THE GLOBAL CHANGE ISSUE - WHAT IT IS, WHERE IT IS GOING AND HOW IT WILL IMPACT UTILITY DSM

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Global Climate change is fast becoming a dominant national and international issue. The Bush Administration has allocated many tens of millions of dollars in research to address the problem. This paper will sort out the policy issues, indicate where we are, and where we are going regarding national legislation, and describe the activities that are currently underway at the Environmental Protection Agency to address these problems. We will also describe what policy options and Federal initiatives may be most effective in contributing to the "clean-up," as well as the potentially significant contribution of utility demand-side management (DSM) activity. Future changes in DSM planning and evaluation will be addressed in order to accommodate these significant environmental needs.

INTRODUCTION

The potential for global change is increasingly being identified as a serious environmental problem with global consequences, which include rising sea levels, higher global temperatures, and significant changes in local climate patterns. The man-made emissions of "greenhouse gases" are viewed as the major cause of global warming, and most of the attention has focused on reducing the release of Carbon Dioxide (CO_2), methane (CH_4), and other trace gases. We will focus on the global warming issue and the control and stabilization of man-made emissions of the trace gases.

These environmental problems are dominant national and international issues. A variety of global and national policies are being developed and proposed to address these problems. Energy efficiency will be an important and cost-effective tool, particularly in the electric utility sector. We will discuss the basic issues associated with global climate change, will review research and policy initiatives, and discuss the implications of climate change on utilities directly and through environmental policy actions. Particular emphasis will be placed on the role of energy efficiency and utility DSM programs in the control of these problems.

OVERVIEW OF GLOBAL CHANGE

The environmental problem with the most potential for climate change is global warming. Global warming describes how the earth's temperature may increase significantly as the result of activities that increase the concentrations of certain "greenhouse" gases in the atmosphere. The "greenhouse effect" is caused by gases in the atmosphere which capture infrared radiation emitted from the earth's surface and prevent part of the energy from escaping into space.

Atmospheric concentrations of certain gases in the troposphere (the lower atmosphere) are responsible for maintaining the earth's temperature balance and climate. Carbon dioxide, methane, and other trace gases from natural sources enter the atmosphere and help to absorb heat radiated from the earth's surface. Other important greenhouse gases include nitrous oxide (N_2O), tropospheric ozone (O_3), water vapor, and chlorofluorocarbons (CFCs). These atmospheric gases are diffused throughout the troposphere. Acting like the glass roof of a greenhouse, the chemical and absorptive properties of these gases prevent infrared energy from escaping into space.

The current concern about the greenhouse effect arises because the atmospheric concentrations of greenhouse gases have increased radically in recent decades--largely from human activities. These increased concentrations could cause the lower atmosphere to warm. When concentrations of greenhouse gases increase, less infrared radiation passes back to space, and the global energy budget becomes imbalanced. That is, less energy leaves the atmosphere than enters it. To maintain the balance, the lower atmosphere and the earth's surface warm until a new balance is achieved (EPA 1988).

Greenhouse gases have natural as well as anthropogenic (i.e., human-caused) sources. The pre-industrial concentration of CO_2 is thought to have been about 275 ppm with some fluctuations associated with the spread and retreat of ice ages (EPA 1989). Post-industrial activities have spurred an increase in CO_2 concentrations to about 350 ppm (EPA 1989). CO_2 levels have increased by about 30% since the industrial revolution. The differences between pre-industrial or "natural" balances of greenhouse gases and current levels in the atmosphere appear to follow post-industrial activities (e.g., the burning of carbon-based fuels for CO_2, rice and cattle cultivation for CH_4, and industrial activities for CFCs).

CO_2 is responsible for approximately 50% of global warming worldwide (EPA 1989). As a result, it is a focus of many proposed control policies. Of this 50%, about two-thirds comes from the combustion of fossil fuels for use by the utility, transportation, and industrial sectors (EPA 1989). The remaining one-third has biological origins, such as the emissions released from agricultural and land-clearing activities and the resultant permanent reductions of standing biomass. CH_4 and CFCs, currently estimated to contribute approximately 18% and 14%, respectively, to the global warming problem, have been growing faster than CO_2, and as a result, they are expected to account for a relatively larger amount of future global warming (EPA 1989).

POLICY OPTIONS TO AMELIORATE THE CLIMATE CHANGE PROBLEM

The primary means of reducing greenhouse gas emissions are to utilize technologies that reduce energy requirements through improved energy efficiency (both in demand and supply of energy services), use less carbon-intensive fuels, and/or replace or reduce emissions of greenhouse gases. These measures include improved energy conversion efficiencies on the electricity supply sector, substitution of less carbon intensive fuels, the adoption of non-CO_2 and non-CFC emitting technologies, and improved end-use efficiency.

A number of possible options are available for legislators and regulators to address the issue of global warming and encourage speedy adoption of the strategies and technologies discussed above. The following section describes three major policy mechanisms: (1) market-based incentives; (2) government regulation and standards; and (3) research, demonstration, and development.

Market-Based Incentives

Perhaps the most economically efficient way to affect the reduction of CO_2 and other greenhouse gas emissions is to provide market based incentives to consumers and industry. This could take the form of actions that would force markets to internalize the costs of their contribution to global warming (e.g., through taxes) by increasing the costs of activities responsible for contributing to global warming. Along with discouraging the use of environmentally damaging pollutants, these market-based incentives will also allow more environmentally benign technologies to compete on a more even basis. Some of the available market-based options are discussed below.

Emissions Taxes. An emissions tax would be imposed to penalize those unable or unwilling to meet an established emissions standard. The emissions tax, unlike a fixed penalty fee, would vary depending on the amount of pollutants over a limit set by standards. The emissions tax may, however, be accompanied by incentives (tax credits) for reduction of pollutant emissions below the standard. Emissions taxes may serve another purpose. In addition to encouraging the utilities to minimize the emission of pollutants, emissions taxes would also provide a new source of revenue that could be used for research and development of alternative energy sources.

Emission Credits. Tradeable emissions credits require a manufacturer producing too many pollutants to buy credits (a penalty) to meet the emissions standards, while a manufacturer producing far fewer pollutants is in a position to sell credits (an incentive) and still meet the standard. An EPA proposal would also allow firms to "bank" these emissions credits. This type of emissions tax and credit system would create an incentive for utilities and automobile manufacturers to develop advanced emissions control technologies and to help subsidize such ventures. It would also give utilities time to develop alternative sources of energy.

Fuel Taxes. A fuel tax would target high CO_2 fuels (coal and oil, for example) and, thus, discourage demand for these fuel types. For many utilities, a fuel tax would probably mean higher fuel costs, depending on generation mix, by increasing the relative cost of the taxed fuel. The fuel tax, like the emissions tax, also would generate revenues that could be used for research and development projects designed to slow the pace of global warming.

Efficiency and Conservation. Efficiency and conservation are key policies for reducing emissions from the combustion of fossil fuels. The following are examples of incentives that can be used to promote energy efficiency and conservation:

- Providing tax credits and other incentives (e.g., rebate programs) to consumers for end-use technologies. Tax credits and incentives may apply to both new and replacement equipment.
- Funding federal and state conservation programs including additional monies for home weatherization programs.
- Establishing hookup fees for new buildings which vary depending on the energy efficiency of the building shell and equipment.
- Building labeling and rating programs (e.g., Home Energy Ratings)

Tax Credits. A primary constraint to reduced greenhouse gas emissions in the utility sector is that the industry is very capital intensive and has a very low capital turnover rate. Given the high costs of new capital, and the financial and regulatory uncertainty associated with the construction of new plant, utilities have few incentives to invest in new, environmentally benign plants. Market-based incentives could also be used to increase the capital turnover rate in the utility sector. These might include tax incentives and regulatory revisions that encourage the earlier retirements of existing equipment. Further fiscal incentives could be given for technologies which are low or non-emitting. This could include tax incentives or higher rates of return for these technologies.

Regulations and Standards

Market-based incentives are only one set of tools to reduce greenhouse gas emissions. There are often limits to the effect of pricing policies, either due to inelastic demand, the absence of alternatives, or political or practical considerations. In most instances, the current practice is not to internalize the environmental costs into the decision-making process through financial means, but to force recognition of these costs by a system of regulations. The regulations control the short-and long-term emissions of pollution, the installation of control equipment and so on. The primary advantage to a system of regulations is the simplicity and predictability of the system.

However, standards are generally not an efficient approach to control because society will generally not receive the maximum value for its money. Additional problems with standards include difficulties in enforcement and achieving compliance. The least expensive way to control emissions from a group of plants is to concentrate efforts where the cost of control (i.e., dollar per ton removed) is cheapest, rather than imposing an arbitrary reduction to all plants where at some plants, the reduction may be very expensive to obtain. This, however, may not be perceived as equitable, if all control costs fall on those who are selected by regulation to implement controls.

Other regulatory tools which can be used to impact emissions include performance standards, and utility regulatory reforms. These are described below.

Emissions standards prescribe maximum levels of pollutants that can be released into the air. These standards are usually accompanied by a phased

emissions reduction schedule with standards becoming more rigorous over time. The effects of phased emissions reduction will differ across utilities. In the case of a CO_2 emissions standard, for example, a utility depending heavily on coal generation would be hit harder immediately by the standard while a utility depending more on natural gas will not be hit until later, if at all.

Energy Efficiency and Conservation Program Requirements. In addition to providing financial incentives to promote energy efficiency, regulations and standards can be established for energy-using equipment and technologies. For example, in 1987, Congress adopted minimum efficiency standards for refrigeration, air conditioners, and other residential appliances. Other possible forms of standards include:

- Implementing energy efficiency standards for other appliances and building shells;
- Setting stringent emissions standards for manufacturers of refrigerators, air conditioners, water heaters, industrial boilers and other such equipment and providing funding for retrofit activity.
- Establishing new standards for energy labeling of light bulbs, windows, and insulation materials.

Some states have enacted performance standards for utilities. Utilities are given incentives, in the form of higher rates of return, or through a shared savings approach, for performance exceeding the standards. Requirements might include minimum heat rates, or reductions in operation and maintenance costs.

Least-Cost Energy Planning. Least cost planning combines the market-based approach with government directed standards and regulation. Least cost plans typically outline policies for conserving fossil energy sources and expanding the use of renewable energy sources in order to meet short-term and long-term energy demands without increasing the production of pollutants contributing to global warming. These least-cost plans would try to minimize the social cost of global warming; i.e., least cost would be measured from a societal perspective. For utilities and their customers, this would mean paying for the cost of pollution production associated with power generation.

Other market-based regulatory actions that could contribute to reductions in CO_2 emissions include revising existing regulation policies so that utilities are required to consider the cost of externalities in evaluation of new resource options, either utility-built or those solicited through bidding programs. The Wisconsin Public Service Commission recently published rules that create a 15 percent non-combustion credit for non-fossil sources (such as renewables or energy conservation).[1] Based on these rules, the technical cost of non-combustion options will be reduced by 15 percent to account for the environmental benefits of avoiding combustion. The Wisconsin Commission implemented this policy to ensure that some of the costs of combustion are explicitly accounted for and reflected in utility plans.

Research, Development and Demonstration

Research and development funding may be increased for renewable and non-fossil energy sources to initiate a movement away from energy sources that contribute significantly to global warming. Specific examples include:

- Research and development on energy efficiency and renewable energy sources such as wind, photovoltaic, solar thermal, biofuels, ocean thermal, geothermal, and hydrogen fuel cells.
- Promoting natural gas as a transition fuel for power generation from coal and oil. Support research and development for intercooled, steam-injected gas turbines.
- Providing for research and development of a new generation of "inherently safe" nuclear reactors and promoting nuclear power.
- Promoting efficient coal repowering technologies (e.g., pressurized fluidized bed combustion or integrated coal gasification combined cycle.

If emissions standards become more stringent, legislators and regulators might also initiate and support research and development programs for best

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1 *Wisconsin Public Service Commission, Re Advanced Plans for Construction of Facilities, 05-EP-5, 102 PUR 4th 245.*

available emissions control technology to reduce the production or emissions of CO_2 and other pollutants.

One area of research that the Bush Administration is actively promoting is research into the extent and severity of global warming. A major research effort to study the extent of climate change is the Mission to Planet Earth. Mission to Planet Earth is a multi-billion dollar program using satellite information to monitor and detect changes in our environment. It involves the use of dozens of earth-orbiting satellites currently under development around the world to study the Earth's oceans, land and atmosphere. It will attempt to coordinate the operation of these satellites and provide comprehensive, long-term "planetary data sets" for the study of ozone depletion, oceanic weather effects and deforestation. The goal of this effort is to develop the scientific data and understanding necessary to assess the extent and existence of global climate change.

LEGISLATIVE PROPOSALS

A number of legislative proposals have been introduced in the U.S. Congress and state legislatures to address global warming. These proposals have primarily taken the standards approach and have focused on across-the-board limits on CO_2 emissions. As of this writing, however, none has passed thus far during the 101st Congress. The major restriction-based legislative proposals under consideration by the U.S. Congress are briefly summarized below.

Wirth Bill (S. 324--original)	20% Reduction in U.S. emissions from 1988 levels by the year 2005; no specific proposals affecting the utility industry
Wirth Bill (latest proposal)	Stabilize emissions (base period and target date are not specified); only calls for evaluating feasibility of 20% reduction by 2005
Schneider Bill (H.R. 1078)	20% Reduction in U.S. emissions from 1988 levels by the year 2000; no specific proposals affecting the utility industry (except least cost planning)
Leahy Bill (S. 333)	Places CO_2 limits on stationary sources based on heat output, i.e., after considering boiler efficiencies: 610 lbs/MMBtu in 1991; 435 lbs/MMBtu in 2001, and 280 lbs/MMBtu in 2011

In addition to the Federal government, state governments have proposed initiatives and laws to reduce CO_2 emissions. In particular, a number of bills have been introduced in California, e.g., the Green Initiative. These bills include proposals to study the affects of global warming trends on California, to reduce greenhouse gas emissions 20% below current levels by 2005, and to mandate a reduction of uneconomical and unnecessary uses of energy.

RESEARCH ACTIVITIES UNDERWAY

Along with these legislative proposals, the Federal government is in the midst of a multi-billion dollar research effort to ameliorate these climate change problems. Under the aegis of the U.S. Global Change Research Program, directed by the White House Science Office, 13 different agencies are investigating all aspects of global change. A few key studies that are currently underway as part of EPA's Global Climate Change Program are discussed here.

EPA's current global climate change program stems from a congressional request in which EPA was asked to conduct two studies. These reports are currently in draft form. The first study examined the health and environmental effects of climate change (EPA 1988). It developed climate change scenarios and studied the potential impacts on agricultural, forests, wetlands, human health, rivers, lakes, and estuaries as well as other ecosystems and societal impacts. A second study produced the Stabilization Report (EPA 1989) that examined the policy options that, if implemented, would stabilize current levels of greenhouse gas concentrations. Two additional ongoing EPA projects are discussed below.

CO_2 Costing Study

The purpose of this project, performed by ICF and others, is to collect available information on the costs of reducing CO_2 emissions and the emissions of other greenhouse gases. The overall methodology includes the projection of CO_2 and CO_2 equivalent emissions out to 2010, the identification of technologies and programs that could significantly reduce these emissions, and the estimation of the CO_2 reduction potential and the associated unit costs for these technologies and programs.

The principal programs investigated were energy conservation, fuel substitution, reforestation, methane control options such as coal bed methane recovery and landfill gas recovery, and the phase-out of CFCs. The cost curve shown in Figure 1 illustrates the preliminary results of the study effort.[2] As shown in Figure 1, the least expensive policies that can reduce Year 2000 emissions are energy conservation, followed by the phase-out of CFCs. The low-cost energy conservation measures that have been identified in this effort include (listed in terms of increasing cost): automobile and truck fuel efficiency, residential shell retrofits on electrically heated homes, residential appliance efficiency, and commercial energy conservation.

Michigan Case Study. In another study examining the implications and costs of policies to reduce CO_2 emissions, ICF has developed a case study of CO_2 reduction strategies for the State of Michigan. The purpose of the project is to build from existing State data and models to begin assessing the implications of alternative technical measures and strategies for reducing CO_2 emissions in the State. The work is focused on two important energy-using sectors in the State: electric utilities and transportation. Specific objectives include:

- Identification of existing and emerging technologies and resource options that potentially can reduce CO_2 emissions in the State.

[2] *The figure is presented in this form because the report is still under review. Complete results will be presented at the Summer Study if they are available.*

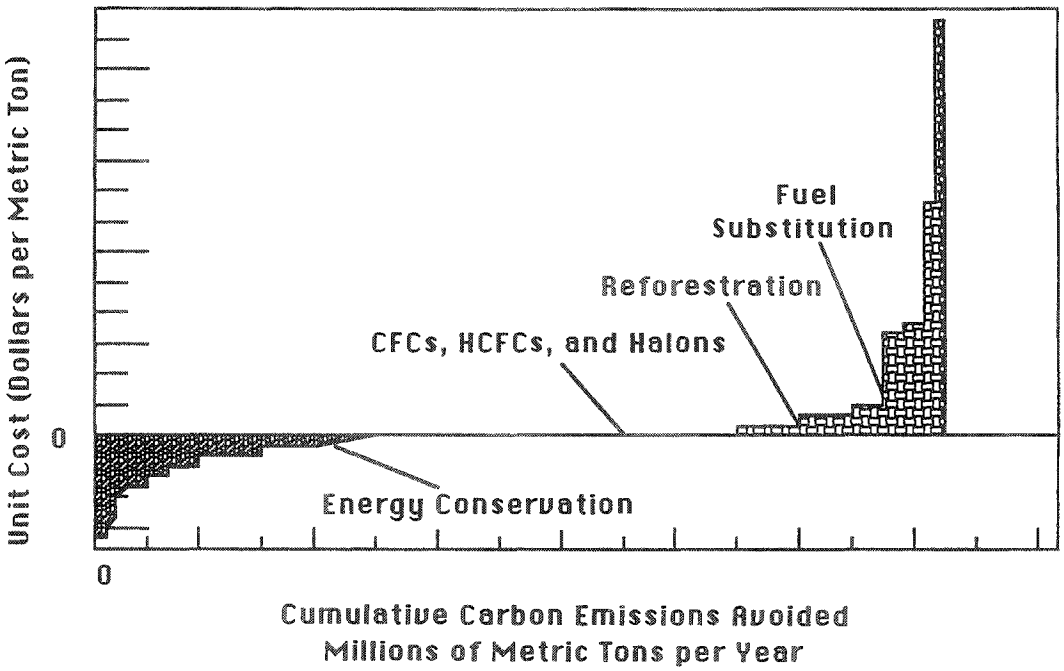

Figure 1. Year 2000 CO_2 Reduction Cost Curve

- Identification of combinations of technologies and resource options (i.e., strategies) likely to achieve alternative, specified reductions in CO_2 emissions (e.g., 20% by 2000) in the State.
- Assessment of the technical and achievable emissions impacts, costs, and uncertainties associated with alternative strategies.
- Estimation of the costs and resource implications of these strategies for Michigan.
- Assessment of state and federal policy options that could be used to implement preferred emissions reduction strategies.

Results are still preliminary from this project, but early indications are that significant reductions in utility and transportation sector CO_2 emissions can be significantly reduced through cost-effective energy efficiency measures.

IMPACT ON ELECTRIC UTILITIES

Electric utilities and their customers will be substantially affected by both possible global climate change and the policies to mitigate or forestall climate change (whether they are market-based or via standards). Utility impacts will be in the areas of electricity demand, electric utility operation, and utility DSM activities. This section briefly describes these impacts.

Electricity Demand

Climate change can affect the level and pattern of electric demand. Changes in temperature and humidity can affect heating and air conditioning needs, which influence peak demand and the shape of the load curve. Utilities serving agricultural areas with sizable pumped irrigation loads might also experience sharp demand fluctuations due to climate-induced changes in soil moisture. In addition, the overall demand in a region could be affected through population and demographic shifts that result from climate changes. A recent report (ICF 1989) examined these demand shifts. The study investigated how changes in temperature might affect energy demand through impacts on heating and air conditioning needs. Figure 2 shows the impact of a moderate temperature rise on patterns of demand in New York State in 2015. As can be seen, electricity demands would increase in the summer and decrease in the winter. These changes are greater downstate because of higher air conditioning loads.

Electric Utility Operation

On the supply side, changes in temperature and precipitation can affect stream flow, which in turn affects the availability of hydro power. Delivery systems can also be affected by shifts in the frequency and intensity of extreme events that are predicted to accompany climate change, such as tornadoes, hurricanes, and severe storms. Finally, a rise in sea level could seriously affect utility operations in vulnerable coastal areas. The results of the recent ICF study (ICF 1989) indicated that temperature-induced reductions in stream flow could lower hydro generation by nearly 10% by the year 2015 in New York. Given the importance of hydro in New York, and the fact that it is the state's least expensive source of power, this result was considered especially significant.

The level of impact will vary widely by utility, however. If phased emissions reduction standards go into effect for CO_2, a utility using a greater amount of coal and oil would be hit harder by the regulation. Under a phased reduction program, initial standards would be taken against coal and oil because they produce more CO_2. For example, because of the diversity of Pacific Gas & Electric's generating resource base, its use of low CO_2-emitting fossil fuels (particularly natural gas) and its expense in developing and implementing energy conservation programs, PG&E's current level of emissions (per kWh generated) is relatively low. Therefore, its electric supply and distribution operations are unlikely to be affected by emissions as severely as other utilities that rely on high CO_2 emitting fuels, such as coal.

In addition, natural gas may become a "transition fuel" for some utilities to assist the utility in meeting

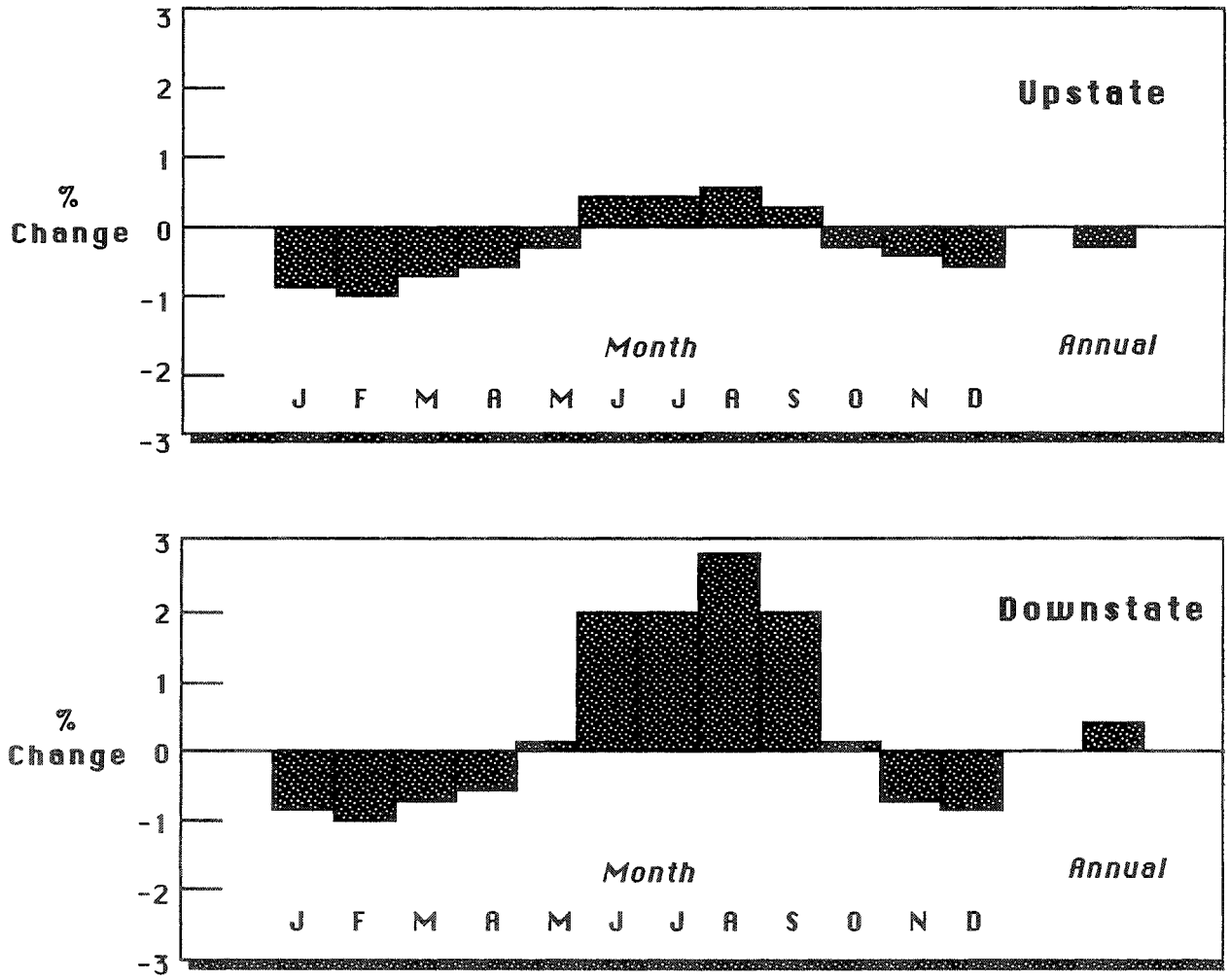

Figure 2. New York State Impact of Temperature Change on Energy Demand by Month in 2015 (Source: ICF, Inc. 1989)

the standards while exploring alternative energy sources. For utilities with existing gas generation and with hydro and nuclear generating capacity, the transition will be smoother, although standards are likely to eventually impact all fossil fuel plants.[3]

[3] *Note that increased are of natural gas also could increase atmospheric emissions of methane, an important greenhouse gas. Methane is leaked into the atmosphere in varying amounts during extraction, transportation, and storage of natural gas.*

IMPACTS ON UTILITY DEMAND-SIDE MANAGEMENT

A common thread in most of the proposed policies, legislation and utility planning strategies to reduce CO_2 is greater reliance on energy efficiency and demand-side management (DSM). The preliminary results of our investigation of the costs to reduce CO_2 emissions support this position. Most of the legislative proposals to reduce the climate change problem include provisions specifically geared

towards the promotion of energy efficiency and electric utility DSM. In addition, energy efficiency and DSM can also be important contributors to solving other environmental problems, such as acid rain.

The impetus for utility DSM activity will come from two directions: (1) the direct need to reduce CO_2 emissions, and (2) the need to economically supply electric power for the future within the constraints associated with emission standards and/or increased costs of combustion technologies.

In order to achieve sizable demand and energy savings to meet the CO_2 goals, a much expanded level of DSM activity will be required. This activity could result from either more stringent appliance efficiency and building standards or greater levels of utility investment in energy conservation. To meet this expanded level of effort, greater research will be needed on customer behavior, end-use patterns, and new energy efficient technologies. Existing utility DSM programs will need to be enlarged and enhanced to encourage greater savings, and new programs will need to be initiated.

Restrictions in the use of high carbon-intensive fossil fuels will create a substantial role for cost-effective DSM as a utility resource option. If emission trading, emission taxes, or fuel taxes are implemented, utility generation costs will increase, particularly at utilities with substantial coal and oil-fired capacity. Utility avoided costs and customer rates will tend to increase at the affected utilities, and will, thus, increase the amount of cost-effective DSM. Increased customer rates will drive price-driven customer conservation activities. The interaction between this price-driven conservation and utility DSM programs needs to be examined in detail.

Finally, as this increased utility DSM activity is undertaken, utility managers, state regulators, and federal policy officials should be aware of the following issues:

- The forecasted increases in summer and winter temperatures could lead to a worsening of utility system load factors. Increased air conditioner usage under these conditions will drive summer peaks higher and cause them to occur more frequently (ICF Resources 1989). This increase in usage will counteract improvements in customer end-use energy efficiency. Energy efficient air conditioners may need to be emphasized to at least partially offset future summer peaks increases.
- Actions to reduce or eliminate the usage of CFCs may have a negative affect on the cost and energy efficiency of residential refrigerators and freezers, and commercial and industrial chillers. DSM programs designed around these technologies will, thereby, have less technical potential and be less cost-effective.
- DSM programs that are associated with the objectives of valley filling, load-shifting, or strategic load growth may not be good candidates for use as a CO_2 reduction strategy. Depending on the base load generation mix of a utility, promotion of these DSM programs could lead to an increase in CO_2 emissions from base-loaded coal and oil-fired generation.
- Federal and state environmental policy should explicitly account for the contribution of DSM to emission reductions. Emission reductions created by reduced energy usage by a utility's customers should be able to create emission offsets or credits.

SUMMARY

Global climate change, and especially global warming, are major concerns that will ultimately have a significant impact on the utility industry and its customers. Among these impacts is the need for more comprehensive efforts in energy conservation promotion. Energy conservation will reduce the need for fossil fuel generation, and would thus, reduce the level of greenhouse gases emitted to the atmosphere. In addition, energy conservation and utility DSM seem to be the most cost-effective CO_2 abatement measures. So, beyond the activities that the utilities will initiate relative to their generation, we will see a marked and renewed interest in new utility conservation and demand-side activity.

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