air pollution would diminish, and climate change would slow. Given these benefits, increasing energy efficiency makes sense even if it turns out that our atmosphere is not rapidly warming. But if our atmosphere is heating up as fast as some scientists believe, than we will be acting prudently. By accepting the challenge of much greater energy efficiency, we can save money, enhance national security, and minimize the risk of ecological catastrophe at the same time. It is a challenge and opportunity we cannot afford to pass up.

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Table 1

POTENTIAL BENEFITS FROM THE ENERGY EFFICIENCY PLATFORM

Policy Proposal	SAVINGS IN 2000: Energy (1) (Quads)	Money (Billion $)	Carbon Emissions (2) (Megatons)
Raise vehicle efficiency standards and gas guzzler tax/sipper rebates	2.0	12	41
Increase the gasoline tax and expand mass transit services	0.9	10	19
Encourage conservation in acid rain legislation	1.9	9	48
Reform utility regulation	3.8	14	94
Increase the efficiency of electricity supply	0.9	--	20
Appliance efficiency standards			
existing standards	1.2	6	25
new standards	1.1	5	25
Promote adoption of buildings standards and retrofit programs	1.2	5	22
Reduce federal energy use through life-cycle cost-based purchasing	0.2	1	4
Reduce industrial energy use through research, demonstration, etc.	2.7	13	58
Increase conservation R&D	--	--	--
TOTAL	15.9	75	356

(1) For reference, the U.S. consumed about 80 Quads in 1988. Projections of energy use in 2000 are given in Table 2.

(2) Units are million metric tons of carbon.

Table 2

OVERALL ENERGY USE, COST AND CARBON EMISSIONS IN 1988 AND IN SCENARIOS FOR 2000

Scenario	Energy Use (Quads)	Energy Services Cost (1) (Billion $)	Carbon Emissions (Megatons)
Actual 1988	79.9	416	1503
Frozen efficiency 2000	107.2	735	2010
EIA Base Case 2000	90.6	621	1699
High Efficiency 2000 (2)	74.7	546 (3)	1343

(1) Annual energy services cost expressed in 1988 dollars.

(2) Based on savings estimates from the policy proposals in this paper.

(3) Includes the levelized cost of additional conservation measures relative to the EIA base case, but excludes any tax impacts from the gasoline tax or economic impacts from the initiative to increase the efficiency of electricity supply.

Appendix A

Methodology and Assumptions Used for Evaluating the Energy Efficiency Platform

General

The methodology and and key assumptions used to estimate the energy, economic, and carbon savings from each of the proposals is explained in this Appendix. The EIA 1989 base case forecast [4] is used as the reference from which energy savings in 2000 are determined. An attempt is made to avoid double counting of savings from related policy proposals as well as savings already incorporated in the EIA forecast. However, EIA primarily uses econometric forecasting techniques. This makes it difficult to determine the specific efficiency levels or improvements implicit in the EIA forecast. By and large, efficiency improvements in the EIA forecast are price-induced and are independent from the policy-stimulated improvements resulting from the platform.

Baseline sectoral fuel shares in 2000 are derived from the EIA forecast. Energy savings from the policy proposals are estimated using these baseline values as a starting point (e.g., savings from auto fuel economy standards and a gasoline tax are based on the EIA projection of 13.5 Quads of gasoline use in the transportation sector in 2000). Proposals that result in end-use electricity savings are assumed to back out fossil fuels entirely since hydroelectric, nuclear, and solar/wind power plants are operated as base load capacity (i.e., fossil fuels are always backed out on the margin). Reductions in coal, oil, and natural gas use are apportioned according to their projected shares of fossil fuel energy input to power plants.

The energy prices used for estimating economic savings in 2000 are also derived from the EIA base forecast. All energy costs are expressed in 1988 dollars (i.e., ignoring the effects of inflation). For example, the world oil price is projected to reach $28 per barrel in 2000. To estimate the net economic benefits from each conservation initiative, the cost of saved energy is subtracted from the value of saved energy in 2000. The cost of saved energy for each proposal is calculated assuming a 6% real discount rate. This rate approximately equals the average return that can be realized on alternative investments. Environmental costs and benefits are not included in the economic analysis unless explicitly noted.

Avoided carbon dioxide emissions are presented in terms of million metric tons of carbon (following the international convention). The following carbon emissions factors are used: coal - 28.2 Megatons per Quad; oil - 20.7 Megatons per Quad; natural gas - 14.5 Megatons per Quad. (Note: a Megaton equals a million metric tons).

The methodology, assumptions, and results from the analysis of each policy initiative are discussed below.

1. Raise car and light truck fuel economy standards, expand the gas guzzler tax, and establish gas sipper rebates so that new cars average 45 mpg and new light trucks average 35 mpg by 2000.

In evaluating this policy initiative, it is assumed that adoption of the full package leads to an average fuel economy of 45 mpg for cars and 35 mpg for light trucks in 2000. These are rated fuel economy values; actual on-road fuel economies are assumed to be 15% lower (as was the case in recent years). In the absence of the policy initiative, it is assumed that new cars reach a rated fuel economy of 34 mpg 2000 as is incorporated into the 1989 EIA forecast [4].

Fleet average fuel economies are computed using a simple vehicle stock model. The model accounts for varying usage levels and retirement rates by vehicle age. Also, the rated fuel economy of new vehicles is assumed to improve linearly in each case during 1988-2000.

In the EIA forecast, vehicle-miles travelled (VMT) is assumed to increase 2.1% per year during 1988-2000. However, the projected VMT level for 2000 is reduced by 8% to account for the impact of the gasoline tax increase (proposal 2). VMT is assumed to be split 70% autos, 30% light trucks consistent with current vehicle sales patterns.

Combining these assumptions leads to gasoline savings of 15.3 billion gallons in 2000 from this policy initiative. This is equivalent to saving 1.0 million barrels of oil per day, or 2.0 Quads of energy per year. Relative to the EIA forecast, gasoline use in 2000 falls by about 15% as a consequence of this policy initiative. Even greater savings occur after 2000 as the full impact of the initiative is observed.

In the EIA forecast, gasoline is projected to cost $10.55/MBtu in 2000. This leads to the fuel savings in 2000 being worth $20.4 billion. The cost of saved energy is estimated assuming that increasing fuel economy in the range of 30-45 mpg costs approximately $46 per 1 mpg improvement in actual fuel economy [18]. Also, it is assumed that there is 107,000 miles of expected driving during the first ten years of vehicle life (with the gasoline tax factored in). This leads to an average cost of saved energy of nearly $0.58/gallon or $4.60/MBtu. The aggregate cost associated with the vehicle fuel economy improvements from this proposal is $8.9 billion in 2000. Thus, the net value of the fuel savings in 2000 equals $11.5 billion.

A reduction in carbon emissions in 2000 of about 41 Megatons would directly result from this policy initiative. This is equivalent to nearly 9% of projected carbon emissions from the transport sector in 2000 in the EIA base forecast.

2. Raise the federal gasoline tax by 50 cents per gallon within five years and spend part of the revenue on mass transit and energy efficiency programs.

It is assumed that an increase in the gasoline tax and mass transit programs reduce VMT, but do not affect vehicle fuel economy. This assumption is made because of the rapid fuel economy improvements associated with the previous initiative. In reality, a substantial new gasoline tax will complement stricter fuel economy standards, gas guzzler taxes, and gas sipper rebates. All of the policies will lead to fuel economy improvements.

It is assumed that the tax reduces VMT based on price elasticity of -0.20. This price elasticity of vehicle use was found in a number of studies that analyzed empirical data [16]. With $0.50/gallon price increase above the average retail gasoline price in 1988 ($0.96/gallon), the tax when fully implemented is estimated to lower VMT by 8%. This leads to a gasoline savings of 7.4 billion gallons (0.9 Quads) in 2000 after adjusting for the savings from the previous proposal. No additional energy savings are assumed from increased use of mass transit. To some extent, the shift from personal vehicles to mass transportation is implicitly accounted for through the price elasticity.

The direct gasoline savings in 2000 are worth close to $10 billion based on the EIA price projections. Carbon emissions fall by about 19 Megatons. Tax revenues and expenditures are ignored in the analysis since they represent transfer payments within the economy. New gasoline tax revenue can be used to replace other taxes, support related programs such as mass transit or energy conservation R&D, or reduce the federal budget deficit.

3. Adopt acid rain legislation that encourages energy efficiency as a means for lowering emissions and reducing emission control costs.

New acid rain legislation is likely to focus on reducing SO2 emissions in the Midwest. However, other states in the eastern part of the country are likely to be significantly affected as well. To evaluate the potential impacts of this proposal, it is assumed that new legislation requires SO2 emissions reductions in a 26 state region of the Eastern U.S. This is consistent with certain acid rain proposals introduced in Congress [19]. Utilities in this region account for nearly 64% of electricity generation in the country.

If acid rain legislation is structured so that utilities/states receive credit for emissions reductions due to conservation and are encouraged to pursue conservation and least-cost approaches to pollution clean-up, substantial savings could occur since most utilities in this region are not aggressively promoting conservation at the present time. Utilities could promote and finance technologies such as compact fluorescent lamps, reflectors in fluorescent fixtures, lighting controls, and variable speed motor drives. These technologies are not covered by efficiency standards.

The EIA base forecast assumes that electricity demand will grow 2.6% per year on average during 1988-2000, slightly above the assumed GNP growth rate. With adoption of the recommended provisions as part of new acid rain legislation, it is assumed that there will be an 8% reduction in electricity use in the applicable region by 2000 (relative to the EIA forecast). This level of savings is on the order of one-quarter to one-third of the total cost-effective electricity savings potential identified in recent studies [20]. Additional electricity savings is assumed to occur in this region as a result of other policy initiatives (e.g., appliance standards or utility regulatory reform).

Cutting projected electricity demand in the region by 8% implies a total electricity savings in 2000 of 176 billion kWh. With an average overall generation, transmission, and distribution efficiency of 31%, reducing electricity demand to this extent would lower fuel use by in 2000 by 1.9 Quads. Consumers would realize a gross savings of $11.4 billion in 2000 based on the projected average electricity price of $0.065/kWh. Furthermore, it is assumed that cost associated with these savings is $0.025/kWh, consistent with utility experience and studies of the cost effectiveness of electricity conservation [21]. Thus, the net economic savings in 2000 are $7 billion. Assuming that the electricity savings are split between coal, oil, and gas-fired power plants in proportion to their utility fuel shares in 2000, the avoided carbon emissions in 2000 would equal 48 Megatons.

4. Reform federal utility regulation to foster investment in end-use energy efficiency and cogeneration systems.

Utilities that are most aggressively promoting and financing conservation measures estimate that their programs are reducing electricity demand growth by 1.0-1.5% per year [21]. In a few cases (e.g., Wisconsin Electric Power Co.), some reforms along the lines suggested here were adopted prior to achieving these savings. The major conservation technologies that produce these savings -- energy-efficient lighting products, control systems, variable speed drives, etc. -- are commercially available and cost effective, but are not widely used yet.

In estimating the potential impacts from this initiative, it is assumed that the degree of electricity savings achieved by more active utilities occurs throughout the country during the next decade. Specifically, it is assumed that the EIA electricity demand forecast for 2000 is reduced by 10% as a result of this initiative. This implies saving 347 billion kWh in 2000, or 3.8 Quads on a primary basis assuming all of the savings back out fossil fuel-based power. Energy savings from expanded use of cogeneration are factored into the industrial efficiency proposal.

To estimate the economic benefits from this initiative, an average cost of saved energy of $0.025/kWh is assumed based on utility experience and studies of conservation cost effectiveness [20, 21]. With an average projected electricity price of $0.065/kWh in 2000, consumers would realize a net savings of $14 billion that year. Assuming that electricity savings back out fossil fuel-based power in proportion to the projected utility generating mix in 2000 (70% coal, 20% gas, 10% oil), 94 Megatons of carbon emission would be avoided.

5. Increase the efficiency of electricity supply through development, demonstration, and promotion of advanced generating technologies.

To estimate the impacts from this initiative, it is first assumed that half of projected gas-fired and oil-fired steam turbines owned by utilities in 2000 are replaced with high efficiency gas turbines or combined cycle power plants. This represents replacing up to 64 GW of capacity (in addition to the 40 GW of new combined cycle capacity anticipated by the EIA). Furthermore, it is assumed that this substitution increases generating efficiency from 32% to 43% on average [11]. With nearly 15% of projected utility power generation expected from this class of power plants in 2000, primary energy savings in 2000 would equal about 0.55 Quads.

The second response that is assumed from this initiative is the replacement or repowering of about one-quarter of projected steam turbine capacity in 2000 with advanced technologies such as fluidized bed combustion. This could affect up to 80 GW of generating capacity. In this case, generating efficiency is assumed to increase approximately 10% (i.e., from 33% to 36.5% on average [22]. Energy use in 2000 would fall by about 0.4 Quads if generating efficiency improves to this extent.

The overall savings estimate from this initiative, about 0.95 Quads in 2000, takes into account the sizable reduction in electricity demand resulting from other policy initiatives. The projected reduction in carbon emissions in 2000 from this proposal is 20 Megatons. The economic impacts from these changes are not estimated because the capital and operating costs of both advanced and conventional generating technologies are uncertain.

6. Strengthen federal appliance efficiency standards and adopt new efficiency standards on lamps and plumbing fixtures.

This proposal calls for more stringent standards or new standards on a variety of products. The Department of Energy is now considering strengthening standards on refrigerators and freezers and setting standards for the first time on televisions. DOE's analysis shows that it is feasible to set new standards on these products, and that doing so will save at least 0.22 Quads by 2000 [23]. Tightening the standards on water heaters (requiring an additional 5% efficiency improvement) and lamp ballasts (requiring electronic ballasts) when these standards are reviewed in the early 1990s could save around 0.25 Quads by 2000. Furthermore, adopting national efficiency standards on incandescent and fluorescent lamps, as Massachusetts is in the process of doing at the state level, could save around 0.40 Quads by 2000. Finally, adopting flow rate limits on showerheads could save around 0.2 Quads by 2000. At least three states have already adopted showerhead standards.

Combining these savings estimates, primary energy use in 2000 will fall by 1.1 Quads. With the projected fuel shares for electricity generation, avoided carbon emissions in 2000 could equal 25 Megatons. Also, assuming a benefit-cost ratio of three, the standards would provide net economic savings of over $5 billion in 2000. Since some of the products under consideration take over ten years to turnover, even greater energy, economic, and carbon savings will result after 2000.

In addition to new standards, the impacts from the 1987 appliance standards and 1988 lamp ballast standards are included in the platform since they were not incorporated into the EIA forecast [17]. Studies previously performed by ACEEE indicate that the existing standards will save about 1.15 Quads in 2000, with about 70% of the savings due to improvements in electrical equipment and about 30% due to improvements in gas or oil-fired equipment [24]. The existing appliance and ballast standards are expected to provide consumers with a net savings of about $6 billion in 2000. Avoided carbon emissions should equal about 25 Megatons.

Estimated savings from both the existing and proposed appliance and lighting standards, 2.25 Quads by 2000, represent 6.5% of projected primary energy use in buildings in 2000 in the absence of new policies to stimulate conservation. Savings of this magnitude would eliminate about half of EIA's anticipated growth in primary energy use in buildings between 1988 and 2000. Also, the estimated reduction in electricity use by 2000 is sufficient to obviate the need for over 60 large (500 MW) power plants.

7. Promote the adoption of building standards and retrofit programs to reduce energy use in residential and commercial buildings.

Since a number of other proposals address building equipment (appliances and lighting products), it is assumed that this initiative primarily affects energy use for space conditioning. Energy savings from different sections of the initiative are evaluated separately.

Regarding new residential building standards and mandatory home energy ratings, space heating and cooling accounts for nearly half of residential energy use on a primary basis. Based on survey data, it is estimated that homes built in recent years consume about 65 MBtu/yr on average for space conditioning [25]. Complying with DOE's forthcoming residential building standard would cut energy use for space conditioning by about one-third [26]. It is assumed that the standard will affect 70% of new homes built during the next decade if it is required for homes receiving federal mortgages, it is promoted among states, and home energy ratings are also required for new homes. This implies about 11 million new homes meeting the standard and an energy savings of 0.23 Quads by 2000.

Regarding DOE's new commercial building standards, it is first assumed that 20% of commercial floor space in 2000 is constructed during 1990–2000. With active promotion of the DOE standard (and given that a few states have already adopted a building code similar to it), it is assumed that half of this floor space complies with the standard. Simulation analysis shows that complying with the second phase of the new standards (effective in 1992) would lead to 20–30% less energy use in the most common commercial building types compared to complying with the 1980 ASHRAE building standard [27]. Average savings of 20% are assumed in order to avoid double counting of savings from lighting efficiency standards. These assumptions lead to 0.30 Quads of energy savings in 2000.

Regarding promotion of the Energy Efficiency Mortgage Programs, it is assumed that 25% of existing homes expected to be sold during 1990–2000 participate in the program and that space conditioning energy use is reduced by 25% on average in participating homes. This level of energy savings is typical of large-scale housing retrofit programs [28]. The resulting energy savings in 2000 are 0.19 Quads.

Regarding the impact from utility retrofit programs, it is assumed that only gas and oil-heated buildings are affected in order to avoid double counting of savings with the electricity-oriented proposals. Further, it is assumed that 20% of applicable residential and commercial buildings are retrofit by 2000, and that energy use for space heating and cooling drops by 25% on average in these buildings [29]. The resulting energy savings in 2000 are 0.44 Quads.

The total energy savings in 2000 from all portions of this proposal are close to 1.2 Quads. This represents 4–5% of projected energy use in buildings in 2000 taking into account savings from other relevant policy proposals. Based on the cost effectiveness of a large number of conservation projects in buildings, it is assumed that the cost of saved energy averages $3/MBtu [28, 29]. With a projected energy price of $7.40/MBtu, consumers would realize a net benefit of about $5 billion in 2000. Also, with most of the energy savings in the form of natural gas and oil, the estimated reduction in carbon emissions in 2000 is 22 Megatons.

8. Reduce federal energy use through life-cycle cost-based purchasing.

Approximately half of the 1.8 Quads of energy use by the federal government is in buildings (most of the remainder fuels military vehicles). It is assumed that implementing this proposal along with the new mandatory building standards for federal buildings and the FEMIA Act of 1988 reduces energy use in federal buildings in 2000 by 20%. This leads to 0.2 Quads of energy savings, $1 billion of net economic savings, and about 4 Megatons of avoided carbon emissions that year.

9. Reduce industrial energy use through research and demonstration programs, promotion of cogeneration, and further data collection.

Implementation of this proposal is assumed to reduce industrial energy use in 2000 by 8% relative to EIA's forecast. This is one-fifth to one-third of the energy savings potential in various energy-intensive industries based on full implementation of state-of-the-art technologies and processes [14]. Additional reductions in industrial energy use will occur as a result of other policy proposals. The assumed energy savings from this proposal, 2.7 Quads, is sufficient to eliminate half of the growth in industrial energy demand projected by the EIA during 1988-2000.

Industrial energy efficiency improvements tend to be very cost effective. One study of conservation opportunities in 15 industries found a levelized cost of $1-2 per MBtu of energy savings on average [30]. If conservation costs $2/MBtu and the projected average energy price is $6.80/MBtu, then consumers will realize a net economic benefit of $13 billion in 2000. Assuming that the energy savings are distributed among fuel types in proportion to their use by industry and utilities, then coal would account for 37%, natural gas for 31%, oil products for 22%, and other fuels for 10% of the savings. This leads to 58 Megatons of avoided carbon emissions in 2000.

10. Increase federal conservation R&D funding and reinstitute demonstration programs.

Federal support can play a critical role in the development and demonstration of new energy-efficient technologies. Many of today's commercially available conservation measures were advanced by R&D programs begun in the 1970s. Past conservation R&D projects are expected to provide significant energy savings over the long run, with economic benefits that far exceed the federal support that was provided [15].

It is difficult if not impossible, however, to estimate the impact on energy demand that could result from expanding conservation R,D, and D programs in the near future. Also, it can take many years before such programs have a significant impact on energy demand. Therefore, no savings are directly attributed to this initiative. Certain projects conducted by DOE, such as technology transfer activities and the least-cost utility planning project, do have near-term impacts which are accounted for through other policy proposals.