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A Cap and Trade System v. Alternative Policies to Curb U.S. Greenhouse Gases

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The views expressed herein are those of the author and do not necessarily reflect those of the institution with which he is associated.

Executive Summary

Since the inception of international discussions regarding climate change, there has been debate within the United States concerning what course of action to take. Some, pointing to recent increases in the earth's temperature, have argued for strict limits on greenhouse gases (GHGs) such as those imposed under the Kyoto Protocol. They claim that human activity, primarily the use of fossil fuels, is the major cause of these temperature increases. Others have warned that such limits will adversely affect the growth of U.S. GDP while having little effect on future climate. They point out that there are many uncertainties regarding climate science, and that it is not possible as yet to distinguish between natural climate variability and human influence.

Many who favor strict limits on U.S. GHGs favor a cap and trade (C&T) system, under which GHG emissions would be limited and emission rights given away or sold. The rights then could be traded on an organized exchange such as is done in Europe under the European Trading System (ETS). There are several variants, but the basic idea would be to first establish a C&T system and then ratchet down the number of rights over time.

U.S. policy to date has not embraced such limits. Instead, it has focused on research, development and promotion of technologies to reduce GHGs, on voluntary public/private partnerships to encourage such reductions, and on multilateral agreements such as the Asia-Pacific Partnership. Part of the debate within the U.S. has centered on how effective this approach has been.

This paper finds that:

- Climate change science, while suggesting a need to take precautionary steps, does not justify extreme high cost policy actions.
- A C&T system which limits the use of fossil fuel energy sources would impose large costs on the U.S. economy. Further, if emission "rights" were freely distributed, as has been the case with all C&T systems in the U.S. to date, resources would be consumed in rent seeking,[1] increasing costs even more.
- The ETS has experienced difficulties to date. It covers some CO_2 sources but not others and has created considerable uncertainty in Europe regarding the price of emission rights.
- Some have argued that a GHG C&T system could be modeled after the U.S. sulfur dioxide (SO_2) trading program. However, the latter involves only a single gas emitted by a limited number of utility plants which can be easily monitored, whereas GHG emissions involve several gases and many thousands of emitters.
- U.S. GHGs have risen over time, but GDP has risen much faster. The GHG intensity of GDP is a proper measure of progress in curbing GHGs because it focuses on GHG reduction while not constraining the GDP growth needed to support the many other policy goals of our society.

- U.S. GHGs have risen in part because of immigration, which has been far higher than into other OECD (Organization for Economic Cooperation and Development) countries and which essentially transfers the generation of GHG emissions to this country from elsewhere.
- The U.S. record in reducing the GHG intensity of GDP is strong. According to Department of Energy data, between 1990 and 2004 the CO_2 intensity of GDP decreased by 21 percent. This record compares favorably with that of other OECD countries.
- The Administration has committed to reducing the GHG intensity of U.S. GDP by 18 percent between 2002 and 2012. Data through 2005 suggest that the U.S. is well ahead of schedule in achieving this rate of reduction.
- The U.S. government invests about $3 billion annually in climate change research. A wide variety of agencies participate in the research activity, which is directed at energy efficiency, lower carbon forms of energy production, greater capture of CO_2 and of methane emissions, and fewer emissions of non-fossil fuel related GHGs. This research has resulted in a number of new technologies and is an important component of U.S. strategy to reduce its GHG intensity.
- The U.S. government also engages in public/private partnerships to encourage voluntary GHG reductions. Such programs publicly recognize firms for their GHG reduction activities, and provide technical information that can result in cost effective, wealth enhancing adoption of energy saving technologies. These programs are having significant impacts on U.S. GHG emissions.
- The U.S. recently initiated the Asia-Pacific Partnership on Clean Development and Climate, a group of countries accounting for over 50 percent of worldwide GHG emissions who have agreed to curb their emissions and to transfer technology to other countries to enable them to curb their emissions as well. This is an important step towards reducing worldwide GHG emissions, not just those in the U.S.
- The higher fossil fuel energy prices of recent years and increased U.S. determination to reduce energy imports likely will stimulate additional efforts to utilize energy more efficiently and to develop alternative, non fossil fuel sources. Such developments are likely to further decrease the GHG intensity of U.S. output.
- Reductions in GHG intensity can be accelerated through policy choices. Continued R&D, incentives to invest in new equipment, agency experimentation with new technologies, strong support for voluntary reduction activities, and agency accountability for their own GHGs would help to stimulate such reductions.

The choice for public policy makers is as follows:

- Continue and strengthen current programs to promote adoption of less GHG intensive technologies without adversely affecting GDP. This is the policy course that has been followed over the past fifteen years, a course which has achieved very substantial reductions in U.S. GHG intensity while not constraining GDP growth.

- Limit the use of fossil fuels in the U.S. economy through some form of C&T system, forcing reductions in energy use to the amount chosen, but also reducing the growth rate of GDP. Estimates of the effects of such policies suggest they will eventually cost many tens of billions of dollars per year, or several hundreds of dollars per year per family.

The state of climate science, the U.S. record in reducing its GHG intensity, and the prospective costs of a C&T system all suggest that the first is the better choice.

Introduction

Since the inception of international discussions regarding climate change, there has been considerable debate within the United States regarding the best course of action to take. Some have argued for stringent caps on U.S. GHG emissions, such as would have been imposed by the Kyoto Protocol. Others have argued that such caps would impose great economic damage on the country while achieving little in the way of temperature reduction. Consensus has emerged, however, that climate change is an issue that needs to be dealt with.

The present Administration, as the previous one, has initiated a series of policy actions to limit the growth of GHGs. For example, the United States recently initiated the Asia-Pacific Partnership on Clean Development and Climate, a group of countries accounting for more than 50 percent of the world's GHGs who have committed to curbing their emissions and to transferring technology to other countries to enable them to curb their emissions as well. The U.S. is spending several billion dollars per year on climate change research and on low carbon energy technologies. The federal government also offers various incentives to activities that reduce GHGs and sponsors an extensive series of voluntary programs whose purpose is to induce the private sector as well as state and local governments to reduce their GHGs.

Despite such actions, some policy makers have suggested that the U.S. should institute stronger, mandatory GHG reduction policies, in particular a nationwide C&T system. For example, in a recent White Paper, the majority and minority heads of the Senate Energy Committee have requested information on how best to institute such a system.[2] More recently, Senator Diane Feinstein has proposed legislation that would cap U.S. emissions at today's level through 2010, and then begin reducing them until they reach 92.75% of today's level in 2020.[3] And in June, Representative Henry Waxman introduced legislation to cap U.S. GHG emissions at 2009 levels in 2010, reduce them 2% per year through 2020, and then reduce them 5% per year to achieve an overall 80% reduction from 1990 levels by 2050.[4]

Under a C&T system, U.S. GHG emissions, and hence fossil energy use, are capped at some chosen amount, with emission rights either given out or auctioned to prospective emitters. Their value would be determined by the tightness of the constraint and

by the demand for the rights, which in turn would be determined by the demand for goods and services that result in GHG emissions. As conceived, the program would operate somewhat like the U.S. sulfur dioxide C&T program, in which utilities are granted annual quantities of permits to emit SO_2 and can trade these permits on an active exchange market. The SO_2 program, however, is far simpler to administer than would be a GHG program.

In this paper we critically examine whether a C&T system is an attractive policy alternative for the U.S. We briefly discuss whether the underlying science of climate change justifies such an approach, and then focus on its economics. Both the state of climate science and the economics of a C&T system suggest that other methods of constraining the growth of GHGs would be superior.

We next examine U.S. policy regarding GHGs over the past fifteen years, which has emphasized the development of new energy efficiency and energy production technologies, and established voluntary programs to encourage private sector organizations to reduce their GHGs. We review the U.S. record with regard to GHG emissions over the period, and compare it to the records of several other OECD countries. In this discussion, we consider an often-overlooked aspect of growth in U.S. GHGs, namely the extent to which they are the result of net immigration into the country. Finally, we offer suggestions for ways in which current U.S. policies to curb GHGs, which already appear to be quite effective, can be strengthened.

Climate Change Science Does Not Justify Extreme High Cost Policy Action

The state of climate change science continues to evolve, with new insights gained as models are improved and as data are obtained from observation and measurement. Still, however, there are many uncertainties.

For example, changes in the earth's atmosphere are known to occur for reasons unrelated to anthropogenic activity, particularly changes in solar activity.[5] In turn, changes in solar activity may produce feedback effects through cloud formation which amplify or dampen its effects.[6] The relative magnitudes of these effects on temperature are far from certain, however.

There also are uncertainties regarding the effects of particulate matter, which both reflect and absorb solar radiation, and thus have both cooling and heating effects. In addition, particulates are thought to lead to formation of both low and high-level cloud cover, with yet further cooling and warming effects.[7]

Further uncertainty arises from the cyclical behavior of ocean temperatures. Oscillation in surface temperature in the Pacific and Atlantic oceans occur over both shorter and longer time periods, confounding estimation of longer run trends in sea surface temperatures.[8]

To date, warming is within the long-term historical range and can be only partly attributed to anthropogenic behavior. Though insight is gained from the use of climate models, uncertainties such as those described above cause great difficulty in matching the timing and location of warming trends, so that the models are far from reliable predictors of future trends. Also, controversy has arisen over underlying assumptions in some of these models, for example regarding assumed long-term rates of growth in developing countries, and whether implications drawn from such assumptions are reasonable. Further, there is substantial uncertainty regarding how today's temperatures compare to those of previous centuries, whether we are experiencing abnormal numbers of extreme weather events and many other questions.

Scientists continue to propose and test new hypotheses concerning warming, including what its effects may be on the U.S. For example, a recent paper by Deschenes and Greenstone suggests that warming would have net positive effects on U.S. agriculture, though with varying effects among the states.[9] Earlier studies of the effects of climate change on U.S. agriculture reached similar conclusions, though with caveats concerning the uncertainties involved.[10]

Some have suggested that there is a "consensus" among scientists regarding climate science, and that this consensus implies mandatory GHG reduction policies. In fact, scientists hold many views concerning warming, its causes and its effects. But more importantly, science does not proceed through consensus. Observation, measurement and hypothesis testing is how climate science will continue to advance, not through polling of what scientists believe. The role of science regarding policy is to provide the best available information for use by political leaders. For now, this science suggests that policies should be considered to reduce the growth of GHGs and to adapt to warming, but it does not require drastic measures that are likely to prove very costly if undertaken.

A Cap & Trade System Would Impose Large Costs on the U.S. Economy

In general terms, output is produced by a combination of labor, capital and energy. There are substitution possibilities among these inputs, but they also complement one another. This means that, though capital or labor could be substituted for energy in producing goods and services, more energy also makes labor and capital more productive and hence increases their output.

In the United States, fossil fuels supply approximately 85% of total energy use. Coal is used almost exclusively to produce electricity, oil products mainly for transportation and chemical goods, and natural gas for heating of homes and other facilities, drying, and chemicals. At the margin of production, renewable forms of energy are increasing rapidly, but they presently constitute a small share of energy and by themselves cannot supply the nation's growing energy requirements.[11]

Energy efficiency can and does reduce fuel use, and there remain many opportunities to implement cost effective energy saving technologies. Further, there likely will be advances in energy efficiency technology that will create yet further opportunities for economization. However, even with ongoing installation of cost effective means of saving energy, continued economic growth still implies a need for more energy.

Given this context, a mandated constraint on total U.S. fossil fuel use imposed by a C&T system would impose costs on the economy because it would force substitution of higher cost inputs for energy, and by so doing would reduce the aggregate product of capital and labor. Some have suggested that such a constraint could be mild at first and then gradually tightened. The Feinstein legislation referenced above would freeze U.S. GHG emissions for four years, then tighten them by ½ percent per year for five years and then by 1 percent per year for another five. The net reduction from the 2006 level over 14 years is 7¼ percent. However, given economic growth over the period, the constraint would be much tighter than this number suggests. For example, were growth otherwise to be associated with 1 percent per year growth in fossil energy use between 2006 and 2020, the reduction relative to what otherwise would have occurred would be over 22 percent. Such a reduction is bound to constrain the productivity of capital and labor and lead to ever-bigger impacts on output growth.[12]

Some have asserted that the economic effects of a binding constraint on U.S. GHGs could be ameliorated through the international trading of emission permit rights. Trading reduces overall costs because it potentially takes advantage of worldwide differences in the costs of reducing GHGs, with the owners of low cost means selling rights to high cost reducers. However, no international emission rights trading system has ever been instituted, and it is unclear what the rules would be, how it would be monitored, or who the actual traders would be, whether governments or private parties. Also, such a system could well imply large, politically questionable wealth transfers between countries, and there would be ample scope for graft and corruption.[13]

A number of economic studies have concluded that the costs of a C&T system, whether imposed to achieve Kyoto or some other target, would be very high. In 1998, the Energy Information Administration (EIA) examined the economic effects of a cap on U.S. GHGs imposed to conform with the U.S. Kyoto target but without trading of rights and estimated that the costs could approach 4% of GDP annually by 2008-2012.[14] A 2003 Charles River Associates study found that a C&T system as proposed by Senators Lieberman and McCain, with trading, would cost $350-$760 per household in 2010, depending on which of two versions of their proposal were enacted.[15] These numbers imply annual costs in the range of $50 – $100 billion per year. DRI, WEFA and others have similarly estimated high costs to the economy from capping U.S. carbon emissions, whether with a trading system or without.[16]

More recently, in 2005, EIA examined policy recommendations of the National Commission on Energy Policy, which included a C&T system with a safety valve in the form of sales of additional permits if the price exceeded certain levels. The proposal also included other items, but the C&T system was the main one analyzed. Even with the

safety valve, EIA estimated reduced consumption in every year between 2010 and 2025, with the reduction reaching $470 per household in the year 2025 (the figures are in year 2000 dollars, so the number would be about $550 per household in today's dollars).[17] If there were as many as 150 million households in the U.S. at that time, the annual costs would be over $80 billion.

Clearly, the imposition of a C&T system in the United States is likely to cost many tens of billions of dollars per year. Economists who have studied mandatory controls on GHGs generally have concluded that, while effort is needed to deal with GHGs, the costs of mandatory controls are likely to be large whereas the benefits are likely to be small.[18]

A C&T System is an Inferior Means to Achieve Compulsory Reductions in GHGs

A C&T system for GHGs in the U.S. is likely to be extremely difficult to administer. The recent Senate Energy Committee White Paper suggests that an "upstream" system, imposed at the producer level, would be simpler to administer than a "downstream" system, but even an upstream system would present many challenges. There are literally thousands of U.S. producers and importers of fossil energy, which means that controlling CO_2 alone through a C&T system would be difficult. In addition, if other greenhouse gases such as methane, nitrous oxide (N_2O) and perfluorocarbons (PFCs) were controlled through a cap and trade system, many farmers, chemical companies and others would be included. Merely monitoring participants to be sure they were complying would be a monumental task. Preventing black markets in fossil fuels and other GHG emitting substances would be another. A C&T system is bound to be extremely complex and difficult to administer, no matter how far upstream it is placed.

Nor is complexity the only serious problem with such a system. The recent Senate Energy White Paper raises the issue of to whom "free" emission rights should be given. It asks whether such free rights should be granted for energy technology development and deployment, adaptation research, low-income consumers, all consumers, early reduction credits, an offset pilot program, fossil fuel producers, electric generators, energy intensive industries, agriculture and small business. These very questions raise the specter of individuals and firms throughout the economy petitioning the Federal government for "free" emission rights. Such rent seeking in itself would consume resources, up to the value of what is sought.[19] Estimates vary, but if the per metric ton cost of a permit were around $25, that alone would imply rents of nearly $200 billion per year. Resources spent fighting for income redistribution in the form of free allowances is a deadweight cost to the economy, not counted in the economic studies referenced above. Nor is it healthy for the U.S. political system to encourage such rent seeking. The public already is skeptical concerning monies spent to gain access to U.S. policy makers, monies frequently spent for purposes of rent seeking which a C&T system with free allowances would encourage. The likely economic costs associated with rent seeking and the associated public cynicism are yet other reasons why a C&T system should be avoided.

If the U.S. government were convinced that reductions in GHGs should be compelled through policy measures, it would be better to approach the matter through the tax system, with some form of a carbon tax. Economic theory strongly supports this conclusion. In a recent paper presented to the American Economic Association, Nordhaus argued that the deadweight economic losses imposed by a tax could be recovered if the revenues were used to reduce other taxes with similar deadweight losses, whereas the deadweight losses imposed by a C&T system probably would not be recovered since emission rights most likely would be given away, not sold.[20] He pointed out too that a C&T system likely would impose costs because it would result in volatile emission right prices, whereas the price impacts of a tax would be relatively stable.[21] A 1999 study by Pizer estimated that a tax-based approach would be about five times as cost effective as a C&T system.[22] Thus, even were the U.S to embark on a compulsory constraint path, a tax related to the carbon content of fuels would be the better approach.

U.S. Record on GHG Reductions

Fortunately, the public record gives good reason to avoid such a compulsory approach. The facts are that U.S. policy has aimed at curbing GHG emissions for some time, that its policies have been working, and that even more can be done using voluntary approaches.

Change in GHG Intensity is a Proper Measure of U.S. Progress

As indicated above, constraints on the absolute amount of GHG emissions will reduce GDP growth, costing many billions of dollars over time. Were GHG reduction the *sole* U.S. policy objective, then the debate would be over the most cost-effective mechanism. But obviously that is not the case, because the U.S. pursues many important policy goals. These include enhancements to the health and welfare of its population, improvements to the environment other than GHG reductions, help for others abroad, more defense and counterterrorist capability, and so on. Constraints on GDP growth reduce the ability of the country to reach its goals in every other policy area.

Further, the U.S. record in dealing with GHGs over the past fifteen years or so stands up well, particularly when compared to others within the OECD. The Energy Information Administration of the U.S. Department of Energy has published data on the carbon dioxide emissions from fossil fuel consumption and flaring for a large number of countries. EIA also has published data on real GDP (in 2000) for each country. Table 1 (right) utilizes such data to show rates of increase in CO_2 emissions and GDP for the U.S. and for several other OECD countries.

According to data in Table 1, U.S. CO_2 emissions rose by more than those of Denmark France, Germany, Italy and the UK, but by less than those of Austria, Belgium, Canada, Japan, Netherlands, Portugal and Spain. Denmark, Germany and the UK achieved decreases in GHG emissions over the period, but the German data counts emission reductions in the former East Germany as factories there were shut down,

Table 1. Rates of Increase of CO_2 Emissions and GDP for Selected OECD Countries

Country	Percentage Rate of Increase in CO_2 Emissions (1990-2004)	Percentage Rate of Increase in Real GDP (1990-2004)
U.S.	**17.9**	**52.1**
Austria	27.2	31.3
Belgium	19.1	30.1
Canada	22.9	44.1
Denmark	(1.8)	32.5
France	10.0	27.1
Germany*	(6.6)	18.2
Italy	17.3	21.5
Japan	24.4	21.1
Netherlands	29.5	41.3
Portugal	45.1	37.0
Spain	61.2	41.8
UK	(3.1)	39.2

**1991 - 2004*

while the UK was switching much of its power generation from coal to natural gas to take advantage of recent North Sea discoveries and to phase out uneconomic mines. Also, the German economy grew by less in real terms than any of the others over the period. At the same time, the U.S. economy grew by more than any of the others, far more in some cases. From this, U.S. GHG growth does not stand out from that of many other OECD countries, even as its economic growth has surpassed that of theirs.[23]

A better measure of progress is the GHG intensity of GDP. This metric shows what a country has accomplished in curbing its GHG emissions while encouraging GDP growth. Table 2 provides data only for the carbon intensity of GDP, but because carbon dioxide makes up the greater part of country GHGs, the EIA data is a good proxy for country GHG intensities.

Table 2 shows carbon intensities for 1990 and 2004 for the same group of countries. The U.S. record in reducing the carbon intensity of its output thus can be compared to that of others within the OECD. Among the countries shown, only the three that actually reduced their GHGs over the period, Denmark, Germany and the UK, show a higher rate of carbon intensity reduction than the U.S. As stated above, two of those, Germany and the UK, are somewhat special cases in that their reductions largely occurred for reasons other than climate policy.[24]

Table 2. Carbon Intensity, by Country 1990 & 2004
(MMT/$1000 US in $2000)

Country	1990	2004	% Change 1990-2004
U.S.	**.19**	**.15**	**21**
Austria	.10	.10	0
Belgium	.19	.17	10
Canada	.24	.20	17
Denmark	.12	.09	25
France	.09	.08	11
Germany*	.16	.12	25
Italy	.12	.12	0
Japan	.07	.07	0
Netherlands	.21	.20	5
Portugal	.15	.16	(7)
Spain	.14	.15	(7)
UK	.14	.10	29

**1991 - 2004*

President Bush has committed the U.S. to a further 18% reduction in GHG intensity between 2002 and 2012. If a like reduction in carbon intensity is accomplished, U.S. carbon intensity will fall to between .12 and .13, approximately the present level of Germany. Between 2002 and 2004 U.S. GDP increased 7% while GHGs increased 3%. Only preliminary fossil energy consumption data is available for 2005 but so far it suggests that carbon dioxide emissions increased very little, whereas GDP rose another 3.5%. If so, GDP will have risen by more than 10% over 3 years while GHGs rose about 3%. That would imply more than a 7% reduction in GHG intensity in three years, well ahead of the President's pledged schedule.

Immigration Often Isn't Accounted for in U.S. GHG Statistics

The U.S. record with respect to GHG emissions should be seen in the light of immigration statistics. Immigration into the U.S. in effect moves the production of GHGs from other countries here; that is, GHGs that would have been produced elsewhere are produced instead within the U.S. For example, between 1990 and 2002 the U.S. population increased by an estimated 39.2 million, or roughly 16%.[25] Total (legal and illegal) immigration over this period is estimated at 14.3 million. The offspring of previous immigrants account for another 7 million or so. Thus, previous and present immigration account for a little over 50% of the population increase over that period.

Between 1990 and 2002 U.S. GHGs increased by 12.4%. Even if immigrants and their offspring produce fewer GHG emissions than other Americans, they add significantly to the U.S. total. For example, even if the per capita GHG emissions of immigrants and their offspring are only two thirds those of other Americans, they still would have accounted for over a third of the increase in U.S. emissions over the period. In other words, on the counterfactual assumptions that no immigration to the U.S. occurred between 1990 and 2002 and no children were born to immigrants over that time period, emissions would have increased by about 8% instead of 12%, while emigrant country emissions would have been higher and increased by more.

Besides Canada, no other OECD country is experiencing the population growth nor immigration that is occurring into the U.S. Table 3 below summarizes population change between 1990 and 2003 for the same group of OECD countries as above. Most exhibit low single digit growth over the period. The implication is that the U.S. record with regard to curbing GHG emissions actually is better relative to others than the simple data suggest.

Table 3. 1990-2003 Population gains for Selected Countries

Country	1990 Population (Millions)	2003 Population (Millions)	Percent Change 1990-2004
U.S.	**250.0**	**291.0**	**16.4**
Austria	7.7	8.0	4.5
Belgium	10.0	10.4	4.1
Canada	27.7	31.6	14.1
Denmark	5.1	5.4	5.9
France	56.7	59.8	5.5
Germany*	80.0	82.5	3.1
Italy	56.7	57.4	1.2
Japan	123.6	127.6	3.2
Netherlands	15.0	16.2	8.0
Portugal	9.9	10.4	5.0
Spain	38.8	41.9	7.8
United Kingdom	57.3	59.4	3.7

**1991 - 2003*

A Strong R&D Program Coupled with Voluntary Means to Constrain GHGs is an Effective Policy Choice

Some have argued that the United States has no GHG policy, or that because its policies stress voluntary actions to reduce GHGs, they are ineffective. Neither is true.

Since 1990, the U.S. has spent heavily on research on climate change, and on research and development of new energy efficiency and energy production technologies. It has promoted an important new international agreement to restrain growth in GHGs. Domestically, it has instituted a wide variety of public-private partnerships and other programs to spur GHG reductions. This combination of policies, coupled with private sector actions to economize the use of energy, is responsible for the record of reduction in GHG intensity to date and for foreseeable continued improvement in the future.

Research and Development

The Department of Energy accounts for approximately 85% of the federal government's annual $3 billion in funding for energy R&D. Over the years, its programs have yielded a variety of technologies aimed at producing and consuming energy more efficiently. These include breakthroughs in thin film solar technology, wind turbines, biofuel production, superconductivity, lithium batteries, industrial process catalysts, and steam turbines. Many of these have entered the marketplace so that their effects on U.S. energy production and consumption have begun to materialize.

The Department of Energy also has been sponsoring R&D on carbon sequestration and advanced coal gasification technologies. These still are in experimental stages, but are intended to enable expanded utilization of the country's large coal resource base while significantly reducing the GHG emissions that otherwise would result.

Asia-Pacific Partnership Agreement

The U.S. took the lead in developing a new Asia-Pacific Partnership on Clean Development and Climate, an agreement among several large countries to voluntarily curb their emissions of GHGs, and to provide technology to other countries to curb theirs as well. The countries comprising the Partnership include China, India, Japan, Australia, South Korea and the U.S. Together, these six countries account for better than 50 percent of world GHGs and GDP. Their aims include developing, deploying and transferring clean energy technology, seeking to reduce the GHG intensity of their respective GDPs, strengthening cooperative efforts, and engaging their private sectors to help meet their country goals. According to EIA data, China already has been reducing the carbon intensity of its GDP at a rapid rate, but S. Korea, Australia, India and Japan have not. Though country goals in the Partnership are voluntarily reached and the Agreement is too new to yet judge, it offers opportunity for the U.S. to transfer newly developed energy efficiency and production technologies to other nations, and a means for it to encourage Agreement participants to curb GHG intensity as well.

Domestic Programs to Curb GHGs

There are a number of ways to reduce GHGs, among them greater energy efficiency, lower carbon forms of energy production, greater capture of CO_2 and of methane emissions, and fewer emissions of non-fossil fuel related greenhouse gases. The U.S. has initiated programs to promote all of these, involving a wide variety of agencies that include the Department of Energy (DOE), the EPA, the Department of Defense (DOD), the Department of Transportation (DOT) and the Department of Agriculture (DOA).

The list of programs is too extensive to list in its entirety, but a few suffice to illustrate the point. DOE sponsors a wide variety of programs and also implements the 1605b registry, under which firms publicly identify the projects they are conducting to reduce GHGs.[26]

DOE's many programs include Climate Challenge, Regional Carbon Sequestration, Clean Cities, Biofuels, and Best Practices. These involve voluntary commitments by utilities to reduce GHGs, development and promotion of carbon sequestration technology, encouragement of alternative fuel use, and sharing of information concerning energy efficiency technology.

DOE also jointly manages the Climate Wise and Combined Heat and Power Partnership programs with EPA, and the AgStar program with both DOA and EPA. Climate Wise is a private-public partnership under which private firms commit to reducing their GHG emissions and are publicly recognized for their accomplishments by the government. The Combined Heat and Power Partnership is a means to develop and implement more energy efficient forms of energy production. AgStar is aimed at capturing methane emissions in agricultural activity and at retaining carbon in the soil.

EPA-sponsored programs include Energy Star, Natural Gas Star, Coalbed Methane, Waste Wise, and the HFC-23 partnership. These programs promote energy efficiency, methane capture from natural gas, coal and landfill operations, and reductions in non fossil fuel GHGs. Energy Star, for example, identifies highly energy efficient products and by so doing provides information to consumers throughout the economy. Within this program, over 1000 manufacturers offer products covering more than thirty commercial and residential product categories ranging from buildings to light bulbs.

DOD has directed that GHG emissions from its facilities be reduced by 30 percent by 2010. Implementation is left to the individual Services, which have initiated a variety of measures to meet the goal, and which also have programs to increase the efficiency of the vehicles they operate. For example, the Air Force reportedly is speeding up the replacement of older, less fuel efficient aircraft engines and is flushing engines more frequently in order to reduce carbon deposits and increase the efficiency with which they burn.[27] Also, the Army and the Marines are jointly developing a new tactical vehicle that will feature hybrid electric drive and which is expected to achieve a 20% fuel economy improvement over similar conventionally powered vehicles.

DOT is involved with a number of programs such as easing traffic congestion that are not aimed specifically at GHGs but which produce such reductions as an ancillary benefit. It also participates in the FreedomCAR program, an advanced vehicle program aimed directly at reducing petroleum use and GHG emissions, possibly through the use of fuel cell technology.

In addition to these federal agency programs, states and localities and non-governmental organizations have programs of their own. The state of Indiana, for example, provides financial support to in-state manufacturers to increase the energy efficiency of their processes. Minnesota's Releaf program funds the planting of trees in that state as a means to store carbon and save energy. And the city of Seattle sponsors a Climate Wise program through Seattle City Light, which partners with local firms to invest in energy efficient equipment.

A number of environmental groups also sponsor GHG reduction programs. These include the Pew Center on Climate Change, Environmental Defense and the World Wildlife Fund, all of whom have established partnerships with private sector companies willing to commit to reductions in their GHG emissions. Also, the World Resources Institute (WRI) has helped to organize a Green Power Market Development Group, whose purpose is to support the development of green energy markets in the U.S. In addition, WRI has also worked with a number of private sector firms to develop protocols for the measurement of corporate GHGs

The 1997 "Climate Action Report" submitted by the United States under the UN Framework Convention, estimated that the voluntary programs of DOE and EPA alone would result in a reduction of about 9% of net U.S. GHGs in 2010. The U.S. did not submit comparable estimates in its 2002 report, but according to an EPA source, the DOE and EPA programs remain on course to achieve about that level of reductions.[28] Programs initiated by others, involving firms not already counted in the DOE or EPA programs, will yield yet further reductions.

Recent Events in Energy Markets are Likely to Stimulate even Greater Investments in Energy Efficiency and new forms of Energy Production

Private sector firms have ongoing incentive to economize on energy use because it is a cost of production. Recent increases in energy prices and expectations that such higher prices are likely to persist for some time will stimulate new investments in energy saving capital equipment and in alternative forms of energy production. The production of renewable forms of energy, for example, is likely to increase at high rates.[29]

In addition, the federal government has begun to reexamine the country's policies towards energy use because of strategic questions concerning fuel imports. The 2005 energy bill, for example, contained provisions encouraging the use of ethanol as a motor fuel, in part to reduce U.S. dependence on imported petroleum.

The combination of strong incentives for private firms to economize energy use and to produce alternative forms of energy, and continuing federal support for energy R&D and for voluntary public-private partnerships, is likely to result in yet further reductions in U.S. GHG intensity. Indeed, the record since 2002, when energy prices began to increase significantly, suggests that U.S. GHG intensity may fall at a greater rate in the future than it has in the past. If so, the U.S. record on GHG intensity reduction plausibly will be at least as strong as that of most other OECD nations, giving indication that present U.S. policies are effective and should continue to be pursued, if not strengthened.

Policies to Accelerate Reductions in GHG Intensity

The federal government is spending large amounts to develop new technologies to reduce GHG emissions or to provide less carbon intensive energy. Such R&D is a necessary component of the U.S. voluntary program. To be effective, however, the technologies developed under the program need to be utilized widely throughout the economy and, where applicable, in other countries as well. The government can expedite the process of adoption by trying out technologies in its own facilities and vehicles, and by providing incentives to private firms to do so. Stronger capital recovery incentives will induce firms to turn over their capital stock at a more rapid rate, resulting in more rapid adoption of energy efficient technologies and a faster rate of reduction in GHG emissions per unit of output. Technology sharing with other countries through database development, sponsorship of international workshops and exchanges of personnel can expedite the application of energy efficiency and low-carbon production technologies both here and abroad.

As described above, federal agencies also are sponsors of, and participants in, a wide variety of voluntary GHG reduction programs. Federal policy should recognize the effectiveness of these voluntary programs and provide strong support for them. It should also encourage the formation of new such programs to take advantage of new GHG reducing technologies. In exchange for the strong support, the government should hold the programs to account. Each of the various federal partnership programs should be encouraged to report its results in terms of verified GHG reductions, and to project what it will accomplish in the future. Those that demonstrably are achieving significant reductions should be given further support and encouragement.

Finally, federal agencies themselves should be encouraged to publicly report their GHGs and to establish plans to reduce them. Through example and persuasion, the federal government also should encourage state and local governmental entities to report their GHG emissions. The greater the public dissemination of such data, the more likely that reductions in public sector emissions will take place.

Conclusions

Dealing with climate change involves choices, with enormous consequences for the economy and therefore for other policy goals. Forced reductions in GHGs, and therefore fossil fuel energy use, through a C&T system will impose large costs in terms of reduced GDP growth, costs estimated to eventually reach tens of billions of dollars per year. An alternative is to continue with the development of new energy saving and low carbon energy production technologies, encouragement of voluntary actions to curb GHGs, and engagement in international efforts to help other countries curb theirs. This policy will not constrain GDP growth, and hence will not sacrifice other social goals for the single purpose of reducing GHGs.

Evidence given in this paper suggests that the latter course, which has been U.S. policy to date, is working. U.S. GHG intensity has been dropping steadily and continues to drop, even with economic growth greater than that of most other OECD countries. High fossil fuel energy prices and ongoing technological development likely will further reduce GHG intensity, through greater application of energy efficiency and non-fossil production technologies. Stronger capital recovery incentives and other policies could speed up the process even more. In short, even without participation in the Kyoto protocol or some other GHG C&T scheme, the U.S. record on reducing GHG intensity is among the best in the developed world and is likely to remain so.

Endnotes

1. Loosely speaking, rent seeking is the seeking of economic gain through lobbying of legislative or regulatory bodies.
2. See "Design Elements of a Mandatory Market-Based Greenhouse Gas Regulatory System," Senators Pete V. Domenici and Jeff Bingaman, Senate Energy Committee White Paper, February 2006.
3. "Strong Economy and Climate Protection Act," Discussion Draft, March 2006.
4. HR5642 of 2006, entitled the Safe Climate Act.
5. See Scafetta, Nicola and Bruce J. West (2005): "Estimated Solar Contribution to the Global Surface Warming Using ACRIM TSI Satellite Composite," *Geophysical Research Letters*, 32, 2005.
6. Svensmaark, Henrik and E. Friis-Christianssen, "Variation of Cosmic Ray Flux and Global Cloud Cover – A Missing Link in Solar-Climate Relationships," *Journal of Atmospheric, Solar and Terrestrial Physics*, 59.
7. Climate Change Science Program and Subcommittee on Global Change Research: "*Strategic Plan for the U.S. Climate Change Science Program*," 2003, p. 31.
8. Houghton, John T., et al. "*Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change,"* Cambridge University Press, Pg. 151ff.
9. Deschenes, Olivier & Michael Greenstone, "The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather," *AEI-Brookings Publication 06-02*, January 2006.
10. See for example Mendelsohn, Robert, William D. Nordhaus and Daigee Shaw, "The Impact of Climate Variation on U.S. Agriculture," in Robert Mendelsohn and James E. Neumann (editors), *The Impact of Climate Change on the U.S. Economy*, Cambridge University Press, 1999.
11. Global markets for solar energy reached $11 billion in 2005, up over 50 percent from 2004. However, this is still just two days of the worldwide sale of oil products.
12. It is exactly such considerations that led the U.S. to refuse to ratify the Kyoto Protocol. The Protocol required the U.S. to reduce its GHGs by 7 percent between 1990 and 2008-12. EIA projected that the U.S. would have to reduce its energy use by around 28% relative to the base case to reach the goal, severely binding U.S. GDP. Understanding the ramifications, the U.S. Senate voted 95-0 to oppose any U.S. GHG treaty obligation that would adversely affect the economy.
13. See Richard N. Cooper, "International Approaches to Climate Change," Weatherhead Center for International Affairs Working Paper No. 99-03, January 1999.
14. U.S. Department of Energy, Energy Information Administration, Office of Integrated Analysis and Forecasting, "Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity," Washington DC, 1998.

15. Anne E. Smith, Paul Bernstein & W. David Montgomery, Charles River Associates, "The Full Costs of S.139, With and Without its Phase II Requirements," Washington DC, October 27, 2003.

16. Joyce Y. Brinner, DRI, Inc., "Commentary: The Impact of Meeting the Kyoto Protocol on Energy Markets and the Economy," in *Climate Change Policy: Practical Strategies to Promote Economic Growth and Environmental Quality*, American Council for Capital Formation Center for Policy Research, Washington DC, 1999. Brinner estimated annual costs exceeding 1% of GDP. See also WEFA: Novak, Mary H., "Global Warming: The High Cost of the Kyoto Protocol – National and State Impacts," Eddystone, PA: WEFA Inc. 1998. WEFA estimated a 3.2% annual GDP impact between 2008 and 2012 but did not include a trading system in its analysis.

17. U.S. Department of Energy, Energy Information Administration, Office of Integrated Analysis and Forecasting, "Impacts of Modeled Recommendations of the National Commission on Energy Policy," Washington DC, April 2005.

18. See for example William Nordhaus, "The Economics of the Kyoto-Bonn Accord," *Science*, November 2001.

19. There is a rich literature on this subject. Among the seminal works are Gordon Tullock, "The Welfare Costs of Tariffs, Monopoly and Theft," *Western Economic Journal*, June 1967, pp. 224-232, and Richard Posner, "The Social Costs of Monopoly and Regulation," *Journal of Political Economy*, August 1975, pp. 807-827.

20. William D. Nordhaus, "After Kyoto: Alternative Mechanisms to Control Global Warming," Paper prepared for the American Economic Association Session on Global Warming and the Kyoto Protocol, December 2005. On the question of how emission rights likely would be distributed, Nordhaus argued that, to date, *all* emission rights in the U.S. have been freely allocated (emphasis his).

21. Illustrating Nordhaus' point, the price of emission rights on the ETS recently and suddenly fell by over 50% when it was announced that 2005 emissions in several European countries had fallen short of their national allowances.

22. William Pizer, "Choosing Price or Quantity Controls for Greenhouse Gases," *Climate Issues Brief No. 17*, Resources for the Future, Washington DC, July 1999.

23. We do not include China and India in Table 1 because their economies are less comparable to that of the U.S. However, as a matter of interest, China's CO2 emissions grew by 110% and India's by 89.2% between 1990 and 2004. Over that period, China's economy grew by an astonishing 280.6%, and India's by 127.3%.

24. Over the period, China reduced its carbon intensity from 1.48 to .86 or by 42%, while India reduced its intensity from .59 to .51, or by 14%.

25. Camarota, Steven A., "Immigrants in the United States – 2002: A Snapshot of America's Foreign-Born Population," Center for Immigration Studies, November 2002.

26. The registry was established under Section 1605 of the Energy Policy Act of 1992.

27. USA Today, March 6, 2006.

28. Conversation with John A. "Skip" Laitner, Senior Economist for Technology Policy with EPA, March 3, 2003.

29. A Clean Energy Trends 2006 Report by Clean Edge, a stock market research firm, predicts that markets for solar, wind and biofuels all will approach $50 billion per year by 2015.

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