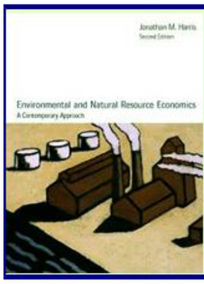

Environmental Policy Update #3:

Getting Serious about Global Warming

***Environmental and Natural Resource Economics: A Contemporary Approach*, Second Edition, Jonathan M. Harris**

Introduction

Recent scientific evidence has increased the urgency of policy responses to global climate change. Because the emissions that contribute to global warming are so fundamentally linked to modern economic and energy systems, developing an effective response poses an enormous challenge. Economic policy tools are an essential element of responding to this challenge. Until recently, most economic analyses have suggested limited responses: for example, a small tax on carbon emissions. But new evidence of rapid warming suggests that much more drastic action may be needed:

- Warmer temperatures over the past decade have significantly increased the rate of Arctic and Antarctic ice melt. Greenland's glaciers now dump twice as much ice into the Atlantic as they did in 1996, contributing to rising sea levels and possible changes in fundamental ocean circulation patterns such as the Gulf Stream.[1] The Arctic may be completely ice-free in summer within a few decades – a condition not seen for at least a million years.

- 2005 is projected to equal or surpass 1998 as the warmest year on record. 1998, 2002, 2003, 2004, and 2005 were the five warmest years since the 1890s.

- There is more evidence that rapid atmospheric and ocean warming could lead to catastrophic climate change including widespread water shortages, abrupt temperature changes of as much as 10º Fahrenheit, massive droughts in parts of Africa and other arid areas, and much more powerful hurricanes and other extreme weather events. Although the overall effect will be warming temperatures, changes in the warm Gulf Stream current could put northern Europe into a deep freeze.

- Low-lying areas such as Bangladesh and Florida could be inundated if Artic and Antarctic ice sheets disappear; by 2080, sea-level rise could cause the loss of up to 22% of the world's coastal wetlands, including highly ecologically productive mangrove forests and salt marshes.[2]

- Positive feedback effects, such as carbon release from melting tundra and less reflection of solar radiation as snow cover diminishes, could accelerate the warming process further.

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[1] Andrew Bridges, "Greenland Glaciers Dumping More Ice," Associated Press, February 16, 2006.

[2] Saleemul Huq (1999), *Vulnerability and Adaptation to Climate Change for Bangladesh* (Boston: Kluwer Academic Publishers); Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2001: Impacts, Adaptation, and Vulnerability* (Cambridge University Press, 2001), p. 358; available at http://www.ipcc.ch/.

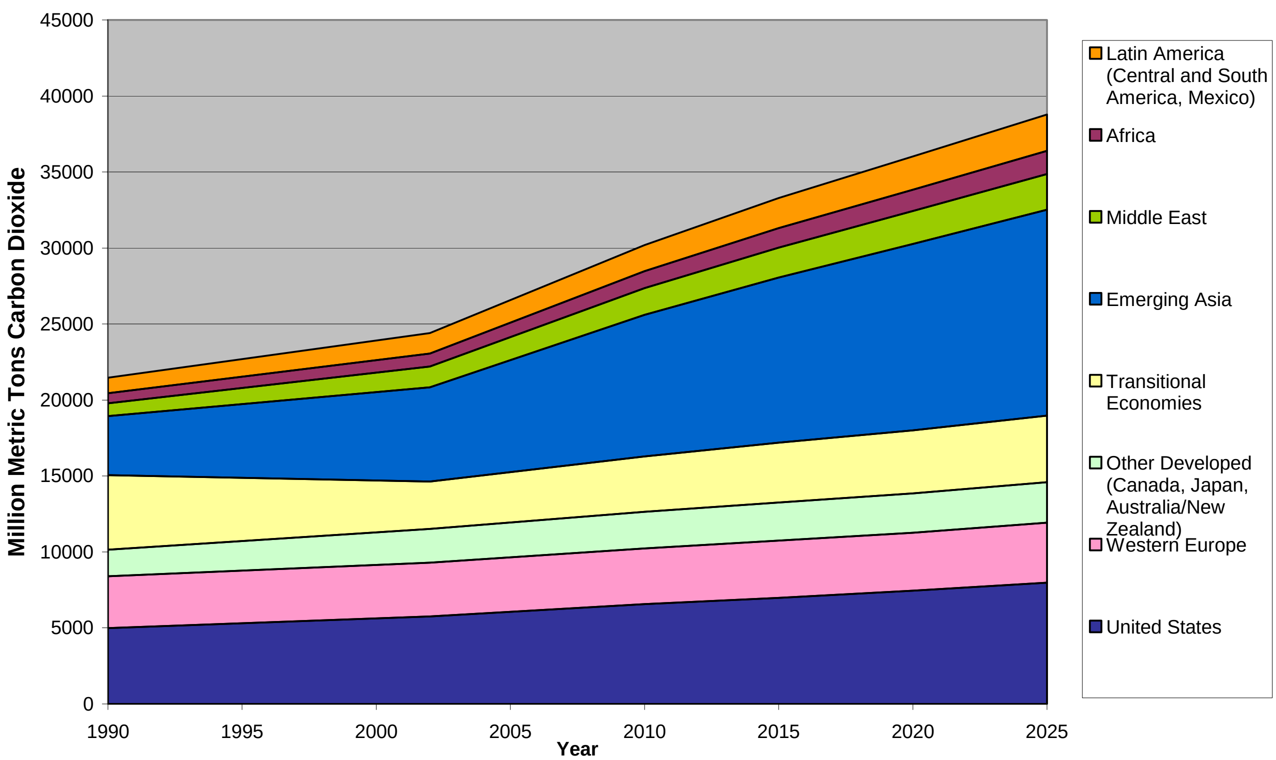
Current Policy Responses

The Kyoto Protocol on greenhouse gas reduction entered into force in 2005, but without the participation of the United States. The impact of Kyoto, however, will be limited. The Kyoto targets specifying a 5% reduction in developed nations' emissions are unlikely to be met, and much deeper cuts would be needed to have a major effect on the course of climate change. Europe and Japan have initiated limited reductions in growth rate of emissions, but will probably not meet targets for cuts by 2010. The US has taken essentially no action, favoring only "voluntary" measures. Meanwhile China, India, Brazil, and other developing nations are projected to increase emissions rapidly.

Emissions, Accumulations, and Targets for Reduction

Figure 1 shows recent and projected patterns of carbon dioxide emissions. (Carbon dioxide is the most important greenhouse gas, although other gases such as methane and chlorofluorocarbons also contribute to the greenhouse effect.) Developed and transitional economies currently emit over 60% of the total CO_2, but by 2025 currently developing nations are projected to contribute about 50% of total emissions.

FIGURE 1: 1990-2025 HISTORICAL AND PROJECTED CO_2 EMISSIONS



Source: U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2005* , The projections shown in Figure 1 are for the U.S. Department of Energy's "reference case", which does not assume any major policy effort to control emissions. Given the current evidence concerning accelerating effects of global climate change, these projections would mean a steady increase in global mean temperature, even if emissions started to fall after 2025.

It is particularly significant that emissions of CO_2 are a **cumulative pollutant**[3] – they remain in the atmosphere for many decades. In the case of a cumulative pollutant, stabilizing *emissions* does not stabilize *accumulations* -- even if emissions rates are frozen, accumulations continue to increase (see Chapter 16 in text). According to the Intergovernmental Panel on Climate Change (IPCC), "stabilizing CO_2 concentrations would require substantial reductions of emissions below current levels."

Even if Kyoto Protocol goals were fully achieved, overall emissions would continue to increase as developing nations' emissions grow. In order to stabilize total CO_2 concentrations at levels that would correspond to no more than a 1-2 º C increase global mean temperature, the IPCC estimates that a reduction of 50-80% in greenhouse emissions will be required.

The Economics of Effective Action

Is it possible to "slow, stop, and reverse" the pattern of steadily increasing emissions shown in Figure 1? Economic analysis suggests that the answer is yes – but at a cost. Thus a starting point for economic analysis of climate change has been the evaluation of costs and benefits. ("Benefits" here are defined as "avoided damages" — thus the higher the expected damages, the greater the benefits from action to avert global warming.) As discussed in the text (Ch. 18), **cost-benefit analysis** of global climate change is controversial. Two issues are particularly significant:

- Economic estimates of damage costs (for example, the value of beachfront property lost to rising sea levels) may underestimate the potential for truly catastrophic damage, for example to low-lying cities like New Orleans and Miami. The costs of hurricane Katrina, for example are estimated at over $100 billion, while typical cost-benefit studies of global climate change estimate hurricane costs at only $1-6 billion a year.

- Estimates of the costs of future damages are especially sensitive to the choice of the discount rate. Standard discount rates reduce costs 50 years in the future by a factor of 10 to 20 (see text Ch. 6, Figure 6-1). But many of the most severe predicted costs of climate change come over a period of 50 to several hundred years – thus standard cost-benefit analysis will tend to lead to prescriptions for minimal policy action as a result of undervaluing these future costs.

[3] See text *Environmental and Natural Resource Economics: A Contemporary Approach* for definitions of terms in boldface.

An alternative to cost-benefit analysis is **cost-effectiveness analysis**. In this approach, the policy goal is selected not based on weighing costs and benefits, but on other factors such as the scientific requirements for ecosystem sustainability and considerations of intergenerational equity. In the case of global climate change, this would imply stabilizing *accumulations* of greenhouse gases at a level which does not threaten major disruption of climate patterns. As noted above, this implies a 50-80% cut in *emissions*. Once the policy goal is chosen, economic analysis is used to determine the most efficient, least-cost way to achieve that goal.

From an economic point of view, the potential for emissions reduction can be divided into demand-side potential and supply-side potential. To combine these most efficiently, economists generally favor market-based policies that create incentives for both demand and supply-side reductions.

Demand-side potential

Over the past 50 years, global energy demand has grown steadily, and this trend continues. Projected world energy demand in 2025 is about 50% above current levels.[4] But this "business as usual" scenario could be drastically altered if serious policies to improve energy efficiency were put in place. According to the IPCC, reductions of up to 10 billion tons of carbon dioxide emissions could be achieved by 2020 with known, relatively low-cost technologies for energy efficiency.[5] These include energy-efficient buildings, hybrid and other fuel-efficient cars, efficient machinery and power generation, and energy-conserving agricultural techniques.

If this ambitious potential for energy efficiency could be achieved, the rising line of total emissions in Figure 1 would become virtually flat, indicating no net increase in emissions over current levels. This would not involve limits on economic development or cutbacks in living standards, but rather the achievement of the same *end-uses*¸ such as transportation and heating or cooling buildings, with less energy inputs.

Supply-side potential

Of course, even limiting emissions to zero net growth – while a big change from current trends – would not solve the problem, since substantial reductions below current emissions levels are needed to stabilize atmospheric accumulations at acceptable levels. But if demand growth can be limited, the potential for percentage reductions through supply-side improvements becomes much more significant. Suppose, for example that it became possible by 2025 to supply 20% of *current* energy use levels from non-carbon sources such as wind and solar power or biofuels. If during the same period energy demand had increased by 50% (as in the standard projection), net carbon emissions would

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[4] U.S. Department of Energy, *International Energy Outlook 2005*, http://www.eia.doe.gov/oiaf/ieo/
[5] IPCC, *Climate Change 2001: Mitigation* (Cambridge University Press, 2001), p. 7; available at http://www.ipcc.ch/. The IPCC estimates are given in tons of carbon; these can be converted to tons of carbon dioxide by multiplying by 3.67.

be 30% higher. But if energy efficiency improvements limited total energy demand growth to, say, 10%, then total carbon emissions would actually fall 10%.

Getting global emissions on a declining trend is a huge challenge, given rapid energy demand growth in developing nations (note that most of the projected demand growth in Figure 1 comes from the developing world). But according to IPCC scientists, it is technologically feasible. The IPCC notes that "significant technical progress relevant to greenhouse gas reduction has been made since 1995 and has been faster than anticipated."[6] Technological advances in wind power, solar power, hybrid vehicles, fuel cells, and energy efficiency – plus anticipated future technological breakthroughs – make it possible to envision global greenhouse emissions moving onto a declining path after about 2020. But this could only occur with a major global shift towards policies to promote energy efficiency and development of non-carbon energy sources. What economic incentives and policies are needed to make this happen?

Policies for Greenhouse Gas Reduction

Three major kinds of policies are available for greenhouse gas reduction: **carbon taxes**, **carbon trading**, and **efficiency standards** (see Ch. 18 in text). In addition, governments can subsidize the development and deployment of "clean", non-carbon technologies and energy efficiency.

Since the adoption of the Kyoto protocol, European nations have moved ahead with a carbon trading system, with a goal of cutbacks of 8% below 1990 levels of carbon emissions by 2012. The system assigns a certain level of emissions permits to each country, which can then be allocated or auctioned to emitting industries. The permits can be traded in a free market, allowing the market to set its own price, but guaranteeing an overall limit on emissions. As discussed in the text (Ch. 18), this system has the advantage of achieving a specific overall goal, while allowing market flexibility in determining the least-cost approaches to reducing emissions. A disadvantage is that it is difficult to cover all sources of emissions: trading systems, for example, can easily be used for power plant emissions, but not for transportation systems with many private vehicles. Many European nations have also implemented carbon taxes; even before Kyoto, European levels of gasoline and other energy taxes were much higher that those in the United States.[7]

Like a carbon tax, an effective trading system will raise energy prices. The cost of the permits will be at least partly passed on to consumers. The European market price for carbon permits is currently around 20 Euros per ton (approximately $25). Unlike a tax, which generates revenues which can be "recycled" to subsidize clean energy or to lower other taxes, trading systems do not necessarily raise money for the government. If the permits are allocated to existing industries, these industries receive a net benefit; but if the permits are auctioned, the government can collect the revenues. A permit system in which all permits are auctioned is virtually equivalent to a tax in its impact – but is likely be opposed by industry for this reason.

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[6] IPCC, op. cit., p. 5.

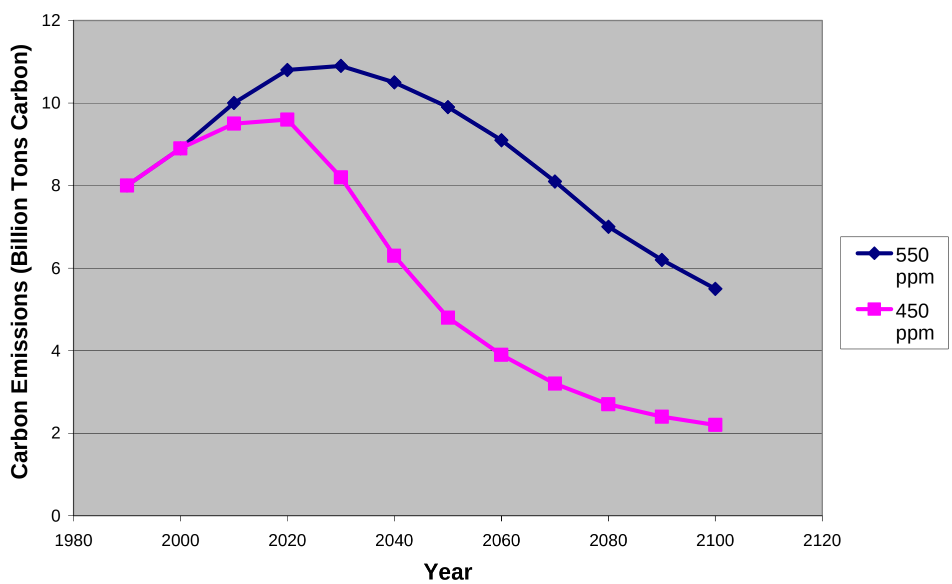
[7] *EU leads Kyoto "Carbon Revolution,"* BBC News February 16, 2006, http://bbc.co.uk; "A Review of Carbon and Energy Taxes in EU," Regional Environmental Center, http://www.rec.org/

While the United States under the Bush administration has refused to participate in the Kyoto protocol, some states and localities have moved ahead with measures to control greenhouse gases. California has proposed an ambitious system of fuel efficiency standards that would reduce greenhouse emissions from cars and light trucks by about 30% by 2016. Nine other states have followed California's lead by adopting its standards, but automakers are suing to overturn the regulations. Portland, Oregon, has been successful in reducing emissions below 1990 levels, and according to its mayor, the carbon reduction program has also has significant economic benefits.[8]

International carbon trading under the Kyoto protocol is not scheduled to start until 2008, but under Kyoto's Clean Development Mechanism and Joint Implementation provisions, companies can purchase carbon reduction credits from clean-energy projects in other countries. For example, the Spanish national power corporation Endesa has purchased 2.6 million tons of CO_2 credits from three wind farms operated by the Chinese electric utility Huaneng. Endesa pays $8.70 per ton for these credits – lower than the current $25 price for a carbon permit in Europe.

While policies such as these represent a serious start on carbon reduction, they fall well short of what will be required for stabilization of atmospheric carbon. Figure 2 shows the trend of carbon emissions that would be required to stabilize accumulations of atmospheric carbon at 450 or 550 parts per million. A level of 450 ppm implies a probable global temperature increase of 1-2º C (2-3º Fahrenheit), while 550 ppm would raise temperature by 2-3º C (3-5º Fahrenheit). Thus even these levels would imply serious climate effects – but might avoid truly catastrophic impacts.

FIGURE 2: CARBON STABILIZATION SCENARIOS (450 and 550 ppm)[9]



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[8] Shoinn Freeman, "States Adopt California's Greenhouse Gas Limits," *Washington Post*, January 3, 2006; "Global Warming Progress Report, City of Portland," http://www.sustainableportland.org

[9] Adapted from IPCC, *Climate Change 2001: The Scientific Basis*, http://www.ipcc.ch/

Conclusion: The 21st Century Challenge

If developed nations can take the lead in carbon reduction, the resulting new technologies for energy efficiency and non-carbon energy sources can be applied worldwide. This would make it far more attractive for developing nations to participate in future climate change agreements – rather than seeing carbon reduction as a crippling limitation on their development, they could take advantage of high-efficiency technologies that would also lower ground-level pollution. (See Chapter 20 for discussion of the huge problems of atmospheric pollution in China.) And under carbon trading schemes, they could receive significant income for doing so. India, for example, already has 300 industrial projects in the areas of carbon trading and clean development. Even though India has not agreed to any commitments under Kyoto, they see potential for their future development in selling carbon credits.[10]

The major barrier to effective action is the unwillingness of many market actors – prominently including the U.S. government – to accept the need for measures that will raise energy prices. Yet from an economic point of view, higher energy prices are an essential element of any effective policy for carbon reduction. The revenues generated by these higher prices can be turned to positive uses – the proceeds from carbon taxes or permit auctions can be used to lower other taxes, or to subsidize the development of new technologies. But measures such as improved efficiency standards, voluntary conservation, or clean power sources, are limited in what they can achieve without higher prices for energy. The reason is what economists call *leakage* – the tendency of reduced demand to lower prices, which encourages increased energy use. Reductions in demand for carbon-based energy by some consumers will tend to be offset by increases in its use by other consumers if prices for fossil fuels remain low.

In addition, the incentive to adopt new technologies for energy efficiency of alternative sources will be limited if oil, coal, and gas remain cheap. An essential element of progress on global climate change will be acceptance of measures such as gas taxes or electricity price increases. These can be made more palatable to consumers by rebating the revenues to lower income or payroll taxes. The advantages of energy independence – the money stays at home, rather than going to foreign energy producers – could also be a selling point. But it is clear that strong political leadership will be required to respond to the increasingly urgent challenge of global climate change.

Discussion Questions

1. What are the relative advantages or disadvantages of carbon taxes, permit trading systems, and efficiency standards? What combinations of these policies would you favor? Which do you think would be politically most practicable?
2. What effect would a policy of subsidizing wind and solar power have on energy supply and demand? Would such a policy be effective in reducing carbon emissions, or would it need to be supplemented with other policies?

[10] Information on carbon trading policies in China and India from International Emissions Trading Association (IETA), http:// http://www.ieta.org/