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# A NEW PARADIGM FOR US CLIMATE POLICY

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from the book Climate Policy for the 21st Century:
Meeting the Long-Term Challenge of Global Warming
Edited by David Michel
Center for Transatlantic Relations
Johns Hopkins University–SAIS., 2004

## ***ABSTRACT***

In the United States, the most prominent domestic emission control options have typically resembled spirit and structure of the Kyoto protocol. These Kyoto paradigm approaches exhibit the following weaknesses:

- The emission reduction goals are formulated as quantitative targets rather than as dollars per ton, thus creating a high risk of incurring excess costs.

- The proposed emission reductions are too steep, compounding the risk of excessive abatement costs.

- The proposals would layer redundant and expensive command and control regulations atop market-like incentives for emission reductions.

- The policies fail to link the initial domestic proposals to the crucial next stage of encouraging fast growing less developed countries (LDCs) to reduce their emission growth rates.

Examining the intellectual foundations of Kyoto paradigm proposals raises serious doubts about the paradigm's validity. Claims that the US has great potential for cheaply reducing energy consumption are dubious. And assertions that the experience with sulfur emissions controls show that carbon emission controls will be cheap are based on a misunderstanding of the actual experience of this program.

Unless the Kyoto paradigm policies are modified, US climate policy seems likely to remain deadlocked. New emission limitation proposals, however, could be designed to avoid prohibitively high abatement costs. The key is to shift emphasis away from exclusive reliance on a strategy of using the emission controls to force private sector technological innovation. Instead, emission controls should *also* be used to start the process of encouraging LDC emission reductions and to fund a more effective government funded energy R&D program. Such an approach would set the US on a course from which it could re-establish climate policy cooperation with Europe.

## ***INTRODUCTION***

Climate policy needs to minimize the sum of the potential costs of climate change and of government policy intended to avoid climate change. Both sets of costs are worth taking seriously. By implication, climate policy must steer between inaction and the adoption of overly ambitious and needlessly costly emission reduction policies.

On the one hand, climate change clearly portends non-trivial damages. Although the time scale and extent of the threat presented by climate change are uncertain, uncertainty does not justify inaction. For example, one economic model projects the present discounted value of the global damage from climate change at $5 trillion (updated into current dollars).[1] Experts like Thomas Schelling have cautioned that this number is still small when compared to total expected economic output during the coming century. The point is valid and should discourage apocalyptic exaggerations of the climate issue. Nevertheless, $5 trillion is still a big number and well worth serious effort to avoid or reduce.

On the other hand, the most straightforward remedy -- reducing the reliance on fossil fuel -- implies economic sacrifice. To significantly affect the concentrations of greenhouse gases, reductions in the use of fossil fuels would have to be large, as would the economic costs. In addition, the possibility that legislators and interest groups will exploit climate as a pretext for generating economic rents and personal and partisan electoral advantage guarantees that emission reduction policies will be far from perfectly cost effective.

By slighting the need to avoid excessive control costs, emission control proponents may have inadvertently contributed to the current political deadlock in US climate policy. Unjustifiably expensive emission reduction proposals encourage the opponents of emission controls to stiffen their resistance and at the least may silence potential supporters of more moderate controls. In the United States, the Kyoto Protocol started this process of polarizing political gridlock. The more recent US Kyoto paradigm proposals have continued the pattern.

Instead of holding out for legislation embodying rapid emission reductions, US climate policy advocates should emphasize initiating controls as soon as possible. The emission controls should be transparent and cost effective. But they should not embody needlessly costly and unjustifiably aggressive emission control targets.

The scenario analysis of the IPCC points out that the most cost effective emission control paths allow for several decades of transition before achieving significant emission reductions. The goal is to synchronize emission reductions with the normal times at which capital stock would be due for replacement. Legislation that ignores this imperative and strains to achieve large near term emission reductions is likely to be unjustifiably expensive.[2]

## ***FLAWED EMISSION CONTROL POLICIES***

This section describes the Kyoto paradigm as it has been applied to emission control policy in the United States. The section also explains why the resulting proposals are unlikely to maximize society's long-term welfare.

Although great uncertainties persist about the size of both the costs and the benefits of reductions in greenhouse gas emissions, there is reason for concern that Kyoto paradigm climate policies could be economically harmful and fail to produce significant reductions in the eventual greenhouse gas concentration levels.

Parenthetically, it is worth noting that the paper frequently refers to "proponents of the Kyoto paradigm." The term is not meant to imply a cabal or even necessarily a conscious strategy. Although the concluding section of the paper explicates the paradigm's underlying economic and political logic, it does not intend to claim that every proponent of Kyoto-paradigm policies fully accepts that logic. For example, most US environmental organizations are to some degree proponents of the Kyoto paradigm. But some of these groups still reject the concept of tradable emission rights. And among the groups that do accept tradable emission rights, points of emphasis and preferred approaches vary. Pro-Kyoto paradigm legislators and journalists have still other views and motives.

Similarly, the term "Kyoto paradigm policies" refers to a family of broadly related approaches to greenhouse gas emission controls. It has frequently been noted that many of the emission reduction policies that have been considered in the US Congress are in the mold of Kyoto even though formally the proposals are purely domestic in nature. There are four characteristics of Kyoto paradigm policies as the term is used here. And the remainder of this section of the paper will describe these four characteristics and explain the reasons for regarding them as problematical.

### ***BASING EMISSION CONTROLS ON QUANTITY RATHER THAN PRICE***

In the Kyoto paradigm, emission reduction goals are stated in terms of quantitative targets rather than in dollars per ton of carbon equivalent. This choice greatly complicates the problem of implementing the right level of controls.

First, the tons of emitted greenhouse gases (GHG) in a particular country in a given year are not directly connected to the relevant trade-off, which is the harm done by an additional ton of emission versus the cost of avoiding that additional ton. As Nordhaus noted, "The approach of freezing emissions at a given level for a group of countries is not related to any identifiable goals concentrations, temperature, costs, or damages. Nor does it bear any relation to an economically oriented strategy that would balance the costs and benefits of greenhouse gas reductions."[3]

Second, basing controls on quantities of emissions rather than on price is a bad risk management strategy. Small changes in emission rate limits can produce large changes in abatement costs. The only way to avoid costly mistakes in setting emission targets is to use a dollar per ton abatement incentive rather than imposing a quantity limit on emissions. With such a price based system, the actual emissions reduction may differ from the predicted one, but this outcome would be inconsequential as long as the price incentive for emission reductions was set to approximate the damage caused by an additional ton of emissions.[4]

Third, a quantity-based system will inevitably exhibit unpredictable fluctuations in control costs. As just discussed, small changes in quantity-based targets are likely to produce large changes in the cost of emission controls. For a closely related reason, variations in economic conditions and weather will cause emission allowance prices to fluctuate widely and unpredictably. Price instability is another source of costs.

Defenders of quantity-based control systems argue that allowance banking and borrowing provisions can dampen these price swings, and to some extent, this argument is valid. Yet the US Title IV emission allowance trading system features banking, and it has exhibited considerable price volatility.[5] There is no obvious reason to assume that a quantity-based carbon emission trading scheme might not do the same.

Despite the obvious advantages of price based controls, some proponents of Kyoto paradigm emission controls object that a price based approach is too transparent. Their concern is that, confronted with the truth about the costs of emission controls, the public will decline to pay. To be fair this paper will suggest later that the public is unwilling to pay the costs of achieving very aggressive Kyoto paradigm emission reduction goals.

Proponents of Kyoto paradigm conclude that by formulating their proposals in terms of quantitative goals or even as still more opaque regulatory measures, the public will not notice the costs. The US the debate on the Kyoto Protocol has shown that this hope is largely naïve. Injured industries and partisan politics ensure that the costs of GHG emission controls will become publicly visible. Perhaps in the past relatively small costs like those of the sulfur emission controls have been successfully hidden. The costs of Kyoto paradigm greenhouse gas emission controls are too large to evade notice.

## ***THE EXTREME CLIMATE POLICY GOALS***

In fact, the costs of economically justifiable emission controls do not necessarily exceed public willingness to pay. Currently, the public is relatively unconcerned about climate. And one would infer that willingness to pay is limited. Whether an emission reduction exceeds the limited public willingness to pay probably depends on its price tag.

The price placed on a ton of carbon emissions might be in the range of $10 to $30 per ton.[6] This range would translate into only 2.5 to 7 cents per gallon of gasoline. The low end of this range is considerably less than the BTU tax that was enacted in the Clinton Administration. And in the recent Senate debate on McCain Lieberman, the Bill's proponents admitted that it might imply carbon prices much higher than $10 to $30 and the Bill still received 43 Senate votes.[7]

The Kyoto paradigm, however, disregards the kind of economic logic that leads to the estimate of a "correct" price per ton of carbon equivalent. Kyoto paradigm policies typically involve implementing emission reductions that substantially exceed the levels most commonly recommended in the economic literature. More generally, the Kyoto paradigm implies a rejection of attempts to use economic analysis to guide trade-offs between climate-related and non-climate objectives.

Many Kyoto proponents simply reject the use of economics in making such trade-offs because the economic approach conflicts with establishing arbitrary limits on concentration levels. Richard N. Cooper's are relevant:

> Many non-economists reject cost-benefit analysis as being an artifact of calculators who ignore or underrate basic human values. But this rejection is simply an intellectual mistake; everyone who urges a change in policy (or resists one) is at least implicitly comparing costs with benefits. The disagreement rather is on how best to measure the alleged benefits and the costs of the proposed change. Thus when Krause, Back, and Koomey (1992) argue that on no account should the average global temperature be allowed to rise more than 2.5NC, the outer limit of the earth's temperature in the last 2 million years, and that worst plausible case calculations suggest that means a maximum of 300 million tons of additional carbon can be emitted into the atmosphere, they are implicitly arguing that the benefits of severe mitigation action are infinitely great, and that any finite cost to achieve them is thus warranted. They are expressing an extreme degree of aversion to environmental risk. Others may properly disagree with such extreme valuation.[8]

Quantifications of the costs and benefits of strategies aimed at capping atmospheric concentrations of greenhouse gases at low levels have generally suggested that the costs exceed the benefits. Nordhaus and Boyer found that stabilizing concentrations of greenhouse emissions at double pre-industrial levels generated a net global economic loss with a present discounted value of $952 billion (in 2002 dollars).[9] The concentration stabilization strategy had a benefit-cost ration of .5; that is, the benefits amounted to only half of the costs.[10]

Compared to an economically optimal control strategy, stabilizing emission concentration levels produced a (global) loss of over $1.2 trillion.[11] Strategies for stabilizing and reducing emissions generally performed even worse. These (admittedly still tentative) numbers should warn us that selecting concentration ceilings and emission reduction targets without reference to costs and benefits is unnecessarily risky. Climate policy is better viewed as a matter of trade-offs rather than of absolute imperatives.

## ***AN ADDITIONAL LAYER OF COMMAND AND CONTROL REGULATION***

Proponents of Kyoto like climate policies also often propose layering a redundant and expensive system of command and control regulations on top of the market like incentives for emission reductions. The most commonly discussed regulatory initiative is the proposal to raise CAFE standards. This policy would degrade the cost effectiveness of the emission control system. Regulatory systems are less cost effective than are price-based approaches, largely because regulatory systems do not encourage the focusing of emission reduction efforts on processes and choices where reductions can be accomplished at the lowest cost.[12]

Beyond the general disadvantages of regulatory approaches, CAFE presents several idiosyncratic drawbacks. In the first place, the automobile sector is the most expensive parts of the US economy from which to seek carbon emission reductions.[13] There is certainly no justification for singling out automobiles for a redundant regulatory overlay.

CAFE is not even a cost effective policy for reducing emissions within the automobile sector. For example, a straightforward fuel tax could have reduced automotive greenhouse emissions by as much as a CAFE did for less than half the cost to society.[14] The fuel tax would have been more efficient because it would reduce emissions by discouraging driving as well as by influencing the

fuel economy of new cars being purchased. Drivers can combine both methods to find the mix of emission reductions that is cheapest for them. A carbon-emission allowance limitation plan would be even more efficient than a fuel tax because it would also create an incentive for substituting renewable fuels for fossil fuels. CAFE entirely lacks this incentive.

In contrast to the concept of limiting emission allowances, CAFE produces serious undesirable unintended consequences. For example, CAFE standards, by making new vehicles less appealing relative to existing ones, also encourage the retention of older, less fuel-efficient cars. Also, CAFE standards reduce the fuel cost per vehicle mile traveled (VMT), thereby encouraging more VMT, and thereby offsetting some of the potential gains in fuel economy.

As just noted, CAFE lowers the out-of-pocket cost of driving, generating additional VMT. This fact implies that CAFE is a policy fraught with numerous unintended and undesirable consequences. More VMT mean more road congestion, more local air pollution, and more highway accidents. The increase in total VMT even offsets a part of the reduction in greenhouse gas emissions. A recent analysis applied commonly-used values for all of these social costs and estimated that the social losses from the cafe-induced VMT may well equal or exceed potential gains from making the fleet more fuel efficient.[15]

## ***FAILURE TO LINK DOMESTIC AND LDC EMISSION CONTROLS***

Kyoto paradigm emission control policies fail to link imposition of domestic US greenhouse gas emission controls to the more important next stage of helping developing countries reduce their emission growth rates. Emission reductions are cheapest in the developing world. Developing countries could reduce their projected growth in greenhouse gas emissions without the high costs of retrofitting or even prematurely scrapping existing infrastructure, capital, or consumer durables. Raising the energy efficiency of future investments above what they otherwise would have been, although not costless, would be much cheaper than retrofitting or scrapping already existing but relatively recent-vintage plants in a developed country.

Another reason it is cheaper to slow the growth of emissions in developing countries is that developed countries often have very high taxes on energy. Developing countries often do not. In fact, they often subsidize energy use.[16]

The potential savings are large if domestic emission controls are followed up with an effort to encourage developing country emission controls. For example, the Energy Modeling Forum multi model analysis showed that the inclusion of emission reductions from developing countries would have reduced the cost per ton of carbon emissions controlled by between 29 and 75 percent, with an average reduction of 55 percent. In other words, the cost per ton of emission avoided was cut by more than half by the ability to draw on the low-cost emission abatement opportunities potentially available in the LCDs.[17]

The OECD countries must reduce their own emissions to gain political credibility. These reductions cannot be seen as trivial, or they are valueless as credibility builders. Yet as soon as emission controls are in place the effort should shift to the higher pay off task of encouraging emission controls in the LDCs. Imposing severe controls within the OECD before the fast-growing developing countries have joined the control regime is likely to entail high costs and small benefits. This strategy would waste what are very scarce resources available for emission reductions.

Such an approach is likely to drive energy-intensive industries to relocate to developing countries, with the consequence that these countries would become increasingly resistant to participate in an emission control regime. Three MIT climate policy experts have described the risk that would result:

> If rich nations do not control their emissions, poorer ones are unlikely even to consider slowing theirs. But carbon dioxide emission controls will raise the cost in participating countries of manufacturing those goods whose production requires substantial energy. For these products, industries in developing countries will gain an advantage over industries in countries that abide by Kyoto. Once they have invested in production facilities, nonparticipating nations will be more reluctant to take emission control measures that threaten these activities.[18]

## ***CRITIQUING THE INTELLECTUAL CASE FOR KYOTO–PARADIGM POLICIES: PART ONE***

The case for Kyoto paradigm proposals rests on several theories. The theories, if true, would suggest that the Kyoto paradigm policies would *not* cost more than is necessary or desirable.

The theories supporting the Kyoto paradigm quite directly contradict much conventional economic analyses and modeling. If these theories are true, large pieces of long standing and widely accepted modern economics must be revised. This contradiction imposes a considerable burden of proof on the theories used to support the Kyoto paradigm.

The case for the Kyoto paradigm policies involves two lines of argument adduced to support the proposition that the US can cheaply reduce emissions by eliminating the wasteful use of energy. If a large share of US energy use were indeed attributable to waste then this energy consumption and the related carbon emissions could be eliminated without cost. This section will suggest several reasons for treating the claims of the "energy waste" theories with skepticism.

### ***THE ENERGY PARADOX***

The first theory is sometimes referred to as the energy paradox. It rests on the existence of many engineering studies seeming to show that businesses and individuals systematically waste large amounts of energy thus causing greenhouse gas emissions. If these emissions were really caused by wasteful energy use, eliminating them would be costless or would actually yield a net economic benefit.

However, having surveyed the economic literature on this controversy, a team of economists summarized the mainstream view that "there are good reasons to doubt the existence of a vast pool of cheap energy-reducing opportunities that offer a 'free lunch' in reducing GHGs".[19] Economic analysis shows that the claims of waste are based, in considerable measure on unrealistic assumptions. Assessments that are more realistic show relatively modest opportunities for costless energy savings. Among the factors cited by the very many economists who reject this theory are:

- Engineering studies assume laboratory conditions, an assumption that often exaggerates the actual energy savings achieved under real world conditions.[20] In real houses, rather than hypothetical ones, people sometimes leave windows open, partly defeating the purpose of improved insulation.

- Engineering studies often understate the costs of new technologies.[21] In particular new technologies may be associated with additional training and management costs that are left out of engineering analyses or are underestimated. If the new system is less dependable it may entail the risk of shutting down an entire facility or of forfeiting customer good will. Such costs are difficult to accurately estimate in generic studies but are real and important to actual managers.

- Engineering studies focus misleadingly on the "average consumer." In reality, however, the preferences of consumers are diverse. Hence, the "average" consumer may operate an air conditioner enough during a year to justify paying a higher initial price to achieve higher operating efficiencies. It does not follow that those consumers using less than average amounts of air conditioning would rationally make the same choice.[22]

- Engineering studies may ignore quality considerations.[23] If engineering judgment is substituted for the market test, it becomes very difficult to know if engineers are underestimating consumers' dislike of fluorescent bulb's light or of a less powerful automobile's poor performance.

- Engineering studies sometimes do not appreciate that consumers have good reason for insisting that investments in energy efficiency surpass relatively high hurdle rates. Consumers and businesses are often correct to believe that waiting to acquire a more efficient appliance or machine may eventually mean lower purchase prices and greater certainty about product performance.[24]

- Engineering studies may ignore "rebound effects" in which more efficient systems, by lowering the marginal cost of use. As a result such policies may actually encourage more use, thus offsetting some of the projected energy saving.

## ***THE CLAIM OF AMERICAN ENERGY WASTEFULNESS***

A second, closely related theory is that international comparisons show that the entire US economy is wasteful of energy and natural resources and, again, could reduce emissions at little cost. This theory was articulated in the 1970s and associated with the criticism directed at the claim that the United States was a "cowboy economy." In fact, the US economy is reasonably energy efficient *for the conditions in which it operates*.

An early version of today's laments and criticisms about the relative energy intensiveness of the American economy was directed at the American use of wood in the 1850s. The following correction applied to the assertions that Americans of that era wasted wood:

> A similar profligacy in wood consumption persisted within the household so long as wood supplies were locally abundant. Under these circumstances, fireplaces were designed to accommodate large logs, an arrangement that was wasteful of fuel wood but economized upon the labor-intensive activities of cutting or chopping wood. As local supplies were exhausted and wood became more costly, stoves, which utilized wood supplies more efficiently but required more labor inputs in preparing the wood, gradually replaced the fireplace.[25]

Such comparisons ignore a basic feature of American economic history, as described by Rosenberg:

> In the United States perhaps the most enduring and pervasive influence shaping the contours of technological development has been the very high land-labor ratio: the abundance of natural resources generally relative to a small population size. A distinctive feature of much American innovation, therefore, was that it was directed toward making possible the exploitation of a large quantity of such resources with relatively little labor, or that it substituted units of the abundant input – natural resources—for units of the scarce input –labor (and to a lesser extent capital).[26]

This correction can be applied today to the charge that Americans waste energy. The resource in scarcest supply is conserved. As relative scarcity of various inputs changes, technology and society adjust to the new relationships. And American economic realities, including the pattern of infrastructure investment, reflect the plentiful and efficient supplies of fossil fuel that have characterized the US economic history (and its current reality).

Other factors have also encouraged the differences between the United States and Europe. For example:

- The United States has relatively large industrial and extractive sectors, sectors which in all economies tend to be relatively energy intensive.

- Geographic spaciousness in the US has encouraged low land prices and correspondingly large dwelling units.

- Climate, wealth, and cheap land have produced intensive air-conditioning-based energy demand in the Sunbelt.

- Long transport distances have encouraged extensive transportation of both freight and passengers even at some energy cost.

- The very early spread of automobile ownership in the US politically discouraged enactment of European level fuel taxes. Low fuel taxes encouraged higher average automobile fuel consumption than that which prevails in Europe. This characteristic of the existing vehicle fleet, in effect, ensures continuing political resistance to government policies that would increase the operating costs and decrease the asset values of cars.

Interestingly given how much has been made of the difference between American and European energy intensiveness, in this measure Europe is anomalous, not the United States. The US shares of world output and of GHG emissions are very similar, indicating that the energy intensity of the US economy is about average. The US produced $4.2 per kilogram of oil-equivalent energy consumption. The world average is $4.5, higher, but not dramatically so. The figures for Europe and Japan were $6.2 and $6.1 respectively.[27]

Thus Europe and Japan are clearly more “energy efficient.” But the difference in conditions among countries makes it difficult to draw from this fact any meaningful conclusions about waste.

## CRITIQUING THE INTELLECTUAL CASE FOR KYOTO PARADIGM POLICIES: PART TWO

Part of the emphasis on emission allowance trading that is now built into the Kyoto Paradigm is derived from the supposed lessons of Title IV of the US Clean Air Act. Title IV is the successful emission allowance trading program for sulfur. Having gone into force in the early 1990s, Title IV is America's first major emission rights trading policy. And much of the case for adopting Kyoto paradigm policies in the US is based on misinterpretation of the experience of Title IV.

The difficulty is not that Title IV was not successful. It was. The problem is that the wrong lessons are being drawn from its success.

### THE FALSE ANALOGY BETWEEN SULFUR AND CARBON

Kyoto paradigm policies are sometimes defended on the grounds that the experience of the US Title IV sulfur dioxide emission controls demonstrates that it is possible to reduce carbon emissions at costs far below those generally predicted. It is true that Title IV was more efficient than previous command and control emissions regulations had been. It would be fair to infer that market mechanisms will be relatively less costly than command and control regulations in achieving a given reduction in carbon emissions. But this fact says nothing about the absolute expense of aggressive carbon emission controls.

Historically in the early years of Title IV, several one time events having no analogue for carbon emission controls were responsible for the low costs. Success depended, in part, on the fortuitous emergence into the market of inexpensive western coal, and a long secular decline in natural gas prices. To the extent that these developments were at all related to public policy changes they were tied to regulatory reform of railroads and natural gas rather than to Title IV. And obviously, these events have no implications for carbon control costs.

In the view of the proponents of Kyoto paradigm climate policies, however, it was Title IV itself that achieved the low cost emission reductions. To validate this belief a theory has arisen that Title IV produced dramatic cost saving technological innovation in sulfur abatement technology. And it was claimed that this supposed burst of innovation was the result of using very aggressive emission control targets. In effect according to this view of things, industry was scared into technological breakthroughs by the aggressiveness of the proposed emission reductions.

### TITLE IV AND THE CLAIMS OF INDUCED INNOVATION

The problem is that the actual course of events does not support these claims. For one thing, the program set limits well within the capabilities of existing control technologies. It is true that after enactment of Title IV, flue gas desulphurization (FGD) became cheaper. But the decline was not the result of new technology called forth by the emission controls.

It resulted because the flexibility of trading combined with the modest emission reduction targets allowed companies to dispense with expensive back-up units. The previous regulations would have required such units in case the primary flue gas desulphurization unit was to fail. Eliminating this requirement reduced the price of a command-and-control version of FGD by 30 percent.[28]

The example also illustrates the fact that the program's success did not depend on its having encouraged new technology. Emission control policies can, of course, encourage technologic

innovation. This factor is known as "induced innovation." And it is even true that policies like Title IV are more like to produce induced innovation than are command and control regulations.

The initial success of Title IV, though, had little or nothing to do with new technology. Had the success of Title IV depended on induced innovation, given the delays inherent in developing and applying new technologies, the pattern of emission reductions would have been lagged. Instead, the pattern was one of such rapid emission reduction that Phase I significantly overshot its legally mandated abatement targets. Title IV will doubtless encourage some beneficial technological innovations. But such innovations were not the cause of the program's early const performance. And the record cannot, therefore, validly be used to defend the claim that emission controls will induce technological innovation to offset the apparently daunting costs of achieving steep near term reductions in emission rages.

## ***INDUCED INNOVATION AS A PANACEA***

Realizing that Title IV did not work because of induced technological change is in fact one important key to reframing the climate policy debate. Once this historical myth is disposed of, another more fundamental question emerges. How much can reasonably be expected of policy-induced technological innovation?

One limiting factor is that markets typically under-invest in research and development. Innovators must incur the full costs of developing new technologies, but have difficulty in capturing the full benefits of their innovations. Hence, even with an economically efficient greenhouse gas emission allowance price, the market would produce less than optimal amounts of R&D on climate solutions because of the inherent difficulty of capturing the benefits of innovation.

When researchers have quantitatively modeled the likely scale of induced innovation, they have found that the impacts, although by no means trivial, were less important than anticipated. Indeed, the substitution of investment among existing energy technologies had more impact in reducing emissions than did induced innovation. According to Nordhaus, "A rough calculation is that the reductions in CO2 concentrations and in global mean temperature resulting from induced innovation are approximately one-half those resulting from substitution."[29]

The policy conclusion of this analysis was that "…we should not look to regulatory stringency or high emissions taxes as a way of forcing inventors to solve our global environmental problems. Necessity may indeed by (sic) the mother of invention, but there is limited payoff in inducing the delivery through regulations or high taxes."[30] Economists will continue to refine their estimates of how much induced innovation will result from emission control policies. But a sober assessment of induced innovation does not seem to validate the Kyoto vision of climate policy.

## KYOTO PARADIGM POLICIES AND US CLIMATE POLITICS

The evidence that applying emission controls to the US is likely to be costly presents a series of choices. As discussed earlier the best currently available analysis indicates only modest potential for cheap energy efficiency gains. Neither does induced technological innovation seem to promise a magic bullet.

Proponents of the Kyoto vision may however still harbor the hope that the political winds will shift in their favor. Politics is inherently unpredictable, but there seem reasons for suspecting that this hope will prove vain.

In part, the political challenge is caused by the fact that the scale of the climate issue makes any policy defects far harder to conceal than was the case with earlier environmental policies. Consider that the annual cost of the emission allowances consumed under Title IV is about $2 billion. A reasonable greenhouse gas emission control program could easily entail an annual allowance stream valued at $30 to $40 billion. Thus a ten percent waste factor would matter economically – and hence politically -- a lot more with carbon than with sulfur.

### POOR POLITICAL PROSPECTS FOR KYOTO - PARADIGM POLICIES

In the United States, the Kyoto Protocol itself is clearly politically non-viable. Indeed, it was non-viable even in the more hospitable political environment of the late 1990s. The Clinton Administration did not submit the Agreement to the Senate. Nor did it spend political credits on trying to sell it to the public. It seems fair to speculate that the United States would have been unlikely to adhere to Kyoto even if the outcome of the 2000 presidential election had been different. The Bush Administration's final rejection of Kyoto merely confirmed an existing political reality.

Subsequent legislative failures have confirmed that domestic versions of the Kyoto approach are no more viable than was the initial agreement. Neither the House nor the Senate has been receptive to the proposals for imposing aggressive emission reduction targets on the electric power sector. And in the US Senate, the efforts to increase CAFE standards were defeated this year by an even greater margin than was the case last year.

Perhaps the recent (as of this writing) relative success of the McCain Lieberman economy wide emission control legislation signals the arrival of better prospects for breaking this legislative deadlock. This legislation has garnered more support than other emission control proposals, although it clearly will not be enacted in this Congress and will need further reworking to be politically viable even in a much longer time frame.

It is noteworthy, though, that before this legislation was voted on Senator McCain had successfully insisted on scaling back the legislation's initially far more extreme emission reduction goals. (The final section of this chapter will raise the possibility that similar moves are key to moving forward on domestic US emission controls.) No one can say with certainty how many Senators would have supported the initial, far more costly version of the legislation. But it seems reasonable to speculate that the more moderate targets and lower costs of the revised McCain Lieberman proposal contributed importantly to making it more politically acceptable.

## ***KYOTO PARADIGM POLICIES AND THE COALITION POLITICS OF CLIMATE***

Although the public debate on Kyoto paradigm policies has often focused on the proposals' overall cost to society, part of these policies political difficulties has been caused by the way they affect industry political strategy.

In part this effect is another result of the policies' high costs. Because the proposed policies are so expensive, industries in the energy sector have especially strong reasons to resist control legislation. These industries recognize, of course, that proponents of climate policy would ultimately settle for legislation less draconian than their initial proposals. But the initial proposals also signal that no control level tolerable to industry is likely to be acceptable to the emission control proponents. (If proponents of emission controls were ultimately willing to compromise on $15 per ton, they would presumably not introduce an initial legislative proposal entailing a cost of $122 per ton.) And industry also knows that once legislation legitimizes the principle of mandatory limits, emission control, advocates will begin pressing for subsequent rounds of legislation embodying their initial more stringent objectives.

Even if the control proponents' proposals were more moderate, one must admit, the most severely affected interests would have every reason to resist to the bitter end all mandatory proposals. Coal producers, railroads, and utilities heavily invested in coal fired generating capacity are likely to fall into this category. But utilities with significant non-coal fired assets could live with moderate emission controls or even profit from them. Oil and gas producers could relatively easily be held harmless with some combination of moderate emission controls and various forms of financial assistance. In effect, the Kyoto paradigm policies are driving these politically potent firms into the camp of the opposition.

The evidence suggests that to date the proponents of emission controls have simply lacked the political clout to enact proposals that draw such powerful resistance from industry. Yet the proponents have also resisted moderating the costs of their demands. In this regard they have acted as if in expectation of an improvement in their political fortunes. It is difficult to see how such a happy reversal of fortune would be possible without a surge in public demand for action on climate. So it is important to enquire into the prospects for such a change.

## ***US PUBLIC ATTITUDES AND FUTURE PROSPECTS FOR THE KYOTO VISION***

Some emission control proponents of may speculate that public pressure will ultimately force legislators to accept Kyoto paradigm climate policies. According to this view, patience will be rewarded and no change in the nature of the emission control proposals is needed or desirable.

Current US public attitudes could, however, be read in to suggest otherwise. Ironically, part of the problem is related to the fact that the US public already believes that anthropogenic climate change is real, and they regard it as undesirable.[31] This belief would seem initially to be good news for the proponents of emission controls. In a sense it is. But it also implies that evolution of the scientific debate on climate is unlikely to greatly increase public demand for emission reductions.

The public's acceptance of the theory of harmful anthropogenic climate change has not, so far, translated into a sense of urgency. In open form interviews even well educated people rarely mention climate change spontaneously as a source of concern. Surveys show that climate is a less compelling source of public concern than are other more directly health related issues. Since 2000 climate has actually declined as a source of public concern. It may be that expectations that

climate will inexorably rise in public priority underestimate the differences in intensity between the contemporary health driven concerns that have sparked action on past emission issues and the more abstract concern for future generations that motivates the climate concerns.

That climate has had difficulty in competing for space on the national policy agenda is not surprising. With the threat of terrorism, the Iraq War, and continuing domestic economic concerns, the national policy agenda has been crowded. Proponents of greenhouse gas emission controls should, however, ask whether the future agenda is likely to be less crowded.

Of course, no one knows for certain. But the problems of international terrorism, the geopolitical strains in the Persian Gulf, the challenges presented by the rise of China, and the fiscal troubles implied by the aging of the Baby Boom generation do not seem likely to disappear soon. In competition for agenda space, climate change, given its very long run nature, is at a competitive disadvantage with these more urgent concerns.

The point is that competition for public attention and concern is more likely to intensify than it is to wane. Certainly, there is no reason to be confident that competition will ease. Thus if the public demand for action is insufficient to force the adoption of very aggressive and expensive emission reduction targets today is it prudent to assume that the demand for such policies will increase any time in the foreseeable future? If not, perhaps political prudence suggests considering the option of moderating the emission reductions rather than banking on some future tide of public opinion that may never roll in.

## A NEW PATH FORWARD

Thus, the Kyoto paradigm policies appear to be poorly suited to current American political realities and to those that can be predicted for the next decade. American climate policy, to maximize political prospects, would have to look different. This fact will doubtless cause both domestic and European emission control advocates considerable frustration. But that frustration will ultimately be less than that occasioned by continued efforts to advance a policy model that does not fit American economic and political realities.

If proponents of Kyoto paradigm emission controls were to be willing to reassess their proposals, they would have several obvious alternatives. A great deal of policy research has been done on alternative approaches. And while there remain serious unresolved problems with all possible ways forward, some of the alternatives offer intriguing promises of ideas that might break the current deadlock.

### AN ALTERNATIVE POLICY PACKAGE

The discussion to this point suggests the outline of an alternative to the Kyoto paradigm policies that have dominated much of the policy discourse in the United States. Five elements are important.

First, such an alternative policy package should start by using price base controls rather than quantity based controls. As noted earlier price based controls are the only way of guaranteeing that abatement costs will remain within acceptable levels, a feature that is essential for political acceptability. Price based controls are more transparent than quantity based systems. Most importantly transparency is absolutely necessary if domestic controls are to set the stage for the essential bid to assist and encourage emission reductions in the LDCs.

Second, the control policy should designate modest emission reduction targets at least in the next decade or two. Achieving the irrelevant goal of making early emission reductions diverts resources from the important goal of maximizing total emission reductions over time. Modest short run targets are, therefore, the best way to use limited resources. In some sense this issue could become less important if a price based strategy is adopted.

Third an alternative policy package should dispense with the overlay of command and control regulation. Dispelling the myth that Title IV performed miracles of instantaneous induced innovation should not obscure the fact that the program produced significant and apparently highly cost effective emission reductions. It would not be realistic to expect that a variant of such program would make carbon emission reductions cheap. But it is likely to make whatever emission reductions occur about as cheap as they can be. Adding command and control CAFE and renewable portfolio standards on top of such a system can do nothing except detract from the program's overall cost effectiveness.

Fourth, the domestic control should be viewed as the opening move in an effort to encourage the adoption of emission reduction policies in LDCs. Once domestic controls sufficiently stringent and transparent for political credibility have been put in place, the focus of the US emission reduction effort should be extending emission reduction efforts to those developing countries with the highest emission levels and growth rates. In order to minimize the leakage of emissions from the US economy to LDCs there needs to be an understanding that US control levels will not increase unless the major LDC emitters respond positively. The recent debate on McCain Lieberman showed that, in any case, such a commitment is a political prerequisite of enacting

domestic control legislation. As it happens it is also vital for maximizing the emission reductions achievable with any given level of abatement effort.

Fifth, control policies must take advantage of price based system's ability to generate revenue. In Title IV all of the emission allowances were given to industry free of charge. And to some degree that will be necessary with carbon if emission controls are to be politically viable. But the value of the emission allowances under a carbon control system would be sufficient to compensate industry for its losses in asset value and still have substantial revenue left over. These resources could be used to compensate LDCs for the costs of instituting emission controls. Or they could be used to support a government funded program of R&D designed to foster new emission free energy technologies.

## ***PRICE BASED CONTROLS, KEY TO A NON-KYOTO CLIMATE POLICY PACKAGE***

Of all these concepts the most important is probably the proposal to base the controls on price rather than quantity.[32] It is also the most technical and may, therefore warrant some additional explanation. One way to establish a price based system would be through an emission tax. Or it could be done though an emission allowance system supplemented by a device that is sometimes referred to as an emission allowance price "safety valve."[33]

A safety valve can be established by the simple mechanism. Government issues only a limited number of carbon emission allowances but also commits to sell an unlimited number of allowances at some pre-determined price, say, $30 per ton. When such a commitment is made, society has the assurance that no one will be compelled to spend more than $30 per ton on emission control. Below that price abatement is a profitable cost minimizing strategy. Buying an additional allowance is cheaper than undertaking abatement measures that cost more than $30.

If the safety valve price is triggered, the emission allowance system becomes a price based mechanism. If the safety valve price is not triggered, the system achieves whatever quantitative targets have been specified as the targeted emission cap. For this reason an emission allowance system with a safety valve has sometimes been referred to as a hybrid system.

A hybrid system could in principle be designed with aggressive quantitative emission control limits, and a relatively low safety valve price. This combination, if implemented, would test the energy conservation free lunch theory. If huge energy savings were possible at little cost, as claimed by the proponents of Kyoto paradigm policies, the aggressive emission reduction goals would be achieved or nearly so. And few or no allowances would be sold through the safety valve mechanism.

Thus the safety valve would seem to offer the proponents of the Kyoto paradigm policies an attractive wager. It offers reassurance to industry and legislators that the price of abatement will not rise to unacceptable levels. Yet the proponents of steep emission reductions would achieve their desired objectives.

Of course if the energy free lunch theory is not true then the safety valve would be employed extensively and the quantitative emission targets would not be met, although an incentive for long run emission reductions would have been established. So far proponents of Kyoto paradigm policies have declined to endorse policies that would test the validity of the energy conservation free lunch hypothesis in this manner.

As two distinguished MIT economists have recently pointed out, policies, which proclaim aggressive quantity goal but do not achieve them because of a price safety valve are likely to prove politically unstable.[34] The policies would probably be criticized as having failed to meet their own goals and the safety valve attacked as "too weak."

This argument is no doubt valid. As a political matter, however, just such a compromise may be necessary to make emission controls acceptable to both those who assert that aggressive emission reductions will be cheap and those who dispute that claim. Once the system is in operation one theory or the other will be falsified. In subsequent legislation the quantitative goals and the safety valve price can be made more consistent.

## CONCLUDING THOUGHTS: CONFLICTING VISIONS

US greenhouse gas emission control proponents should re-examine the Kyoto paradigm. Most observers have concluded that the US will not join the Kyoto system, or at least not for a long while. But the most widely discussed domestic climate policies remain analogous to Kyoto. It is quite possible to design an alternative policy package more suited to American conditions.

The choice, however, is not strictly speaking one between alternative policy packages. At least it is not *only* one between policy packages. The Kyoto paradigm and the alternative package both imply a series of opposite strategic choices. This section describes the strategic vision implied by the Kyoto paradigm. Then it sketches the strategic vision underlying the alternative policies. Finally it poses a few questions that might illuminate the choice between the rival strategic visions.

### THE STRATEGIC VISION BEHINDK KYOTO PARADIGM POLICIES

The logic of the Kyoto Paradigm may be traced along the following lines.

The goal behind the Kyoto strategic vision is to put in place now or soon policies that will eventually eliminate the problem of climate change. The proponents of these policies are sophisticated and realize that solutions will require time. But they want to establish a commitment to a solution. Mitigation policies that would merely gain time are inadequate. According to most economic analysis policies that would stop climate change cannot yet be economically justified. But this fact is relatively unimportant because the proponents of the Kyoto policy paradigm typically oppose application of cost benefit analysis to environmental problems.

The Kyoto paradigm policy package assumes that induced technological innovation will be the basic engine for halting climate change. Some proponents believe that only very draconian emission control targets *expressed in quantitative terms* can produce enough induced innovation. Most economists would question whether quantitative controls would stimulate innovation better than price. But they would accept that to produce enough private sector R&D the mandated emission reductions would have to be draconian.

LDC emission reductions appear to play little role in this strategic vision. US Emission control opponents have repeated pointed to the absence of concrete plans for involving LDCs. But true to the Kyoto paradigm, the various US domestic emission control plans simply ignore the issue. This failure may suggest that the proponents' only strategy is a further ratcheting up of domestic emission controls. Perhaps the assumption is that the resulting new technologies could successfully compete in LDC markets without the aid of emission control policies.

The obvious defect of this strategy is that it costs more than the American public seems willing to pay to eliminate climate change. A possible solution is to make the emission control policies as opaque to the American public as possible. By inference opaque policies like quantitative emission reduction targets and command and control regulations are preferable to price-based mechanisms.[35]

### THE ALTERNATIVE VISION

Essentially on all these points the alternative vision makes opposite choices.

The alternative vision does not now seek to actually eliminate climate change. Its goal is mitigation, slowing the rate of change. According to this view policies to actually halt climate change will probably eventually become necessary. But contemporary society cannot legislate the behavior of people two and three generations hence. And those are the generations who will ultimately need to decide the issue. Meanwhile a slower rate of climate change would be helpful. So we should weigh the benefits of this initial slowing of climate change against other desirable goals.

In comparison with the Kyoto paradigm, the alternative vision places less emphasis on induced innovation. Instead it would supplement induced innovation with spending designed to encourage inexpensive reductions in the rate of growth in LDC emissions. And it would encourage government funded R&D.

Both of these choices raise substantial questions. Several proposals have been made suggesting ways of encouraging developing countries to introduce emission reductions. But other experts have expressed skepticism about the political feasibility of these approaches.[36] Similarly, assessments of the effectiveness of government energy R&D are distinctly mixed.[37]

The alternative vision places less demands on public willingness to pay for climate change mitigation than does the Kyoto paradigm policy. But the alternative vision also involves making the costs that do exist somewhat more transparent to the electorate. Thus in this area, too, the two approaches would imply opposite choices.

## ***A POLICY RESEARCH AGENDA***

The obvious question is how to decide the relative merits of the two strategic visions. This choice is clearly a different one from the issue of which package has superior merits as public policy although one might hope that policy merit would have at least some relevance.

In fact neither the Kyoto paradigm nor the alternative is exempt from serious objections. Neither one may be adequate to the challenge. But it does not follow that the success of the two rival strategic visions is *equally* improbable.

Some aspects of the choice between the two visions are irresolvable by research. People who place an extremely high value on stopping climate change whatever the price will probably not be dissuaded by research showing that the costs are greater than the benefits as measured by conventional economics. Other aspects of the choice may, however, be at least somewhat susceptible to empirical research.

Among the questions for which additional evidence and analysis might help to choose between the competing strategic visions are the following:

- Is the energy conservation free lunch hypothesis credible enough to serve as a basis for policy? The current author would clearly answer this question in the negative. And the issue has now been much disputed in the literature for a long time. The only upshot has been a seemingly irreconcilable difference of opinion between the engineering economists who believe in the free lunch theory and most of the neo-classical mainstream of the economics discipline (mainstream at least in the United States). It seems unlikely that research will settle the matter anytime soon. But one would have to note the issue as having great policy relevance.

- What are the realistic prospects for induced innovation that might result from emission control policies? The Nordhaus analysis cited above suggests that considerable caution is prudent. By the nature of the case estimating the potential for induced innovation in the particular area of emission free energy technology is highly speculative. But it would clearly be useful to more narrowly bound the range of plausible options, if for no other reason than to expose wishful thinking masquerading as policy analysis.

- Is it possible to devise better institutions for conducting government R&D? Innovative incentive arrangements have been suggested. Yet much many of the problems in manifest in earlier government funded R&D have been traced to the operation of the electoral incentives of key legislators. Can government R&D be insulated from this efficiency degrading factor?

- Can developed countries devise a plausible political strategy for inducing LDCs to adopt policies that would effectively restrain their growth in emissions? Proposed policy mechanisms range from targeted development assistance intended to offset the diminution in economic growth entailed by emission controls to trade sanctions on LDCs that fail to cooperate. But all such policies involve economic and political costs for the developed countries seeking to influence LDC behavior. Doubts remain about the most promising policy mechanism, the best political strategy, and the feasibility of the entire venture.

## ***THE DISCUSSION IN TRANSATLANTIC PERSPECTIVE***

Initially, a European observer might be inclined to regard this discussion as just more American indecisiveness on climate. That reaction would however miss two realities. First, progress on climate change will be hard enough with the United States' full cooperation. And ultimately no adequate global response is likely with the US remaining on the sidelines. For the moment, though, US climate policy it deadlocked. If there is a chance that alternative proposals might help to break this deadlock, that chance is worth exploring.

Second and more generally, there is also at least some chance that the problems with the Kyoto paradigm policy package will also surface in Europe and elsewhere. European nations are themselves implementing a mix of policies very similar to the ones that America has been resolutely rejecting as excessively expensive and inadequately cost effective. So far, this process has not produced any particularly negative consequences. But the real test of the affordability of these policies lies in the future. Emission control proponents on both sides of the Atlantic have good reason to retain a flexible attitude on the issue of the best way forward.

**Acronymns Used**

BTU: British Thermal Unit
CAFE: Corporate Average Fuel Economy
$CO_2$: Carbon Dioxide
FGD: Glue Gas Desulphurization
GDP: Gross Domestic Product
GHG: Greenhouse Gas
IPCC: Intergovernmental Panel on Climate Change
LDCs: Less Developed Countries
MIT: Massachusetts Institute of Technology
OECD: Organization for Economic Cooperation and Development

US: United States
VMT: Vehicle Miles Traveled

[1] William D. Nordhaus & Joseph Boyer, *Warming the World: Economic Models of Global Warming* (Cambridge: The MIT Press, 2000), p. 163 (updated into 2002 dollars).
[2] Alternatively such legislation may be mere political sham with aggressive seeming targets but much less actual emission reduction.
[3] William D. Nordhaus, "After Kyoto: Alternative Mechanisms to Control Global Warming," Yale University and NBER, October 23, 2003, p. 12.
[4] In theory the change in the quantity of emissions might change the estimate of the value of avoiding an additional ton of emissions. Greenhouse gases as a global stock pollutant do not have this characteristic.
[5] William D. Nordhaus, "After Kyoto: Alternative Mechanisms to Control Global Warming," Yale University and NBER, October 23, 2003, p. 14.
[6] Studies estimating the damage from greenhouse gas emissions produce widely varying results. But an average figure is around $30 per ton of carbon equivalent. And there is some economic literature suggesting that the incentive for eliminating a ton of emissions should be set somewhat below the estimated damage. The reason is that abatement incentives interact with taxes and other economic distortions to diminish economic welfare. (Taxes deprive workers and investors of part of the fruits of their labor and savings, thus weakening the incentive to produce.) The higher prices caused by emission controls worsen these pre-existing economic distortions, canceling out some of the emission controls' environmental benefits. Setting the optimal price for a ton of emissions requires weighing this extra economic loss against the environmental gains. Hence, the optimal price for a ton of emissions is less than it would be considering only the environmental damage of the emissions.
[7] The Washington Post, Friday, October 31, 2003, p. A04.
[8] Richard Cooper, "International Approaches to Global Climate Change," Weatherhead Center for International Affairs, Working Paper No. 99-03, January 1999, pp. 12-13.
[9] Nordhaus and Boyer, p. 128 (updated into 2002 dollars).
[10] Ibid, Nordhaus and Boyer, p. 130 (updated into 2002 dollars).
[11] Ibid, Nordhaus and Boyer, p. 130.
[12] W.H. Parry, William A. Pizer, and Carolyn Fischer, *How Large Are the Welfare Gains from Technology Innovation Induced by Environmental Policies?* (Resources for the Future, 2002), p. 2 n. 5.
[13] Energy Information Administration, *Impacts of the Kyoto Protocol on US Energy Markets and Economic Activity*, US Department of Energy, October 1998, p. xvi.
[14] Pietro S. Nivola and Robert W. Crandall, *The Extra Mile: Rethinking Energy Policy for Automotive Transportation*, (Washington: The Brookings Institution, 1995), p. 56.
[15] Parry, forthcoming.
[16] Nordhaus and Boyer, p. 135.
[17] Jean-Charles Hourcade, Priyadarshi Shukla, "Global, Regional, and National Costs and Ancillary Benefits of Mitigation" in *Climate Change 2001 Mitigation; Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, B. Metz, O. Davidson, R. Swart and J. Pan (Eds.), (New York: Cambridge University Press, 2001) p. 537 Hourcade and Shukla p. 537.
[18] Henry D. Jacoby, Ronald G. Prinn, and Richard Schmalensee, "Kyoto's Unfinished Business," *Foreign Affairs*, July/August 1998, Volume 77, Number 4, p. 60.
[19] Adam B. Jaffe, Richard G. Newell and Robert N. Stavins, Climate Issue Brief No. 19, "Energy-Efficient Technologies and Climate Change Policies: Issues and Evidence," (Washington, DC, Resources For the Future, December, 1999), p. 16.
[20] Gilbert E. Metcalf and Kevin A. Hassett, "Measuring the Energy Savings From Home Improvement Investments: Evidence from Monthly Billing Data" (n.p. February 1997), pp.21, 3 ; Ibid, Hourcade and Shukla p. 507.
[21] Ibid, Hourcade and Shukla, p. 507.
[22] Ibid, Jaffe, Newell, and Stavins, p. 7.
[23] Ibid, Hourcade and Shukla, p. 507.
[24] Avinash K. Dixit and Robert S. Pyndyck, *Investment Under Uncertainty* (Princeton: Princeton University Press, 1994), p. 7.
[25] Nathan Rosenberg, *Technology and American Economic Growth*, (New York: Harper & Row, Publishers, Inc., 1972), p. 28-29.
[26] Rosenberg, p. 25.
[27] World Development Indicators, The World Bank, 2003, pp 149, 150.
[28] Anne Smith, Vice President of Charles River Associate, *Personal correspondence with the author*.
[29] William D. Nordhaus, "Modeling Induced Innovation in Climate Change Policy," Forthcoming in A. Grubler, N. Nakicenovic, and W. D. Nordhaus - *Modeling Induced Innovation in Climate Change Policy*, Resources for the Future Press, 2002, Nordhaus, p. 284.
[30] Ibid, p. 285.

[31] M. Granger Morgan, Baruch Fischhoff, Ann Bostrom, and Cynthia J. Atman, *Risk Communication: A Mental Models Approach*, (Cambridge, UK: Cambridge University Press, 2002), pp. 131, 133; Willet Kempton, James S. Boster, and Jennifer A. Hartley, *Environmental Values in American Culture*, (Cambridge: The MIT Press, 1999), pp. 129, 130.

[32] The early European concept of harmonized carbon taxes was a version of a price based system and ultimately may well have been superior to the quantity based system, which dominates the current incarnation of Kyoto and the thinking of many American environmental NGOs.

[33] Raymond Kopp, Richard Morgenstern, William Pizer and Michael Toman, "A Proposal for Credible Early Action in U.S. Climate Policy," (Washington, DC: Resources for the Future, 2000), pp. 3-4.

[34] Henry D. Jacoby and A. Denny Ellerman, "The Safety Valve and Climate Policy," MIT Joint Program on the Science and Policy of Global Change, Report No. 83, February [Revised: July] 2002, p. 9.

[35] It would hardly be fair to reproach emission control advocates for this choice. In making it, emission control advocates are merely copying the successful political strategy of many other interests groups.

[36] Thomas C. Schelling. "What Makes Greenhouse Sense? Time to Rethink the Kyoto Protocol." *Foreign Affairs*, May/June 2002, Volume 81, Number 3, p. 3.

[37] Linda Cohen and Roger G. Noll, *The Technology Pork Barrel* (The Brookings Institute, 1991), pp. 296, 297.