I am greatly honored to be asked to present the fourth Amilcar Herrera lecture. From what I know of Professor Herrera’s outstanding career and influence, he would understand well how dealing with a complex science and technology-related issue that will have profound effects on developing and industrial countries alike is a central policy issue for all societies. And, he would agree that it is not enough to probe the technical aspects, but rather that it is essential to confront the political surrounds of the science and the technology in order to craft sensible policies. I want to try to do just that, with particular reference to my country, the United States.

Most in this audience are undoubtedly quite familiar with the climate change issue, either in detail or at least as a well publicized and critically-important policy issue for Europe and the world. I dare say most are also quite critical of the United States which has refused to join the Kyoto Protocol, the major international attempt to confront the issue.

The reasons behind the US position are often seen as self-evident: a country too rich for its own good, not interested in multilateral approaches to international issues, dominated by a deeply conservative ideology and President, and more concerned about its own economy and jobs than about the dangers to, or views of, others. Not surprisingly, it isn’t that simple, though there are elements of that accusation that I am afraid are all too valid.

I am not going to present an apologia for the US position, a position I deeply disagree with. Instead I want to lay out in political terms why this issue is essentially unique and so hard to deal with, especially given the form of government we have in the United States.

I will start with a brief review of the scientific situation and the current state of the negotiations to be sure we all have a similar appreciation of the phenomenon and of the response to date of the international community. Then I’ll move on to a more political analysis of the climate change issue itself, why it is in many respects entirely unique. And why the US political system is not able, yet, to mount an adequate reply. Finally, some musings about what might have been and what the future is likely to hold.
The global warming phenomenon is by now well-known. The basic greenhouse effect itself is neither a new concept, nor in doubt. In fact, it is essential for life on Earth. Without the warming action of the atmospheric blanket, the surface would be approximately 35 degrees C cooler and unable to support life as we know it, or possibly any life at all.

Earth's atmosphere is largely transparent to short-wave energy from the sun. Some of the energy is reflected back into space, but a portion is absorbed by the surface and clouds and reradiated as long-wave energy—that is, as heat. Several gases absorb energy at these wavelengths and, in turn, warm the atmosphere. The gases contributing most to the greenhouse effect include water vapor, carbon dioxide (CO$_2$), methane, and several others.

Several of these greenhouse gases have been increasing rapidly as a direct result of human activities—on a scale sufficient to alter significantly the determinants of climate and weather. The concentration of CO$_2$, the gas that accounts for approximately half of the human-caused warming effect, has increased some 30 per cent in a century, largely as a result of the burning of fossil fuels and the destruction of forests. Other greenhouse gases come from agriculture, mining, automobiles, and industry.

This part of the story is straightforward and generally not in dispute. Estimates of the effects, however, are less definite. They come from theoretical analysis, calculation using complex models of the atmosphere and oceans, and the interpretation of a limited but growing body of measurements. Important uncertainties are introduced, and controversies over the models and their interpretation necessarily arise.

The more prominent projections by such authoritative scientific bodies as the Intergovernmental Panel on Climate Change (IPCC) and the US National Academy of Sciences coalesce around the estimate that if greenhouse gases increase to the equivalent of a doubling of the atmospheric concentration of CO$_2$, average temperatures would rise by 1.5 degrees-4.5 degrees C at the equator but up to twice the average at the poles. The range of possible temperature rise is quite large, and it should be noted that not all temperatures within the range are equally probable. Rather, it is likely to approximate a gaussian distribution, with very low probability at either extreme of the range and the most likely outcome somewhere in the middle.

Whatever the final result, a temperature rise of roughly this magnitude would lead to average surface temperatures higher than any recorded in human history. What temperatures would be reached and when depends on the rate at which gases are emitted and on complex feedback effects of clouds and oceans that are still not well understood. In the absence of controls on emissions, and with no surges or large dips in economic growth, typical analyses predict the average temperature rise would take place toward the end of the century.

The surface effects of such a temperature rise are not predictable in geographic detail; they would vary regionally and even locally. Many estimates, however, anticipate reduced availability of fresh water during summer growing seasons in inner areas of the continents, migration of agriculture toward the poles, increased desertification, and more weather extremes. And increasingly there is concern about the melting of the Arctic ice cap, already quite visible.
Probably the most publicized prediction is a sea level rise by one-third to one-half a meter by sometime in this century. Low-lying areas would be particularly vulnerable to storm surges. If the forecasts are correct, all of this will happen more rapidly than has virtually any ecosystem change in the last 160,000 years, raising questions of such unanticipated and possibly serious nonlinear effects as shifts of major ocean currents.

Not only are these forecasts uncertain and controversial, they depend on future developments in the economy, in technology, and in policy, as well as on the results of greater knowledge from research. And not all the effects will necessarily be damaging; some activities will be enhanced and some localities and nations may in fact benefit by the changes.

Note that in these projections, we are anticipating life 95 years from now. If, in 1910, 95 years ago, similar threats were raised that would affect life today, what would it mean? Without automobiles, ubiquitous paved roads, natural gas, aircraft, nuclear power, air conditioning, widespread electricity in the home, and so many other aspects of our world today, how could we possibly make a sensible decision about what to do, or anticipate our actual lives and life style now? Yet, we are faced with just such policy choices today when we have to cope with the threat of global warming and uncertainty about its effects in the future.

International Consensus

This so-called greenhouse effect and its possible physical and socioeconomic effects are frequently presented in cataclysmic terms. The expectations of catastrophic change have stimulated the international community to undertake an unprecedented attempt to confront the dangers by coalescing around measures to limit, and ultimately reduce, the emissions of greenhouse gases that are caused by mankind’s activities.

This international action was symbolized by the signing and subsequent ratification, by 189 countries (including by the US), of the Framework Convention on Climate Change at the Rio Earth Summit in 1992. It was seen at the time as a major milestone in growing international concern about global warming and its dangers. Though nations made only paper commitments to “return greenhouse gas emissions to 1990 levels,” it was assumed by most that the next step would be a treaty binding countries to specific reductions in emissions. Such a treaty followed in 1997, commonly known as the Kyoto Protocol. That treaty has been ratified by 156 countries. It came into force in February of this year when Russia signed and became the final adherent required by the terms of the Protocol.

Under Kyoto, industrial countries are obligated to cut their CO₂ emissions by negotiated percentages below the levels they were at 1990, the arbitrary date chosen at the time the Framework Convention was negotiated in 1992. It should be noted that some EU countries, the economically poorer countries (e.g. Greece and Portugal), are allowed to increase their emissions with others in the EU in effect taking a larger cut to compensate. In addition, the accident of choosing 1990 made it easier for the UK and Germany to accept larger cuts, the UK because the closing of the coal mines and switch to natural gas under Margaret Thatcher meant emissions
would naturally be reduced, and Germany because the merger of East and West and consequent decline of East German industry also resulted in lower emissions after the base date of 1990. And Russia as well would have no problem meeting its emission cuts because of the deep fall in the Russian economy after 1991. In fact, Russia will be able to “sell” its excess emission rights to those nations that have difficulty meeting their commitments.

The US signed the Protocol in 2000 but the Clinton administration then in office did not submit it for Senate ratification. It almost certainly would not have been ratified by the Senate. The new George W. Bush administration withdrew the signature in 2001 arguing that it would have too large a negative impact on the US economy, that it was “unfair” because the developing nations, especially the rapidly developing China and India, would have no commitments under it, and in any case was unjustified by the state of scientific knowledge.

Meanwhile the Protocol has spawned a substantial international secretariat and has enabled the establishment of a complex and politically demanding system of emissions trading among European Union countries. It has also established several procedures to allow these countries and their industry to receive credit for programs to reduce emissions in developing nations that have no formal commitments under the Protocol. As a global problem, it makes no difference where reductions take place; the effects are the same.

Kyoto specifies emissions reductions to 2008-2012; negotiations are just beginning to consider what should be the next period and what new commitments the participating nations will make. It is not yet clear what form those commitments will take, nor even if the nations of the EU will in fact all meet the commitments they made for the first period. But, there is no doubt of the seriousness of the process that has begun, nor the fact that most of the participating nations are endeavoring to live up to the spirit of the original agreement.

Uniqueness

There are many unique aspects of the climate change issue and of the US government and polity that have made it difficult from the start for the US to join an international approach to dealing with the issue. These were clear in advance and could have been overcome only with determined political leadership that was not forthcoming either under a Democratic or a Republican administration. In what way is this issue harder to deal with than most, for all nations, not just the US?

The subject is rich in complexity and detail, but there are several characteristics that make it different from, larger than, and more difficult than other environmental issues.

The first is that climate change epitomizes the intense interaction among a wide range of disparate issues, each affecting all the others. The possibility of human-induced climate change arises from the growth of human population and wealth. It is rooted in industrialization, technological change, dependence on energy, striving for economic growth, and the many other aspects of a human population that aspires to improve its quality of life.
The buildup of greenhouse gases is a result of normal, not aberrant, human behavior and is a product of innumerable independent decisions by individuals, industries, and governments in daily life all over the globe.

Societies are increasingly familiar with the need to make decisions in the context of interacting issues; the control of greenhouse gases—or of their effects—is not different in kind from other policy issues in the management of risks and control of the externalities of technology. In the climate debate, however, the nature of the interactions, the number of relevant actors, and the scale involved all mean that core economic and political interests within and among countries are directly involved in measures to limit emissions, as well as in the effects of warming that do take place. Agriculture, energy, industry, water, ecology, population, development, and contentious issues such as tax policy, are only the most obvious interests at stake.

The breadth of such interests greatly complicates bureaucratic politics within governments and among international organizations. Virtually all government ministries and international organizations have some stake in climate change, either in trying to prevent its occurrence, mitigating its effects or adapting to it. Overlapping jurisdiction, differing agendas and priorities, varying knowledge and influence, and competition for budgets and power all conspire to complicate tradeoffs and make concerted policy difficult to achieve.

Moreover, the interaction of so many interests and issues means that policies will probably have significant unexpected consequences, and that developments in subjects far afield, such as political change in Eastern Europe or China, will affect the climate issue.

It has been impressive to this observer that the EU has been able to negotiate among the complexities of this issue and emerge with a plan for the first Kyoto period that has been agreed to by all members. Frankly, I did not expect it.

A second major characteristic of the issue is the interaction of two vast and complex systems, the planet's ecosystem and the human socioeconomic system. Large systems usually have large inertia, making change slow and difficult. Natural changes in the ecosystem occur over periods normally measured in centuries, which has made a reasonably consistent and predictable climate a staple of the development of civilization.

The evolution of the socioeconomic system, once also measured in centuries, is now clearly moving more rapidly, both in growth and in internal structural modification. Nevertheless, major elements of the socioeconomic system such as energy generation and the location of urban populations can also only change slowly.

Thus, both systems have substantial momentum and are resistant to rapid alteration.

The fact that climate change involves the interplay of two large systems has several consequences. The most obvious is that their resistance to rapid change means that the time horizon of policy intervention must be very long. Their momentum also guarantees some climate change will take place, whatever policy interventions are made. But this momentum also means
that taking no action or delay will extend the effects further into the future and with greater magnitude. Some degree of irreversibility becomes an inherent and unavoidable aspect of the situation.

This long time horizon makes it particularly difficult to evaluate policies intended to reduce emissions. The present value of benefits that will be realized only decades from now is small. Even if direct comparison of the future with the present were possible, the costs and benefits of ill-defined future consequences would necessarily be much more uncertain than the near-term costs and benefits of specific actions in other subjects today. Thus, specific policies are likely to be assessed principally for their short-term impact, and their costs will be judged against funding for other societal needs. The necessarily more theoretical long-term consequences are likely to be more contentious. The less certain the future costs, the more likely the future will carry less weight in comparison to the present.

But also recognize that, barring intervening catastrophes, at least the industrial countries and many of the developing countries, especially China and India, will be much richer as the century unfolds. Even a modest 2% growth rate means doubling of an economy in about 35 years. If China’s growth rate continues, assumed today to be 9%, that would mean doubling of its economy in only 8 years. In principle that means “fixes” to energy efficiency or to adapting to the effects of climate change will be more affordable in the future. In practice, of course, there will be many other needs that will also have to be met.

Ironically, the complexity of these large systems also suggests they could be vulnerable to dislocation in unexpected ways. Complex systems that are incompletely understood may have unsuspected trigger effects when subjected to unusual stress. Major war is an example of stress that can produce large discontinuities in the socioeconomic system. Although the ecosystem is resilient and self-correcting under a variety of disruptive events, it is now being taxed by human activities at a greater rate than ever before.

The ecosystem's responses to that stress are uncertain, making confident prediction of stability hazardous. Surprises, for example changes in ocean currents such as the Gulf Stream, cannot be ruled out on the basis of current knowledge, though considered to be unlikely until at least far in the future.

A third characteristic of the issue is the importance of uncertainty. In the case of climate change, the uncertainties are particularly large, contentious, and slow to be reduced. The policy process needs information first about the phenomenon itself and then about its causes. Yet that information is of little policy interest without knowing the effects on precipitation, sea level, crops, ice cover, frequency and violence of storms, and other possible consequences.

At the next level, the effects on agriculture, coastal zones, economic development, energy demand, international status, migration, disease and pests, and urban areas become important. At each successive level, the uncertainties are likely to be greater, as the variables and possible future effects become less well-defined and, basically, speculative.
Removing or reducing all these uncertainties is not essential; policy is often made without definitive "downstream" analysis. However, if policies are especially costly, affected interests are apt to use the absence of a definitive analysis of effects as an argument to defer, moderate, or prevent action.

A fourth major characteristic of the climate issue is the global nature of its causes, effects, and the actions and policies required to modify it. No country can solve the problem on its own, and the actions of one can be negated if others fail to act. That does not mean unilateral action is irrelevant, only that it is not a solution.

Universal action clearly seems required. An appreciation of that fact may be valuable in promoting a global approach, but it can also deter national action if it proves difficult to achieve common policies, or if a nation tries to act as a free rider, benefitting from the actions of others without contributing.

The complicated bargains over policy that must be struck within nations will be rendered more difficult by international negotiations not likely to parallel domestic choices. Perhaps more significant in the long run is the absence of any institution in the international system with the authority to dictate or enforce trade-offs. National attitudes, even in Europe, remain unwilling to accept a dramatic ceding of power to international institutions.

Further complicating the global nature of climate change are the profound differences between developing and industrialized countries in both causes and consequences. Today, the developing world (including China with its large coal reserves and rapidly growing economy) accounts for about one-third or more of the emissions of greenhouse gases, but its emissions will grow rapidly as population and development increase.

Developing countries are not willing to sacrifice economic growth in response to a problem created by rich countries. As developing nations are fond of pointing out, with justification, it is the industrialized countries that have benefitted from using the global atmosphere as a sink for their carbon byproducts and that now propose limits on the use of that shared resource. Curbing greenhouse gases is not the highest priority of developing countries; and in any case, their response would require an immediate infusion of money, skilled labor, and technology.

Moreover, it is clear that agriculture-based economies, characteristic of most developing nations, are likely to be more vulnerable to climate change than wealthier industrial economies. Whether we like the idea or not, it is probable that our richer industrial economies will much more easily be able to afford and adapt than will most developing nations.

To induce developing countries to mount substantial programs to cap or reduce emissions would require global bargains between the North and the South, including a large expansion of development assistance, notwithstanding the creation of innovative Kyoto programs to stimulate atmosphere-friendly investment by corporations in developing countries.
Moreover, some countries may see themselves as winners if warming occurs, reasoning that they will benefit from longer, more productive growing conditions or from a more hospitable climate. Or they might calculate that the discounted costs today of damage from warming that will take place well into the future, are smaller than the costs they are being asked to bear today to prevent it. Such nations are likely to be lukewarm participants in negotiations toward more than cosmetic common international action.

The global character of the issue also has important implications for international cooperation, first for reaching agreements and later for the oversight and management of commonly agreed rules, resource transfer, research, monitoring, and dispute settlement. International organizations perform all these functions today within their areas of responsibility, and do so more effectively than is often asserted.

Nevertheless, national governments, especially the US at the moment, are reluctant to delegate significant authority to an external body over matters they see as central to their political and economic interests. Thus, negotiation and implementation of agreements are and will continue to be carried out within the basic nation-state system.

A fifth dominant characteristic of the global warming issue is its dependence on science, on the theories, research, and calculations of scientists even to know there is a problem. The buildup of CO$_2$ as measured on a mountain in Hawaii since the 1950s and some other sites is not in dispute. However, only uncertain data indicate a warming trend consistent with the predictions, notwithstanding the hot summers in Europe and the string of intense hurricanes in the US.

Estimates of future temperature rise and its effects rely on complex computer models of the Earth's atmosphere, designed and manipulated by a relatively small group of scientists. These scientists would be the first to concede the inadequacies of their models and the incompleteness of their data, especially with regard to the effects of clouds and the interaction of the oceans with the atmosphere. Potentially significant feedback effects are not adequately accounted for, and computers are still unable to perform computations on the needed scale.

Nevertheless, a consensus among many researchers holds that the consistency in the predictions of various models, along with evidence of change around the world, provides a reasonable basis for anticipating temperature rise. Few scientists would assert definitively by how much and by when, but the overwhelming majority leave no doubt that they accept the general consensus.

Although the warnings of scientists is enough in many subjects—thinning of the Earth's ozone shield or the relationship between molecular level phenomena and disease, among others—observable, convincing evidence of some kind is usually necessary to precipitate corrective action. For climate change, scientists as a whole, with a few exceptions, have concluded there is an observable effect. But even they would say that conclusion is based on the preponderance of evidence and cannot be “proven.” The evidence of such a buildup is growing and becoming more precise, and imaginative paleoclimatic research is uncovering a relationship (not necessarily causal) between the atmosphere's greenhouse gas content in the past and swings in the
In essence, elements of the scientific community have reached a judgment based on limited evidence and imperfect models that has massive implications for the health of the ecosystem and for the fate of people and of nations. The image of an inverted pyramid comes to mind, of a steadily broadening body of implications that rests ultimately on the point of a relatively small band of dedicated scientists who nevertheless recognize the uncertainties of their work.

The dependence of the public and policymakers on scientists for basic information on global warming has few parallels that come close—weapons and pandemic threats may be the closest examples. The uncertainties, however, make it inevitable that respected scientists will disagree on the details; judgments will differ about the importance of the shortcomings in the data, the models, the interpretations, and the expectations of what future research will show. When it comes to costly, economic and political choices, scientific experts often are in disagreement with one another.

The press plays an important role here. Much of the public concern about global warming is undoubtedly a result of the media focus on the more dramatic predictions, since apocalypse makes for good copy. However for questions being debated among scientists, media coverage that strives to present all sides tends to portray differing scientific viewpoints as equal in merit, whatever the actual balance is among the scientists.

The presence of hard evidence is particularly important to the staying power of public attitudes. The North American heat and drought of 1988, heralded by a prominent scientist in congressional testimony as the arrival of the greenhouse effect, helped catapult the issue high on the American environmental agenda. Although it was not possible to prove a direct relationship between that summer's weather and global warming, the heat and drought nonetheless served to focus attention and opinion.

Similarly, hot summers in Europe and the recent hurricanes in the US, whether or not there is a causal tie to temperature rise that can be demonstrated, will continue to fuel the public pressure necessary to override obstacles in the policy process. On the other hand, a series of cooler-than-normal years might lessen both public interest and the ability to mobilize political action.

Scientists face serious dilemmas in presenting their evidence, in characterizing uncertainty, in steering a course between objectivity and advocacy, and even in handling potential conflicts of interest as they seek research funding. Brutal candor about the imperfections of data and models may discourage appropriate political action, just as advocacy may lead to unjustified action. The importance of effective science policy mechanisms in governments thus becomes clear: They must be able to sort out conflicting views and relate knowledge and uncertainty to the demands of the policy process. Such mechanisms cannot resolve uncertainty or differing scientific judgments, but they can clarify policy choices and their implications.
Perhaps the most philosophical or psychological characteristic of the issue is its planet-wide nature. Climate change is seen as a threat to the entire planet in a way only previously encountered in the destruction of the ozone layer and, of course, the threat of nuclear war. There is, or may be, a visceral public response to that kind of threat that goes beyond other environmental concerns. Is this response significant in the ecological consciousness being expressed on this issue, especially in Europe? It may prove to be a critical quality everywhere.

These considerations lead to a conclusion that may be deeply troubling to some but is nevertheless compelling, especially in the US. It will take strong and enduring public consensus to bring forth policy action that can have a serious impact only when the uncertainties surrounding climate change are greatly reduced, and probably not until evidence of warming is palpable. Even in Europe, which has been able to reach a first-step consensus, very much to your credit, the Kyoto Protocol if not followed by more substantial cuts will have essentially negligible effect on the ultimate concentration of greenhouse gases.

The Structure of Government in the US

But how explain the US response to this unprecedented issue?

The structure of government in the United States makes it harder to reach closure on an issue of this kind that has such major implications and levels of uncertainty than it is for any other industrial democracy. You may understand well, though many do not, how markedly different is the US government system from the parliamentary systems of your and other European countries. Most in the US do not appreciate the differences either.

The central factor is the real division of power between the executive and the legislature, with different structures, responsibilities and power. Senior executive officials do not serve in, or at the pleasure of, the legislature, and must seek funding and legislation from a bicameral congress elected independently and organized into committees with large staffs at their disposal. The commitment of the Founding Founders to checks and balances to prevent excesses of power in any part of the government has translated in practice into an adversarial policy process that permeates both the executive and the congress, within them and between them.

The result is that the government necessarily finds itself in deep conflict over any issue that touches major interests and ideologies. Almost every agency in the executive branch has some legitimate interest in the climate issue, while most congressional committees are (or will be) involved in the debate—each with turf to defend or expand and each with a limited vision of the national interest. Moreover, as a result of the domestic orientation of the House of Representatives, fragmented committee structure in congress and weak party discipline, interest groups have easy access to the levers of power.

An administration is inevitably considerably constrained in its freedom of action, even when the congress is dominated by the same political party. Only on security issues does an administration have more of a free hand, sad to say.
In this setting, scientific evidence has a long row to hoe to have a decisive impact on policy. Although that evidence may be crucial in placing an issue on the political agenda, or in influencing how that issue evolves as new knowledge is acquired, at any given time its role in the actual determination of policy is usually far less important than that of the political, economic, and other interests involved. Or, if the level of uncertainty is high enough, science may become the principal instrument that all sides use to justify positions reached primarily on other grounds.

The problem is magnified when the issue has high visibility and the economic stakes are large, as is the case with climate change. Those who stand to lose from efforts to reduce emissions find it more acceptable to question the science than to defend their interests directly. Challenging the science is also more effective because most of the public cannot judge the attacks critically and thus can be easily misled or confused. As a result, disagreements among scientists are amplified and the science itself appears more uncertain—to the public, the congress and the executive—than would be the case with a less prominent issue or one with fewer consequences.

Scientific analysis is likely to play a larger role in the executive branch than in congress because the executive has a government-wide structure for conducting analyses and determining policy choices. In addition, the President has his own science adviser to evaluate scientific assessments and present conclusions in the highest policy councils. Unfortunately, that formal structure, the Office of Science and Technology Policy in this administration is but a shadow of its former influence.

It would be a mistake, however, to assume in any case that science plays the dominant role in determining an administration’s position on a complex issue. Administrations do have many other factors to consider, as well as other influences on them, including concerns over the state of the economy, pressure from industry, the public’s reaction, tradeoffs with other policy goals, relations with other nations, and, not least, the need to sell a particular policy to Congress when there are many other items on the agenda. Finally, there are the partisan factors of a party’s electoral prospects and personal electoral ambitions.

Adding substantially to the difficulties that science faces in the political arena on this issue is the fact that the benefits of present expenditures may not be realized until far in the future. No politician likes to be in the position of advocating such expenditures today when there are more immediate needs to be addressed that are likely to have more immediate political benefits. And especially when the case for such expenditures can be challenged as “not proven.”

Congress is in an even more politicized position because it is structurally more exposed to the interests of influential stakeholders. It is all too easy for individual members or their staffs to judge the validity of scientific evidence as their own politics or ideology dictate. Even highly convincing scientific cases are often overridden when important interests or influential constituents will be adversely affected.

Congress’s handling of the global warming issue illustrates this only too well. The threat of higher prices for fossil fuels or regulatory measures that would force greater efficiency in energy use has led to hearings in which the selection of witnesses was heavily biased against taking the
threat seriously. In fact, efforts by the Clinton administration to promote mild policies that would make sense even without the threat of global warming (for example, small increases in fuel taxes and emissions trading) were attacked as “end-runs” around the Kyoto Protocol ratification process. The Bush administration has not even tried.

Of course, those who would benefit from lower emissions of carbon or higher energy efficiency are also able to influence the policy process. But in a Congress dominated since 1995 by a Republican Party with a strong (even radically) conservative wing, and since 2001 with an equally radical conservative White House, the influence of environmentalists has been greatly weakened. Some manufacturing companies and trade organizations have lobbied in favor of policy actions to limit greenhouse gas emissions, but their influence, though symbolically important, has been marginal so far and will remain so as long as the present political constellation is in power or until industry sees its competitive position on new energy technologies seriously eroding.

The range of policy options is further constrained by the attitudes of American voters, particularly their antipathy toward additional taxes. This is obviously important for measures to limit or reduce greenhouse gas emissions may well have to include some form of carbon tax. Even if such taxes are obscured by calling them fees or some other neutral term, or offset by reductions in other taxes, they can easily be attacked in a political atmosphere in which any tax “increase” is unacceptable. Moreover, those who would be harmed by a carbon tax are likely to be clearly focused and politically powerful while those who would benefit are widely dispersed, with the intended benefits fairly distant in time; any tax proposal is in that situation doubly in danger.

The separation of powers between the executive and the legislative branches, coupled with the bicameral structure of congress and the decentralization of authority among numerous committees, further complicates the negotiations necessary to reach agreement on a consequential issue like climate change. Moreover, the tradeoffs implicit in such negotiations may be quite different from those encountered at the international level. At Kyoto, for instance, the bargaining was over general country commitments to reduce emissions; in the United States, the debate was over the specific measures that would be necessary and their economic implications.

I must add the further complication that the American public is considerably less aware, and less cognizant of, international affairs (except for military adventures such as Iraq or when threatened by terrorism abroad) and less likely to be affected by the views of other countries. It is not a manifestation of isolationism as in the interwar years, but rather an inward-turning, a parochialism based in good measure on the size, history, geography, and variability of the country, that leaves them considerably less knowledgeable about the world at large or about how others see them. That makes it much more difficult to deal with climate change as a global issue, rather than one that is measured only by how it affects the US.

This also means that in the face of the divided powers and the easy access to influence of those who believe they would be hurt by a change, any real ratcheting up of US policy will require massive public support. In this we are quite different from the European parliamentary system where even modest public support can more easily be translated into policies that may be costly. In the US, a few skeptics or influential interest groups can more easily manipulate the system to
prevent action, and are doing so.

Given all this, it may seem surprising that the Clinton administration agreed in the Kyoto negotiations to a cut of 7 percent in U.S. emissions by 2008–12. It was a product of Vice President Gore’s prominence on the issue and his intention to run for President, and presumably the sense that 2008 looked to be far off. A decade may be a short time as far as climate change is concerned, but it is an eternity in politics when there are three presidential elections along the way.

Of course, President Bush reversed the Clinton decision in March of 2001, rather brutally withdrawing President Clinton’s signature.

It is important to recognize that the Bush administration has not totally neglected the subject. It is unwilling to impose caps on CO₂ emissions or introduce efficiency regulations of any reasonable scale, but it is supporting by far the largest program of any nation on R/D devoted to energy and climate related subjects. The National Climate Research Program and its sibling, the National Climate Technology Program, are together at the level of $5 billion per year. Though cut this year, energy R/D, including development of alternative energy technologies, is roughly another $3 billion.

Unfortunately, these programs are affected by competing fiscal demands in the US and have been declining in real terms. But, I hasten to add that energy R/D in European countries is not only smaller but also declining; in the case of the UK, energy R/D is surprisingly almost negligible, especially given that nation’s frequent criticism of US policies.

**Present Status and Prospects**

There is no question any longer that public opinion toward climate change in the US is substantially changing. A barrage of scientific studies, apparent more severe weather events (whether or not actually related to global warming), a growing number of worrisome indicators such as the thinning and reduction in size of the Arctic ice cap, and accusations of misuse or distortion of scientific evidence by the administration have had an effect. The runup of gasoline and fuel oil prices to unprecedented levels (in the US), coupled with other aftereffects of the Gulf Coast hurricanes, have created a new and more receptive atmosphere for a more sensible energy policy that would reflect both shortages and climate dangers.

The impression of an administration in disarray, with too many examples of ineptitude, have also contributed to a more skeptical public about its policy directions. This does not mean that the US might join Kyoto; it would no longer be possible given the growth of the economy since 1990. To meet the 7% cut from 1990 levels by 2008-12 the US agreed to, would mean now a cut of some 30% in five years. That is not a feasible target either politically or economically, or even physically.

But new political and economic attitudes are beginning to be heard. Several states and even cities have banded together to commit themselves to capping emissions to prevent further growth; several significant industrial companies, notably General Electric, the largest manufacturing
corporation in the world, have made a commitment not only to slowing emissions but also to
development of energy-saving commercial technologies that would be competitive; wind farms
are becoming more numerous; and biofuels such as ethanol are becoming more popular.

American automobile companies suddenly realized how far behind Japanese hybrid
technology they are and what the demand in the US may be. Even nuclear power is being
reconsidered: no nuclear plants have been contracted for since the 1970s in the US but the industry
is stirring once again. To considerable surprise, even President Bush has for the first time called
for conservation of oil, though that was tied to the effects of hurricanes Katrina and Rita.

Perhaps most significant politically is the proposed legislation in the Senate that would
establish an emissions trading system for CO\textsubscript{2} emissions in the US as you have accomplished in
Europe (ironically, this approach was originally proposed by the US in the Kyoto negotiations,
receiving deep skepticism in Europe). Its sponsors are Republican Senator McCain and Democrat
Lieberman, two prominent and committed Senators. The bill did not pass in the last Congress, but
came close. It probably will not pass this time around either because of the strenuous opposition of
the administration. But its existence and support is a harbinger of changes to come.

In fact, however, even with the reduced political clout of this administration, there is no
reason to expect any major change before the next presidential election in 2008 unless there is a
massive Republican Congressional defeat next year, which I am afraid will not happen, or if there
were some catastrophic environmental developments that could be credibly tied to climate change.
That, too, is unlikely for, in contrast to the threat of avian flu for example, clear evidence of
human-caused climate change will only be certain after the fact.

There is, of course, as I noted earlier, the possibility that discontinuities in the complex
climate system cannot be ruled out, discontinuities that could spell major disaster if they came
about. The most often cited example that would affect Europe is the slowing down or cessation of
the Gulf Stream that gives northern Europe a temperate climate. There is no effective way, as yet,
for developing enough evidence to assign a probability for such an event; most scientists in the
field acknowledge it is a possibility, but all their models show it is either extremely unlikely or
would be far in the future if it occurred at all. In political terms that is a weak reed on which to base
large scale action.

We do have to remember that opportunity costs are real. That is, the more we spend on one
issue or problem today, the less will we have to spend on other, perhaps equally or more pressing,
needs. There is no “free lunch.” The so-called “precautionary principle,” popular among many in
Europe and enshrined in EU procedures is either self-evident, that is “avoid risks whenever
possible,” or misleading, by ignoring opportunity costs.

So where do I come out?

As I said at the outset, I am profoundly in disagreement with current US policy. Personally,
however, I thought the Kyoto Protocol was the wrong approach. for it meant engaging in a
complex international negotiation among so many countries with different stakes in the issue as to
make progress inevitably glacially slow. Moreover, as studies of international agreements have shown, legally binding agreements are often not the most effective way to tackle difficult environmental issues, especially when many countries are involved. They lead negotiators to the least risky, most conservative, outcomes, rather than try to set more ambitious but non-binding goals.

My preference, even for this quintessentially global issue, would have been first for a smaller number of countries that have the most effect on the issue to try to hammer out ideas among themselves before engaging the entire global community. These would have been the US, the EU, Russia, and the major developing countries China, India, Brazil and perhaps Indonesia. I believe that route could have been a way for making genuine progress while bringing the key developing countries effectively into the bargain.

But, that didn’t happen, and the US under President Bush managed to react to Kyoto in a way that has caused grievous harm to dealing with the issue and to the international prestige of the US. He could have said Kyoto was too unreasonable to accept outright; let us discuss why and consider possible changes through negotiation. But, that wasn’t, and still isn’t, his style.

Today, it is futile to look for a “solution” through complex formal treaties. Rather, I see no alternative to action by individual countries (treating the EU as a single country) important to the climate issue to take action on their own, or through informal agreements with others, to initiate measures that can eventually make a difference. Europe in this context is well ahead of all, but it cannot solve the problem on its own. This will not be an orderly neat pattern, with many backsliders. But it is only recognition and commitment of publics in different countries and different political systems that will eventually bring about genuine action.

I am hopeful that the recognition of the issue has advanced sufficiently in the US that the next administration will have quite a different attitude. It still won’t be “Kyoto,” but it could make genuine change possible.

In any case, at least part of the long-term answer is technology. If the danger of climate change is real, as I believe it is, the only way we are going to be able to ameliorate the effects and adapt to them, without draconian reductions in living standards, while at the same time allowing developing countries to improve their own standard of living, is to find ways to use energy more efficiently and to produce energy without damaging emissions and at reasonable cost.

There are many promising avenues, some controversial such as nuclear power, most costly and likely to remain so. They will all also have some undesirable side effects; all technologies do. But, we can hope that those side effects are more benign, or manageable, than the growing un-benign consequences of fossil fuels.

These new technologies will not replace current technologies overnight, but they will come on line, I believe (and hope), in time to avoid the worst of the forecast consequences. They may even spark a new industrial revolution. Which country will most successfully recognize the opportunities? So far, not the US.