# *The Climate Change Action Plan as an Economic Development Strategy for the United States*

Skip Laitner

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# I. Introduction and Summary

Energy-related carbon emissions in the Unites States have reached an all-time high. Emissions from the nation's use of fossil fuels climbed to 1,373 million metric tons (MMT) in 1993, an increase of 32 MMT (2.5%) relative to 1992, and 35 MMT (2.6%) compared to 1990. The estimates are based upon newly available data from the U.S. Department of Energy.[1]

The jump in carbon emissions largely results from a 4.9 percent increase in economic activity since 1990. This was partially offset by a 1.5 percent decrease in the amount of energy consumed per dollar of Gross Domestic Product (GDP) between 1990 and 1993. A change towards less carbon-intensive fuels offset emissions by another 0.6 percent in that same period.[2]

The increase in U.S. carbon emissions in 1993 was the first significant hike since 1990. In fact, carbon emissions in 1993 were already higher than the level projected for 1995 in the Administrations' Climate Change Action Plan (CCAP) for 1995. This is troubling in light of the Framework Climate Change Convention, and the commitment of industrialized nations to return to 1990 emission levels by the year 2000.[3]

The Administration plan proposes a series of 44 carbon reduction initiatives to achieve the year 2000 target. Of the 44 initiatives, 22 involve energy efficiency improvements in the nation's buildings, industries and transportation systems. The balance of the initiatives involve changes in the nation's fuel mix, improvements in the energy delivery systems, reductions in methane and other greenhouse gas emissions, and changes in forestry management practices to increase carbon sequestration.[4]

Full implementation of the CCAP is critical to U.S. efforts to reduce growth in greenhouse gas emissions. But the jump in energy-related carbon emissions last year, along with the recent plunge in oil prices and other factors, suggest that Congress and

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1. The 1993 emissions are preliminary estimates completed by ACEEE using 1993 data from the Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(94/02), Washington, DC, March 1994; and *Emissions of Greenhouse Gases in the United States 1985-1990*, DOE/EIA-0573, Washington, DC, September 1993.

2. The influences on the 1993 growth in carbon emissions are taken from a decomposition analysis by ACEEE using data from the *Monthly Energy Review*, op. cit.

3. President William J. Clinton and Vice-President Albert Gore, Jr., *The Climate Change Action Plan*, Washington, DC, October 1993.

4. These initiatives are summarized in the "Summary of Individual Actions" found in the *Climate Change Action Plan*, op. cit.

the Administration will need to take further actions beyond those proposed in the climate change plan in order to achieve the target for the year 2000.[5]

But there is good news in almost any effort to meet, or even to exceed the CCAP target. The energy efficiency investments that underpin most of the carbon reduction strategies can help save American homes and businesses billions of dollars. Moreover, they help restore sagging productivity levels, create new employment opportunities for American workers, as well as reduce overall emissions of greenhouse gases. Thus, meeting the Administration's year 2000 target would not only be good for the environment, it would also be good for the economy.

Building on a previous study that demonstrated a positive link between job creation and energy efficiency investments,[6] the American Council for an Energy-Efficient Economy (ACEEE) sought to determine whether the Administration's climate plan would also increase the employment and income opportunities for the United States. In this current analysis we evaluated only the energy efficiency initiatives outlined in the climate plan; they are a primary means for reducing greenhouse gas emissions. We assumed that the energy efficiency initiatives within the plan will be fully implemented, and that they achieve the level of energy savings projected by the Administration.

The Climate Change Action Plan calls for cumulative investment of $64 billion in energy technologies and programs in the period 1994 through the year 2000. These investments would result in cumulative energy bill savings of $266 billion through the year 2010.[7] In effect, the benefits outweigh the costs by more than 4 to 1, according to the Administration's evaluation of the plan.

The analysis in this report rests on a rather simple notion — that energy efficiency will lead to economic efficiency; and that economic efficiency, in turn, will strengthen the nation's employment opportunities. As summarized in the Table 1 on the following page, we estimate that the climate plan will lead to 157,000 more jobs by the year 2000 compared to a "business-as-usual" scenario without the plan. The net increase in employment nearly doubles to 260,000 jobs by 2010.

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5. See, Howard Geller, John DeCicco, Neal Elliot, Daniel Lashof and Marika Tatsutani, "Bridging the Gap: Initiatives to Achieve President Clinton's Climate Commitment," American Council for an Energy-Efficient Economy and Natural Resources Defense Council, Washington, DC, April 1994.

6. See, Howard Geller, John DeCicco, and Skip Laitner, *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies*, American Council for an Energy-Efficient Economy, Washington, DC, October 1992.

7. The details of the economic analysis of the Administration assumptions can be found in, Office of Policy, Planning and Program Evaluation, *The Climate Change Action Plan: Technical Supplement*, U.S. Department of Energy, Washington, DC, March 1994.

In addition, we estimate that the nation's GDP would also rise by $4.6 and $8.7 billion in the years 2000 and 2010, respectively, as a result of implementing the energy efficiency initiatives in the climate plan. Thus, the Administration's proposals will benefit the United States both economically and environmentally. It should be fully funded and vigorously implemented.

**TABLE 1. CCAP SUMMARY ECONOMIC IMPACT**

| Impact | Year 2000 | Year 2010 |
|---|---|---|
| Efficiency Investment | $13,700 | $0 |
| Energy Savings | $9,100 | $20,800 |
| Employment | 157,400 | 260,000 |
| Labor Income | $4,300 | $7,100 |
| GDP | $4,600 | $8,700 |

Note: All values are in millions of 1993 dollars, except employment which reflect actual totals.

# II. Explaining Input-Output Analysis

One tool that can assist in the evaluation of macroeconomic benefits of the CCAP is referred to as input-output analysis — sometimes called multiplier analysis. An input-output model is a tool to examine the economic makeup of a national or regional economy. For example, in the petroleum sector, an input-output model can identify how much of the total revenues generated by petroleum sales are used to support local jobs and their associated payrolls. It can also be used to evaluate how energy alternatives will increase or decrease the total employment base within the United States.

This study applies input-output analysis to evaluate the impact energy efficiency initiatives in the CCAP. The approach is based upon two scenarios:

(1) A **Baseline Case** that reflects continuation of existing energy policies and trends in energy consumption and carbon emissions through the year 2000 and 2010; and

(2) An **Action Plan Case** that anticipates a reduction of U.S. greenhouse emissions to 1990 levels by the year 2000 through a series of 22 cost-effective energy efficiency initiatives and other actions designed to reduce all greenhouse gases.

The employment impact analysis incorporated a variety of investments and savings as described in CCAP. The resulting difference in expenditures between the two scenarios was fed into an input-output model designed by ACEEE based upon the IMPLAN database.[8] The input-output model generated an estimate of total employment, wage and salary income, and GDP benefits that are likely to result from the difference in the two scenarios.

In effect, input-output analysis can be thought of as a means to evaluate and sum the job and income benefits (i.e., the outputs) that are likely to results from changes in business and consumer spending patterns (the inputs) created by the Climate Change Action Plan. To determine the total economic impact of any technology investment — for example, the installation of more efficient motors in a manufacturing plant — three separate effects or influences must be evaluated.

The first influence is the *direct effect* which refers to the work done by an electrical contractor hired to complete the efficiency upgrade. The second is the *indirect effect* which includes any operation necessary to support the work of the contractor. This might include, for instance, the work of design professionals, wholesale suppliers, manufacturers, component suppliers and lenders. The last is the *induced effect* which includes the respending of wages by those directly and indirectly employed by a project. This might include money spent for groceries, educational expenditures, recreational activities, or new clothes.

The sum of these three effects yields the *total effect* of a given expenditure, in this case an investment in more efficient motors. Even at this point the analysis is incomplete since it only deals with the direct, indirect and induced effects of the efficiency investment itself. To generate a complete impact analysis of the upgrade, three additional impacts must be evaluated for their respective direct, indirect, and induced effects. These three additions to the analysis are the revenue, substitution, and displacement impacts.

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8. *Micro IMPLAN Users' Guide*, Version 91-F, Minnesota IMPLAN Group, Inc., Stillwater, MN, March 1994. Persons who wish to contact the Minnesota IMPLAN Group about the economic database directly can call (612) 439-4421.

The *revenue impact* accounts for the lost benefits of diverting money away from some other economic activity and into the efficiency investment. This is a negative influence on the overall net benefit. The *substitution impact* refers to the net savings (or loss) generated by the installation of the more energy-efficient technology. In effect, the new technology is a "substitute" for some amount of energy use. If that amount generates a net savings, the result is increased spending equal to the energy bill savings.

The *displacement impact*, on the other hand, is the loss of revenues to energy suppliers as a result of the efficiency upgrade. All or part of the revenues might be an economic loss to the United States.

Since each sector of the economy supports a different level of wage and salary income and employment, the overall income and employment levels will increase or decrease as total expenditures change in response to a given policy. The effect of each change in expenditure can then be represented by a total multiplier.

The positive employment and income results shown in this study are due primarily to the relatively low labor intensity of the energy sectors (including coal, oil and gas extraction, fuel refining, and electric and gas utilities) compared to the economy as a whole. For example, spending $1.0 million for the purchase of electric utility services supports a total of 16 jobs, directly and indirectly.

The nation's industrial and commercial sectors, however, support between 33 and 40 total jobs per million dollars of electricity bill savings, respectively. Thus, shifting investment from energy supply to energy efficiency, and lowering business and consumer energy bills (enabling greater purchase of non-energy goods, equipment, and services) lead to a net addition of jobs and income throughout the economy. Table 2 provides a more detailed listing of the labor intensities among the different economic sectors included in this study.

# III. Steps in the Analysis

There were essentially four steps in setting up a complete impact analysis of the energy efficiency initiatives in the Climate Change Action Plan. They include: (1) setting up a framework for the analysis; (2) developing the relevant sectoral multipliers; (3) identifying the role of energy efficiency and its related expenditure patterns; and (4) completing the analysis by matching the relevant multipliers with changes in business and consumer expenditures. These steps are described in turn. Section IV will then review the results of the analysis itself.

## A. Establish Analytical Model

The input-output framework used in the analysis is the IMPLAN database previously mentioned. This database provides the needed information to adequately describe the economy in such a way as to evaluate the economic changes brought about by variations in consumer and business expenditures. Hence, the first step in the analysis was to download the available data and format it for use in a spreadsheet input-output model. There are four issues which should be noted at this point, however.

First, input-output models such as IMPLAN require the use of producer rather than consumer prices. In other words, the model imposed a requirement that the expenditure for any product sold at the wholesale or retail level be allocated to both the producing and trade sectors. This requirement mostly affected petroleum sales which were allocated to mining, refining, wholesale trade (including transportation of bulk commodities), and the government sectors. The latter sector was needed to capture the collection of various sales taxes.

Second, while IMPLAN contains details for as many as 528 sectors of the U.S. economy, only 12 selected sectors of the model were actually used in the analysis. These were based upon the energy sectors within the U.S. economy, as well as the basic end-use sectors described in the climate plan. The list of sectors together with their appropriate multipliers is provided in Table 2 of section III-B. Given the level of detail offered in the CCAP technical supplement, it was difficult to utilize a larger model. Despite this level of aggregation, the resulting impacts described in Table 1 offer a clear pattern of benefits associated with the energy efficiency initiatives in the climate plan.

Third, surrogates were used for the energy efficiency investment sectors and for the bulk sales and distribution of fossil fuel products. In the case of efficiency investment activities, a subset of the construction sectors was used as the surrogate. Although this scheme will likely not match the precise spending pattern of efficiency investments, a sensitivity analysis was performed to see how the results would change under a variety of spending patterns.

The biggest influence in the final set of multipliers associated with efficiency investments is the assumed level of foreign imports. The assumption used here is that such investments will reflect the same level of local content as used by U.S. construction firms and special trade contractors. The resulting multipliers, therefore, are reasonably conservative and provide a useful indicator of employment impacts from the efficiency improvements.

In the case of the bulk distribution of energy supplies, we adapted information from the wholesale sector within IMPLAN to convert energy purchase patterns into the equivalent of producer prices. Unfortunately, IMPLAN does not have a great detail of detail about the wholesale trade sectors which made it difficult to narrowly define these activities with respect to energy sales. While this specific adaptation provided a reasonable description of overall impact, it tended to overstate (or understate) the precise impact within the trade sectors as they affected energy sales.

Fourth, the base-year data used in the IMPLAN model was for the year 1990. However, the pattern among sectoral multipliers will change vary little between 1990 and the year 2000. Moreover, the limitations of the 1990 database were minimized by the overall project design. For example, all dollar and job values were converted to 1990 dollars prior to being used in the analysis. Future employment impacts were also deflated by the annual productivity rate assumed in the climate plan — one percent through the year 2010.

## B. Develop Relevant Multipliers

Table 2, on the following page, provides the job, income and GDP multipliers used to match each transaction (or change in expenditure pattern) brought about by the climate action plan.

To summarize, the job multipliers represent the direct, indirect, and induced effect for a one million dollar expenditure delivered as final demand for each of the identified sectors. The labor income multipliers — in effect, the wages and salaries earned by the labor force — reflect the direct, indirect, and induced income for each dollar of final demand delivered to each of the sectors. The GDP (value-added) multipliers reflect the direct, indirect and induced value-added contributed by each dollar delivered as final for each of the respective sectors. The data are all adapted from the IMPLAN model, adjusted for the sectors shown in the table.[9]

9. Actually, the multipliers shown in Table 2 were never used in the analysis. Rather, the net impacts (shown in Tables 5a and 5b) were estimated by multiplying a 12 by 12 total requirements matrix for employment, income and GDP times a 1 by 12 final demand matrix. In this way, the modeler can identify the sector by sector impact from a change in final demand in one or more sectors. The multipliers only represent a summary of the impact in all sectors brought about by changes in final demand.

| TABLE 2. MULTIPLIERS FOR KEY ECONOMIC SECTORS | | | |
|---|---|---|---|
| **Sector** | **Jobs (Per Million Dollars)** | **Labor Income (Per Dollar)** | **GDP (Per Dollar)** |
| Coal Mining | 20.0 | 0.6050 | 1.0370 |
| Oil/Gas Mining | 10.5 | 0.2642 | 1.0973 |
| Oil Refining | 8.2 | 0.2322 | 0.9166 |
| Wholesale Petroleum | 37.6 | 1.0289 | 1.7435 |
| Retail Sales | 48.0 | 1.0394 | 1.7301 |
| Electric Utilities | 16.1 | 0.3978 | 0.9650 |
| Natural Gas | 10.5 | 0.2785 | 0.9039 |
| Efficiency Investments | 36.4 | 0.8371 | 1.4155 |
| Industry | 33.2 | 0.8174 | 1.5029 |
| Commercial | 39.9 | 0.8253 | 1.5520 |
| Government | 41.6 | 1.0238 | 1.5616 |
| Households | 29.6 | 0.6380 | 1.1912 |

Source: Derived from the 1990 IMPLAN database for the United States as described in the text.

A quick review of the multipliers table reveals an important point. When looking at the jobs column of Table 2, the energy sectors have the smallest employment multipliers. Petroleum refining, natural gas utilities, and electric utilities show a total impact of 8.2, 10.5 and 16.1 jobs, respectively, per million dollars of revenue. If we compare these to the commercial and industrial sector values of 39.9 and 33.2 jobs, respectively, we can conclude that lower energy bills mean dollar savings will likely be spent in sectors with a stronger employment impact.

## C. Determine Appropriate Expenditure Patterns

The third step in this analysis is to identify the expenditure patterns associated with the two scenarios. More importantly, we need to isolate the role of energy efficiency within the CCAP policy scenario. With that in mind, the broad outline of the two scenarios are briefly described. The role of efficiency investments in mitigating carbon emissions are reviewed and the cost assumptions associated with the key periods of analysis — the years 2000 and 2010 — are then presented.

### 1. Baseline Case

The starting point for the Administration's baseline scenario for energy was the reference case in the Energy Information Administration's (EIA's) *Annual Energy Outlook 1993* (AEO 1993).[10] Some minor adjustments in economic assumptions led to a projected energy consumption level of 94.1 quadrillion Btus (Quads) in the year 2000, an 11 percent increase compared to 1990 levels. This was largely driven by an increase in total economic activity.

The baseline forecast was that Gross Domestic Product (GDP) would rise from $4,887 billion in 1990 to $6,153 billion in the year 2000, a 25.9 percent increase in that time. Total energy expenditures were forecasted to increase from $416.2 billion in 1990 to $485.7 billion in the year 2000, a smaller 17 percent increase in energy expenditures when compared to the growth in economic activity.[11]

In 1990, total emissions of greenhouse gases and energy-related carbon emissions were estimated to be 1,462 and 1,338 million metric tons of carbon equivalent (MMT), respectively. The baseline analysis suggested that in the year 2000 carbon emissions would grow to 1,568 and 1,445 MMT, respectively. The information is summarized in Table 3 on page 11.

### 2. Action Plan Case

Once a baseline scenario had been established, the Administration began to identify a series of mitigation strategies to reduce overall greenhouse gas (GHG) emissions. The greenhouse gases included carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

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10. Energy Information Administration, *Assumptions for the Annual Energy Outlook 1993*, DOE/EIA-0527(93) (Washington, DC, January 1993).

11. All dollar values referenced in Table 3 are in constant 1987 dollars.

Based upon the 44 strategies that were eventually included in the Climate Change Action Plan, the Administration indicated a 109 MMT reduction in the emission of greenhouse gases. In other words, instead of a projected 1,568 MMT emissions in the year 2000, the Administration estimated that overall emissions could be held to 1,459 MMT.

Energy-related emissions, as Table 3 indicates, were estimated to fall to from 1,445 to 1,379 MMT in the year 2000. Economic activity, as measured by the growth in GDP, was anticipated to remain at the baseline level. As we shall see later in the study, GDP is expected to rise slightly over the baseline scenario as a result of the action plan.

The energy savings referenced in Table 3 reflect both efficiency and supply-side savings.[12] According to the action plan, expenditures and program activities would begin in 1994 and continue through the year 2000. Total federal and private expenditures through 2000 were forecasted to be $63,845 million (in 1991 dollars). Cumulative energy savings to consumers and businesses through the year 2010 were estimated at $265,600 million (also in 1991 dollars). Thus, the plan indicates a benefit-cost ratio of 4.2 through 2010.[13]

### 3. The Role of Energy Efficiency

From Table 3 we can see that energy-related carbon emissions account for more than 90 percent of all GHG emissions. Under the climate plan energy efficiency improvements account for about one-half of the total GHG emission reductions. The balance of the improvements are assumed to come from increased methane recovery actions in landfills and agriculture, the reduction in use of HFC, PFC and nitrous oxide, and increased forestry benefits as increased tree plantings, reduced forest depletion, and recycling absorb more of the available carbon emissions.

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12. According to the climate plan, the reduction in energy-related carbon emissions is achieved by implementing improvements in energy efficiency (actions 1 through 22) as well as by changes and improvements in energy supply strategies (actions 23 through 31). The impact analysis considered in this study, however, reflects only the energy efficiency actions.

13. The investment total cited here does not reflect the reduction in federal tax obligations from the proposed reform of the federal tax subsidy for employer-provided parking (CCAP action 19). Presumably the money would have to be spent in any event.

**TABLE 3. KEY CCAP ECONOMIC DATA AND ASSUMPTIONS**

| | 1990 | 2000 Baseline | 2000 CCAP |
|---|---|---|---|
| Gross Domestic Product (billion 1987 dollars) | 4,887 | 6,153 | 6,153 |
| Energy Intensity (Btus/$GDP) | 17,352 | 15,293 | 14,855 |
| Primary Energy Consumption (Quads) | 84.8 | 94.1 | 91.4 |
| National Energy Bill (billion 1987 dollars) | 416.2 | 485.7 | 477.4 |
| Carbon Emission Coefficients (MMT/Quad) | 15.78 | 15.36 | 15.09 |
| Carbon Emissions (MMT) | 1,338 | 1,445 | 1,379 |
| Total Greenhouse Gas Emissions (MMT) | 1,462 | 1,568 | 1,459 |

**Source:** *The Climate Change Action Plan: Technical Supplement*, Office of Policy, Planning and Program Evaluation, U.S. Department of Energy, Washington, DC, March 1994.

Since the employment impact analysis is based only on the benefits from energy efficiency investments, the balance of the discussion in this report will focus on the energy-related carbon emissions shown in Table 3.

In simplified terms the level of energy-related carbon emissions is a function of three things. The first is an increase in economic activity which tends to increase overall energy consumption. The next is an improvement in energy efficiency which decreases overall energy use. The last is a change in the mix of fuels. Moving to less carbon-intensive fuel utilization will lower carbon emissions.

The interaction of these factors lead to a projected level of carbon emissions that can be summarized by the equation (1), as follows:

$$Carbon_{2000} = Carbon_{1990} * (GDP_{2000}/GDP_{1990}) * (EI_{2000}/EI_{1990}) * (CI_{2000}/CI_{1990}) \quad (1)$$

Where

$Carbon_{2000}$ = Total carbon emissions in million metric tons
$GDP_{2000}/GDP_{1990}$ = Change in GDP from 1990 to year 2000 in constant dollars
$EI_{2000}/EI_{1990}$ = Change in energy intensity, 1990-2000, in Btus per dollar of GDP
$CI_{2000}/CI_{1990}$ = Change in carbon intensity, 1990-2000, in MMT per Quad

The information in Table 3 provides the needed data to illustrate how each of these three factors are applied in equation 1 to generate emission estimates for the year 2000. From the data we know that economic activity as measured by GDP is projected to rise by 25.91 percent in years 1990 to 2000. This is true for both the baseline and CCAP scenarios.

On the other hand, the energy intensity in the year 2000 baseline scenario, as measured by the number of Btus per dollar of GDP, is projected to fall to 88.14 percent of the 1990 level. Finally, the carbon intensity, expressed as the ratio of carbon emissions per unit of energy consumed, is also expected to fall to 97.32 percent of the 1990 level. This results, for example, from the increased use of natural gas which emits less carbon than either coal or petroleum.

Plugging these figures into equation (1) generates the following result:

$$\text{Carbon Baseline} = 1{,}338 * 1.2591 * 0.8814 * 0.9732 = 1{,}445 \text{ MMT} \qquad (2)$$

In short, the three effects combine to increase energy-related emissions from 1,338 to 1,445 MMT from 1990 to 2000. The Administration's plan, on the other hand, yields the following result:

$$\text{Carbon CCAP} = 1{,}338 * 1.2591 * 0.8561 * 0.9562 = 1{,}379 \text{ MMT} \qquad (3)$$

Thus, the net effect of the climate plan is to decrease the nation's energy intensity by 2.53 percentage points (from 0.8814 to 0.8561) and to decrease carbon intensity by 1.70 percentage points (from 0.9732 to 0.9562). Stated differently, about two-thirds of the carbon reductions are from efficiency while the balance is from fuel-switching.[14]

While this methodology accurately captures the change in carbon emissions, it understates the full contribution of energy efficiency measures in the climate plan. This is because

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14. We can show even more carbon reduction benefits by referencing data from another study on the potential for energy efficiency. Titled *America's Energy Choices* (AEC), the 1991 study suggested that by the year 2000, cost-effective energy efficiency investments might lower the nation's energy intensity ratio to 81.67 percent of the 1990 average. This, in turn, would reduce the carbon emissions well beyond the CCAP scenario. Holding all coefficients to the values shown in equation (3) generates the following impact in the year 2000:

$$\text{Carbon AEC} = 1{,}338 * 1.2591 * 0.8167 * 0.9562 = 1{,}316 \text{ MMT}$$

The value shown in the equation above indicates an emission level of only 1,316 MMT in the year 2000. The result is 22 MMT below the 1990 values shown in Table 3 compared to the Administration's plan which is 41 MMT above the 1990 levels. The macroeconomic impacts of the AEC scenario is briefly compared to the climate plan in section VI of this study.

much of the fuel switching (from more carbon-intensive coal to less carbon-intensive natural gas) is the result of implementing the efficiency measures in the first place.

According to the climate plan, total energy-related emissions will decrease by 66 MMT. Of that amount, the energy efficiency actions (items 1 through 22 in the plan) are responsible for a drop of 54 MMT. This implies that the efficiency actions account for closer to 82 percent of the energy-related carbon emissions.[15]

## 4. Year 2000 and 2010 Expenditure Patterns

The primary focus of the climate plan is in the years 1994-2000. All of investment activities are assumed to occur in this time frame. A reasonable amount of detail is provided within the technical supplement of the Department of Energy to enable us to construct an efficiency expenditure profile for the year 2000. This is summarized in Table 4a. The results are presented in millions of 1991 dollars as they estimated from data contained in the technical supplement.[16]

The Administration anticipates that its climate plan will spur a total energy-efficiency investment of $13,252 million in the year 2000. The overwhelming majority of these funds will come from the private sector. Cumulative energy savings in that year are estimated to be $9,041 million. At that point in time, it is clear that the investments will not have yet paid for themselves. Despite this stretched-out payback period, there is still a significant level of net macroeconomic benefit that results from the plan — as we shall see in section IV.

The technical supplement provides considerably less detail for the outlying years from 2001 through 2010. This required a number of adjustments to be made in order to establish an expenditure pattern for the year 2010. The results of those adjustments are summarized in Table 4b.

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15. See the summary table of the individual actions in, *Climate Change Action Plan*, op. cit.

16. See, *The Climate Change Action Plan: Technical Supplement*, op. cit., Appendices A and D. Persons who are interested following up on questions about the technical supplement should contact either DOE's Howard Gruenspecht at (202) 586-4767, or John Conti at (202) 586-4430.

## Table 4a. Key Expenditure Data For Year 2000
(In Millions of 1991 Dollars)

| Savings By Fuel | | Expenditure Summary By End-Use Sector | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Investment | | | | |
| Fuel | Savings | Sector | Federal | Private | Total | Energy Savings | Net Savings |
| Petroleum | 3,770 | Residential | 64 | 6,800 | 68,64 | 3,615 | -3,249 |
| Natural Gas | 200 | Commercial | 59 | 4,500 | 4,559 | 1,695 | -2,864 |
| Coal | 91 | Industrial | 44 | 1,300 | 1,344 | 3,305 | 1,961 |
| Electricity | 4,980 | Transportation | 15 | 470 | 485 | 425 | -60 |
| Total | 9,041 | Total | 182 | 13,070 | 13,252 | 9,041 | -4,211 |

## Table 4b. Key Expenditure Data For Year 2010
(In Millions of 1991 Dollars)

| Savings By Fuel | | Expenditure Summary By End-Use Sector | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Investment | | | | |
| Fuel | Savings | Sector | Federal | Private | Total | Energy Savings | Net Savings |
| Petroleum | 4,530 | Residential | 0 | 0 | 0 | 8,560 | -8,560 |
| Natural Gas | 3,050 | Commercial | 0 | 0 | 0 | 3,610 | -3,610 |
| Coal | 130 | Industrial | 0 | 0 | 0 | 8,040 | 8,040 |
| Electricity | 12,500 | Transportation | 0 | 0 | 0 | 0 | 0 |
| Total | 20,210 | Total | 0 | 0 | 0 | 20,210 | -20,210 |

Source: Calculated from data on actions 1 through 22 found in *The Climate Change Action Plan: Technical Supplement*, Office of Policy, Planning and Program Evaluation, U.S. Department of Energy, Washington, DC, March 1994.

To derive the 2010 expenditures, we assumed that investments in the industrial and building applications would have a life of only 15 years. Hence, the energy savings in year 2010 for these measures would no longer reflect activities completed in 1994 and 1995.

Fortunately, the climate plan assumes only a very small level of activity in those earlier years and, as a result, the savings were only modestly adjusted (downward). For the transportation measures, we assumed an eight-year life. This means that in the year 2010, there are no remaining savings from efficiency investments in transportation made prior to the year 2000.[17] This adjustment was consistent with the assumptions in *America's Energy Choices*.[18]

Since the action plan was based upon the 1993 *Annual Energy Outlook*, we applied the energy prices in the reference scenario for the year 2010 to the remaining energy savings left in the climate plan. As shown in Table 4b, that implies a total energy bill savings of $20,210 million. The savings are the result of remaining investments made up to and including the year 2000.

## D. Complete the Analysis

At this point, the basic input-output model has been completed. We can understand how these steps fit together within a completed analysis by setting up a simple problem to solve. Finally, we discuss how the expenditure patterns are translated into changes in final demand that will be actually used to determine the net macroeconomic impacts.

### 1. Working Through an Example

To illustrate the technique of applying input-output data to an efficiency scenario, let us use the example of a purchase of a more efficient heating, ventilation and air conditioning (HVAC) unit in a commercial building. The technique matches differences in expenditure patterns, referred to as changes in final demand, with their appropriate sectoral multipliers.

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17. For the annual savings through the year 2000, see Tables 20, 24, 26 and 30 of the *Technical Supplement*, op. cit.

18. Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, and the Union of Concerned Scientists, *America's Energy Choices: Investing in a Strong Economy and a Clean Environment*, published by the Union of Concerned Scientists, Cambridge, MA, 1991.

In this example, we want to know what would be the net job benefit based upon the $1.0 million incremental cost of the more efficient HVAC unit over a less efficient unit. Let us assume that with the $1.0 million efficiency investment the electric bill will drop by $0.25 million annually over a 15-year period. This implies a 15-year electric savings of $3.75 million.

At this point we need to match the proper change in final demand with the correct job multipliers found in the Table 2, earlier. In this example there are four such calculations to be made and summed. These are shown as follows:

(1) Investment Impact = $\$1.0_{\text{HVAC}} * 36_{\text{efficiency}} = 36_{\text{jobs gained}}$

(2) Revenue Impact = $-\$1.0_{\text{revenue loss}} * 40_{\text{commercial}} = -40_{\text{jobs lost}}$

(3) Electricity Impact = $-\$3.75_{\text{electric bill}} * 16_{\text{electric utility}} = -60_{\text{jobs lost}}$

(4) Savings Impact = $\$3.75_{\text{utility bill savings}} * 40_{\text{commercial}} = 150_{\text{jobs gained}}$

Net Impact = $86_{\text{net jobs in 15-year period}}$

In this example, total employment will be increased by 86 job-years compared to buying a less-expensive HVAC system. When averaged over 15-years, it means the investment supports an average of almost 6 new jobs each year of 15-year period. This net benefit includes the direct, indirect and induced effects of all four sets of expenditures. Similar calculations would be done for the wage and salary and value-added multipliers to generate estimates of net income and GDP benefits.

## 2. Changes in Final Demand

Before we were able to estimate the macroeconomic impacts of the climate plan, we had to make a number of adjustments to the expenditure patterns shown in Tables 4a and 4b. First, all expenditures were converted to 1990 dollars to properly match the base-year of the IMPLAN data. This was done using sector-specific deflators estimated from data provided by the Bureau of Economic Analysis and the Energy Information Administration.[19]

19. The deflators were based upon price deflators found in the *Survey of Current Business*, Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC, July 1992 and February 1994, pages S-5 and S-6. This was supplemented by energy cost data from the March 1994 issue of *Monthly Energy Review*, op. cit.

Second, the investments and energy bill savings in Tables 4a and 4b were allocated as changes in spending among each of the 12 sectors identified in Table 2. For example, energy bill savings in the residential sector became, in effect, purchases of other goods and services. The residential allocation scheme was based upon the personal consumption expenditure pattern contained in the IMPLAN model. Similarly, it was assumed that businesses would respend their savings (or relinquish any losses) in a similar manner as other revenues or income they might receive (or losses they might incur).

Third, it was assumed that about 50 percent of the petroleum savings would be from imports. The Administration assumed a 100 percent import replacement at the margin. However, to maintain a conservative estimate of net impacts, we used the 50 percent figure since it more closely reflected current import levels.[20]

Fourth, all labor estimates in the years 1994 through 2010 were adjusted to reflect productivity changes. For purposes of this analysis, it was assumed that labor productivity will increase by an average of 1.0 percent per year. This is the same assumption made by the Administration and it reflects the average productivity rate over the last decade.

Finally, no parameters were established to account for either changes in interest rates or in labor participation rates as a result of the analysis. These impacts are expected to be minimal, however. The reason is that the employment gains from the climate plan represent only about one-tenth of a percent of the employed workers.

20. A sensitivity analysis of this assumption suggested that the Administration's assumption of replacing 100 percent of the imported oil would increase the net employment benefit by about 9,000 jobs in the year 2000. Similarly, assuming a zero import replacement would decrease employment by the same amount.

## Table 5a. Energy Efficiency Impacts in Year 2000

| Sector | Final Demand | Jobs | Labor Income | GDP |
|---|---|---|---|---|
| Coal Mining | ($55) | (1,429) | ($76) | ($117) |
| Oil/Gas Mining | ($719) | (5,893) | ($150) | ($951) |
| Oil Refining | ($593) | (345) | ($24) | ($120) |
| Energy Wholesale | ($701) | 2,459 | $94 | $149 |
| Retail Sales | ($138) | (49) | ($1) | ($2) |
| Electric Utilities | ($5,239) | (13,639) | ($489) | ($1,852) |
| Gas Utilities | ($260) | (1,503) | ($61) | ($178) |
| Efficiency Investments | $14,027 | 121,325 | $3,341 | $4,308 |
| Industry | $935 | 54,642 | $1,786 | $3,156 |
| Commercial | ($4,027) | 16,020 | $377 | $718 |
| Government | ($1,510) | (15,570) | ($555) | ($538) |
| Households | ($49) | 1,423 | $11 | $11 |
| Total | $1,670 | 157,440 | $4,253 | $4,585 |

**Note:** All values are in millions of 1993 dollars, except jobs which are actual totals.

## Table 5b. Energy Efficiency Impacts in Year 2010

| Sector | Final Demand | Jobs | Labor Income | GDP |
|---|---|---|---|---|
| Coal Mining | ($72) | (2,798) | ($165) | ($252) |
| Oil/Gas Mining | ($820) | (11,716) | ($330) | ($2,088) |
| Oil Refining | ($292) | (238) | ($18) | ($91) |
| Energy Wholesale | ($124) | 7,175 | $304 | $479 |
| Retail Sales | $264 | 7,628 | $218 | $321 |
| Electric Utilities | ($12,645) | (30,107) | ($1,193) | ($4,516) |
| Gas Utilities | ($3,295) | (8,705) | ($389) | ($1,137) |
| Efficiency Investments | $1,854 | 9,609 | $292 | $377 |
| Industry | $7,304 | 94,063 | $3,395 | $6,002 |
| Commercial | $7,574 | 197,839 | $5,148 | $9,791 |
| Government | ($643) | (5,087) | ($200) | ($194) |
| Households | $19 | 2,124 | $19 | $19 |
| Total | ($875) | 259,785 | $7,081 | $8,710 |

Note: All values are in millions of 1993 dollars, except jobs which are actual totals.

While the higher cost premiums associated with the energy efficiency investments might be expected to drive up the level of borrowing (in the short-term) and, therefore, interest rates, this upward pressure would be offset by the investment avoided in new power plant capacity, exploratory well drillings, and new pipelines. Similarly, while an increase in demand for labor would tend to increase the overall level of wages (and thus lessen economic activity), the modest job benefits are small compared to the current level of unemployment or underemployment. Hence the effect would be negligible.

# IV. Analytical Results

Tables 5a and 5b summarize the net impact of Climate Change Action Plan for the years 2000 and 2010. Each table provides the sector-by-sector change in final demand as derived from the expenditures shown in Tables 4a and 4b (based upon the allocation pattern referenced in section III-D, above). Successive columns provide the net gain (or loss) in jobs, labor income, and GDP. All dollar values are in millions of dollars. They have been reinflated from 1990 to 1993 dollars to provide a more current interpretation of the results. The employment figures reflect productivity changes through 2000 and 2010, respectively.

One comment should be made on the final demand changes at this point. To balance the model as shown in the example in section III-D, each positive change in final demand should be offset by a negative impact. The total initial change in final demand should therefore be zero.

Both Tables 5a and 5b, however, show a figure different than zero. The reason is that each change in final demand may be affected by the import or export of a variety of goods and services. Hence, the column total under the final demand vector will more than likely not equal zero. With that note of caution established, we will now review the results for the years 2000 and 2010.

## A. Year 2000 Impacts

Despite an efficiency investment that has not been fully recovered by the year 2000, there are substantial net benefits shown in Table 5a. The overall economy is ahead by nearly 157,000 jobs as a result of the energy efficiency investments made in the climate action plan. For every job lost under the climate plan, about five jobs are created.[21] Moreover, both labor income and GDP are up by $4.3 and $4.6 billion, respectively.

21. Total employment gains from Table 5a are 195,869 jobs. Employment reduction from reduced energy spending is estimated to be 38,428. That produces a positive gain-to-loss ratio of 5.10.

One of the reasons the economy is shown to be ahead is the number of jobs from the investment activities compared to energy bill savings. Of the net 157,000 jobs, more than 121,000 are in the efficiency investment sector. In other words, about 77 percent of the net employment gain in the year 2000 is from the investment activities.

The industrial sector also shows a strong employment gain of nearly 55,000 jobs. Table 4a provides a clear reason for this circumstance. It is the only major end-use sector that reveals a net savings by the year 2000. Government spending is down, however, as a function of both lower receipts from reduced gasoline sales, and from its own efficiency investments which have not been fully amortized in the year 2000. In the latter case, the assumption is that the government sector would share in the energy efficiency improvements carried out by the commercial sector as a whole.

Interestingly, both the commercial and energy wholesale sector[22] have a small positive employment benefit. This is despite a negative final demand in both sectors. The reason is that the positive spending in the industrial and efficiency investment sectors indirectly compensate for negative change in final demand. But this does not appear to carry over to the government sector. Examining the results for the wholesale sector can help explain such a result.

It turns out that the $701 million drop in final demand for the wholesale services reduces total U.S. employment by a total of 22,978 jobs. Of this amount, 11,658 jobs are lost in the wholesale sector directly. At the same time, the net positive change in final demand for all other sectors increase the demand for wholesale services by a total of 14,117 jobs. The difference between the positive 14,117 and the negative 11,658 jobs yields the small but positive gain of 2,459 jobs as presented in Table 5a. Because of these indirect impacts, the reader should be careful not to necessarily draw a one-to-one relationship between the changes in final demand and the resulting economic benefits.

As might be expected, the energy supply sectors are the bigger losers. Adding up their losses reveals a total loss of just over 20,400 jobs. Here too a cautious interpretation is warranted, however. These are not jobs lost in the strictest sense of 20,400 people being given pink slips in the year 2000 as a result of the CCAP policies. Instead, it reflects a drop in employment compared to what might exist under the baseline scenario.

For example, a recent forecast by the U.S. Department of Labor suggests that energy supply sectors will, in the aggregate, lose jobs at the rate of about 0.2 percent annually

22. The energy wholesale sector largely reflects the bulk distribution and transportation of coal and petroleum products.

through the year 2005.[23] Under the CCAP 2000 scenario, this loss would increase to only 0.3 percent per year. But the additional one-tenth of one percent loss in jobs leads to a much greater net benefit for the economy. Hence, the decreases shown in Table 5a represent as much of an opportunity or transition cost as it does a job loss within the energy industries. One indication of this circumstance is the growing number of utilities which are expanding employment opportunities in customer-based energy efficiency programs even while they are reducing staff within their production areas.

## B. Year 2010 Impacts

By the year 2010 a different story unfolds. The efficiency investments made during the period 1994-2000 have long ago since paid for themselves. All that influences the final set of impacts in Table 5b are the sector-by-sector energy bill savings. By 2010, the economy has a net gain of nearly 260,000 jobs. Income and GDP have increased by $7.1 and $8.7 billion, respectively.

The energy supply sectors sustain a loss of nearly 46,000 jobs in the year 2010 compared to the baseline scenario. The continued loss of tax revenues from the energy supply sectors continues to influence government jobs in a negative manner. All other sectors show a strong contribution to the nation's employment base, however.

There is one other minor point worth noting from Table 5b. This refers to the net loss in final demand compared to the impact shown in Table 5a. The reason is that the level of energy bill savings respent on imported goods is greater than the revenue losses to American energy supply companies.

## C. Other Economic Benefits

In recent years economic activity in the United States has been constrained by relatively low levels of productivity improvement. In successive decades ending in 1970, 1980 and 1990, for example, multifactor productivity grew at annual rates of 1.8, 0.6 and 0.9

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23. This estimate is based upon data taken from, Bureau of Labor Statistics, *Outlook 1990-2005*, U.S. Department of Labor, BLS Bulletin 2402, Washington, DC, May 1992, pages 56-60.

percent annually.[24] Programs to improve energy efficiency will likely also improve multifactor productivity in the United States.

The CCAP technical supplement contains little insight on this point for either the years 2000 or 2010. However, we can adapt the CCAP data for the year 2000 and apply it to historical data to see whether efficiency improvements might have made a difference. Table 6 summarizes this analysis.

**Table 6. Illustrating Gains in Multifactor Productivity (MFP)**

| Scenario | GDP | Investment | Jobs | Energy | MFP |
|---|---|---|---|---|---|
| 1980 | $3,776 | $594 | 113,700 | 76.0 | n/a |
| 1990 | $4,897 | $747 | 138,800 | 81.3 | 7.07% |
| 1990 Alternative | $4,901 | $747 | 138,912 | 78.6 | 7.38% |

**Notes:** Historical data is taken from a variety of sources, including *Economic Report of the President* (Washington, DC, February 1994), and the *Monthly Energy Review*, previously cited. GDP and Investment are in billions of 1987 dollars while jobs are in thousands of workers. Energy is in quadrillion btus. The 1990 Alternative scenario adapts the CCAP impacts and uses the data to adjust the values for 1990. The multifactor productivity (MFP) is the 10-year change since 1980. Finally, MFP was calculated according to the technique outlined in Bureau of Labor Statistics, *BLS Handbook of Methods*, U.S. Department of Labor, Bulletin 2414, Washington, DC, September 1992, pages 94-97.

Using the data shown in Table 6, multifactor productivity in the U.S. grew by 7.1 percent in the period 1980 to 1990. Adjusting the 1990 benchmark year to reflect comparable 10-year benefits found in the Administration's climate action plan, it appears that productivity could have grown 7.4 percent, about 0.3 percent more than it actually

24. As used here, multifactor productivity is found by dividing the GDP growth by the weighted average of the growth in labor, capital and energy. Changes in multifactor productivity reflect changes in a number of factors which affect production such as changes in technology, capacity utilization, research and development, skill of the work force, and management improvements. See, for example, Bureau of Labor Statistics, *Monthly Labor Review*, U.S. Department of Labor, Washington, DC, June 1993. Table 45 of that document contains indices of multifactor productivity for selected years.

did. Although the issue needs to be explored more thoroughly, the information suggests a small but positive productivity change from the hypothetical efficiency investments.[25]

A large number of energy efficiency investments, especially those in the industrial sector, yield a significant level of other secondary benefits. These typically include achieving "other economic goals like improved product quality, lower capital and operating costs, or specialized product markets."[26] To the extent these "co-benefits" are realized in addition to the energy savings, multifactor productivity can be further enhanced. This, in turn, can lead to additional gains in employment and income for the United States.

# V. Extending the Efficiency Benefits

The CCAP contains only a limited set of 22 energy efficiency initiatives that rely primarily on voluntary participation. Also, the plan contains only limited initiatives in the transportation sector, and it only considers investments through 2000. There is a growing body of literature that point to significant opportunities to capture cost-effective energy savings well beyond those identified in the Administration plan.

Adopting more comprehensive, stronger and longer-term policies could have even greater energy, economic and environmental benefits. This point is supported by comparing the job benefits of the climate plan with the potential benefits highlighted in a 1992 ACEEE employment study entitled, *Energy Efficiency and Job Creation.*[27]

In that earlier ACEEE study we compared a high efficiency scenario for all end-use sectors of the economy with a business-as-usual scenario.[28] The high efficiency scenario assumed extensive efficiency improvements in all sectors of the economy — more efficient vehicles, improved appliances, better insulated buildings, more efficient lighting, manufacturing improvements, and the like.

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25. Among the issues to be explored would be the net impact of efficiency improvements on investment. Here it was assumed that investments in efficiency improvements would exactly offset investments in traditional energy supplies. To the extent that efficiency improvements reduce overall investment requirements, the investment total shown in the 1990 alternative scenario would decrease slightly. The effect would be to show a further increase in multifactor productivity.

26. Office of Technology Assessment, *Industrial Energy Efficiency*, Congress of the United States, Washington, DC., September 1993, page 65.

27. Also previously cited.

28. The high efficiency scenario used in the 1992 jobs study was based upon the market case scenario in *America's Energy Choices*, op. cit.

The efficiency measures were either commercially available technologies or prototypes for which cost and performance data were available. All were shown to be cost-effective on a conventional life-cycle cost analysis. The additional investment in energy efficiency averaged $46 billion per year through 2010 compared to the CCAP average annual investment of less than $10 billion through 2000.

The investments in the ACEEE high efficiency scenario result in about 20 percent less energy consumption in 2010 compared to less than three percent for the climate plan. As a result, energy use per unit of GDP fell 2.4 percent per year on average through 2010 under the ACEEE scenario. That rate parallels the decline in U.S. energy intensity during 1973-1986. Under the CCAP assumptions, however, the decline (when estimated through the year 2010) would be only 0.8 percent.

Using an input-output modeling technique similar to the one used in this analysis, we estimated that *nearly 500,000 additional jobs* could be created by the year 2000 if cost-effective energy efficiency improvements are widely adopted throughout the economy. This is three times the level of benefit offered by the Administration plan.

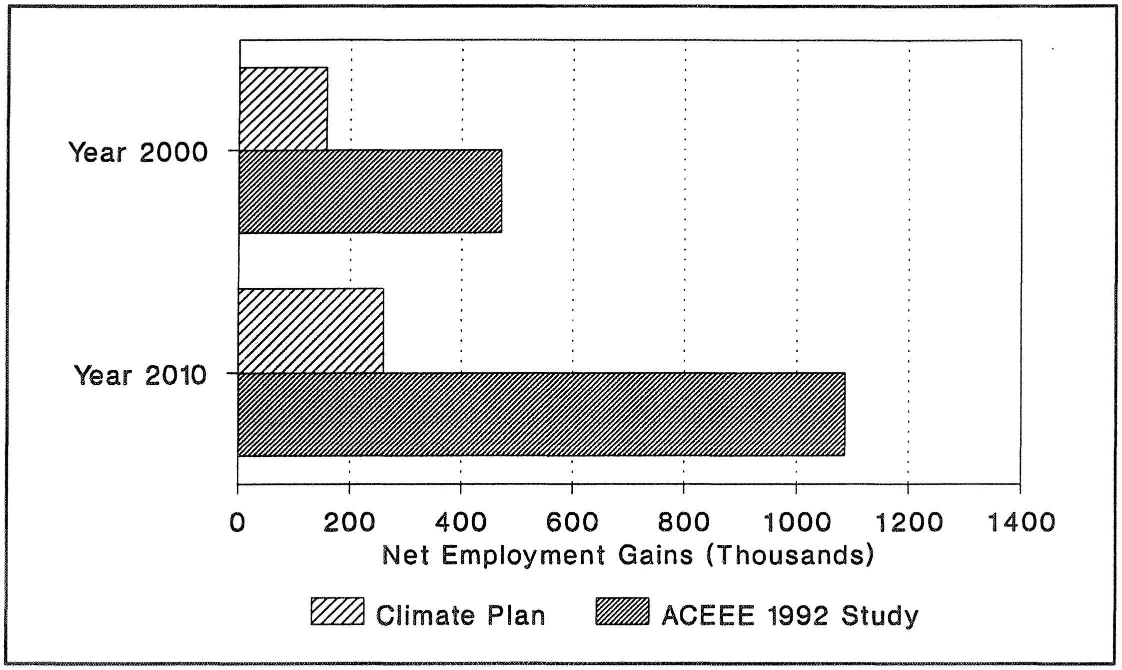
By extending the scope of investments beyond the year 2000, the ACEEE study indicated the potential for an additional 1.1 million jobs by 2010 — more than four times the impact of the climate plan. These comparisons are summarized in Figure 1 on the following page.

# VI. Conclusion

The Climate Change Action Plan announced by the Clinton Administration in October 1993 makes sense — both as an important economic development strategy for the United States, and as a strategy to also protect the global environment. Full and effective implementation of the energy efficiency initiatives in the plan could lead to a net increase of nearly 160,000 jobs by the year 2000, and nearly 260,000 jobs by 2010. The resulting energy efficiency investments also will tend to raise productivity and provide other economic benefits that were not specifically captured in this study.

The net employment benefits of the plan are small compared to the economy as a whole. The 160,000 new jobs provided in the year 2000 represent an increase of only 0.1 percent over the baseline employment totals projected for that year. While small, these gains are not trivial. The problem is one of scale rather than of net return on the investment. Expanding the energy efficiency improvements could greatly amplify these gains for the American economy.

**Figure 1. A Comparison of Employment Impacts**




Additional actions such as stronger fuel economy standards are especially needed to improve energy efficiency in the transportation sector. But further cost-effective efficiency improvements can be made in all sectors of the economy. As noted in ACEEE's 1992 *Energy Efficiency and Job Creation* study and summarized in Figure 1, above, an aggressive investment in energy efficiency technologies could lead to a net increase of over one million jobs in the U.S. by 2010.

Thus, the question must be asked: "With the prospect for billions of dollars of net economic benefits, and the creation of hundreds of thousands of more jobs throughout the American economy, can we afford not to implement energy efficiency initiatives beyond those in the climate plan?" In addition to fully funding and implementing the Administration's current climate plan proposal, we therefore recommend adoption of additional energy efficiency initiatives both to enhance U.S. economic activity and to protect the global environment.