Meeting America's Kyoto Protocol Target: Policies and Impacts

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ABSTRACT

This paper examines ten major national policies that would increase energy efficiency, accelerate the adoption of renewable energy technologies, and shift to the use of less carbon-intensive fossil fuels in order to reduce U.S. greenhouse gas emissions. We estimate that the ten policies would cut carbon emissions about 28 percent by 2010 and 55 percent by 2020, relative to emissions if current policies and trends continue. While this is not quite enough to reach our Kyoto Protocol target, it is very close. While a few of the policies have a net positive cost, most result in energy bill savings exceeding investment and implementation costs. Overall, we estimate that consumers and businesses would realize net savings of about $200 billion through 2010 and over $500 billion through 2020. The ten polices also would significantly reduce local air pollution and cut oil imports.

Introduction

In December 1997, 160 nations negotiated and reached agreement on the Kyoto Protocol to the Framework Convention on Climate Change. The Kyoto Protocol establishes binding greenhouse gas (GHG) emissions reduction targets for industrialized nations during the first "budget period"(2008-2012). For the United States, the target is 7 percent below 1990 emissions. But the United States emitted 1,803 million metric tons (MMT) of carbon or carbon equivalent in 1998, nearly 10 percent more than U.S. GHG emissions in 1990. With the passing of time, is it still possible for the United States to meet its Kyoto Protocol target (or substantially meet its target) through domestic actions? What set of policies could be adopted to reach or approach America's Protocol target? What economic costs and benefits would these policies have? And what other impacts?

Description of Policies

In order to address these questions, we examine a set of ten national policies that would increase energy efficiency, accelerate the adoption of renewable energy technologies, and shift to the use of less carbon-intensive fossil fuels (i.e., displace some coal use with natural gas). These policies are advocated by a wide range of groups promoting a more sustainable energy future (SEC 1999). This paper briefly describes the ten policies and then presents our estimates of overall energy, emissions, and economic impacts, summarizing a more detailed analysis that includes assumptions about the response to each policy (Geller, Bernow, and Dougherty 1999).

New Appliance Efficiency Standards and Product Labeling

The U.S. Department of Energy (DOE) has the authority to set and upgrade appliance and equipment efficiency standards where technically and economically feasible. We assume DOE sets new standards on lighting ballasts, water heaters, clothes washers, central air conditioners and heat pumps, transformers, refrigerators and freezers, furnaces and boilers, commercial packaged air conditioning equipment, gas ranges, and reflector lamps during the next five years. We assume these standards are set at the highest levels justified under current law using assumptions given in Geller et al. (1998). As part of this policy, we also propose that the federal government expand ENERGY STAR® labeling programs to a wider range of products, including various home electronics products, microwave ovens, and packaged commercial refrigeration equipment.

Greater Adoption of Building Energy Codes and Market Incentives for Efficient New Construction

The Energy Policy Act of 1992 (EPAct) requires all states to adopt a commercial building code that meets or exceeds the ASHRAE 90.1-1989 model standard and requires all states to consider upgrading their residential code to meet or exceed the Model Energy Code. We assume that DOE enforces the commercial building code requirement in EPAct and that states comply. We also assume that relevant states upgrade their residential energy code to either the 1995 or 1998 Model Energy Code, either voluntarily or through the adoption of a new federal requirement. Some major states (such as Arizona, Illinois, Michigan, New Jersey, and Texas) have not yet adopted these "good practice" energy codes. Furthermore, we propose that the model energy codes are significantly improved during the next decade and that all states adopt mandatory codes that go beyond current "good practice" by 2010. To complement building energy codes, we propose offering financial incentives to stimulate the construction of some highly efficient new homes and commercial buildings.

Stimulating Building Retrofits

Buildings in existence today will account for approximately two-thirds of the energy used in the buildings sector in 2020. To promote energy savings in existing buildings, we propose setting energy performance targets for different types of buildings and providing a variety of inducements and services to encourage (and in some cases require) building owners to upgrade their buildings to meet these targets. For residential buildings, a possible target level is the 1993 Model Energy Code, which defines good practice for new homes. For commercial buildings, a possible target level is the eligibility threshold for the ENERGY STAR Commercial Buildings Program. In order to induce building owners to meet these performance levels, we propose a combination of technical assistance and financing to help owners identify and implement the most cost-effective efficiency measures. Attractive financing should be made widely available at the time-of-sale (so-called energy-efficient mortgage programs). Also, municipalities should be encouraged to adopt retrofit ordinances that require buildings to meet certain performance levels prior to sale.

Public Benefit Trust Fund as Part of Electric Utility Restructuring

Electric utilities historically have funded programs to encourage more efficient energy use, assist low-income families with home weatherization and energy bill payment, promote the development of renewable energy sources, and undertake research and development. However, increasing competition and restructuring have led to a decline in these "public benefit expenditures." In order to ensure that energy efficiency programs and other public benefits activities continue, we propose creating a national public benefits trust fund, similar in concept to the public benefits fund included in the Clinton Administration's federal utility restructuring proposal. The federal trust fund would provide matching funds to states for eligible public benefits expenditures. The size of the public benefits trust fund we recommend is based on a non-bypassable wires charge of two-tenths of a cent per kilowatt-hour, identical to proposals included in Senator Jeffords' (S. 1369) and Rep. Pallone's (H.R. 2569) restructuring bills. Our analysis estimates the incremental energy savings from the federal public benefits trust fund, excluding savings from public benefit programs already underway or likely to occur due to state action (Nadel 1999).

Renewable Portfolio Standard as Part of Electric Utility Restructuring

Utilities and other power generators can be required to supply or purchase a specified amount of capacity or percentage of total electricity generation from renewable sources through what is known as a Renewable Portfolio Standard (RPS). We propose requiring 10 percent non-hydro renewables by 2010 and 20 percent non-hydro renewables by 2020, along the lines of the requirements in Senator Jeffords' bill (S. 1369). Utilities and other power generators would be allowed to achieve the RPS through installation of renewables on their own and/or purchase of tradable renewable credits. But rather than allowing the amount of renewable generation to vary with the amount of electricity demand, we assume fixed amounts of renewables are required nationwide. These amounts are calculated by applying the percentage requirements given above to the levels of electricity demand in our Base Case (see explanation of Base and Policy Cases below). In particular, we propose a total of 349 terawatt-hours (TWh)of non-hydro renewable power by 2010 and 876 TWh by 2020, compared to 73 TWh in 1997. We assume wind and biomass provide most of the incremental clean power.

Standards, Market Incentives, and Voluntary Programs to Increase the Efficiency of Passenger and Freight Vehicles

The average fuel economy of new passenger vehicles (cars and light trucks) has declined from nearly 26 miles per gallon (mpg) in 1988 to less than 24 mpg in 1999 due to increasing vehicle size and power, the rising market share of light trucks, and the lack of tougher Corporate Average Fuel Economy (CAFÉ) standards. We propose strengthening the CAFÉ standards for cars and light trucks and instituting complementary market incentive and promotion programs. Specifically, we propose increasing the CAFÉ standards for cars and light trucks combined to 42 mpg by 2010 and 58 mpg by 2020. Furthermore, we propose expanding the federal "gas guzzler" tax and converting it to a revenue-neutral fee and rebate system. This would stimulate demand for cleaner and more efficient vehicles in all classes. Also, we recommend adopting tax

incentives and other initiatives at both the federal and state levels to help create markets for innovative, highly efficient hybrid and fuel cell vehicles.

We also propose policies to improve the efficiency of new medium- and heavy-duty trucks. These policies include expanded research and development, vehicle labeling and promotion, financial incentives to stimulate the introduction of new technologies, and efficiency standards if necessary.

Greenhouse Gas Standards for Motor Fuels

We propose adopting full fuel-cycle GHG standards for motor fuels, similar in concept to the renewable portfolio standard for electricity generation. The standards would be specified as a cap on the average GHG emissions factor of all motor fuels, thereby reducing both petroleum use and net carbon emissions from the transport sector. Fuel suppliers would have the flexibility to meet the standard on their own or by buying tradable credits from other producers of renewable or low-GHG fuel. In particular, we propose a GHG emissions standard for gasoline, starting at a 5 percent reduction in the emissions factor in 2010 and increasing 1 percent per year to a 15 percent reduction by 2020. We assume most of the low-GHG fuel is provided by cellulosic ethanol, which has a delivered cost that reaches $1.75 per gallon of gasoline equivalent by 2010. The GHG standards could be complemented by expanded research and development (R&D) programs, market creation programs, and financial incentives to stimulate the production of low-carbon fuels such as cellulosic ethanol and biomass- or solar-based hydrogen.

Reducing Barriers to Combined Heat and Power

Combined heat and power (CHP) systems greatly increase energy efficiency by simultaneously producing electricity and useful thermal output in industries or buildings. However, a variety of barriers including hostile utility policies, onerous environmental permitting requirements, lack of recognition of CHP's full benefits in environmental and utility regulations, and unfavorable tax treatment are limiting the growth of CHP in the United States. In order to overcome these barriers, we propose: (1) providing expedited permitting for CHP systems; (2) recognizing the full benefits, including avoided power plant emissions and greater utility grid reliability, in environmental and utility sector assessments and policies; (3) removing utility-driven barriers through Federal Energy Regulatory Commission action, national restructuring legislation, and state action; and (4) establishing a standard depreciation period of seven years for all new CHP systems. We assume that these actions would result in an additional 50,000 megawatts (MW) of CHP capacity by 2010 and 144,000 MW by 2020, with most of this capacity natural gas-fired (Geller, Bernow, and Dougherty 1999).

Voluntary Agreements and Incentives to Reduce Industrial Energy Use

In order to stimulate energy efficiency improvements by industries, we propose establishing voluntary agreements between the federal government and individual companies or entire industrial sectors. Companies or sectors would pledge to reduce their overall energy and carbon emissions intensities (energy and carbon per unit of output) by a significant amount, say at least 10-20 percent over 10 years. The government would encourage participation and support

implementation by providing technical and financial assistance to participating companies, offering to postpone consideration of more drastic regulatory or tax measures if a large portion of industries participate, and by expanding federal R&D and demonstration programs. Voluntary agreements of this type have resulted in substantial energy and carbon emissions reductions in some European nations such as Germany, the Netherlands, and Denmark (Bertoldi 1999). We estimate that widespread adoption of voluntary agreements and supporting activities could reduce primary energy use in the industrial sector by about 11 percent in 2010 and 16 percent in 2020.

Tighter Emissions Standards on Coal-Fired Power Plants

Older, highly polluting coal-fired power plants are "grandfathered" under the Clean Air Act, meaning that a majority of the 300,000 MW of coal-fired generating capacity in the United States does not meet the same emissions standards as plants built after the enactment of the Clean Air Act in 1970. Utilities have an incentive to operate these dirty power plants due to their low operating cost. We propose requiring these older coal-fired power plants to meet the same emissions standards as new plants. Some plants would be modernized and cleaned up but many would be shut down and replaced with much cleaner resources, either renewable sources or natural gas-fired combined cycle power plants. We assume that 25 percent of coal-fired capacity remaining after implementation of the other policies is displaced by state-of-the-art gas-fired power plants by 2010, and 50 percent is displaced by 2020.

Analysis and Results

We analyze energy use, carbon emissions, other pollutant emissions, and economic costs for both a Base Case and integrated Policy Case during 2000-2020. We use DOE's National Energy Modeling System, known as NEMS, to conduct this analysis, along with our own assessments of some of the policies and key parameters. Our Base Case is derived from the Reference Case Forecast in the Annual Energy Outlook 1999 prepared by the Energy Information Administration (EIA 1998). It is meant to represent energy use and carbon emissions given current policies and trends. The ten policies are considered together in what we designate as the Policy Case.

Table 1 shows the overall results. In the Base Case, total primary energy consumption reaches about 112 quads in 2010 and 121 quads in 2020, a 1.1 percent per year growth rate on average. The ten policies reduce primary energy consumption 18 percent by 2010 and 33 percent by 2020, relative to energy use in the Base Case in those years, through increased efficiency and greater adoption of CHP. Renewable energy use (both hydro and non-hydro) accounts for about 12 percent of primary energy supply in 2010 and 19 percent of total energy supply in 2020 in the Policy Case. In contrast, renewables contribute only 7.5 percent of total energy supply in 2020 in the Base Case, about the same percentage as in 1997.

The ten policies also would significantly lower oil consumption and oil imports. Relative to the Base Case where oil use and imports continue to rise, oil use in the Policy Case falls 18 percent by 2010 and 38 percent by 2020. If domestic oil production does not change, than oil imports would be cut by 25 percent in 2010 and 50 percent in 2020 in the Policy Case.

Table 1. Overall Results for the Base and Policy Cases

	1997	2010 Base Case	2010 Policy Case	2020 Base Case	2020 Policy Case
Energy					
End Use (Q)	70.4	84.7	74.8	92.6	73.4
Primary Energy Use (Q)	93.2	111.9	92.0	121.1	80.5
Non-Hydro Renewable (Q)	3.6	5.0	7.7	5.7	11.6
Hydro Renewable (Q)	3.1	3.2	3.2	3.4	3.4
Intensity per Unit GDP (Q/trillion $)	12.9	11.3	9.3	10.4	6.9
Carbon					
Emissions (MMT)	1,453	1,779	1,277	1,968	894
Intensity per unit energy (MMT/Q)	15.7	15.9	13.9	16.3	11.1
Intensity per unit GDP (MMT/trillion $)	204	180	129	168	77
Air Pollutants [1]					
Sulfur dioxide (MMT)	18.2	12.3	5.4	12.4	2.9
Nitrogen oxide (MMT)	17.8	11.7	9.9	11.7	8.4
Particulate matter (MMT)	1.4	1.3	1.1	1.4	1.0
Economic Impacts [2]					
Net Benefits (billion 96$)	-	-	203	-	510

[1] Air pollutant emissions are from burning fossil fuels and biomass in the industrial, buildings, transport (on-road only), and electric sectors.

[2] Costs and benefits are cumulative, using a 5 percent discount rate.

In the Base Case, carbon emissions reach 1,779 MMT carbon equivalent by 2010 and 1,968 MMT by 2020. Base Case emissions are 33 percent greater than the 1990 level by 2010 and 47 percent greater by 2020. In the Policy Case, carbon emissions decline so that they are 12 percent less than 1997 emissions and about 4.5 percent less than 1990 emissions by 2010. Carbon emissions in 2010 in the Policy Case are about 500 MMT (28 percent) less than in the Base Case. While this is not quite enough to reach America's Kyoto Protocol target of 7 percent below 1990 emissions during 2008-2012 (assuming the Base Case Forecast is accurate), it is very close. It should be possible to achieve the Kyoto target (i.e., a further 30 MMT reduction) through some combination of: (1) further domestic reductions from additional policy initiatives; (2) deeper reductions in emissions of other GHGs; (3) purchase of emissions reductions from

other Annex 1 countries; and (4) reductions in developing countries from Clean Development Mechanism projects.

The set of ten policies continues to provide carbon emissions reductions after 2010 while the economy is expanding. Compared to the Base Case, carbon emissions are cut 1,074 MMT (55 percent) in 2020 in the Policy Case. Emissions in 2020 in the Policy Case also are about 34 percent less than energy sector emissions in 1990

Figure 1 shows the history of the carbon intensity of the U.S. economy (carbon emissions per unit of gross domestic product [GDP]) from 1970 to the present, along with the carbon intensity projections in the Base and Policy Cases. Carbon intensity declined by about 40 percent over the past three decades. In the Base Case, it is projected to decline at a slower rate—about 17 percent from 1997 to 2020 due to continued modest reductions in energy intensity. In the Policy Case, the projected decline is much more dramatic, by 60 percent from 1997 to 2020, owing to both energy intensity reduction and decarbonization of energy supplies. But the downward slope is much closer to historical trends in the Policy Case than in the Base Case.

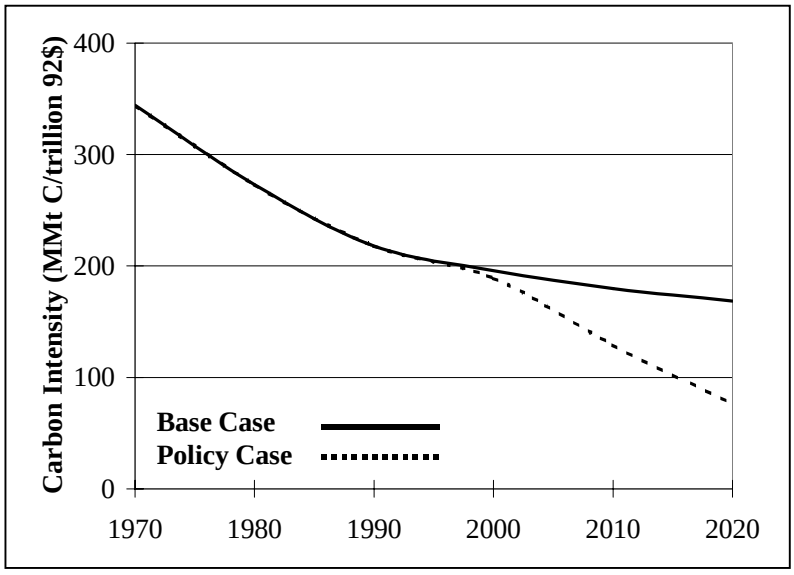

Figure 1: Carbon Intensity (GDP Basis): Base and Policy Cases

Table 2 presents the carbon emissions reductions from each of the ten policies. In this breakdown, carbon emissions reductions arising from policies that reduce electricity use are credited to the buildings and industrial sectors since this is where the policies are aimed. Also, the public benefits trust fund policy is divided between the buildings and industrial sectors since it affects electricity consumption in both sectors. With this perspective, the buildings-related policies are responsible for about 22 percent of the overall reductions, largely through impacts on electricity generation and emissions. The industrial policies are responsible for about 25 percent of the total reductions, the transportation policies about 33 percent, and the electric supply policies about 20 percent. Figure 2 displays these results graphically.

Table 2. Carbon Emission Reductions for Each Policy (MMT)

	1990	2010
TOTAL BASE CASE EMISSIONS	**1,338**	**1,779**
Reductions in the Buildings Sector		
appliance standards & labeling	0	23
building codes	0	11
building retrofits	0	14
public benefits	0	70
Total Sectorial Reductions	*0*	*119*
Reductions in the Industrial Sector		
CHP	0	49
voluntary agreements	0	71
public benefits	0	33
Total Sectorial Reductions	*0*	*153*
Reductions in the Transportation Sector		
greenhouse gas standard for fuel	0	22
vehicle efficiency improvement	0	109
Total Sectorial Reductions	*0*	*130*
Reductions in the Electric Sector		
renewable portfolio standard	0	55
emission standards on coal power plants	0	43
Total Sectorial Reductions	*0*	*98*
TOTAL POLICY CASE EMISSIONS	**1,338**	**1,277**

The set of ten policies also significantly reduces other air pollutants (see Table 1). Implementing the policies would reduce sulfur dioxide emissions the most—62 percent by 2010 and 84 percent by 2020. Emissions of particulates would be cut 20 percent by 2010 and 35 percent by 2020 and nitrogen oxides emissions would drop 17 percent by 2010 and 30 percent by 2020. Clearly, taking action to reduce carbon emissions as proposed in the Policy Case would provide public health and local/regional environmental benefits.

Table 3 summarizes the direct economic costs and benefits in the Policy Case and Table 4 shows the costs and benefits by policy. The policies would induce incremental investments in high-efficiency motors, advanced industrial processes, more efficient lighting and appliances, more fuel-efficient cars and trucks, renewable energy technologies, alternative fuels, cleaner and more efficient power plants, and so on. We estimate a total investment of $213 billion through 2010 and $627 billion through 2020, expressed in 1996 dollars using a 5 percent real discount rate. But final consumers would save over $400 billion through 2010 and over $1.1 trillion through 2020 in energy bill and operating savings. These savings more than offset the

investments costs, with net savings of about $200 billion through 2010 and over $500 billion through 2020. While the ten policies taken together provide positive net economic impacts, a few of the policies are not "no regrets" options individually (see Table 4).

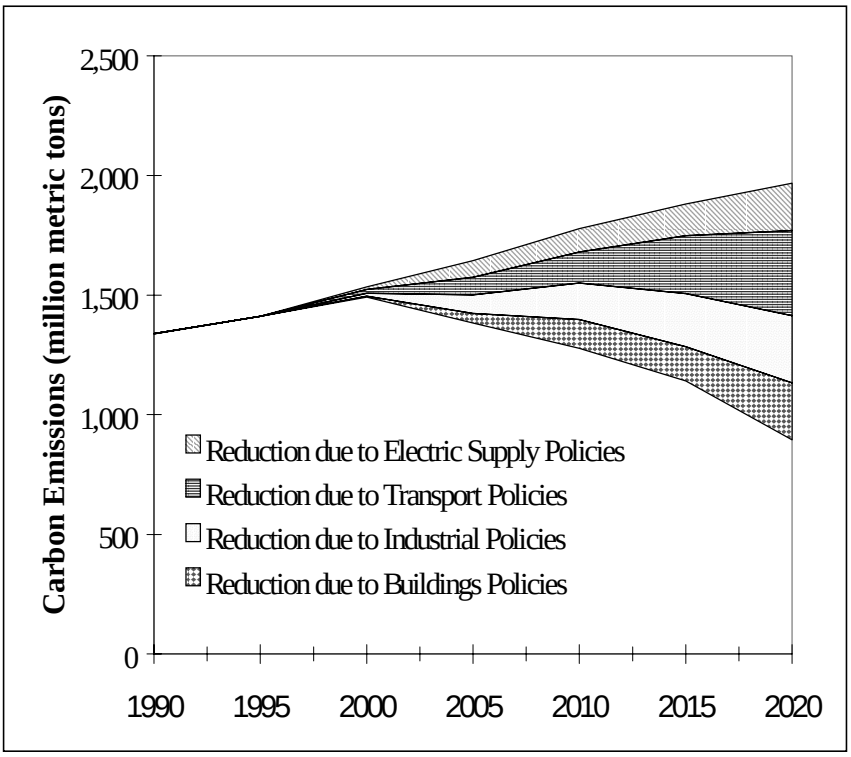

Figure 2: Carbon Emissions Reductions in the Policy Case

Implementing the ten policies creates incomes and jobs for those companies that produce, market, and service the energy efficiency and renewable energy. The efficiency measures then lower the energy bills of the businesses and households that utilize the more efficient equipment. Re-spending of these energy bill savings creates additional jobs and incomes since expenditures are shifted to areas of the economy (such as food, housing, and entertainment) that are more labor-intensive than the energy supply sectors. While we believe the overall effect would be a net increase in jobs in the economy in the Policy Case (Bernow, Duckworth, and DeCicco 1998; Geller, DeCicco, and Laitner 1992), we did not explicitly analyze these macroeconomic impacts in this study.

Table 3. Cumulative Investment Costs and Fuel/O&M Savings in the Policy Case (billion, 1996$)

	Through 2010	Through 2020
Investment Costs	213	627
Fuel and O&M Savings	416	1137
Net Savings	203	510

Table 4. Cumulative Discounted Costs and Savings through 2020 (Billion 1996$)

Policy	Costs	Benefits	Net Benefits
Appliance efficiency standards and product labeling	18	59	41
Building energy codes	12	30	19
Building retrofits	43	44	1
Public benefit trust fund	106	238	132
Renewable portfolio standard	112	-24	-136
Vehicle efficiency	115	503	388
Fuel GHG standard	144	108	-36
Combined heat & power	20	117	97
Voluntary agreements	36	98	62
Tighter emission controls on coal power plants	20	-37	-58
Total	**627**	**1,137**	**510**

Conclusion

This study shows that the United States can achieve its emissions target under the Kyoto Protocol—7 percent below 1990 levels for the first "budget period" of the Protocol—entirely or largely through domestic actions, even though the first budget period starts in about eight years. However, U.S. GHG emissions in 1998 were 10 percent greater than in 1990. Achieving America's Kyoto target requires strong, new national policies. Further delay could jeopardize America's ability to meet the Kyoto target.

New policies are needed to stimulate greater energy efficiencies in all sectors of the economy as well as to accelerate the adoption of renewable energy sources and the shift away from carbon-intensive fossil fuels. Some of the policies can be implemented without new legislation, such as adoption of more stringent appliance efficiency standards, additional product labeling, tougher fuel economy standards on cars and light trucks, reducing barriers to CHP, and voluntary agreements and related policies to reduce industrial energy use. Other policies require new legislation but have been adopted already by some states or municipalities.

The set of policies proposed here would yield other benefits besides lower GHG emissions and economic benefits for households and businesses. Oil imports would be reduced, thereby improving America's trade balance and reducing its vulnerability to supply constraints and oil price shocks. U.S. industries that produce efficient and clean technologies to meet climate policy goals would be poised to capture a large share of the rapidly growing world markets for these technologies. And cutting fossil fuel use would reduce air pollutants, thereby improving public health and reducing damage to crops, forests, buildings, and water resources.

In summary, striving to achieve our Kyoto Protocol target through new policies to increase energy efficiency and renewable energy development would provide broad benefits to American consumers and businesses. The primary obstacle is lack of political will, not technical or economic viability.

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