COST-EFFECTIVE CARBON DIOXIDE REDUCTION INITIATIVES

Howard Geller
John DeCicco
Steven Nadel

American Council for an Energy-Efficient Economy
1001 Connecticut Ave., N.W. Suite 801
Washington, DC 20036

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Executive Summary

President Clinton has committed the United States to at least stabilizing its emissions of greenhouse gases at 1990 levels by 2000. In order achieve this target and realize further reductions in U.S. greenhouse gas emissions beyond 2000, in keeping with the goals of the global warming treaty, new initiatives will need to be taken to reduce fossil fuel consumption and resulting carbon dioxide (CO2) emissions. The United States will be developing and analyzing various options this summer as it revises its climate action plan. Policies and programs to increase the efficiency of energy supply and use are likely to top the list of new initiatives because of their availability, cost effectiveness, and ability to significantly reduce CO2 emissions.

This paper proposes and analyzes ten national energy efficiency initiatives. Each initiative would be led by the Federal government, but would leverage significant amounts of private investment in energy efficiency measures. The improvements in energy efficiency that would result from these initiatives are cost effective for society, i.e., the resulting energy savings more than pay for the initial investments. In this manner, energy efficiency improvements are able to cut CO2 at a net negative cost (i.e., with economic benefits for the nation).

A number of the proposed energy efficiency initiatives expand upon current programs; others are entirely new initiatives (see Table S-1). Overall, we propose that the Federal government increase its funding of energy efficiency programs by about $3.6 to 4.3 billion per year during 1995-2010. This in turn would leverage about five times as much private investment in energy efficiency measures throughout the economy. The new or expanded Federal energy efficiency programs could be funded by shifting funding priorities within the current energy budget and by adopting new revenue-neutral fee and incentive programs.

By undertaking these ten energy efficiency initiatives, we project that national CO2 emissions would be reduced by nearly 9 percent in 2000 (see Table S-2). In addition, national energy use in 2000 would fall by 7 percent and consumers' energy bills would be reduced by over $50 billion that year. By 2010, CO2 emissions would fall by 20 percent, national energy use would fall by nearly 17 percent, and consumers' energy bills would be slashed by over $160 billion per year. These reductions in CO2 emissions, energy consumption, and energy bills are relative to projected levels based on the Reference Case in DOE's Annual Energy Outlook 1993.

The ten energy efficiency initiatives would eliminate about 81 percent of the projected growth in national CO2 emissions between 1990 and 2000. The initiatives will fully offset the projected growth in CO2 emissions by 2003, and would reduce CO2 emissions to about 2 percent below their 1990 level by 2010. Further reductions in CO2 emissions would result from pursuit of other energy efficiency adoptions, adopting a gasoline or broader energy tax, efforts to shift to less carbon-intensive fuels, moving towards a more efficient intermodal transportation system, and accelerated adoption of renewable energy technologies.

We estimate that the ten energy efficiency initiatives would cut energy bills paid by households and businesses by over $1.3 trillion during 1994-2010, in return for an overall investment (public and private) of $360 billion. Besides cutting CO2 emissions and saving consumers and businesses money, the targeted energy efficiency programs could result in a net increase of over 550,000 jobs in the U.S. economy within ten years. The energy efficiency initiatives also would reduce our trade deficit, enhance energy security, and cut emissions and other pollutants associated with energy use.

Limiting CO2 emissions in 2000 to their level in 1990, with significant reductions thereafter, thus requires prompt and aggressive action. Energy use and CO2 emissions increased in the United States over the past five years in spite of weak economic growth. Much will need to be done to get the United States "back on the energy efficiency track." Taking quick and strong action on energy efficiency should be embraced rather than resisted, as it offers a win-win strategy for the domestic economy and the global environment.

TABLE S-1

PROPOSED ENERGY EFFICIENCY INITIATIVES (1)

EXPAND THE "GREEN TECHNOLOGY" PROGRAMS

Increase funding to $150 million per year for programs that promote voluntary manufacture of energy-efficient products and installation of energy efficiency measures.

LIGHT VEHICLE FUEL ECONOMY IMPROVEMENT

Adopt tougher fuel economy standards, expand the gas guzzler tax program, and provide up to $2 billion per year to auto manufacturers for investments needed to make cars and light trucks more energy efficient.

UNDERTAKE INDUSTRIAL ENERGY EFFICIENCY INITIATIVES

Establish targets, promote voluntary energy efficiency commitments, increase technical assistance and training, provide loan guarantees and interest rate buydowns, and demonstrate innovative industrial process improvements.

HOME WEATHERIZATION LOAN PROGRAM

Allocate $400 million per year to state-based low-interest loan programs for housing retrofits by middle-income homeowners.

SUPPORT BUILDING CODE ADOPTION AND IMPLEMENTATION

Provide $25 million per year for state-level building code adoption, training, and compliance efforts.

EXPAND RD&D ON IMPROVED EQUIPMENT EFFICIENCY

Increase Federal funding by $50 million per year for research, development and demonstration of new energy savings technologies, with matching funding from the private sector.

LEVELIZE TAX BENEFITS FOR COMMUTERS

Require employers to offer the same tax-free benefit to commuters who drive cars, use mass transit, or other use other non-automobile-based transport modes.

TABLE S-1 (cont.)

PROPOSED ENERGY EFFICIENCY INITIATIVES (1)

PUBLIC HOUSING RETROFITS

Devote $400 million per year to retrofitting HUD-assisted housing.

RETROFITS OF FEDERAL BUILDINGS

Devote $300 million per year to upgrading the energy performance of Federally-owned buildings.

LOW-INCOME WEATHERIZATION

Increase the Federal Weatherization Assistance Program by $500 million per year.

(1) Funding levels refer to programs at full phase in.

Table S-2. Summary of Climate Action Initiatives Results

a) SUMMARY BY PROGRAM (ordered by year 2000 impact)	Federal spending M$/yr			Carbon emission cuts MT/yr	
Program	1994	1995	2000	2000	2010
1 Green Technology Programs	150	150	150	53.8	94.0
2 Improve auto fuel economy	2,000	2,000	2,000	32.3	149.1
3 Industrial sector efficiency	50	100	500	26.9	56.1
4 Home weatherization loans	133	267	400	9.0	20.7
5 State building code adoption	25	25	25	6.0	18.0
6 RD&D for equipment efficiency	50	50	50	5.3	8.9
7 Commuter subsidy reform	0	0	0	3.2	3.5
8 Public housing retrofits	200	400	400	3.2	4.9
9 Federal building retrofits	300	300	300	2.7	3.9
10 Low-income weatherization	250	500	500	1.7	3.9
TOTAL	3,158	3,792	4,325	144.2	363.0

b) AVOIDED CARBON EMISSIONS (MT/yr)	1990	2000	2010
DOE AEO93 Baseline Emissions	1341	1501	1641
Baseline adjusted for non-CO2 gases	1478	1656	1809
Reductions from efficiency initiatives	--	144	363
Efficiency scenario emissions	--	1512	1446
Percent reduction below adjusted baseline	--	8.7%	20.1%
Percent change from 1990 level	--	2.3%	-2.2%

NOTE:
Annual spending is given in millions of constant 1990$ (M$/yr).
Carbon emissions are given as millions of metric tons per year (MT/yr), on a carbon mass basis and counting full fuel cycle greenhouse gas emissions.

A. Introduction

President Clinton has committed the United States to at least stabilizing its emissions of greenhouse gases at 1990 levels by 2000. In order achieve this target and realize further reductions in U.S. greenhouse gas emissions beyond 2000, in keeping with the goals of the global warming treaty, new initiatives will need to be taken to reduce fossil fuel consumption and resulting carbon dioxide (CO2) emissions. The United States will be developing and analyzing various options this summer as it revises its climate action plan. Policies and programs to increase energy efficiency are likely to top the list of new initiatives because of their availability, cost effectiveness, and ability to significantly reduce CO2 emissions.

This paper proposes and analyzes ten national energy efficiency initiatives. Each initiative would be led by the Federal government, but would leverage significant amounts of private investment in energy efficiency measures. The improvements in energy efficiency that would result from these initiatives are cost effective for society, i.e., the resulting energy savings more than pay for the initial investments. In this manner, energy efficiency improvements are able to cut CO2 at a net negative cost (i.e., with economic benefits for the nation).[1]

B. Energy Efficiency Initiatives

The ten targeted energy efficiency initiatives are summarized in Table 1. The energy efficiency programs as a whole are designed to: 1) generate a high level of private investment in energy efficiency, 2) accelerate the implementation of cost-effective efficiency measures and reduce energy demand in all sectors of the economy, and 3) complement ongoing energy efficiency programs at the Federal, state, and local levels. The energy efficiency programs would be based primarily at DOE, although a few are based at other agencies such as EPA or HUD. New legislative authority may be needed in order to undertake some of the initiatives. Also, a number of the initiatives would be implemented through the states, where activities such as building codes or weatherization of low-income households are traditionally based.

The rationale for and descriptions of the ten initiatives are provided below, along with key assumptions about the effectiveness of each initiative. Our estimates of CO2, energy, and economic impacts are presented in the next section of the paper.

1. Green Technology Programs

The Global Change Division of the U.S. EPA is sponsoring a set of "Green Programs" devoted to saving energy and thereby preventing pollution. These are voluntary

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[1] Other major studies of the cost of cutting carbon dioxide emissions reach the same conclusion. For example, see OTA 1991a and NAS 1992.

programs such as Green Lights, Energy Star Computers, and the Golden Carrot Super-Efficient Refrigerator Program. The initial results for these programs are very encouraging. For example, over 700 organizations joined the Green Lights program by the end of 1992; Intel has agreed to incorporate energy-savings features into its microprocessors in response to the Energy Star Computer program; and 25 utilities have pooled $30 million in incentives to accelerate the commercialization of highly efficient, non-CFC refrigerators (EPA 1992). The Green Technology efforts concentrate on increasing the efficiency of electricity use, where cost-effective energy savings of 30-70 percent are possible (Fickett, Gellings, and Lovins 1990).

This initiative involves expanding the EPA Green Programs and greatly increasing their overall funding. Total Federal funding for the programs would be increased to $150 million per year, over ten times their budget in recent years. New funding would be used to: 1) increase promotion within current programs, 2) extend the Green Lights concept to other major energy end uses in buildings and to the industrial sector, 3) extend the Energy Star concept to other types of equipment such as printers, air conditioners, or cooking equipment, and 4) extend the Golden Carrot concept to other products such as heat pumps, clothes washers, or clothes dryers. The Green programs complement R&D and implementation efforts sponsored by U.S. DOE, EPRI, GRI, and other organizations.

Based on information provided by EPA, we estimate that every dollar of Federal expenditure on Green Programs will lead to about $30 of total investment in energy efficiency measures during 1994-2010. We further estimate primary energy savings of 57 billion Btus/yr on average per million dollars invested. By rapidly scaling up the EPA Green Programs and extending them to a wide range of end uses and technologies in the residential, commercial, and industrial sectors, primary energy savings could reach 2,650 trillion Btus/yr by 2000 and 4,630 trillion Btus/yr by 2010.

2. Light Vehicle Fuel Economy Improvement

The rated fuel economy of new cars and light trucks (known as light vehicles) peaked at about 26 miles per gallon (mpg) in 1988 and has recently hovered around 25 mpg. Short of another oil crisis, substantial increases in fuel economy will only occur if there are new Federal policies specifically directed at improving vehicle efficiency, such as stronger CAFE standards, a program of fees and rebates, or an expanded gas guzzler tax.

The original CAFE standards were the main reason manufacturers nearly doubled the average fuel economy of new cars between 1975 and 1988 (Greene, 1990). Tougher CAFE standards can have a similar effect in the future. However, substantial investments are needed to develop new vehicles and retool for their production. Although automakers continually upgrade their products in order to remain competitive, there is justification for providing investment assistance to the automotive industry in conjunction with mandated fuel economy improvements. Assisting with capital investments for production of more efficient vehicles in the United States also would enhance the competitiveness of our auto industry.

We propose a $2 billion annual investment assistance program, in conjunction with steady increases in automobile and light truck fuel economy such that a minimum 40 percent overall improvement is achieved within ten years and a 75 percent overall improvement is achieved by 2010.[2] This would entail achieving an average new car fuel economy of 40 mpg in 2003 and 50 mpg in 2010, with proportionate increases for light trucks. The investment assistance program would allocate grants to automakers for capital expenditures associated with new or retooled facilities needed to build efficient vehicles (or components for efficient vehicles) in the United States. The assistance program would be paid for by expanding the coverage of the current gas guzzler tax, such that the tax starts to phase in on cars and light trucks that are below average efficiency in their product class. The program would be revenue neutral in the context of the auto industry and market. Thus, the program does not require new Federal expenditures.

To qualify for a grant, automakers would make proposals showing product plans for vehicles that will exceed the CAFE standards in their model year of release. If automakers do not comply with strengthened CAFE standards, we suggest that they be required to repay their grants to the Federal government (i.e., the grants could be converted to loans). Other details of such a program, including where it is administered, terms of grant applications, restrictions, and other issues, will have to be worked out.

Coupled with strengthened CAFE standards, the Federal investment assistance would leverage substantial private investments in energy efficiency measures. As more efficient vehicles penetrate the on-road vehicle stock, the annual energy savings and CO2 reductions from this initiative will grow rapidly. Of our ten initiatives, this proposal provides the second largest savings by 2000 and the largest savings by far in 2010. Increasing light vehicle fuel economy is crucial for achieving long-term mitigation of global warming.

3. **Industrial Energy Efficiency Initiatives**

There are many opportunities for energy efficiency improvements in the industrial sector. One study sponsored by DOE shows that industrial energy intensity could be reduced by 24% through investments in cost-effective efficiency measures (Carlsmith et al. 1990). EPRI estimates that energy efficiency measures could cut industrial electricity use by 24-38 percent by 2000 (Faruqui et al. 1990). Increasing materials recycling and reuse also would cut industrial energy use (Lewis and Morris 1993).

A variety of obstacles hamper industrial energy efficiency efforts, however. Outside of a few industries, energy is a small cost of production and plant managers are more concerned about capacity, output, and product quality. In many industries, energy

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[2] Efficiency improvements of this magnitude are technically economically feasible based on technologies that are already available or expected to be available in the next few years. See Ross et al. 1991; DeCicco and Ross 1993.

conservation projects must offer a payback of two years or less in order to be implemented (Geller et al. 1991). And some industries lack capital or technical know-how.

In order to accelerate industrial energy efficiency improvements and enhance the competitiveness of American industry, we are proposing a combination of: 1) obtaining voluntary corporate commitments to implement a large fraction of cost-effective energy efficiency measures, 2) establishing voluntary energy intensity reduction targets for each industrial sector, 3) expanding technical assistance, demonstration and training programs, 4) encouraging more effective utility energy efficiency programs for industrial customers, and 5) setting up a energy productivity fund that would enable small and medium-size companies to obtain low-interest loans or loan guarantees. The total Federal cost for these activities is estimated to be $500 million per year when the programs are fully phased-in four years.

Following the example of the EPA Green Lights program, individual companies could be encouraged to make a voluntary high-level commitment to implement all energy efficiency measures and process modifications that offer a rate of return equal to or greater than their cost of capital. This could lead to much greater pursuit of energy efficiency opportunities within industries. The energy intensity reduction targets would be established by DOE, with input from industry and other interested parties, as voluntary targets for each industrial sector as a whole. Voluntary targets along these lines were successfully implemented in the past (DOE 1980).

Two activities build on successful but small-scale projects already occurring at DOE, the Energy Analysis and Diagnostic Centers (EADC) program and the National Industrial Competitiveness through Efficiency: Energy, Environment, Economics (NICE3) program. These programs provide technical assistance to small and medium-size industries, train industrial energy managers, and demonstrate advanced energy efficiency and waste minimization technologies. In addition, DOE should help utilities design more effective energy efficiency programs for industrial customers, building on the success that some utilities have had in this area.

To complement these information, promotion, demonstration and technical assistance programs, we propose establishing a new energy productivity fund. The fund would be used to reduce the effective interest rate on private capital borrowed by industries for projects that reduce energy intensity, prevent pollution, and enhance competitiveness. Industries could also use the fund for collateral to secure private loans where necessary.

Considering the experience with the EADC program as well as the fact that the fund can leverage substantial private capital if it is well-designed, we assume that each Federal dollar spent in this area will leverage six dollars of total investment in efficiency improvements. Based on broad experience with industrial energy efficiency improvements, we assume a 2.5 year payback and ten year measure lifetime on average (Alliance to Save Energy 1983; Ross 1987). This implies 100 billion Btus of primary energy savings per million dollars of investment.

4. State-Based Loan Program for Home Weatherization

While many electric utilities offer demand-side management programs, few gas utilities offer such programs. For homes using oil, propane and other fuels, such programs are non-existent. In many states, even electric demand-side management programs are limited. Other residential energy conservation programs developed during the 1970s have since been abandoned (e.g., the Federal Solar Energy and Energy Conservation Bank, which was administered by HUD and implemented by states). As a result, most middle-income homeowners have nowhere to turn if they need assistance financing energy efficiency measures. In order to help fill this gap, several states have used oil overcharge funds to provide low-cost loans to homeowners wanting to implement energy efficiency measures. However, as these funds run out, most of these programs are ending. A Federal program which provides grants to states to operate energy efficiency loan programs for middle-income home owners would allow these programs to continue, and would allow additional states to offer such programs.

We propose allocating $400 million per year to this effort (with a two year phase-in). Assuming that utilities add $1 for every $2 of Federal money, financing would be available for approximately 600,000 home retrofits annually. This level of activity and financing is consistent with the experience of a model loan program run for four years in Massachusetts (DOER 1993). Under the proposed program, homeowners would receive zero interest loans from local banks and utilities. State energy offices would contract with the banks and utilities to pay interest costs.

Based on the Massachusetts experience, a typical loan for heating system improvements, insulation, and other weatherization measures will average approximately $4000. Loan subsidies and administrative costs average about $1000 per loan, and thus total investment levels will be about four times the cost to the government (DOER 1993). Based on the experience of the Solar Energy and Energy Conservation Bank and other retrofit programs, we assume that these home retrofits have an average simple payback of four years and average lifetime of 15 years (OTA 1992).

5. Support for State Building Code Adoption and Implementation

All states have some form of energy efficiency requirements for new buildings, typically in state building codes. Approximately 30 states have mandatory statewide requirements while the other 20 leave the decision on code adoption to local jurisdictions (NCSBCS 1991). While some state energy codes are based on recent standards developed by the Council of American Building Officials (CABO), the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and other organizations, the majority of state codes have not been updated since the 1970s or early 1980s (ASE 1991).

Substantial energy can be saved if states adopt up-to-date codes. For example, use of

the most recent major upgrade to the residential sections of the CABO Model Energy Code (CABO 1989) will result in energy savings of 15-20 percent (depending on climate) relative to earlier versions (ASE 1991). Similarly, use of the most recent ASHRAE standard for commercial buildings (ASHRAE 1989) will result in energy savings of approximately 15 percent relative to earlier versions (PNL 1987). New standards now under development will result in additional savings of approximately 20 percent for residential buildings (PNL 1992) and 30 percent or more for commercial buildings (ASHRAE 1992).

Furthermore, code adoption is only half the equation. If codes are not enforced, energy savings can be reduced dramatically. Analysis of code compliance in California estimated that immediately following adoption of a new code in 1988, only 50 percent of the energy savings embodied in the code were being captured. After extensive training and enforcement were undertaken, an estimated 75 percent of the available energy savings were being captured (Johnson 1992).

We propose that $25 million per year be provided to states to fund state-level code adoption, training, and enforcement efforts.[3] This level of funding is proportionally scaled to California's current level of energy code expenditures ($3.2 million). When this initiative is fully implemented, we assume it reduces energy use in new buildings by 15 percent on average. This assumption is derived from a combination of improved codes in some states and better code implementation in most states. Due to the time needed to ramp-up the program, we assume this level of savings is not achieved until the fifth year of the program. In the future, code updates are assumed to keep pace with efficiency improvements that would occur in the absence of codes, thereby maintaining the 15 percent average savings relative to prevailing construction practices.

6. RD&D on Improved Equipment Efficiency

The U.S. Department of Energy presently spends about $40 million annual on research, development, and demonstrations (RD&D) of new energy saving technologies for buildings. This research is primarily carried out by national laboratories and tends to be long-term in nature. Over the past 15 years this program has accelerated the commercialization of various energy efficiency measures, including electronic ballasts, low-emissivity window coatings, improved compressors for refrigeration equipment, and heat pump water heaters (Geller et al. 1987).

It would be useful to expand DOE's RD&D program on building technologies, particularly emphasizing RD&D funded jointly by the government and the private sector (ACEEE/ASE 1992). Many energy-saving technologies have been partially developed by manufacturers, but work to complete their development is proceeding slowly due to cutbacks

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[3] The Energy Policy Act of 1992 directs DOE to undertake a this type of state assistance program, but with a much lower funding authorization.

in private sector R&D budgets and/or manufacturer concerns that consumers will not be interested in energy-efficient equipment. Among the promising products whose commercialization could be accelerated by DOE co-funding are incandescent lamps that are 25-50% more efficient than today's products, microwave and heat pump clothes dryers, fuel cells for building applications, new "electronic" motors that operate at high efficiency even under part-load conditions, and high efficiency commercial air conditioning equipment (Nadel et al. 1993).

We propose that $50 million in Federal funds be added to building energy efficiency RD&D program each year, with the private sector required to match these funds dollar for dollar. Based on the results of just the three most successful DOE R&D efforts in the 1975-1985 period, we estimate that benefits in the tenth year of this initiative will be five times greater than the cumulative RD&D expenditures on all projects through that year (Brown, Berry and Goel 1989).[4] Energy savings and CO2 reductions are assumed to begin in the fourth year of the initiative, with linear increases thereafter for ten years. Savings then level off as efficiency gains from new projects are assumed to be offset by savings that would occur in the market in the absence of this program. Total investments by consumers in energy-efficient equipment are estimated assuming a three year simple payback period.

7. Reform Commuter Subsidies

Currently, the Federal government encourages single occupancy vehicles by allowing employers to provide their workers with free parking as a non-taxable benefit. The parking benefit is tax-exempt up to $155 per month, while employer reimbursement for mass transit use is only tax-exempt up to $60 per month. No tax-exempt benefit is available to cover other commuting costs incurred by workers who walk, bike, or rideshare (such as shared vehicle costs, other than workplace parking, in a carpool). The parking subsidy is also unfair to people who live in cities or small towns but do not drive to work.

We propose leveling the playing field between automobiles and other commuting modes by raising the tax-free benefit limit for mass transit use to $155 per month and by requiring that employers who offer a parking subsidy provide a the same benefit to their employees who do not drive to work. This would establish a broad, tax-exempt commuter allowance, based on the local market value of workplace parking, up to the current parking benefit limit.

Currently, about 91% of commuters go to work by private motor vehicle (Hu and Young 1992). About 90% of these receive free parking at a national average cost of $30 per month, amounting to an aggregate subsidy of $30 billion per year (Shoup 1992). Assuming that about 33% of the remaining 9% of workers are given a comparable general commuting

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[4] In other words, to be conservative, we assume only three highly successful projects, and ignore savings from all other projects.

subsidy implies an annual cost of $1 billion.

Energy savings would come from employees now driving who switch modes or rideshare in order to "cash-out" the commuter benefit. We estimate energy savings of 0.14 Quads/yr and fuel cost savings of $1.5 billion/yr by 1998. The savings increase slightly thereafter due to population growth (Spencer 1989). In making these estimates, we assume that the tax modification stimulates five percent of commuters to stop driving alone to work by 1998. There is no cost to the Federal government; in fact there will be a revenue windfall to the Treasury because those benefits now delivered as cash become taxable. We do not show the revenue gain here, but is addressed elsewhere (Shoup 1992).

8. **Public Housing Retrofits**

Each year, HUD spends about $2-3 billion subsidizing the energy bills for the 3.6 million tenants that live in HUD-assisted housing units, i.e., public housing and so-called "Section 8" housing (OTA 1991). Public housing units on average consume significantly more energy than privately owned multifamily housing -- one study indicated 65 percent greater energy use (Greeley et al. 1987). Reducing energy waste in public housing is a smart investment for the federal government since it will recoup this investment through reduced publicly-paid energy bills.

The potential for conserving energy, increasing occupant comfort, and improving the quality of public housing is very large. One comprehensive study estimated over 30 percent savings potential in public housing with an average payback period of 4.5 years (HUD 1988). Evaluations of actual public housing retrofits indicate that savings of around 20 percent are common, although comprehensive rehabilitation and retrofit has resulted in measured savings of 44 percent (Ritschard and MacAllister 1992).

We propose devoting $400 million per year to retrofitting HUD-assisted housing (with a two-year phase-in). The program would reach the entire eligible housing stock by about 2005. Assuming the more thorough rehab-retrofit strategy involving adding insulation, new windows where appropriate, and heating system upgrade or replacement, experience shows a cost of around $1,500, an annual end-use energy savings of 60 MBtu per housing unit, and a 15 year average measure lifetime (Ritschard and MacAllister 1992). This implies saving 58 billion Btu of primary energy annually per million dollars of expenditure. Also, there should be some leveraging of non-federal funds from utilities and other sources, say at the rate of $0.25 for every federal dollar.

9. **Retrofits of Federal Buildings**

Federal buildings consume 1 percent of national energy use at a cost of about $3.5 billion per year. Studies indicate that at least 25 percent energy savings are technically and economically feasible in federally owned or leased buildings (OTA 1991b). Despite an Executive Order that set a goal of a 20 percent reduction in average energy use per square

foot of floor area in federal buildings by 2000, little is being done to improve energy efficiency in federal buildings. In fact, total federal spending on energy efficiency improvements declined from about $300 million in 1981 to just $50 million in 1990 (OTA 1991b).

The Energy Policy Act of 1992 contains a wide range of provisions intended to increase the implementation of cost-effective efficiency measures. However, the Act does not provide an essential ingredient for making energy efficiency happen -- namely adequate funding. We propose investing $300 million per year to improve the energy performance of Federal buildings over a ten-year period.[5] With some use of utility rebates and energy service company financing, the total energy efficiency investment over a ten-year period could reach $4.2 billion, the level estimated to be necessary to achieve a 25 percent reduction in Federal energy use by the tenth year (Hopkins 1991).

Funding for Federal energy management should also be used for bulk purchases of energy-efficient products, particularly for new products where initial costs are still relatively high. This will help to establish markets for and reduce the cost of new energy efficiency measures. Savings from this type of action are not included in our analysis, but are included under other initiatives (e.g., the Green Technology Programs).

Based on the assumptions explained above, the level of energy savings would reach 105 trillion Btus/yr by 1998 and 210 trillion Btus/yr by 2003. The reduction in the Federal energy bill is estimated to be $280 million by 1995, $700 million by 1998 and $1.4 billion by 2003. Thus, the Federal government would save more than it invests beginning in the third year of the program.

10. **Low-Income Weatherization**

Low-income families typically spend about 25 percent of their income for energy and consume 20 percent more energy per square foot of living space compared to middle and upper income households (Vine and Reyes 1987). Because of inefficient housing and low family income, some poor families cannot afford to pay their utility bills. This results in energy bill subsidies from the federal government as well as utilities, or service cut-offs.

The Weatherization Assistance Program (WAP) based at DOE funds energy efficiency improvements in households with incomes up to 150 percent of the poverty level. The budget is currently $185 million per year. In addition, states are allowed to shift up to 15 percent of Low-Income Home Energy Assistance Program (LIHEAP) funds into weatherization. States have used about $130 million per year for this purpose in recent years (OTA 1992). Together, the WAP/LIHEAP efforts are serving about 250,000 households

[5] The investment package proposed by the Clinton Administration calls for spending $1.7 billion on Federal energy management during FY94-98.

annually, with about 3 million low-income units weatherized to date. Considering that there are 15-18 million eligible households that have not yet participated in the weatherization program, reaching them would take another 60-70 years at current rates. There is an urgent need to expand the program.

We propose increasing the WAP program by $500 million per year (with a two-year phase-in) in order to more than double the number of households served each year by federally-funded weatherization efforts. In addition, this level of federal support should attract some private funding through utility DSM programs and other sources. We assume that each federal dollar attracts $0.25 of private funds, meaning a total of $625 million per year of additional investments in low-income weatherization.

Based on improvements in program performance that have occurred in recent years in a number of states, it is reasonable to assume end-use energy savings of 25 million Btu/yr per unit weatherized, at an average cost of around $1,500 per unit, and a 15 year average measure lifetime (Schlegal et al. 1991). This implies about 25 billion Btu/yr of primary energy savings per million dollars invested. An additional 2.7 million low-income households would be weatherized by 2000 (6.9 million by 2010) as a result of this initiative.

C. Overall Energy, CO2 and Economic Savings

In performing our savings analysis, we considered: 1) the stream of federal investments in the ten programs during 1994-2010, 2) the stream of total investment in energy efficiency measures during this period resulting from the federal initiatives, 3) the expected primary energy savings during 1994-2010 resulting from the initiatives, 4) the corresponding reductions in CO2 emissions, and 5) the overall energy bill savings during 1994-2010 as a consequence of the energy efficiency actions. We have not estimated energy, CO2 or economic savings beyond 2010 even though large savings will continue to occur. Also, we have attempted not to "double count" energy savings that result from other energy efficiency efforts (e.g., appliance standards or utility DSM programs).

To estimate energy, economic and CO2 savings, each program was evaluated separately. For converting energy savings into avoided CO2 emissions, energy savings were allocated to different fuel types using assumptions about energy demand growth in the AEO93. For example, electricity savings were allocated to power plant type based on projections of new power plant fuel shares during 1990-2010. This provides internal consistency when comparing the reductions in CO2 emissions from the energy efficiency initiatives to the growth projections in the AEO93.

Our assumed CO2 emissions factors (emissions per unit of energy consumption) differ from those used in the AEO93, because the factors used by DOE ignore some of the upstream energy losses and associated emissions of other greenhouse gases. We used more complete emissions factors from another source (DeLuchi 1991), and applied these factors both to our energy savings estimates and the baseline energy consumption projections in the

AEO93.

For converting energy savings into energy bill reductions, we used the energy price projections in the AEO93, along with the original energy tax proposed by the Clinton Administration. Our energy price assumptions are shown in Table 2. For most of the programs, average sectoral energy prices (constant 1990 dollars per million Btus of primary energy) were used to estimate energy bill savings. For the two transportation-related programs, gasoline prices were used since the initiatives pertain to light vehicles. We did not try to adjust energy prices as a consequence reducing energy consumption on a large scale.

Implementing the ten targeted energy efficiency programs would directly cost the Federal government $3.2 billion in 1994, $3.8 billion in 1995, rising to $4.3 billion by 1997. The cost to the Federal government declines after 2000, however (Table 3). If the investment assistance for vehicle manufacturers is excluded since it has its own funding mechanism, the maximum Federal expenditure would be $2.3 billion per year. The net cost to the Federal government would be somewhat less because some of the programs (e.g., retrofits of Federal buildings and publicly assisted housing) would also cut Federal spending. In addition, tax receipts from businesses should rise as their energy bills fall and additional taxes would be collected through reforming commuter subsidies.

We estimate that the ten initiatives would result in about $8 billion per year of total investment in energy efficiency measures in 1994, $14 billion in 1995, and in the range of $20-23 billion per year thereafter (Table 4). The cumulative investment from 1994 through 2000 would be $132 billion, with about $230 billion invested in total the following decade. Vehicle efficiency improvements represent about 44 percent of the total energy efficiency investment, followed by Green Technology programs at 21 percent, industrial energy efficiency improvements at 12 percent and the home weatherization loan program at about 11 percent of the total.

For the set of initiatives as a whole, we estimate about $5.30 of total nationwide investment in energy efficiency for each Federal dollar. The programs that result in the greatest leveraging of private funds are the Green Technology programs and support for state building code activities.

We project that these initiatives would save about 3 Quads of primary energy within five years, growing to over 7 Quads by 2000, and nearly 18 Quads by 2010 (Table 5). Achieving savings of this magnitude would reduce national energy consumption by 7 percent in 2000 and by 17 percent in 2010, relative to current DOE projections (EIA 1993a). The Green Technology Programs, vehicle efficiency initiative, and industrial energy efficiency initiative provide the most energy savings.

Using our emissions factors, the avoided greenhouse gas emissions reach 144 million

metric tons (MT) of carbon by 2000, 8.7 percent of projected emissions that year according to the AEO93 energy forecast (Tables 6 and 8). The Green Technology programs provide the most carbon emissions reductions in 2000 (37 percent), followed by the vehicle fuel economy initiative (22 percent) and the industrial energy efficiency initiative (19 percent). With all ten efficiency initiatives, the United States would emit 1512 MT of carbon in 2000, 2.3 percent more than our estimated emissions in 1990. The ten efficiency initiatives would eliminate 81 percent of the projected growth in carbon emissions between 1990 and 2000, based on economic and activity growth levels in the AEO93 forecast. In order to keep carbon emissions in 2000 below their level in 1990, further efforts related to fuel switching, renewable energy promotion, and/or energy efficiency are necessary and feasible (ASE et al. 1991).

The carbon emissions reductions from the ten energy efficiency initiatives rise significantly during 2000-2010. The total projected carbon emissions reduction in 2010, 363 MT, is equivalent to 20 percent of projected emissions that year in the base case. Improving vehicle fuel economy provides the most carbon savings in 2010 (41 percent), followed by the Green Technology programs (26 percent) and industrial efficiency initiative (15 percent). Furthermore, projected total carbon emissions in 2010 in the high efficiency scenario, 1446 MT, is 2.2 percent less than estimated emissions in 1990. Thus, according to our estimates, the ten energy efficiency initiatives are sufficient to reduce national carbon emissions to below their level in 1990 early in the post-2000 decade.

The projected energy bill savings build up over time, reaching over $50 billion in 2000 and $166 billion in 2010 (Table 7). The Green Technology programs and vehicle efficiency improvements provide about two-thirds of the total projected bill savings. Each of the initiatives provides energy bill savings that are greater than the sum of Federal and private expenditures over the seventeen year period, although a few (e.g., low-income weatherization and home weatherization loans) do not "break even" until after 2000. Over the seventeen-year period, the estimated energy bill savings of over $1.3 trillion exceed the total investment requirements of $360 billion by about $975 billion.

Additional economic benefits will result when consumers reinvest their energy bill savings in sectors of the economy that are more labor-intensive than the energy industries. In other words, investing in energy efficiency can be considered a stimulus for long-term economic growth and employment as well as an improvement of economic efficiency (Geller, DeCicco, and Laitner 1992). An analysis of these issues indicates that the targeted energy efficiency programs along with the proposed energy tax could lead to a net increase in employment of around 560,000 jobs by 2003 (Laitner 1993).

D. Conclusion

By expanding current energy efficiency programs and starting new programs in key areas, the Clinton Administration could stimulate widespread energy efficiency improvements throughout the United States. A set of ten comprehensive energy efficiency initiatives could lead to nearly a 9 percent reduction in projected CO2 emissions in 2000, leaving emissions only 2 percent above the level in 1990. Early in the post-2000 decade (i.e., by 2003), these targeted energy efficiency policies and programs would return CO2 emissions to their level in 1990. By 2010, CO2 emissions would fall 2.2 percent below their level in 1990. Of course, complementing the targeted energy efficiency programs with an energy tax, accelerated adoption of renewable energy technologies, and shifting to less carbon-intensive fossil fuels would lead to even greater reductions in U.S. CO2 emissions.

The beauty of energy efficiency investments is that save consumers money, help businesses become more competitive, and lead to a net increase in jobs in the U.S. economy. CO2 emissions are cut while the economy becomes more productive and economically efficient. We estimate that the ten proposed energy efficiency initiatives would cut energy bills paid by households and businesses by over $1.3 trillion during 1994-2010, in return for an overall investment (public and private) of $360 billion. In addition, there could be a net increase of approximately 560,000 jobs in the United States within ten years. Other benefits from the energy efficiency initiatives include a reduction in our trade deficit, enhanced energy security, and substantial reductions in other pollutants associated with energy use.

Limiting CO2 emissions in 2000 to their level in 1990, with significant reductions thereafter, thus requires prompt and aggressive action. Energy use and CO2 emissions increased in the United States over the past five years in spite of weak economic growth. Much will need to be done to get the United States "back on the energy efficiency track." Taking quick and strong action on energy efficiency should be embraced rather than resisted, as it offers a win-win strategy for the domestic economy and the global environment.

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TABLE 1

PROPOSED ENERGY EFFICIENCY INITIATIVES (1)

EXPAND THE "GREEN TECHNOLOGY" PROGRAMS

Increase funding to $150 million per year for programs that promote voluntary manufacture of energy-efficient products and installation of energy efficiency measures.

LIGHT VEHICLE FUEL ECONOMY IMPROVEMENT

Adopt tougher fuel economy standards, expand the gas guzzler tax program, and provide up to $2 billion per year to auto manufacturers for investments needed to make cars and light trucks more energy efficient.

UNDERTAKE INDUSTRIAL ENERGY EFFICIENCY INITIATIVES

Establish targets, promote voluntary energy efficiency commitments, increase technical assistance and training, provide loan guarantees and interest rate buydowns, and demonstrate innovative industrial process improvements.

HOME WEATHERIZATION LOAN PROGRAM

Allocate $400 million per year to state-based low-interest loan programs for housing retrofits by middle-income homeowners.

SUPPORT BUILDING CODE ADOPTION AND IMPLEMENTATION

Provide $25 million per year for state-level building code adoption, training, and compliance efforts.

EXPAND RD&D ON IMPROVED EQUIPMENT EFFICIENCY

Increase Federal funding by $50 million per year for research, development and demonstration of new energy savings technologies, with matching funding from the private sector.

LEVELIZE TAX BENEFITS FOR COMMUTERS

Require employers to offer the same tax-free benefit to commuters who drive cars, use mass transit, or other use other non-automobile-based transport modes.

TABLE 1 (cont.)

PROPOSED ENERGY EFFICIENCY INITIATIVES (1)

PUBLIC HOUSING RETROFITS

Devote $400 million per year to retrofitting HUD-assisted housing.

RETROFITS OF FEDERAL BUILDINGS

Devote $300 million per year to upgrading the energy performance of Federally-owned buildings.

LOW-INCOME WEATHERIZATION

Increase the Federal Weatherization Assistance Program by $500 million per year.

(1) Funding levels refer to programs at full phase in.

Table 2. Energy Price Assumptions (end-use purchase prices, $/MBtu primary)

As used to compute savings:	1994	1995	2000	2005	2010
Residential	6.50	6.66	7.26	7.78	8.33
Commercial	5.17	5.35	6.01	6.58	7.20
Industrial	4.04	4.23	4.89	5.41	5.98
Transportation (gasoline only)	9.74	9.89	11.01	11.81	12.68
Resid. + Comm. average price	5.90	6.07	6.70	7.24	7.82
Green Programs average price	5.23	5.41	6.05	6.59	7.19
Energy tax levels:					
Residential	0.04	0.11	0.22	0.22	0.22
Commercial	0.04	0.11	0.21	0.21	0.21
Industrial	0.05	0.14	0.28	0.28	0.28
Transportation (gasoline only)	0.10	0.30	0.60	0.60	0.60
As given by DOE AE093:					
Residential	6.46	6.55	7.04	7.56	8.11
Commercial	5.13	5.24	5.80	6.37	6.99
Industrial	3.99	4.09	4.61	5.13	5.70
Transportation (gasoline only)	9.64	9.59	10.41	11.21	12.08

Table 3. Federal Expenditures (Million 1990$)

Program	1994	1995	2000	2005	2010	Cumulative through 2000	Cumulative through 2010
Low-income weatherization	250	500	500	500	500	3,250	8,250
Public housing retrofits	200	400	400	400	0	2,600	4,600
Federal building retrofits	300	300	300	0	0	2,100	3,000
Green Technology Programs	150	150	150	150	150	1,050	2,550
State building code adoption	25	25	25	25	25	175	425
RD&D for equipment efficiency	50	50	50	50	50	350	850
Home weatherization loans	133	267	400	400	400	2,400	6,400
Industrial sector efficiency	50	100	500	500	500	2,400	7,400
Improve auto fuel economy	2,000	2,000	2,000	2,000	2,000	14,000	34,000
Commuter subsidy reform	0	0	0	0	0	0	0
TOTAL	3,158	3,792	4,325	4,025	3,625	28,325	67,475

Table 4. Total Public and Private Expenditures (Million 1990$)

Program	1994	1995	2000	2005	2010	Cumulative through 2000	Cumulative through 2010
Low-income weatherization	312	625	625	625	625	4,062	10,312
Public housing retrofits	250	500	500	500	0	3,250	5,750
Federal building retrofits	420	420	420	0	0	2,940	4,200
Green Technology Programs	2,370	6,270	5,440	2,960	780	49,110	75,980
State building code adoption	250	250	250	250	250	1,750	4,250
RD&D for equipment efficiency	100	100	952	1,719	1,858	2,681	19,387
Home weatherization loans	800	1,600	2,400	2,400	2,400	14,400	38,400
Industrial sector efficiency	300	600	3,000	3,000	3,000	14,400	44,400
Improve auto fuel economy	2,900	3,800	8,300	11,800	13,800	39,200	157,700
Commuter subsidy reform	0	0	0	0	0	0	0
TOTAL	7,702	14,165	21,887	23,254	22,713	131,793	360,379

Table 5. Energy Savings (Quads, primary)

Program	1994	1995	2000	2005	2010	Cumulative through 2000	Cumulative through 2010
Low-income weatherization	0.008	0.023	0.102	0.178	0.230	0.383	2.206
Public housing retrofits	0.014	0.044	0.188	0.336	0.292	0.710	3.714
Federal building retrofits	0.021	0.042	0.147	0.210	0.210	0.588	2.625
Green Technology Programs	0.170	0.480	2.650	4.020	4.630	9.990	49.820
State building code adoption	0.013	0.038	0.315	0.630	0.945	1.009	7.624
RD&D for equipment efficiency	0.000	0.000	0.427	0.713	0.713	1.084	7.931
Home weatherization loans	0.031	0.091	0.516	0.913	1.192	1.865	11.213
Industrial sector efficiency	0.030	0.090	1.440	2.850	3.000	4.320	30.900
Improve auto fuel economy	0	0	1.444	4.011	6.655	3.527	46.330
Commuter subsidy reform	0.028	0.056	0.143	0.149	0.157	0.704	2.206
TOTAL	0.315	0.864	7.371	14.010	18.024	24.181	164.569

Table 6. Carbon Emissions Reductions (million metric tons per year)

Program	1994	1995	2000	2005	2010	Cumulative through 2000	Cumulative through 2010
Low-income weatherization	0.1	0.4	1.7	3.0	3.9	6.4	37.1
Public housing retrofits	0.2	0.7	3.2	5.6	4.9	11.9	62.4
Federal building retrofits	0.4	0.8	2.7	3.9	3.9	10.9	48.8
Green Technology Programs	3.5	9.7	53.8	81.6	94.0	202.8	1011.3
State building code adoption	0.2	0.7	6.0	12.0	18.0	19.3	145.6
RD&D for equipment efficiency	0.0	0.0	7.6	12.7	12.7	19.3	141.2
Home weatherization loans	0.5	1.6	9.0	15.9	20.7	32.5	195.1
Industrial sector efficiency	0.6	1.7	26.9	53.3	56.1	80.8	577.8
Improve auto fuel economy	0.0	0.0	32.3	89.8	149.1	79.0	1037.8
Commuter subsidy reform	0.6	1.3	3.2	3.3	3.5	15.8	49.4
TOTAL	6.2	16.9	146.5	281.2	366.8	478.7	3306.6

Table 7. Energy Bill Savings (Million 1990$)

	Program	1994	1995	2000	2005	2010	Cumulative through 2000	Cumulative through 2010
10	Low-income weatherization	52	153	741	1,384	1,916	2,705	17,109
8	Public housing retrofits	91	293	1,365	2,613	2,432	5,014	28,637
9	Federal building retrofits	109	225	883	1,381	1,512	3,390	16,960
1	Green Technology Programs	889	2,595	16,037	26,506	33,276	58,392	325,266
5	State building code adoption	77	231	2,110	4,559	7,391	6,581	55,463
6	RD&D for equipment efficiency	0	0	2,857	5,157	5,574	7,143	57,260
4	Home weatherization loans	200	605	3,749	7,100	9,933	13,195	87,060
3	Industrial sector efficiency	121	381	7,042	15,407	17,940	20,449	167,085
2	Improve auto fuel economy	0	0	15,894	47,381	84,389	38,193	555,245
7	Commuter subsidy reform	273	554	1,571	1,766	1,986	7,461	25,370
	TOTAL	1,812	5,037	52,247	113,255	166,350	162,523	1,335,454

Table 8. Summary of Climate Action Initiatives Results

a) SUMMARY BY PROGRAM (ordered by year 2000 impact)	Federal spending M$/yr			Carbon emission cuts MT/yr	
Program	1994	1995	2000	2000	2010
1 Green Technology Programs	150	150	150	53.8	94.0
2 Improve auto fuel economy	2,000	2,000	2,000	32.3	149.1
3 Industrial sector efficiency	50	100	500	26.9	56.1
4 Home weatherization loans	133	267	400	9.0	20.7
5 State building code adoption	25	25	25	6.0	18.0
6 RD&D for equipment efficiency	50	50	50	5.3	8.9
7 Commuter subsidy reform	0	0	0	3.2	3.5
8 Public housing retrofits	200	400	400	3.2	4.9
9 Federal building retrofits	300	300	300	2.7	3.9
10 Low-income weatherization	250	500	500	1.7	3.9
TOTAL	3,158	3,792	4,325	144.2	363.0

b) AVOIDED CARBON EMISSIONS (MT/yr)	1990	2000	2010
DOE AE093 Baseline Emissions	1341	1501	1641
Baseline adjusted for non-CO2 gases	1478	1656	1809
Reductions from efficiency initiatives	--	144	363
Efficiency scenario emissions	--	1512	1446
Percent reduction below adjusted baseline	--	8.7%	20.1%
Percent change from 1990 level	--	2.3%	-2.2%

NOTE:
Annual spending is given in millions of constant 1990$ (M$/yr).
Carbon emissions are given as millions of metric tons per year (MT/yr), on a carbon mass basis and counting full fuel cycle greenhouse gas emissions.