

## **Climate Change Risks and Policies: An Overview**

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# Climate Change Risks and Policies: An Overview

Michael A. Toman

## INTRODUCTION AND SUMMARY

A great deal of controversy surrounds the issue of climate change. Some participants in the debate say that climate change is one of the greatest threats facing humankind, one that calls for immediate and strong controls on greenhouse gases (GHGs), particularly carbon dioxide emissions from fossil fuel burning and releases of other gases such as methane. Others say that the risks are weakly documented scientifically, that adaptation to a changing climate will substantially reduce human vulnerability, and that consequently little action is warranted other than further study and development of future technological options. The same kinds of divides arise in discussing policy options to reduce greenhouse gas emissions, with some predicting net benefits to the economy and others fearing the loss of several percentage points of national income.

These disagreements surface in the ongoing efforts of the international community to negotiate goals and actions under the 1992 United Nations Framework Convention on Climate Change (UNFCCC). They reflect both different interpretations of the evidence and different interests. Article 2 of the Framework Convention requires signatories to take actions to “prevent dangerous anthropogenic interference with the climate system” from greenhouse gas emissions (and other actions such as deforestation). However, the term “dangerous” in Article 2 does not have an unambiguous, purely scientific definition; it is inherently a question of human values.

Articles 3 and 4 of the Convention likewise are a blend of concerns. Article 3 states that precautionary risk reduction should be guided by equity across time and wealth levels, as expressed in the concept of “common but differentiated responsibilities.” Article 4 states that nations should cooperate to improve human adaptation and mitigation of climate change through financial support and low-emission technologies. Articles 3 and 4 also refer to the use of cost-effective response measures.

This tangle of ideas carried over to the Kyoto Protocol to the UNFCCC, negotiated in Kyoto in December 1997. The Protocol emphasizes legally binding emission reductions by the “Annex I” group of industrialized countries, with negotiated differences in obligations across these countries. These obligations call for fairly substantial reductions in GHGs compared to

business as usual, over a fairly short period of time (a little more than a decade). The Protocol also includes policy measures designed to provide flexibility in how Annex I countries meet their obligations through various forms of international partnership in “emissions trading.” But the details of these mechanisms were not worked out in the Kyoto negotiations, and these details remain quite controversial. Finally, the Protocol contained no targets for GHG reduction by developing countries, but it contained a number of still-undeveloped measures for assisting these countries in GHG mitigation and adaptation. Again, the details remain to be worked out. All in all, the ultimate fate of the Kyoto Protocol remains uncertain.

In this paper I provide an overview of these issues and a summary of some ways to think about climate change risks and policies that can be useful for considering both international agreements and actions by the United States. The paper starts with some background on the current state of the knowledge and then presents a six-step decision framework. The steps include the following:

- Think comprehensively about risks.
- Think long term.
- Address adaptation.
- Think internationally.
- Keep distributional issues in mind.
- Estimate control costs comprehensively and realistically.

Using this framework, I also suggest some points for enhancing the effectiveness of climate policies:

- Incorporate economic incentives into emissions-reduction policy.
- Allow flexibility in the timing of cumulative emissions reductions to reduce overall costs.
- Provide opportunities for emissions reductions wherever possible.
- Encourage development of the climate change knowledge base and improved technology for emissions reduction.
- Increase the emphasis on adaptation.

As an overview, the discussion of each of these points necessarily is somewhat abridged. Other Issues Briefs produced for RFF's Climate Economics and Policy Program explore in greater detail the issues raised here.

## **BACKGROUND**

In its 1995 Second Assessment Report, Working Group I of the Intergovernmental Panel on Climate Change (IPCC)—a body of several hundred distinguished scientists established by the United Nations—concluded that a human cause for the climate change now observed is likely, not just possible. This was a much stronger conclusion than the one the IPCC reached in its First Assessment several years earlier, although it is dogged by skepticism from some who feel that dissenting views were not adequately represented in the process. In its First Assessment, the IPCC stated that although all signs pointed to human-induced climate change, crucial evidence for cause and effect was not yet available. The evidence at the time indicated that atmospheric greenhouse gas concentrations had increased in the previous 130 years and that the global climate had warmed; however, when applied retrospectively, complex computer simulations of climate change predicted a larger warming than had actually occurred and did not adequately represent climate changes in different regions and at different altitudes.

The latest generation of models can now replicate the past with greater realism. In particular, new models include analyses of the cooling effect of aerosols—tiny particles—in the air formed during the burning of fossil fuels. By including in their analyses the cooling effects of aerosols and stratospheric ozone depletion, most of the latest studies have detected a significant climate change. The Summary for Policymakers of the Working Group I report states that “the observed warming trend is unlikely to be entirely natural in origin.... The balance of evidence suggests a discernible human influence on global climate.”

Despite recent improvements, however, climate models are still unable to project the details of climate change on a regional scale, complicating assessment of potential impacts and response options. (Chapter 8 of the Working Group I Second Assessment Report details the uncertainties.) A recent report from the National Academy of Sciences in the United States emphasizes that while there is more conviction among scientists that human activities are changing the climate, the greater appreciation of the complexities and uncertainties has reduced their confidence in quantitative forecasts of climate change.

Moreover, while the improved capacity of climate models to track past events increases confidence in their capacity to explain observed changes, future changes in climate could depart

from the models' predictions. In particular, the change may be neither gradual nor continuous, but abrupt and surprising.

In its Second Assessment Report, Working Group II of the IPCC addressed many potential impacts of climate change, including the effects on agriculture, forestry, terrestrial and marine ecosystems, hydrology and water resource management, human health, human infrastructure, and financial services. While the potential impacts of climate change are broad, some aspects of human society are more sensitive than others. In particular, more highly managed systems like agriculture, where skills and resources for investing in adaptation are available, may be less sensitive than less managed systems like wilderness areas. By the same token, some of the adverse effects of climate change may fall disproportionately on poorer parts of the world where adaptation capacity is more limited. Particularly if climate change is very rapid, damage could be severe and long-lived, perhaps irreversible. However, such rapid change may be unlikely and is difficult to predict.

In any event, the ability to quantify future damage and adaptation potential varies greatly across sectors. The physical consequences of a given magnitude of sea level rise, or the impacts of climate change on agricultural yields and forest conditions, can be projected with higher confidence than, say, impacts on wetlands and fisheries. Yet even when confidence is high that a certain effect will occur if the climate changes, its magnitude cannot be predicted precisely. In addition, already significant damage to ecosystems and human structures arising from population growth, industrial expansion, and changes in land use may be of more immediate concern than how best to respond to climate change risk. Over the longer term, however, these forces could combine with the effects of climate change to push already stressed systems "over the edge."

In evaluating the context for climate change policies, several points need to be kept in mind.

**Some degree of climate change appears inevitable.** Given current emissions trends and the inertia of the climate system, even if emissions were stabilized or substantially reduced, the scientific models suggest that climatic changes and their consequences would continue. To stabilize atmospheric concentrations of greenhouse gases and thus their effects would eventually require very large cuts in emissions from current levels (let alone future levels implied by continued economic growth under a "business as usual" scenario). For example, to stabilize carbon dioxide concentrations at something over twice pre-industrial levels would require emissions ultimately to fall by over 70 percent from their *current* level.

**The problem is global.** Rich and poor countries argue over how the burden of greenhouse gas emissions reductions should be allocated. However, no solution can be effective in the long term unless it ultimately leads to reductions in total *global* emissions, not just emissions in selected countries.

**It is the human consequences of climate change that will animate public support for policies.** The findings of climate scientists or studies of physical impacts from climate change cannot drive policy alone. This simple but important point often seems to be overlooked in debates about “what the science says,” and it leads to our next major topic—what kind of framework is useful for evaluating climate risks and policies?

## DECISION FRAMEWORK

Although substantial scientific and socioeconomic uncertainties exist about the risks that climate change poses, these uncertainties do not justify taking no action. At the same time, priorities must be set in how the public’s scarce resources will be used. At the broadest level, there must be some weighing and balancing of the benefits and costs of different actions in response to climate change risks. The values served by reducing the risks from climate change can only be appreciated in comparison with other values to which society devotes its scarce resources.

The need for such balancing casts doubt on the usefulness of a strict “safety first” framework that puts a high premium on any and all forms of risk reduction. We cannot devote disproportionately huge amounts of resources to reducing climate change risks while, for example, utterly ignoring health care needs. Moreover, not all the effects of climate change are likely to be equally serious, so it is not helpful simply to argue that the risks of climate change should be minimized.

Some analysts argue that we can enjoy the benefits of reduced climate change risks without significant economic costs or even with net benefits from economic and environmental improvements arising from greenhouse gas control. They suggest that pervasive but latent markets exist whose failure to operate, once fixed, will yield substantial economic and environmental benefits. Many people who have examined this argument—including participants in the IPCC’s Second Assessment—seem to agree that some low-cost reductions in greenhouse gases are feasible. However, for reasons discussed below, I believe that skepticism is warranted regarding sweeping claims about the potential for low-cost emissions reductions.

If a strict “precautionary principle” of the type sketched above is of limited practical use for evaluating the risks of climate change, there are also limits to what can be gleaned from conventional benefit-cost analysis. Climate change risks and policies inherently have substantial distributional effects that may operate both within generations (who bears what share of response costs) and across generations (how much the future benefits from our actions to reduce climate change risks). In addition, uncertainty surrounding the risks and costs of climate change is especially large, and there is at least the possibility of very large-scale impacts that human responses will have a hard time mitigating. These issues are not easily handled through normal benefit-cost calculations.

While there is no easy cookbook answer to what should go into a climate change decision framework, and no approach that commands universal agreement, several elements seem useful.

**Think comprehensively about risks.** Given the number of risks associated with climate change, efforts to gauge the benefits of reducing them should be as broad as possible. Elements to consider include the impacts on market goods like agriculture; effects on human health; effects on nonmarket resources like wilderness areas and wetlands that provide both recreational values and ecological functions; and the ancillary benefits of greenhouse gas reduction such as improved air quality.

Given the current state of knowledge, it will be difficult to attach monetary values to many of these risk reductions. This uncertainty is likely to persist for many risk categories (especially those related to ecological impacts) even if uncertainty about the physical manifestations of climate change declines. Nevertheless, these risks are important to consider; lack of information about a risk should not be confused with that risk being negligible. Where economic assessments are problematic, information about the likelihood, potential magnitude, and timing of impacts still is useful for decisionmakers. In this connection, an assessment of climate change risks should go beyond a sequence of “best guess” estimates of atmospheric changes, biophysical impacts, and socioeconomic impacts. It is necessary to consider the variability of possible consequences as well. At the same time, the assessment should not be limited only to severe but unlikely effects in “worst case” scenarios.

**Think long-term.** The risks posed by climate change depend on the path of changes in the atmospheric concentration of greenhouse gases over many decades and centuries, not just on the emissions of these gases over a relatively short period of time. The long-term aspect of climate change means that we are dealing with the cumulative effect of many smaller influences on the biosphere, a process with a great deal of natural inertia. Having to deal with the distant



future greatly complicates risk assessment and the development of consensus for policy actions. To be effective, at least some actions must be taken in anticipation of long-term impacts, before all of the scientific evidence is clear. Our political system arguably is less effective at responding to such issues than to a single large and immediate concern. On the other hand, the long-term nature of climate change risks means we also have time to hone our scientific understanding and policy responses over time; we need not do everything right away. Indeed, there is a real advantage to a more gradual but purposeful approach in terms of being able to develop and take advantage of technical progress, reduce the cost of rapid obsolescence of existing capital, and adjust policies over time to changes in understanding of climate change risks.

**Address adaptation.** In a number of areas such as agriculture, managed forestry, and human settlements, intuition and experience in other contexts suggest a medium-to-high degree of potential adaptability to natural changes, given enough lead time and investment. Adaptation possibilities include development of new plant varieties and crop patterns, changes in irrigation technology, relocation of coastal infrastructure, and expanded protection of wetlands to compensate for their potential future damage. Failure to account for adaptation as a viable response to climate change will cause climate change risks to be overstated.

Adaptation may be difficult in other cases, for example in response to potential damage to natural ecosystems whose functions are not well understood. Even where adaptation seems problematic, it should not automatically be treated as negligible. Improving the capacity to adapt where it is weak—as in many poor developing countries—may be one of the most effective ways to respond to some climate change risks, at least until the cost of stabilizing atmospheric concentrations of greenhouse gases falls.

**Think internationally.** Long-term global climate change risks will not diminish to any significant degree until total *global* emissions are reduced. This will require global cooperation, not just action by today's rich countries. This point deserves to be underscored in light of the likely future decline in the share of total emissions from advanced industrial countries (currently about 50 percent) as economic growth proceeds in other areas. The efficacy of any policies the United States pursues to reduce climate change risks thus will depend on the actions taken by others.

No simple rules of thumb exist as to how the international burden of emissions control should ultimately be allocated. Developing countries note that rich countries are responsible for the vast bulk of emissions to date. They assert that allowing developed countries to maintain high emissions levels while constraining the growth of emissions in developing countries to reduce

climate change risks would impose unacceptable burdens on the latter countries' economic development. Developed countries note that most emissions growth will occur in developing countries, that past economic progress has had at least some global benefits, and that simply treating all countries as having equal rights to carbon emissions (after adjusting for population differences) would impose unacceptably high control costs on developed countries. The ongoing tension over the responsibilities of different parties to the Framework Convention—including the debate surrounding the implementation of the Kyoto Protocol—can only be resolved by negotiation among the parties themselves.

**Keep distributional issues in mind.** Climate change risks and response capacities vary with income level. There is also a fundamental asymmetry between the timing of response costs—which will be borne to a significant extent by the current generation—and the benefits of reduced climate change—which will largely accrue to future generations. This asymmetry complicates a comparison of benefits and costs, since we cannot simply compare the expected costs of reducing the risk with the expected future value of the ultimate benefits. Instead, we must assess both the costs members of the current generation would bear and the strength of our concerns for the well-being of future generations—not just our own descendants, but all those who would be vulnerable in the future. These are economically and ethically complex questions about which we know little and which require a very mature political debate.

Some analysts have argued that intergenerational equity concerns should be incorporated into climate risk assessments by applying a lower “philosophical” discount rate to the evaluation of benefits received by future generations, so as to not trivialize these benefits relative to current costs. A weakness of this approach is that it attempts to reduce a very complex ethical debate to the value of a single parameter. A more general approach is to carry out the best possible assessment of the costs to be borne in the short to medium term (taking into account various effects on productivity and economic growth as well as such benefits as reduced air pollution), combined with the best possible enumeration of the potential advantages (physical and economic) of our actions for future generations. Such an approach would give policymakers the information they need to make more explicit, well-informed judgments about the desired level of risk reduction.

**Estimate control costs realistically.** Assessments of the costs of response options should be as broad and sensitive to uncertainties as assessments of the risks of climate change. For example, the overall economic costs of abatement policies that distort existing patterns of employment, investment, and innovation may be a multiple of direct out-of-pocket compliance costs. By the same token, technical progress over time in reducing greenhouse gases can lower

abatement costs. Cost assessment should also address ancillary effects of policy responses—some positive, like reduction of conventional air pollutants with reduced energy use, and some negative, like increased indoor air pollution from tighter insulation, or increased pressure to develop hydroelectric capacity on scenic rivers. Finally, a comprehensive approach must be concerned with other greenhouse gases besides carbon dioxide (such as methane from pipeline leaks and landfills), and with changes in carbon sequestration in forests due to shifting land use patterns.

As already noted, some people argue that market inefficiencies are so rife, and opportunities for innovation so plentiful, that emissions abatement is actually a low-cost proposition that might even benefit the economy. This point of view is in sharp contrast to the outputs of economic models indicating that stabilizing emissions may cost as much as several percent of a country's gross domestic product (implying that deeper cuts in emissions to reduce greenhouse gas concentrations in the atmosphere would be even more expensive). This divergence of opinion reflects in part a long-standing disagreement about the cost of improving energy efficiency. Energy analysts have argued that opportunities for large and low-cost improvements in technical efficiency have been missed because of market failures that require government action, while economists have generally assumed that most of the supposed failures to act were actually rational responses to factors such as the likelihood that a new technology was not going to perform as expected.

Most people who have looked at the debate seem to agree that some low-cost improvements in energy efficiency exist. Reducing subsidies and other distortions in energy markets that encourage excess energy use can reduce greenhouse gas emissions while improving economic and environmental well-being. However, it is open to question whether these opportunities are substantial compared to, say, the amount of abatement needed to stabilize greenhouse gas emissions. Against the backdrop of future increases in global energy demand, the cost of longer-term reductions in greenhouse gas emissions cannot help but rise unless further progress occurs in the development of nonfossil energy alternatives. In assessing medium-to-long-term costs, it is a mistake to treat technical progress as a panacea for reducing abatement costs, or to assume no technical progress.

Another argument offered in the debate over the cost of greenhouse gas emissions reductions is that our tax system is so distorted that we can use energy taxes to reduce greenhouse gas emissions and use the proceeds to lower other taxes that hamper economic growth. However, recent analysis calls into question the magnitude of this “double dividend.” While the technical details can be complicated, the basic point is that broader-based taxes like

the income tax tend to cause less overall economic distortion than narrower-based taxes like energy taxes. Adjusting other taxes might soften the economic bite of an added carbon tax, but not to negligible levels. Moreover, any effective tinkering with the tax system is possible only if politicians take the difficult step of imposing higher energy taxes in the first place, and if revenues are put to good (efficiency-enhancing) uses.

Most studies of greenhouse gas abatement costs assume the application of idealized least-cost policy measures like a comprehensive “emissions trading” program or a comprehensive carbon tax. The costs of meeting any particular emissions reduction goals likely will be significantly higher if less well-designed measures are followed. The debate about which greenhouse gas reduction targets are appropriate cannot be conducted independently of discussions about what concrete measures can and should be used to actually restrict emissions.

## **POLICY LESSONS**

In assessing climate change policies, we must consider complex “portfolios” of actions that include abating emissions, investing in technical innovations to reduce emissions sources and increase adaptation capacity, and improving risk assessment. In putting together a portfolio of policies, it is important to consider the synergies among them, such as the effects of economic incentives to reduce greenhouse gas emissions on the rate of innovation for new energy sources and other types of emissions reduction options. Because of the long-term nature of the climate change problem, the ultimate goals for responding to it also must be long-term. Such a perspective offers increased opportunities for implementing low-cost strategies to reduce emissions and promote adaptation opportunities through new investments.

Beyond these general observations, the decision framework developed above has several implications for how to formulate policy.

**Incorporate economic incentives into emissions-reduction policy.** Such incentives are crucial to both short- and long-term policy successes because they make emissions limitations less expensive. Both a large body of analysis and a small but growing body of evidence in areas other than greenhouse gas control show that incentive-based policies help bring about the lowest-cost options and stimulate innovative new methods for abatement. (Both Articles 3 and 4 of the Framework Convention support the concept of such cost-effective policies.)

The main alternatives for incentive-based policies (beyond “no regrets” actions like reductions in energy subsidies) are carbon taxes on energy sources, and various forms of “tradable permits” systems. The latter approach would effectively establish quotas on emissions

but allow trade in emissions, so that sources with higher control costs could (in effect) pay emitters with lower control costs to assume more of the reduction burden. A full discussion of the pros and cons of different tax and tradable permit schemes is beyond the scope of the paper. It should be noted, however, that both types of policies have advantages, and neither should be written off. Hybrid policies combining tax and quantity restrictions may be very useful. Moreover, there are many policy combinations that might be relevant in future policy debates (such as a mixture of emissions trading with command and control for different sectors) whose performance is still largely unknown.

**Seek flexibility in the timing of cumulative emissions reductions to reduce overall costs.** As noted, such flexibility in target-setting takes into account the inertia in the economic system that makes rapid adjustments more costly; for example, it may be cheaper to replace long-lived electricity generating capacity more slowly while also achieving improved energy efficiency when the capital is replaced. It would also provide increased scope over time for investments in knowledge to enhance technological change. The cost savings from intertemporal flexibility in meeting long-term emissions reductions goals depend on the assumptions made, but it appears that savings of 50 percent might be realized.

Taking this approach does not mean that all or even most policy actions are deferred to the future. It simply means that the emphasis is placed on sequential decisions that add up to avoiding unacceptable damage from anthropogenic greenhouse gas emissions. Some actions will be appropriate in the short term as first steps down the policy path, or to enhance the domestic or international credibility of policy agreements. Other actions may be more useful later. Unless we start with a longer-term perspective, it is impossible to consider these tradeoffs.

**Provide opportunities for emissions reductions wherever possible.** Given the international nature of the problem and the need for international action to solve it, policies should seek to provide abatement opportunities everywhere, including in developing countries outside the Annex I group. The Kyoto Protocol allows for formal emissions trading among Annex I countries as well as project-based “joint implementation” of emission reductions among Annex I partners. In addition, the Protocol’s Clean Development Mechanism (CDM) would allow emitters in, say, the United States, to invest in actions that reduce emissions in non-Annex I countries and obtain credits that can be used to satisfy their own emissions reductions requirements. The emissions reductions are achieved through the transfer of technology and investment to a host country in order to reduce emissions below some established baseline level. The resulting technological, economic, and environmental improvements are the source of benefits for the host country.

A number of analyses indicate that the cost savings from using these “Kyoto mechanisms” to meet emissions reduction goals could be very large. The savings depend on the assumptions made, but savings of 50 percent or more seem possible. However, a number of practical problems need to be addressed in pursuing these approaches. Procedures must be established to ensure that large-scale trading and project-based investments could occur without excessive red tape, while also ensuring that credible emissions reductions occur relative to some well-defined baseline. The credibility and appeal of the CDM to potential host countries in the developing world must be demonstrated. And Annex I countries must come to terms with the politics of transferring substantial sums to developing and transitional countries to purchase lower-cost emission reductions.

**Encourage development of the climate change knowledge base and improved technology for emissions reduction.** The flow of technology transfer and new investment occurring as a matter of course in world markets presents a number of potential opportunities for greenhouse gas limitations. Particularly in a number of developing countries and economies in transition to market systems, many opportunities exist to improve energy and economic efficiency at the same time. Even where there are some costs to upgrading capital stock and improving energy efficiency, they may be more than offset by the gains from improved environmental quality. To realize these gains requires policymakers worldwide to come to grips with broader handicaps that thwart economically sound and environmentally sustainable development.

Even if we do all the best things possible to reduce emissions given the current state of knowledge, economic growth—especially in developing countries—will continue to push up greenhouse gas emissions and atmospheric concentrations. Unlike the problem of limiting pollutant gases such as sulfur dioxide, for which a variety of technical control options is available, limiting carbon dioxide emissions currently requires either reduced energy use (greater energy efficiency) or substitution of energy sources with lower carbon content. To avoid unacceptable climate change risks ultimately will require a fundamental change in our energy systems toward much greater reliance on other energy sources—solar, biomass, and possibly nuclear. Such a transition would be too costly now, given the current state of knowledge. To make the transition economically manageable will require continued or enhanced investments in basic and applied knowledge.

The government has an inescapable role to play, not just in creating the incentives for private parties to seek better technologies but also in funding the development of basic knowledge about technology as well as climate change impacts. At the same time, we must

recognize that our understanding of what policy can actually do to induce climate-friendly innovation is weak at best. We must also recognize that diverting resources from other areas to research on low-carbon energy systems may well reduce innovation elsewhere in the economy—technical progress is not a free good.

**Increase the emphasis on adaptation.** Adaptation is part of an optimal response strategy in any event. Indeed, it is the means of transcending the narrow concern about our vulnerability to climate change from greenhouse gas emissions to a broader concern with global-scale changes that place stress on natural systems and pose threats to human well-being. Furthering human capacity to adapt to climate change entails investment in improved understanding of the options and their international diffusion. It also entails adjusting economic and other distortions that limit adaptation potential (such as assistance programs that subsidize coastal development or water use). In many cases, the best climate policy may have less to do with greenhouse gases or climate per se, and more to do with developing better basic social infrastructure for natural resource conservation and use and public health protection.

## FURTHER READING

**Note:** all the of the items that follow contain at least some material accessible to a general audience, though some items contain a higher proportion of technical material than others. In producing this list I have tried to emphasize sources that provide relatively broad-ranging treatments of climate change issues from several perspectives.

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