WORLD RESOURCES INSTITUTE

CLIMATE PROTECTION POLICIES: CAN WE AFFORD TO DELAY?

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CLIMATE PROTECTION INITIATIVE

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DA

FOREWORD

As the Chinese proverb says: "If you don't change direction, you will surely end up where you are headed." Five years ago, at the Earth Summit in Rio de Janeiro, developed countries made a voluntary commitment to reduce emissions to 1990 levels by 2000. Instead, in the United States and many other nations, emissions have grown at an accelerated pace and fossil fuel dependency has increased—trends that defy the need to reduce the level of greenhouse gas emissions. Though the United States implemented a number of small-scale voluntary programs, these were not supported by appropriate market and policy signals and fundamental patterns of investment and consumption remained unaltered. The message is clear: no real change in direction, no change in where we are headed.

Current negotiations on climate policy offer an opportunity to set nations on a different path—one that will allow us to better meet the challenges of economic development and environmental protection. The prospects are perilous, however. As this publication is going to press, no international consensus has yet formed on how to achieve reductions significantly below 1990 levels, let alone the ultimate goal of stabilizing atmospheric concentrations of greenhouse gases.

One of the most frequent arguments against taking action now to reduce emissions is the supposed cost-effectiveness of a strategy of delay—doing less now and more later. After all, some argue, the shift toward a less carbon-intensive economy will take time and, if technology is constantly improving, reductions will be easier to make in the future. Moreover, since climate change is itself a slow process, surely we can "wait and see" and still have plenty of time to catch up later if we need to. Added to these arguments is the heavy weight of political expediency: a decision delayed is a decision avoided. Political and business leaders will be tempted to defer tough decisions to their successors, who will presumably be better informed of the science, better equipped with technology, and wealthier to boot.

In this report, WRI associate Duncan Austin identifies the fallacies in those arguments and the risks inherent in delaying policy action. Long-term economic transition requires clear policy signals now, allowing investors to make appropriate choices today and giving researchers the incentives they need to switch the focus of their development efforts from conventional energy options toward renewable and low-carbon alternatives. Without clear market and policy signals—signals that are broad enough to engage the economy as a whole—investment and technological development will continue along their present paths, just as they have done since the Earth Summit in 1992. In addition, the notion that we can "wait and see" represents a gamble we can ill afford. Precisely because we don't know what levels of greenhouse gas concentrations may be safe, we must exercise caution. Early policy signals allow us to do just that.

What's really needed are changes in attitude and direction, changes that may be most difficult for the United States, given its high energy use and heavy burden of international leadership. If we are to avoid ending up where we are currently heading, the wealthy countries responsible for most of the emissions must take the lead and give firm, clear signals to their own constituents and to the rest of the world. We do not have 20 years to decide what to do. Rather, we have 20 years to achieve actual emissions reductions. Those reductions will mark the tangible beginnings of global action on this issue and make for a real change in where we are headed.

This report builds on the earlier work of WRI's Climate Protection Initiative: *The Costs of Climate Protection: A Guide for the Perplexed; Climate Protection and the National Interest: The Links among Climate Change, Air Pollution, amd Energy Security; Are Developing Countries Already Doing as Much as Industrialized Countries to Slow Climate Change?; U.S. Competitiveness Is Not at Risk in the Climate Negotiations.*

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Jonathan Lash

President

World Resources Institute

1 INTRODUCTION

If international efforts to reduce carbon dioxide emissions are to succeed, much will depend on the willingness of the U.S. Administration to make a meaningful commitment at Kyoto, and on the ability of Congress to ratify a treaty and to enact implementing legislation. For various reasons, the United States occupies a unique and highly influential position within the ongoing negotiations. It is the largest emitter of carbon dioxide (CO_2) and other greenhouse gases both as a nation and on a per capita basis. Moreover, the United States alone has the economic and political influence to ensure that an international protocol is reached and adhered to. It is fair to say that U.S. action will play a major role in determining both the shape of the Kyoto agreement and its subsequent success or failure.

Since the Rio summit, emissions trends, investment decisions, and technological trajectories have all advanced in the wrong direction, working against the need to slow, and ultimately reverse, growth in greenhouse gas emissions.

Unfortunately, the precedent set by the U.S. response to the previous international commitment is not encouraging. Despite the commitment made at the 1992 Earth Summit in Rio to reduce emissions to 1990 levels by 2000, the reductions promised will not be achieved because the voluntary programs adopted domestically were not backed up by appropriate market and policy signals. The economy has reacted accordingly. Negotiations will take place against a backdrop of steadily rising emissions, already more than 8 percent above 1990 levels and predicted to be 15 percent higher than 1990 levels by the year 2000 (U.S. EIA, 1997, 1996).

Tying us to future emissions growth is the present pattern of investment and consumption choices. Industries and utilities continue to make heavy investments in fossil fuel-dependent power stations, machinery and equipment. Meanwhile, consumers are increasingly opting to use light trucks for personal use, ensuring that the overall fuel efficiency of new vehicles is falling (Mackenzie, 1997). Fossil fuel-dependence is reinforced by the latest technological developments. Nearly twice as much is being spent on R&D for fossil fuel technologies as is being spent on R&D for renewables and energy conservation (Dooley, 1996). Coupled with forecasts of decreasing fossil fuel costs, projections of future renewable energy use have dropped, not risen, over the last decade. In the early 1990s, projections for U.S. consumption of renewable energy in 2010 stood at 12.48 quadrillion Btus, or 12 percent of total energy consumption (U.S. EIA, 1991). By 1997 the forecast was for 7.25 quadrillion Btus, or 7 percent of total energy consumption (U.S. EIA, 1996).

Since the Rio summit, emissions trends, investment decisions, and technological trajectories have all advanced in the wrong direction, working against the need to slow, and ultimately reverse, growth in greenhouse gas emissions. Nonetheless, these developments are consistent with calls from certain interest groups and coalitions for further delay before responding to the potential threat of climate change. To support their case, some have pointed to recent economic research which has seemingly endorsed a strategy of delayed emissions reductions.

A CASE FOR DELAY?

Several economic studies have caught the attention of policy-makers because they show that letting emissions rise in the short-term before cutting them subsequently may lower the overall costs of climate protection (Manne and Richels, 1997; Kosobud et al., 1996; Richels et al., 1996; Wigley et al., 1996).[1] These results stem from attempts to identify cost-effective ways to meet the long-term goal of stabilizing atmospheric concentration levels of greenhouse gases—the challenge set by the United Nations Framework Convention on Climate Change.[2]

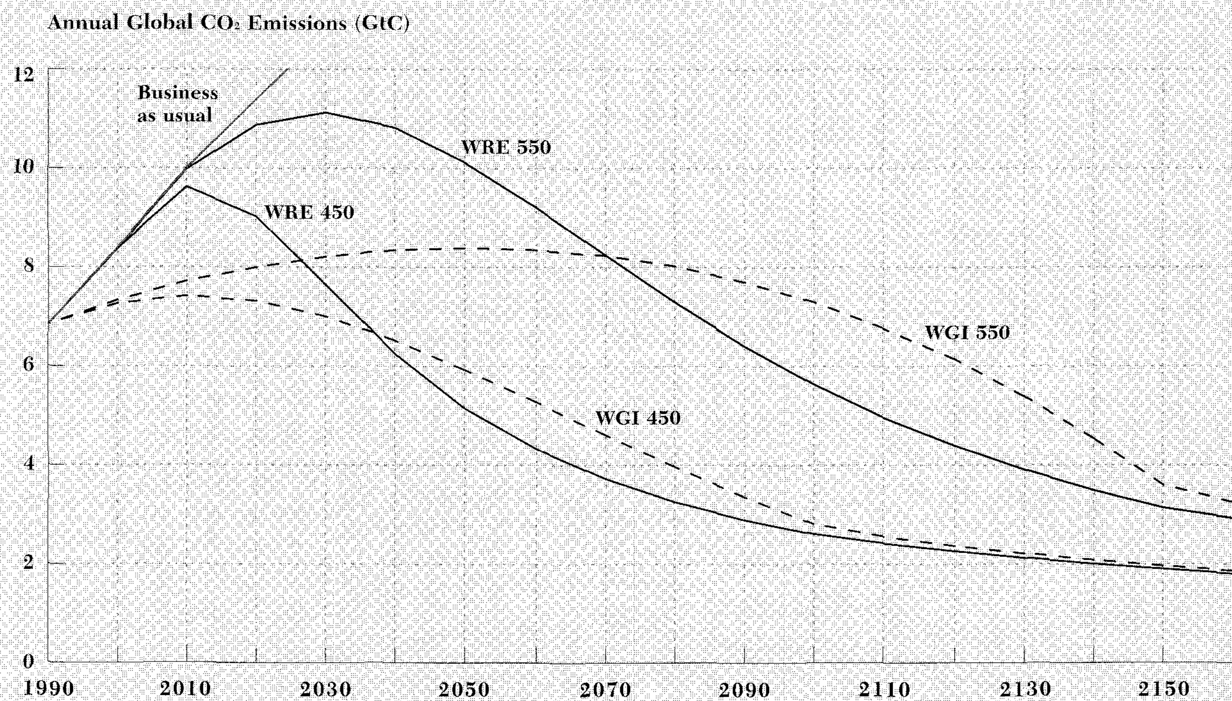
A given concentration target can be achieved by following any number of different emissions paths over time. Figure 1A illustrates two possible emissions paths (WRE and WGI) for each of two alternative concentration targets (atmospheric concentrations of CO_2 of 450 and 550 parts

1 Of these studies, the Wigley, Richels and Edmonds (WRE) study has attracted the most attention (Wigley et al., 1996). Their article has been widely misinterpreted and even construed as a recommendation to 'do nothing,' despite express comments to the contrary in the text (e.g. p. 242). The frequent reference here to the WRE study, and the use of their emissions paths, reflects the article's prominence and is not intended to suggest that the authors advocate a 'do nothing' approach.

2 The goal of the U.N. Framework Convention on Climate Change is to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

FIG. 1A

ALTERNATIVE EMISSIONS PATHS TO REACH FINAL CARBON DIOXIDE CONCENTRATIONS OF 450PPMV AND 550PPMV (parts per million by volume)



WRE paths allow for significantly higher emissions in the near-term than their WGI counterparts before requiring more stringent reductions later to meet the same final concentration level.

Source: Wigley et al., 1996

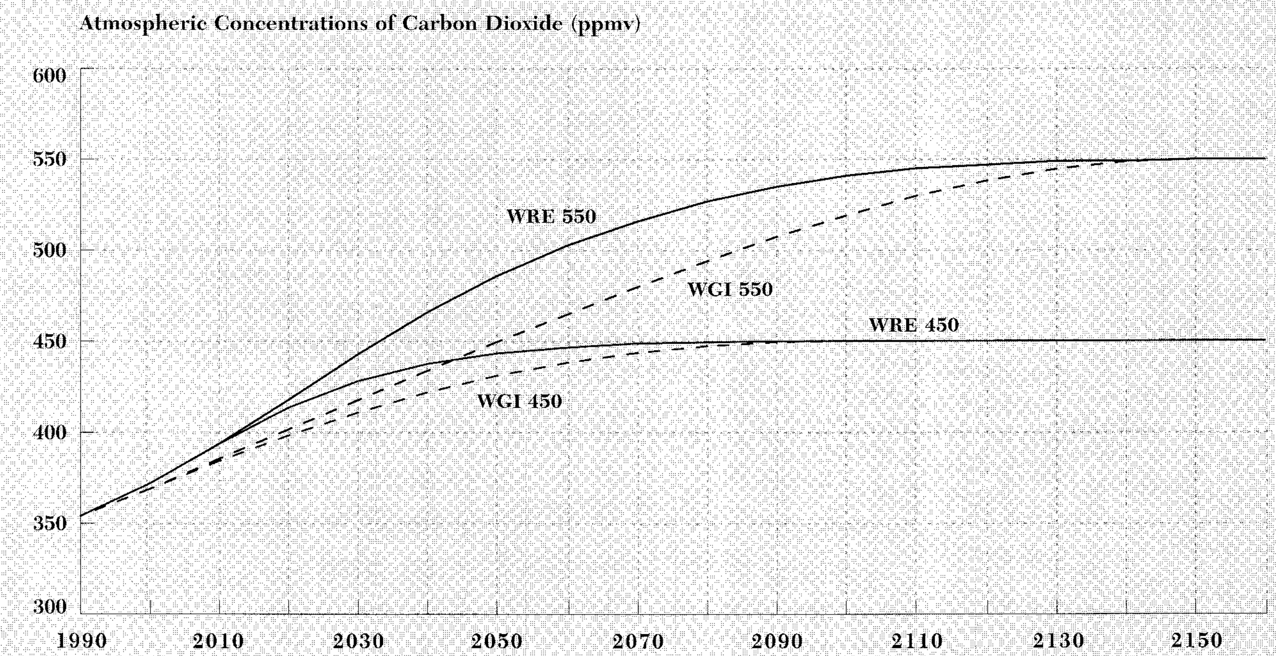
per million by volume).[3] WRE paths allow for significantly higher emissions in the near-term than their WGI counterparts before requiring more stringent reductions later to meet the same final concentration level. Figure 1B shows the concentrations over time implied by the alternative emissions paths. With higher emissions at the outset, the WRE paths lead to higher CO_2 concentrations than the corresponding WGI paths prior to eventual stabilization. The different degrees of near-term action have implications for the overall cost of reaching a given concentration. In particular, some studies argue that emissions paths that rise higher in the short-term may be more cost-effective for four reasons (Wigley et al., 1996).

First, by allowing *more time to alter the capital stock*—everything from factories and machinery to entire power plants—the costs of adjusting the economy should be lower because less equipment will have to be modified or replaced prematurely. The transition toward a less car-

3 WRE refers to paths generated by Wigley, Richels, and Edmonds as alternatives to the WGI paths originally generated by Working Group I of the Intergovernmental Panel on Climate Change.

FIG. 1B

ALTERNATIVE CONCENTRATION PATHS TO REACH FINAL CARBON DIOXIDE CONCENTRATIONS OF 450PPMV AND 550PPMV (parts per million by volume)



With higher emissions at the outset, WRE paths lead to higher CO_2 concentrations than the corresponding WGI paths prior to eventual stabilization.

Source: Wigley et al., 1996

bon-intensive capital stock can occur as part of the natural and ongoing process of replacement. Second, as technology improves with time, so it will become easier to reduce carbon emissions without sacrificing energy demands. As a consequence, postponing some reductions until better technologies are available will lower the costs. Third, a positive discount rate, reflecting the return on investment, ensures that future reductions are cheaper than present reductions, all else being equal. A dollar saved and invested today will earn more dollars to spend on climate protection in the future. Fourth, because CO_2 gradually dissipates from the atmosphere, emissions in the near term will have little or no impact on the concentration level a century from now. If final concentrations are all that matter, there are some 'free' emissions available, but they can only be used early on.

Economic models which account for these factors predict that reaching a given stabilization target by a certain date is cheaper if a path of delayed emissions reductions is followed. A recent study suggests that following the WRE path to a final CO_2 concentration of 550 parts per million by volume (ppmv) could lower the present value of overall costs by more than 75 percent compared with the corresponding WG1 path (Manne and Richels, 1997). These cost savings are sometimes referred to as the benefits of 'when' flexibility.

A CASE FOR EARLY ACTION

Such results do *not* imply, however, that policies to reduce emissions can be postponed. Though the emissions paths suggest a 'do nothing' approach in the near term, the models achieve their results only because they are implicitly or explicitly premised on immediate and credible policy action. It is important to distinguish emission abatement paths from the timing of abatement policies needed to produce those paths (Schneider and Goulder, 1997).

Though the emissions paths suggest a 'do nothing' approach in the near term, the models achieve their results only because they are implicitly or explicitly premised on immediate and credible policy action.

By examining the assumptions and limitations of these models, the benefits of delayed action become much less certain. In particular, the conclusion that we can postpone policies overlooks seven key considerations.

- Early policy action is needed to establish a credible commitment to climate protection and to reverse years of policy choices that have favored carbon-intensive technologies. A promise to take action only after many years have passed will not be credible. (*See Section* 2.)
- Without credible policy signals, the needed changes in investment toward less carbon-intensive and renewable alternatives will not occur. Instead, new additions to an increasing capital stock will con-

tinue to rely on fossil fuels, making future transition more difficult. (*See Section 2.*)

- The opportunity to redirect technological advances toward more rapid development of renewable technologies will also be delayed. Instead, R&D efforts will continue to focus on fossil fuel-based systems and technologies, thereby enhancing our dependence on them. (*See Section 2.*)
- Delay by the United States will have global implications since other countries will not take action unless the United States does so. Consequently, carbon emissions will continue to grow rapidly in both developed and developing nations. (*See Section 3.*)
- Since scientists can't specify a safe concentration level, decisions have to be made under uncertainty. Emissions increases in the near term will make it harder to achieve lower concentration levels later should they be necessary. (*See Section 4.*)
- Potential benefits from climate protection policies, such as reduced air pollution and savings from more efficient use of energy, will be postponed. (*See Section 5.*)
- Postponing emissions reductions would mean faster rates of concentration build-up, raising the risks. (*See Section 6.*)

Unfortunately, the promise of benefits from delayed policy action may be illusory. They arise from a misunderstanding of the dynamics of the economy, a misinterpretation of certain economic studies, and, above all, a failure to account for important political considerations. Under a more realistic assessment of the issue, clear and consistent abatement policies should be implemented as soon as possible.

2 ACHIEVING THE TRANSITION TO A LESS CARBON-INTENSIVE ECONOMY

Achieving a transition from a fossil fuel-dependent economy toward a less carbon-intensive one will require far-reaching change over many years. How best to time the transition is an important question. Analyses of this question have generated useful insights but rest on crucial limiting assumptions which policy-makers must take into account. (*See Box 1 for summary, page 10.*)

TIMING AND THE CAPITAL STOCK

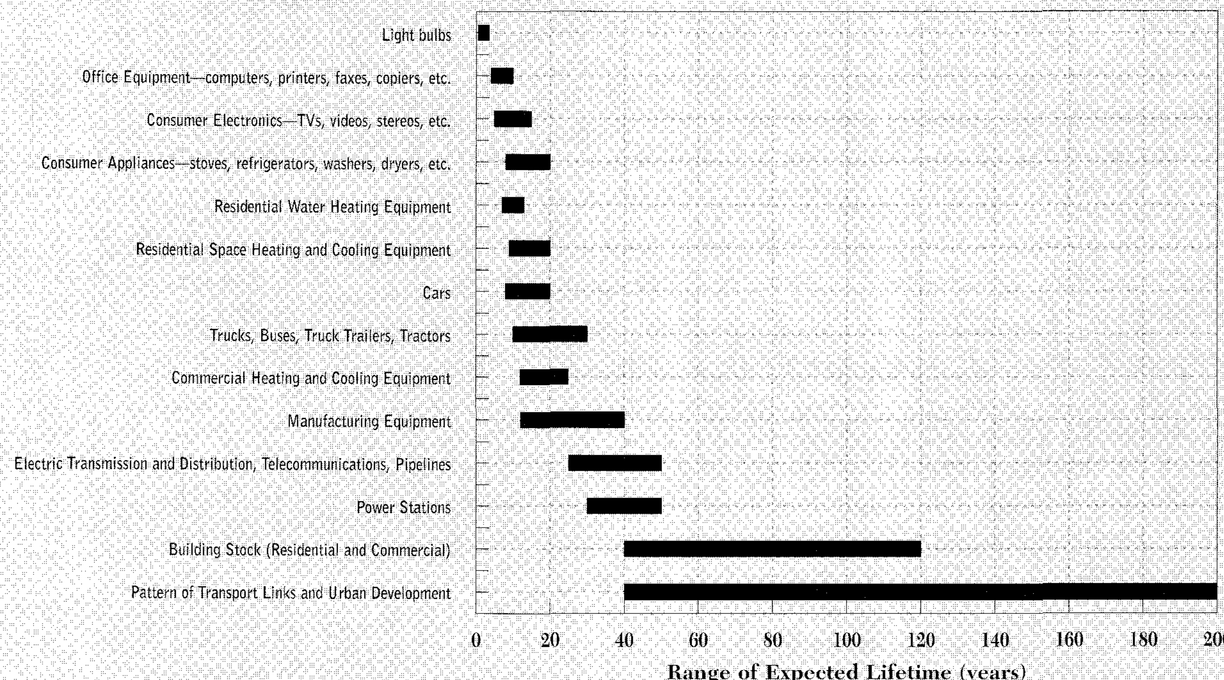
The stock of energy-related capital within the economy is huge, ranging from factories and industrial machinery to automobiles and computers to core infrastructure such as pipelines and transport links. This capital stock is subject to a continual process of turnover as old and run-down appliances and equipment are retired and replaced with new investments.

For most capital goods, decisions about replacement will have significant long-term consequences. Because of the long life of buildings, power plants and manufacturing equipment, today's investments determine in part the energy requirements thirty or forty years hence. In the case of deep-rooted infrastructure such as patterns of urban settlement and transport, today's decisions have even longer-term implications for the economy's energy needs. (*See Figure 2.*)

The transition toward a less carbon-intensive economy will require replacing a large capital stock whose continuing economic efficiency relies on relatively cheap fossil fuel prices. If emissions reductions are required, and if conventional fuel prices rise, then a whole spectrum of investments may become uneconomic before the end of their planned lives. The result will be

Because of the long life of buildings, power plants and manufacturing equipment, today's investments determine in part the energy requirements thirty or forty years hence.

FIG. 2 AVERAGE LIFESPANS FOR SELECTED ENERGY-RELATED CAPITAL STOCK



Note: Figures are intended to illustrate typical lifespans, for which there will always be exceptions. For example, some hydro-electric power plants are over 90 years old.

Sources: Chien, 1997; Grubb, 1997; Katz and Herman, 1997; Laitner & Symons, 1997; Appliance Magazine, 1996; Mullins, 1996; U.S. EIA, 1995.

either premature scrapping or expensive modifications that would otherwise have been unnecessary. Where equipment is left in place, running costs will become higher. By extending the time available, more changes can be absorbed as part of the natural replacement process.

However, to maximize the time available, the process of adjustment must start as soon as possible. Even model results that suggest emissions can rise now and fall later turn out to be premised on immediate changes in the capital stock toward less carbon-intensive alternatives.

LONG-LIVED INVESTMENTS AND INERTIA

These arguments are especially true for the long-lived investments (for example, power plants, buildings and urban patterns) which dictate long-term energy needs. Although these existing investments are the ones most vulnerable to changes in energy prices, they are also the investments that we most need to get right today. Fitting an inefficient light bulb entails very mild and short-term repercussions—either a short period of marginally higher running costs or premature replacement with minimal loss in investment. Building a conventional power plant, however, ties us to fossil fuel use for many years and is far less likely to be retired early, because huge investment costs would not yet have been recouped.

The long lifespan of basic infrastructure ensures that there is considerable inertia in the economy's energy systems. This inertia is compounded by the linkages between energy capital and other parts of the economy. Energy investments are often at the center of vast networks of supporting or dependent industries which represent further large-scale investment and which further hold in place fossil fuel-based energy systems (Grubb, 1997). For example, electricity generation relies on extraction, refining, delivery and transmission systems—all of which may be redundant if energy is provided by alternative sources. Investments, too, may be of a social nature, including the skills that labor possesses and the location of communities.

Under inertia, there is a temptation to postpone core changes until they are deemed unavoidable and to focus instead on changes that are less disruptive to the economy. This approach is problematic. A policy that focussed only on efficiency gains in the near term may leave long-term investment patterns unchanged. Though efficiency gains (for example, in end-use technologies and domestic appliances) will be important and felt rapidly, ultimately changes in energy generation sources, building structures and transport patterns will be required to make up the bulk of reductions, especially in the latter part of the next century. By ignoring these at the outset, the opportunity for an early start would have been wasted and later changes may need to be both deeper and more severe.

THE NEED FOR POLICY ACTION

In the absence of immediate incentives, it is safe to assume that investment patterns will continue along their current path, with only marginal funds made available for nonconventional energy generation. U.S. expe-

BOX 1

UNDERSTANDING WHY SOME MODELS PREDICT SAVINGS FROM DELAY

■ A number of economic models suggest that doing less now and more in the future would lower the overall costs of stabilizing concentration levels (e.g. Manne and Richels, 1997; Richels et al., 1996). Yet, using these results as an argument to do nothing now ignores the importance of key assumptions, overlooks the limitations of such models, and in some cases, fails to observe the authors' own conclusions.

■ Model results are typically influenced by several key assumptions:

- **Policies are credible from the outset.** Policies are announced, come into place on schedule and are met without fail. Implicitly, the government is able to act with complete credibility on the issue, irrespective of what may have gone before.
- **Capital stock turnover starts immediately.** Investors in the models have perfect foresight or anticipation. Because announcements of future policies are perfectly credible, investors start making changes in the capital stock immediately.
- **Appropriate technological advances occur even in the absence of price and policy signals.** The majority of models assume that the needed advances in energy efficiency and alternative energy generation occur even without explicit price and policy signals being in place.

■ Models are also limited in certain respects:

- **Many models take no account of uncertainty.** Emissions paths are computed on the basis that the final concentration target is known to be safe from the outset. Models which account for uncertainty tend to suggest early action as a hedging strategy (Grubb, 1997; Manne, 1996).
- **Models ignore the international negotiation process.** Most models treat the world as a single policy-making entity, ignoring national interaction. Even if it were beneficial to let global emissions rise for many years, if action by developed countries is a precondition of developing country action, then the former must start making emissions reductions before global emissions peak.
- **Models ignore environmental benefits.** There is no benefit from having a lower rate of concentration build-up, nor from reducing damages from conventional air pollutants.
- **Models neglect potential benefits from 'no regrets' changes.** Models ignore potential gains from energy efficiency and subsidy removal that lead to net economic savings irrespective of emissions benefit.

rience over the last five years shows that, without tangible market and regulatory signals, investors and consumers will not change their plans. In that case, the growth in the carbon-intensive capital stock will be enormous and will make the delayed transition considerably more difficult.[4]

U.S. experience over the last five years shows that, without tangible market and regulatory signals, investors and consumers will not change their plans.

It is worth considering whether any U.S. Administration would be willing to initiate a policy of more severe turnover than that rejected by their predecessors. To meet any given concentration target, a much higher level of adjustment would have to occur within a shorter period of time—a prospect even more expensive and even less attractive politically than the current situation.

TECHNOLOGICAL CHANGE

That technology will improve over the next few decades is beyond question. The more important issue is to understand what type of technological improvements can be expected under different market and policy conditions. Rather than assisting a future transition, advances in conventional energy technologies may hinder alternative energy developments, making transition more difficult.

Rather than assisting a future transition, advances in conventional energy technologies may hinder alternative energy developments, making transition more difficult.

A simple view of technological improvement, adopted by most models, is that inexpensive low- or non-carbon energy production will materialize in the future, independent of policy and price signals. The reality, however, is that technological advance is shaped by societal need as expressed through market demand and policy directives (Ahmad, 1966; Goulder and Schneider, 1996; Kamien and Schwartz, 1968). It is further driven by "learning by doing"—that is, the more a technology is used, the greater the knowledge base to feed back into the next rounds of development (Arrow, 1962).

4 Even the WRE-550 path in Figure 1, which is premised on appropriate changes in the capital stock from the outset, implies investing "in at least as much new CO_2 based capital stock over the next few decades as is embodied in the world's entire energy systems today." (Grubb, 1997, p. 163). Subsequently, this would have to be replaced by carbon-free sources in the matter of a few decades. Without the appropriate capital investment from the outset, emissions growth rates would be higher still and the degree of reduction required later even more stringent.

INDUCING TECHNOLOGICAL CHANGE

For renewable technologies to develop rapidly enough to provide viable alternatives to conventional energy sources, an appropriate climate for innovation must be created now. Market incentives would encourage the diffusion of alternative technologies, facilitate the process of learning by doing and influence the large private R&D funds that a government cannot control directly. They are also preferable to inflexible regulations which dictate the form of industry's response and stifle creative solutions (Milliman and Prince, 1989).[5]

> It is ironic that proponents of delay place so little faith in near-term technological improvements driven by market and policy signals and so much faith in long-term technological improvements driven by nothing at all.

In addition, there is a direct role for public R&D, especially in providing 'basic research'—invention and early innovation—that develops technologies in the first place. Typically, private research shies away from such activity because it is difficult to appropriate all the gains that may result. Increasing public R&D expenditure in this area would not only encourage innovation directly, but would send a further signal to the private sector regarding areas of long-term promise (Romm and Curtis, 1996).

Evidence from previous environmental mandates shows that appropriate technological innovation and diffusion can be attained quickly once signals are in place. In the cases of acid rain regulation and CFC phase-out, for example, unanticipated technological innovation lowered compliance costs well below the levels projected by sectoral interests before the policy change (Cook and Miller, 1996). Similarly, the 'Golden Carrot' program, which offered a monetary reward to the first manufacturer able to produce an energy-efficient and non-CFC domestic refrigerator, led to the development of a new product in two years, rather than the usual eight or nine years (Cook, 1996). Moreover, evidence suggests that technologies already or nearly available could substantially reduce emissions without compromising energy needs if there is sufficient national commitment to support them (Laitner, 1997; U.S. DoE, 1997). It is ironic

5 Economic instruments should be carefully targeted to have most impact. While a carbon tax always provides a focussed incentive, additional R&D subsidies may be useful supplements if advances in one area generate benefits for other sectors that cannot be appropriated by the initial innovator (Schneider and Goulder, 1997).

that proponents of delay place so little faith in near-term technological improvements driven by market and policy signals and so much faith in long-term technological improvements driven by nothing at all.

TECHNOLOGICAL 'LOCK-IN'

Without explicit incentives to promote alternative energy systems, technological development may steer us further from a non-carbon path. Economists refer to a phenomenon of technological 'lock-in' whereby particular technologies become the market standard even though alternatives—both existing and potential—may be better (Arthur, 1988). Once locked-in, it is difficult for new, and perhaps superior technologies even to emerge, let alone claim market share. The classic case of lock-in is the development of the internal combustion engine, which led to parallel developments of petroleum refining, automobile manufacture, highway construction, gasoline provision networks, patterns of urban sprawl, decline of trolleys, etc. Technological lock-in reinforces the problems of capital inertia described earlier.

THE NEED FOR CREDIBLE SIGNALS AND POLICIES

Even models that suggest emissions should rise in the short term require that changes in capital stock and technological development occur from the outset to meet the more stringent cuts needed later. However, this does not make for a consistent policy path. The very signal that emissions can rise in the short term removes the imperative for implementing the necessary policies. Subsequently, achieving future emissions reductions will be harder because nothing will have been done in the interim.

MAKING A CREDIBLE COMMITMENT

For changes to occur in capital investment and technological progress, investors need to be convinced that policy-makers are committed to a new direction. In the artificial world of modeling, it suffices to have the government simply declare its *intention* to start reducing emissions in a

BOX 2

ESTABLISHING CREDIBLE POLICIES— A LESSON FROM CONTROLLING INFLATION

- The need for credible policy signals is well understood by economists because such signals form the cornerstone of inflation control. Inflation needs to be kept low for the long-term health of the economy. However, doing so imposes a short-term cost in terms of lower immediate growth and potentially higher unemployment than would otherwise occur.
- The tension between inflation and employment especially means that *establishing commitment to a policy of stable prices is difficult.* There will always be a temptation for the government to take the easier option in the short term of relaxing monetary control, thereby lowering the cost of credit and loans, reducing highly visible mortgage interest payments, and temporarily boosting output and employment. Particularly near election time, when there is a premium on short-term popularity, this temptation may be irresistible. The adverse consequences will only be felt later, by which time elections will be over.[a]
- If a government is serious about controlling inflation, it must establish credibility by building a reputation for stable prices. Building a reputation, though, takes time. Only when the temptation to relax monetary policy has been repeatedly resisted does the government's commitment to stable prices become credible. In many countries, the only credible way to assure consumers and investors of a commitment to low inflation has been to pass control to an independent central bank sheltered from political pressure, as with the Federal Reserve.
- For climate change, as for inflation, the consequences are potentially severe but will only be felt later. In contrast, prevention measures may be costly and unpopular immediately. There are also key differences: the consequences of inflation are known with certainty, through bitter experience, and materialize in the short term not the long term.

[a] This is the well-documented 'time inconsistency' problem (Kydland and Prescott, 1977). Time inconsistency of policy refers to the breaking of a policy commitment in order to take advantage of benefits that are immediate and usually short term. More plainly, it is the difference between what policy-makers say they are going to do and what they end up doing.

future year, perhaps over a decade away. Decision-makers in the model, blessed with perfect foresight and fully convinced of future policies, immediately alter their behavior.

In reality, such a framework is impossible to establish. Declarations of which policies will come into place many years hence are meaningless. Instead, investors' expectations are shaped predominantly by policies implemented now. Governments can signal long-term intent to decision-makers only through *consistent and persistent policy action*. In so doing, the government effectively builds a reputation for controlling carbon emissions. Establishing and maintaining a reputation are often key components of macroeconomic management. (*See Box 2.*)

Of course, reputations cannot be earned overnight. As long as the government's commitment is questioned, investments will not change markedly, even though policies are in place. This is because investors will factor in a probability that the commitment may waver and that the policy may be reversed. Gradually, as the commitment proves resilient to changing political and economic circumstances, so investors' doubts will diminish. This implies several things for policy implementation.

- First, given the delay while expectations form, policies will have a 'lead time' before the pattern of long-term investments fully responds to changed prices.
- Second, the building of a reputation may be hastened by careful policy design. In terms of establishing credibility, meeting a pre-announced schedule of incremental carbon tax increases which reaffirms commitment early and often would be preferable to a tradable permit program with long compliance periods. With the latter, commitment to the program can only be demonstrated at the end of the period by penalizing defaulters.
- Third, there is a trade-off between flexibility and credibility of policy. Policies that incorporate escape clauses such as the ability to "borrow from the future"—allowing permit holders to forego reductions now in return for more stringent reductions later—do not establish as strong a commitment to emissions reduction as less flexible policies.
- Fourth, a single policy is unlikely to convey commitment by itself. Instead, it would need to be buttressed by other policies that establish across-

the-board consistency, lowering the likelihood of removal in the investor's mind (Rodrik, 1989).

THE DANGER OF WEAK COMMITMENTS

If investors are skeptical of the commitment to emissions reductions, they may even feel that their behavior could force policy reversals. They may continue to make traditional investments, accepting the short-term impact of higher fuel prices, but knowing that such investments will prove to be the most profitable in the long-term when the policy that raised prices is removed. In these circumstances, it may quickly become impossible for the government to adhere to the initial policy target.

The Rio commitment serves as an example. Although there are three years remaining to meet that target, any political pressure to do so has long since vanished. Voluntary programs alone, though successful, were insufficient to alter investment and consumption patterns across the economy. To meet the target now would require abrupt and immediate change.

Reneging on commitments only makes it more difficult to establish a reputation later, setting in train a vicious circle of missed targets and resolution to start anew. Only if climate conditions become much more severe will this pattern be broken. But by then, it may be too late to avoid further severe conditions, or if not too late, vastly more expensive than if earlier preventive measures had been taken.

If credibility cannot be instantly assumed, then policy implementation is required early. Initially, this will require a sufficiently tough international signal from Kyoto to force the appropriate domestic response. Delay paths such as those in Figure 1A are not credible politically, because conceding that emissions can rise in the short term removes the imperative for immediate change that is necessary even for those paths. Subsequently, domestic policies need to be implemented as soon as possible to maximize the time available to meet national targets.

Conceding that emissions can rise in the short term removes the imperative for immediate change that is necessary even for "delay".

3 THE INTERNATIONAL IMPLICATIONS OF U.S. ACTION

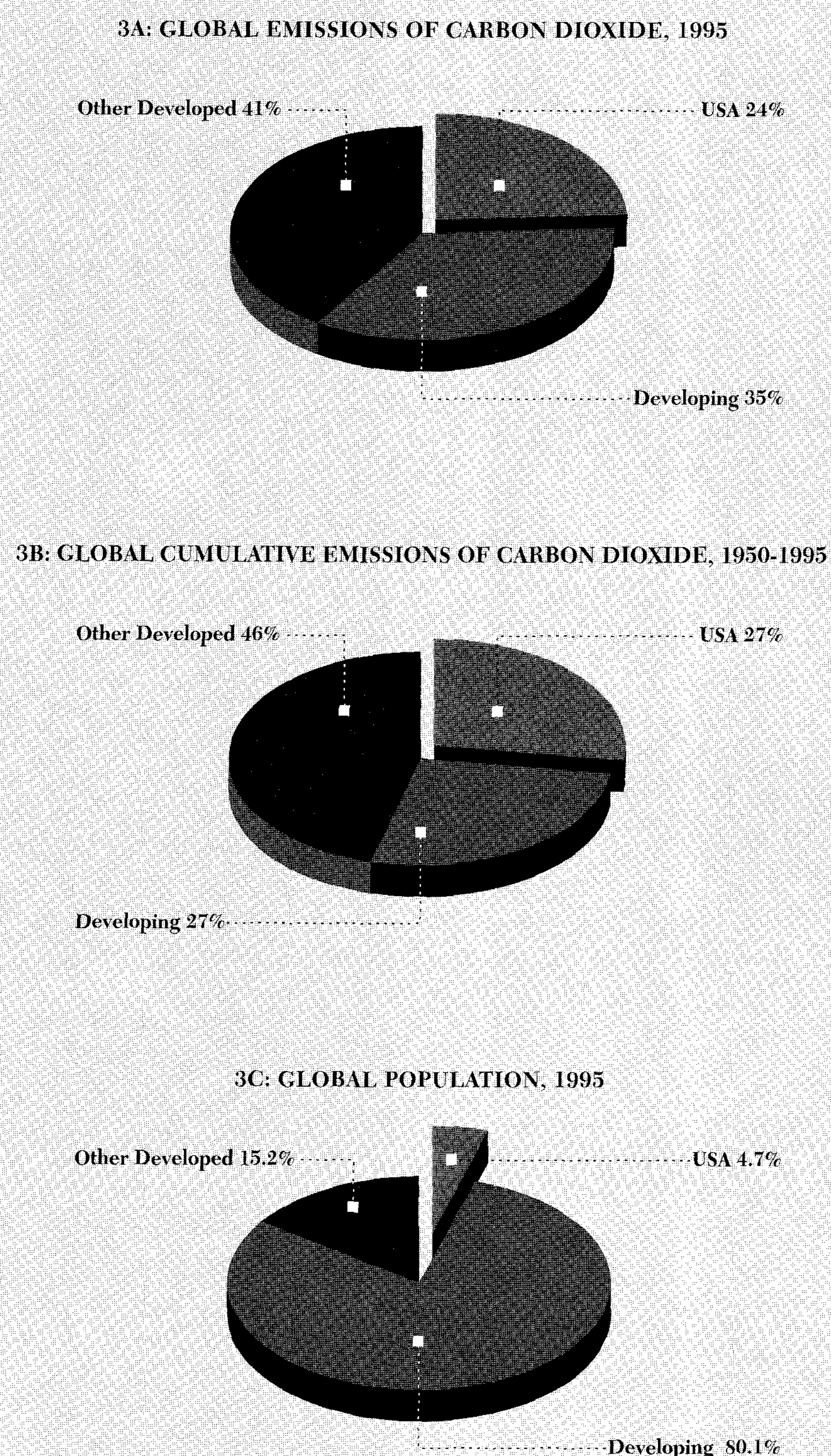
The policy interdependence of nations raises the significance of U.S. decisions. If the United States endorses a meaningful commitment, it is very probable that other developed countries will agree to commitments, thereby creating a much stronger basis for the subsequent involvement of developing countries. If the United States opts to delay, then it is unlikely that Europe and other developed nations will implement carbon reduction policies either. Developing countries will almost certainly follow suit. In either case, the political and economic importance of the United States means that the U.S. decision will be amplified.

Current negotiations have recently been hamstrung by differences of opinion over "evolution"—the process by which developing countries take on binding commitments. The Berlin Mandate affirms the principle that developed countries have a responsibility to act first. Developed countries not only have higher per capita emission rates than developing countries but have been responsible for an even greater share of cumulative anthropogenic emissions to date. (*See Figure 3.*) While the developed countries have only 20 percent of total population, they are responsible for 65 percent of present global emissions and 73 percent of the cumulative emissions between 1950 and 1995 (CDIAC, 1996; United Nations, 1996).[6] The U.S. contribution, both present and historical, stands out. Developed countries also have substantially higher levels of wealth and technology at their disposal.

Nonetheless, some U.S. politicians are now calling for developing countries to agree to commitments from the outset (Congressional Record, 1997). This move is prompted by the fear that unilateral action by developed countries will lead to displacement of energy-intensive industries to developing countries, with little or no overall effect in global carbon emissions. These fears may be overstated and ignore emissions reductions that have occurred in developing countries anyway (Reid and Goldemberg, 1997; Repetto and Maurer, 1997).

[6] Because CO_2 remains in the atmosphere for approximately a century, cumulative emissions provide a better insight into present responsibility. Ideally, one should account for emissions prior to 1950 but reliable data is unavailable.

FIG. 3 GLOBAL CARBON DIOXIDE EMISSIONS AND POPULATION



Ultimately, developing country action will be crucial. As their populations swell and as their economies grow, so their carbon emissions will increase. This is especially likely given that many developing countries have vast fossil fuel resources waiting to be tapped. Already, in the absence of imminent action, growth in developing countries is proceeding along conventional lines. Since 1992, the World Bank has helped to finance 87 fossil-fuel projects whose expected CO_2 emissions over their lifetime are one and a half times greater than today's total annual global emissions (IPS, 1997).

Just as making a transition to alternative energy technologies is constrained in the United States by the degree of carbon-intensive stock in place, so the same is increasingly true for developing countries. Their choices regarding core energy systems and energy-related infrastructure could establish the same high dependency on fossil fuels evident in the Western world. The opportunity to nip this in the bud should not be wasted.

The issue then is how best to ensure the involvement of developing countries. At the outset, the degree of their involvement hinges on moral arguments relating to responsibility for current concentrations and relative wealth. In the long term, the involvement of developing nations depends entirely on creating attractive investment and development opportunities that offer feasible alternatives to conventional growth. For both reasons, further delay by developed countries could potentially make it harder rather than easier to ensure developing country action.

First, the issue of signaling is again pertinent. The Byrd-Hagel Resolution has been perceived as a sign of U.S. reluctance to act at all as much as a call for developing country commitment at the outset.[7] As a consequence, it prompts developing countries to push climate protection further down their list of priorities. In contrast, early action by developed countries would signal exactly the opposite. Even if developing countries are not required to

[7] The Byrd-Hagel Resolution, passed 95-0 in the U.S. Senate, expresses the view that the United States and other developed countries should not accept new commitments unless developing countries also accept specific scheduled commitments within the same time frame (Congressional Record, 1997).

Just as making a transition to alternative energy technologies is constrained in the United States by the degree of carbon-intensive stock in place, so the same is increasingly true for developing countries.

make an explicit commitment at the outset, an agreement by the developed nations to reduce emissions, followed by action toward that goal, would send an unmistakable signal about expected future development. Not only would it provide a much stronger basis for ensuring developing country action in due course, but it would force developing countries to consider alternative energy systems even before binding commitments were in place.

Second, developing countries will be persuaded not to use their fossil fuel reserves only if feasible energy alternatives exist. The bulk of technological advance will need to occur in the developed countries, but may be rapid enough only if appropriate policies are set in place now. If new technologies succeed in providing more favorable alternatives, developed countries could benefit from important trading opportunities in international markets. Equally, developing countries could avoid embarking on a conventional development path from which they would rapidly have to depart in the future. Technology-forcing domestic policy should make emissions reduction in both developed and developing countries less costly.

4 A STRATEGY FOR UNCERTAINTY

For all the discussion of final concentration levels of carbon dioxide, we have no firm idea of what constitutes a "safe" level. Scientists have shied away from quantifying safe levels because of inherent uncertainties and because of reluctance to make broad value judgments, a task more suited to politics than to science (Azar and Rodhe, 1997). The unfortunate consequence is that arbitrary targets have emerged unchecked to fill this vacuum.

The central IPCC projection suggests that concentrations of carbon dioxide under a business-as-usual scenario will be over 700ppmv in 2100, compared with the preindustrial level of 280ppmv. A target concentration of 550ppmv has gained prominence in the literature for the simple reason that it represents an approximate doubling of preindustrial carbon concentrations.[8] Worse, because most published ranges use 550ppmv as a mid-point prediction, it appears as a reasonable compromise. Yet, a concentration of 550ppmv is estimated to lead to a rise in global average temperature of between 2C° and 5C° by 2150. By contrast, the natural fluctuation over the last 10,000 years has been only 1C° (Azar and Rodhe, 1997; Gleick and Sassin, 1990).

Despite the uncertainty regarding targets, many economic analyses of delay attempt to plot cost-effective paths to reach targets that are regarded as safe from the outset and remain fixed. They aim to lay out the best way of getting from here to there as if we knew with certainty where there was.[9]

Of course, we cannot be so certain about final desirable concentrations. Some have argued that we should not act until we know more. In their eyes, it would be wrong to impose immediate economic change to reach a low target if further research reveals that higher concentrations and temperatures are perfectly safe. Clearly the uncertainty may work in the other direction as well: if we set 550ppmv as our target now, we may

8 When the growth of other greenhouse gases is taken into account, some of which are far more potent at trapping heat, anything over 500ppmv is equivalent to a doubling of CO_2 alone.

9 Even in studies which consider alternative final concentrations, the implication is often that the choice of final target is resolved at the outset, not that we proceed towards one target at the start only to find that we have to change targets later as better information becomes available.

later discover that a much lower target is required. We would then be forced to make further cuts in emissions than we had predicted. These cuts would be even more severe if we do nothing in the interim.

Even if the probabilities of getting it wrong were equal in both directions, the expected costs of excessive abatement at one extreme may be considerably less than the costs from climate change-induced catastrophes at the other extreme. Economic costs should have a lower bound than climate change costs given the immediate political pressure that keeps economic costs in check. Costs from severe climate-related damage would be largely beyond our control and may be difficult to avoid if they appear, given the time-lags in the system. Economic costs on the same scale could only occur if we set out immediately on a path far more stringent than any that have been suggested and adhere to it in the face of high costs—something that would fail to pass muster politically (Grubb, 1997).

For all the discussion of final concentration levels of carbon dioxide, we have no firm idea of what constitutes a "safe" level.

In a framework of uncertainty, a sensible strategy is to adopt a position from which it is possible to meet different contingencies. Taking early incremental action would allow us to meet more stringent cuts if necessary without compromising our ability to revert quickly to today's emission paths if they are confirmed as safe. Alternatively, failure to act now may foreclose our ability to meet low stabilization targets without severe economic disruption, if we later realize that they are necessary. Models which incorporate uncertainty tend to advocate more near-term action as a type of hedging strategy (Grubb, 1997; Lempert et al., 1997; Manne, 1996).

5 OPPORTUNITIES FOR ECONOMIC GAINS

The call for delay is driven by the fear of adverse effects for the economy as a whole and for specific sectors. Many policy-makers and business interests believe that policies to restrict carbon emissions would be costly for the economy, a view supported by the pessimistic predictions of numerous economic models. These models, however, often rely on unduly pessimistic assumptions regarding economic behavior and potential policy responses (Repetto and Austin, 1997). Models based on more favorable assumptions tell a different story. With sensible climate protection policies, carbon reductions can be achieved with minimal impact on economic growth. This may be of little consolation to certain sectors, though.

Moreover, many models do not account for the full potential benefits from climate protection policies. If there are advantages from reducing emissions, then the argument for delay is stood on its head. Early action would bring forward benefits not costs.

BENEFITS FROM IMPROVED ENERGY EFFICIENCY

Many economic predictions suppose that energy is already being used efficiently, contrary to much evidence. From manufacturing processes to transportation options to household appliances, there are countless opportunities for improvements in energy efficiency (von Weizsäcker et al., 1997). Recent evidence suggests that energy use in U.S. residential and commercial sectors could be cut by between 25 and 50 percent (Energy Innovations, 1997). Other studies have estimated that a reduction of more than 20 percent of present carbon emission levels could be achieved at overall savings (IPCC, 1996c, ch.9).

Such savings are not guaranteed, of course. Estimates ignore some 'hidden' costs, such as time needed to install and become familiar with new equipment. In some cases, market failures, such as a lack of information, and poor business practices prevent savings. Nonetheless, if a growing public commitment to lowering greenhouse gas emissions raises the visibility of energy costs, industries may actively seek out previously overlooked savings.

BENEFITS FROM REDUCED AIR POLLUTION

Fossil fuel combustion is a major source of local and regional air pollution, which contributes to respiratory illnesses, mortality, damage to crops and vegetation, and acid rain. Many people suffer from less dramatic effects, such as minor symptoms not requiring treatment and reduced visibility in scenic areas. Many of these impacts have no "price" and thus are often ignored by the conventional economic calculus used to evaluate the effects of carbon restrictions. Yet, they have a very real impact on people's welfare.

Climate protection policies that reduced fossil fuel use would also reduce air pollution and its associated costs—benefits that would be felt immediately. These benefits could be sizable, offsetting between 30 and 100 percent of the potential abatement costs (IPCC, 1996c, ch. 6; Burtraw and Toman, 1997). In particular, the reduction in particulate matter pollution alone that would result from less fossil fuel use, could have major health implications worldwide. Under a relatively stringent climate policy—a 15 percent reduction in developed country emissions by 2010, with smaller reductions in developing nations—an estimated 700,000 deaths per year could be avoided by 2020 (Working Group on Public Health and Fossil-Fuel Combustion, 1997).

REVENUE BENEFITS FROM REMOVED SUBSIDIES AND TAX EXEMPTIONS

Another immediate step toward reducing carbon emissions would be the removal of certain subsidies and tax exemptions to conventional energy sources. Worldwide, subsidies to conventional energy sources have been estimated at more than $300 billion (IPCC, 1996b, ch. 19). By helping to lower conventional energy prices, these subsidies ensure that consumption of fossil fuel is greater than it would be under more competitive conditions. In addition, a wide range of indirect subsidies, such as road construction programs, encourages fossil fuel use.

In the United States, government has already cut many subsidies to fossil fuel energy sources. Yet, between 1998 and 2002, federal subsidies for nuclear, coal, oil and natural gas will total $3.9 billion, while potential revenues of $13.2 billion will be passed up in preferential tax treatment to the same sectors (Shapiro and Soares, 1997).

6 THE SPEED OF CLIMATE CHANGE

Although economic and political issues are currently generating the most heated debate, certain scientific issues also bear on the timing of policy response. One concerns the rate at which greenhouse gas concentrations increase. Final concentrations are not the only relevant measure of environmental impacts. Figure 1B shows that the concentration levels over the next century vary between the two paths. In practice, this variance implies differences in the rates of change of radiative forcing and global average temperature en route to stabilization.

RISKS OF SURPRISE

Radiative forcing is the process by which gases in the atmosphere trap heat and raise global temperature. Even if increases in radiative forcing and concentration levels were gradual and continuous, the non-linear nature of the climate system means that future changes may involve surprises (IPCC, 1996a, p.7).[10] By definition, the unexpected nature of these effects makes them impossible to guard against and so potentially more costly to respond or adapt to. Though we do not know what rate of concentration build-up would generate surprises, clearly higher concentrations in the near term, and hence higher radiative forcing, raise the risks of surprise (Schneider, 1997).

[10] The unanticipated appearance of a hole in the ozone layer is an example of such a surprise, though caused by a different process.

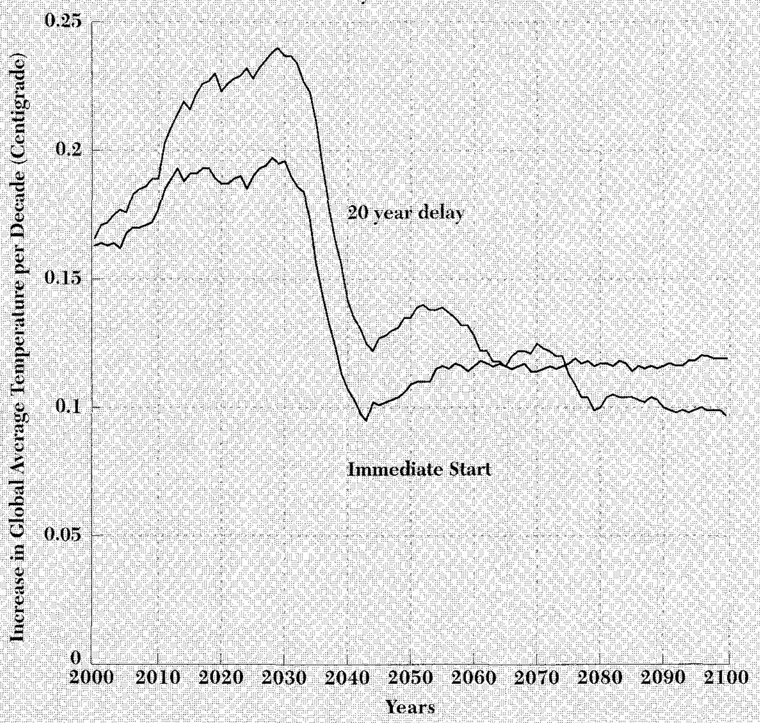
RATES OF TEMPERATURE CHANGE

Even without surprises, different rates of build-up will generate different rates of temperature change. Although ecosystems possess a natural resilience to change, too rapid a rate of change may overwhelm certain species' ability to adapt. Climatic zones may shift faster than natural forest migration processes (Davis, 1989). Coral reefs may die out as sea level rise outpaces the upward growth of reefs that keeps them near the surface (Harvey, 1996; Gleick and Sassin, 1990). Human responses may also be slow. The spread of malaria into developing countries may outpace the development of health care systems that might otherwise contain the disease (Harvey 1996; Martens et al., 1994). For such reasons, some argue that it is more appropriate to focus on the rates of change of key variables, or to impose a "speed limit" on climate change (Alcamo and Kreileman, 1996; Amano, 1996).

One variable of interest is the rate of change of global average temperature. Unfortunately, little is known about what constitutes a safe rate of change. Moreover, it is the rate of change sustained over several decades that is important. Nonetheless, delayed reduction paths with higher near-term emissions may sustain higher absolute rates of temperature change over the first few decades of the next century than is ever achieved under a path of immediate action. (*See Figure 4.*)

FIG. 4 THE IMPACT OF DELAY ON DECADAL RATE OF TEMPERATURE CHANGE

(Two paths to reach CO_2 concentrations of 550ppmv calculated by the IMAGE model)



Source: Alcamo and Kreileman (1996)

The scope for surprise impacts and the uncertainty regarding the effects of higher sustained rates of temperature change may mean that ecosystems and human health face higher threats under a path of delayed reductions.

Predictions of rate of temperature change are sensitive to assumptions about aerosol emissions, which have a cooling effect that offsets greenhouse gas emissions. In a scenario where aerosol emissions are coupled to greenhouse gas emissions, the pattern may be somewhat reversed. Figures from another model show that both paths may have low rates of temperature change early on, before the delay path rises above a path of immediate reductions. For example, under these assumptions, between 2040 and 2100, the sustained rate of change for the WRE-550 path is 0.17C° per decade as opposed to 0.14C° per decade under the WGI-550 path (Wigley et al., 1996).

Though there is uncertainty regarding the impacts of different rates of change, such figures represent potential risks imposed by delay and add another dimension to near-term policy decisions. The scope for surprise impacts and the uncertainty regarding the effects of higher sustained rates of temperature change may mean that ecosystems and human health face higher threats under a path of delayed reductions. Taking account of these effects also undermines the notion that some emissions are "free" in environmental terms, if used early on. Even though early emissions may not bear on final concentrations, they do influence near-term rates of radiative forcing and temperature change.

7 CONCLUSIONS AND RECOMMENDATIONS

As the Administration and Congress shape U.S. policy on climate protection in the coming months, they will face persistent pressure to postpone action. Where calls for delay are more than an attempt to simply derail climate policies, they will be motivated by the belief that delaying now and implementing policies later will lower the costs without affecting our ability to meet long-term climate objectives.

This notion, however, ignores key aspects of economic, political and climate systems:

- From an economic perspective, early action is needed to initiate appropriate changes in the capital stock and to hasten technological advances. Climate protection policies may also be consistent with certain economic benefits.
- Politically, action sooner rather than later will help to establish a credible commitment to climate protection that will be necessary to ensure domestic change. Leading by example will also create a much stronger basis for ensuring international cooperation.
- Early action seems prudent given the uncertainties regarding safe stabilization levels and the risks from faster rates of concentration build-up.

As a consequence, Congress and the Administration should consider steps that will begin immediately to influence capital investment and that will spur more rapid development of alternative energy technologies. An initial role for the Administration is to ensure that a meaningful treaty is reached in Kyoto—one that incorporates sufficiently stringent targets in the near-term to create an imperative for domestic policy implementation. Ratification by the Senate and the passing of enabling legislation should occur quickly to reaffirm commitment and to make full use of the time available. Above all, the mistake made after Rio must be avoided, where failure to implement firm policies from the outset has forced the United States to concede early on that it would fail to meet the targets.

A central plank of any emissions reduction strategy must be the use of economic incentives. Evidence since Rio has shown that small-scale voluntary programs alone are unable to fundamentally change investment and consumption patterns. Broad mandatory policies will be required to alter behavior throughout the economy. A balance needs to be struck between a policy that is sufficiently early and firm to signal commitment, yet sensitive to the slow processes of capital turnover and technological development. A carbon tax implemented soon and at a low level yet which rises gradually is one policy that meets these criteria. Though taxes remain politically unpopular, if they are levied as part of a tax shift rather than a tax increase, the overall tax burden would remain unchanged. The same incentive structure could be achieved with a tradable permit system. Ideally, this should be based on short budgetary periods, say of a year or two, so as to remove the temptation to delay action and thereby increase the risk of failure to comply.

As firms and consumers perceive policies as permanent, the changing direction of capital investment and technology should make it possible to avoid high tax levels or permit prices. Experience shows that the costs of environmental compliance have tended to fall, not rise, once actual measures have been implemented.

A market instrument should be supported by a series of other policies that will not only provide direct benefits but will help to convey commitment to climate protection. In particular, inducing appropriate technological change is key. Incentives need to be set up

A balance needs to be struck between a policy that is sufficiently early and firm to signal commitment, yet sensitive to the slow processes of capital turnover and technological development.

> **By, in effect, delaying since 1992, we have already lost precious opportunities to make emissions reductions.**

to encourage greater private R&D in renewable energy sources and in energy conservation. There is also a need for greater R&D on the government's behalf, particularly for invention and innovation. In addition, the existing pattern of subsidies and tax expenditures to conventional energy sectors should be reassessed and changed. Most important, short-term policies must be recognized as merely the first step of a long-term economic transition that will be necessary under any path to achieve stabilization of greenhouse gas concentrations.

The Administration and Congress must be aware of the message that inaction would send to the economy. Failure to reach or ratify a treaty would add another precedent for non-action to the failure of the Rio commitments. Industries would begin to expect the same again if they could demonstrate that the same adjustment costs are relevant. Further investment would likely be channeled into carbon-intensive capital and technological development of carbon-intensive energy systems, which would increase dependency on fossil fuels and make adjustment costs higher and even more relevant in the future.

By, in effect, delaying since 1992, we have already lost precious opportunities. Meeting any emissions target now is already more expensive than it would have been if credible market and policy signals had been put in place five years ago. Continued postponement of policy implementation only risks making future changes of direction both more abrupt and more costly.

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The Climate Protection Initiative (CPI) is a partnership between WRI and private firms to identify acceptable policies and business strategies for achieving strong climate protection goals. This institute-wide effort is motivated by the belief that there is a positive link between climate protection and a sound economy. Wider recognition of this linkage is essential for the development and implementation of an effective international climate treaty.

WRI's CPI team is working with leading corporations to define Safe Climate, Sound Business Scenarios—policy pathways for stabilizing greenhouse gas concentrations and meeting world energy demand, while maintaining a healthy economic environment. We are contributing to business strategies by developing case studies of how companies have overcome barriers to implementing carbon dioxide reduction initiatives and achieved financial and productivity benefits. And, we are investigating how the development of advanced technologies could position such industries as electronics and communications as leaders in climate protection.

The build-up of greenhouse gases in the atmosphere and human-caused warming of the Earth is the largest global environmental challenge facing society as it approaches the 21st century. According to the Intergovernmental Panel on Climate Change, if action is not taken to slow and reverse the growth of greenhouse gas emissions, there could be ecological impacts on a scale outside all of human experience. In turn, these impacts would have serious economic and social consequences. Significant technological, economic, and policy changes are needed now and in the coming decades to head off these risks.

The actions needed to address the threat of climate change, however, provide an opportunity to chart a more sustainable course into the future as individual firms and national economies become more efficient, embrace environmentally-sound technologies, and accelerate the transition to a global economy fueled by renewable energy resources.

The CPI team is committed to designing and advancing policy options that are flexible and market-based, allow least-cost mitigation strategies, and are sensitive to competitiveness issues within and among nations. Through this initiative, WRI seeks to reduce the risks of climate change while nurturing sustainable economic development worldwide.

For additional information on the Climate Protection Initiative, visit WRI's website at:

http://www.wri.org/wri/climate/

or write to:

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