1 Introduction and overview[1]

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Diverse aspects of human activity around the world result in greenhouse gas (GHG) emissions that contribute to global climate change. Emissions come from coal-fired power plants in the United States, diesel buses in Europe, rice paddies in Asia, and the burning of tropical forests in South America. These emissions will affect the global climate for generations, because most greenhouse gases reside in the atmosphere for decades to centuries. Thus, the impacts of global climate change pose serious, long-term risks.

Global climate change is the ultimate global-commons problem: Because GHGs mix uniformly in the upper atmosphere, damages are completely independent of the location of emissions sources. Thus, a multinational response is required. To address effectively the risks of climate change, efforts that engage most if not all countries will need to be undertaken. The greatest challenge lies in designing an *international policy architecture* that can guide such efforts. We take "international policy architecture" to refer to the basic nature and structure of an international agreement or other multilateral (or bilateral) climate regime.[2]

[1] We are indebted to the twenty-six research teams of the Harvard Project on International Climate Agreements who have contributed to the Project, this *Summary for Policymakers*, and the complete book (Aldy and Stavins 2009). We are also grateful to the Project's management: Robert Stowe, project manager; Sasha Talcott, communications director; Jason Chapman, project coordinator; Tyler Gumpright, project assistant; Susan Lynch, webmaster; and Matthew Ranson, research assistant. We are particularly grateful to Rob Stowe, who has managed the production of this *Summary for Policymakers* – and the overall Harvard Project – with inspired leadership and unfailing grace and kindness. Marika Tatsutani edited the manuscript with skill and insight. We also express our sincere gratitude to the Doris Duke Charitable Foundation for providing major funding for the Project, and Andrew Bowman for his collaboration, beginning with the Project's conception. We greatly appreciate additional financial support from Christopher Kaneb, the James and Cathleen Stone Foundation, Paul Josefowitz and Nicholas Josefowitz, the Enel Endowment for Environmental Economics at Harvard University, the Belfer Center for Science and International Affairs at the Harvard Kennedy School, and the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School.

[2] The need for scholars to focus on the development of a long-term climate policy architecture was first highlighted by Richard Schmalensee: "When time is measured in centuries, the creation of durable institutions and frameworks seems both logically prior to and more important than choice of a particular policy program that will almost surely be viewed as too strong or too weak within a decade" (1998, p. 141).

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) marked the first meaningful attempt by the community of nations to curb GHG emissions. This agreement, though a significant first step, is not sufficient for the longer-term task ahead. Some observers support the policy approach embodied in Kyoto and would like to see it extended – perhaps with modifications – beyond the first commitment period, which ends in 2012. Others maintain that a fundamentally new approach is required.

Whether one thinks the Kyoto Protocol was a good first step or a bad first step, everyone agrees that a second step is required. A way forward is needed for the post-2012 period. The Harvard Project on International Climate Agreements was launched with this imperative in mind. The Project is a global, multiyear, multi-disciplinary effort intended to help identify the key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for addressing the threat of climate change. This *Summary for Policymakers* is a product of the Project's research, the results of which are described in much greater detail in our book, *Post-Kyoto International Climate Policy: Implementing Architectures for Agreement* (Aldy and Stavins 2009).

By "scientifically sound" we mean an international agreement that is consistent with achieving the objective of stabilizing atmospheric concentrations of GHGs at levels that avoid dangerous anthropogenic interference with the global climate. By "economically rational" we mean pursuing an approach or set of approaches that are likely to achieve global targets at minimum cost – that is, cost-effectively. And by "politically pragmatic" we mean a post-Kyoto regime that is likely to bring on board the United States and engage key, rapidly-growing developing countries in increasingly meaningful ways over time. As Tim Wirth emphasizes in his Foreword, these three criteria are essential for identifying a promising and meaningful path forward.

The Project draws upon leading thinkers from academia, private industry, government, and non-governmental organizations (NGOs) around the world. It includes research teams operating in Europe, the United States, China, India, Japan, and Australia, and has benefited from meetings with leaders from business, NGOs, and governments in many more countries.

The Project originated from a May 2006 workshop at which the Harvard Environmental Economics Program brought together twenty-seven leading thinkers from around the world with expertise in economics, law, political science, business, international relations, and the natural sciences. This group developed and refined six policy frameworks, each of which could form the

backbone of a new international climate agreement. These six frameworks, which range from a stronger version of the Kyoto Protocol to entirely new approaches, are the subject of our earlier book, published in September 2007 by Cambridge University Press and titled *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World* (Aldy and Stavins 2007). With these proposals as the starting point, the Harvard Project on International Climate Agreements aims to help forge a broad-based consensus on a potential successor to Kyoto.

The first stage of our work, which focused on establishing the importance of considering alternative architectures for the post-2012 period, featured wide-ranging and inclusive discussions of the six proposed alternatives, as well as others not addressed in *Architectures for Agreement*. It also featured meetings with government officials, business leaders, NGOs, and academics around the world. In the second stage of the Project, we focused on developing a small menu of promising frameworks and key design principles, based upon analysis by leading academics from a variety of disciplines – including economics, political science, law, and international relations – as well as ongoing commentary from leading practitioners in the NGO community, private industry, and government. Economic analysis has been supplemented with political analysis of the implications of alternative approaches, as well as legal examinations of the feasibility of various proposals.

From the beginning, there have been no constraints on what might emerge from the Project. We have maintained from the outset that anything is possible – from highly centralized Kyoto-like architectures for all countries to proposals that are outside the context of the UNFCCC, such as proposals for G8+5 or L20 agreements.[3] This *Summary for Policymakers* draws upon the findings of our diverse research initiatives in Australia, China, Europe, India, Japan, and the United States.

Learning from experience: the Kyoto Protocol

It is helpful to reflect on the lessons that can be learned from examining the Kyoto Protocol's strengths and weaknesses. Among the Protocol's strengths

[3] The G8 refers to Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States; in addition, the EU is represented within the G8, but cannot host or chair. The G8+5 refers to the G8 countries plus the 5 leading developing countries – Brazil, China, India, Mexico, and South Africa. The L20 refers to the G8+5 nations plus Australia, Argentina, the European Union, Indonesia, Korea, Saudi Arabia, and Turkey.

is its inclusion of several provisions for market-based approaches that hold promise for improving the cost-effectiveness of a global climate regime. We refer, for example, to the well-known flexibility mechanisms, such as Article 17, which provides for emissions trading among the Annex I countries[4] that take on commitments under the Protocol. More specifically, this provision allows the governments of Annex I countries to trade some of the assigned emission allowances that constitute their country-level targets. Second, the Protocol's Joint Implementation provisions allow for project-level trades among the Annex I countries. Finally, the Protocol established the Clean Development Mechanism (CDM), which provides for the use of project-level emission offsets created in non-Annex I countries (the developing countries of the world) to help meet the compliance obligations of Annex I countries.

A second advantage of the Kyoto Protocol is that it provides flexibility for nations to meet their national emission targets – their commitments – in any way they want. In other words, Article 2 of the Protocol recognizes domestic sovereignty by providing for flexibility at the national level. The political importance of this provision in terms of making it possible for a large number of nations to reach agreement on emission commitments should not be underestimated.

Third, the Kyoto Protocol has the appearance of fairness, in that it focuses on the wealthiest countries and those responsible for a dominant share of the current stock of anthropogenic GHGs in the atmosphere. This is consistent with the principle enunciated in the UNFCCC of "common but differentiated responsibilities and respective capabilities."

Fourth and finally, the fact that the Kyoto Protocol was signed by more than 180 countries and subsequently ratified by a sufficient number of Annex I countries for it to come into force speaks to the political viability of the agreement, if not to the feasibility of all countries actually achieving their targets.

In the realm of public policy, as in our everyday lives, we frequently learn more from our mistakes or failures than from our successes. So, too, in the case of the Kyoto Protocol. Therefore, we also examine some key weaknesses of the Protocol and explore what potentially valuable lessons they may hold for the path forward.

First, it is well known that some of the world's leading GHG emitters are

[4] We use Annex I and Annex B interchangeably to represent those industrialized countries that have commitments under the Kyoto Protocol, though we recognize that a few countries are included in one Annex but not the other.

not constrained by the Kyoto Protocol. The United States – until recently the country with the largest share of global emissions – has not ratified and is unlikely to ratify the agreement. Also, some of the largest and most rapidly growing economies in the developing world do not have emission targets under the agreement. Importantly, China, India, Brazil, South Africa, Indonesia, Korea, and Mexico are not listed in Annex B of the Kyoto agreement. Rapid rates of economic growth in these countries have produced rapid rates of growth in energy use, and hence carbon dioxide (CO_2) emissions. Together with continued deforestation in tropical countries, the result is that the developing world has overtaken the industrialized world in total GHG emissions. China's industrial CO_2 emissions have already surpassed those of the United States; moreover, China's emissions are expected to continue growing much faster than US emissions for the foreseeable future (Blanford, *et al.*).[5]

These realities raise the possibility that the Kyoto Protocol is not as fair as originally intended, especially given how dramatically the world has changed since the UNFCCC divided countries into two categories in 1992. For example, approximately fifty non-Annex I countries – that is, developing countries and some others – now have higher per capita incomes than the poorest of the Annex I countries with commitments under the Kyoto Protocol. Likewise, forty non-Annex I countries ranked higher on the Human Development Index in 2007 than the lowest ranked Annex I country.

A second weakness of the Kyoto Protocol is associated with the relatively small number of countries being asked to take action. This narrow but deep approach may have been well intended, but one of its effects will be to drive up the costs of producing carbon-intensive goods and services within the coalition of countries taking action. (Indeed, increasing the cost of carbon-intensive activities is the intention of the Protocol and is fully appropriate as a means to create incentives for reducing emissions.) Through the forces of international trade, however, this approach also leads to greater comparative advantage in the production of carbon-intensive goods and services for countries that do not have binding emissions targets under the agreement. The result can be a shift in production and emissions from participating nations to non-participating nations – a phenomenon known as emission "leakage." Since leakage implies a shift of industrial activity and associated

[5] Citations without a year refer to the author's work in the Harvard Project on International Climate Agreements, which is described in a brief summary in Appendix 1. We also refer to the Foreword in this manner ("Wirth"). Where articles or books outside this volume are referenced, the usual citation with a year is provided, with the full reference provided in the list at the end of Chapter 2.

economic benefits to emerging economies, there is an additional incentive for non-participants to free-ride on the efforts of those countries that are committed to mitigating their emissions through the Protocol's narrow but deep approach.

This leakage will not be one-for-one (in the sense that increased emissions in non-Annex I countries would be expected to fully negate emission reductions in Annex I countries), but it will reduce the cost-effectiveness and environmental performance of the agreement and, perhaps worst of all, push developing countries onto a more carbon-intensive growth path than they would otherwise have taken, rendering it more difficult for these countries to join the agreement later.

A third concern about the Kyoto Protocol centers on the nature of its emission trading elements. The provision in Article 17 for international emission trading is unlikely to be effective (Hahn and Stavins 1999). The entire theory behind the claim that a cap-and-trade system is likely to be cost-effective depends upon the participants being cost-minimizing entities. In the case of private-sector firms, this is a sensible assumption, because if firms do not seek – and indeed succeed in – minimizing their costs, they will eventually disappear, given the competitive forces of the market. But nation-states can hardly be thought of as simple cost-minimizers – many other objectives affect their decision-making. Furthermore, even if nation-states sought to minimize costs, they do not have sufficient information about marginal abatement costs at the multitude of sources within their borders to carry out cost-effective trades with other countries.

There is also concern regarding the CDM. This is not a cap-and-trade mechanism, but rather an emission-reduction-credit system. That is, when an individual project results in emissions below what they would have been in the absence of the project, a credit – which may be sold to a source within a cap-and-trade system – is generated. This approach creates a challenge: comparing actual emissions with what they would have been otherwise. The baseline – what would have happened had the project not been implemented – is unobserved and fundamentally unobservable. In fact, there is a natural tendency, because of economic incentives, to claim credits precisely for those projects that are most profitable, and that hence would have been most likely to go forward even without the promise of credits. This so-called "additionality problem" is a serious issue. There are ways to address it through future restructuring and reform of the CDM; we examine some of these options in several parts of this *Summary for Policymakers*.

Fourth, the Kyoto Protocol, with its five-year time horizon (2008 to 2012), represents a relatively short-term approach for what is fundamentally a long-term problem. GHGs have residence times in the atmosphere of decades to centuries. Furthermore, to encourage the magnitude of technological change that will be required to meaningfully address the threat of climate change, it will be necessary to send long-term signals to the private market that stimulate sustained investment and technology innovation (Newell).

Finally, the Kyoto Protocol may not provide sufficient incentives for countries to comply (Barrett). Some countries' emissions have grown so fast since 1990 that it is difficult to imagine those countries being able to undertake the emission mitigation or muster the political will and resources necessary to purchase enough emission allowances or CDM credits from other countries, so as to comply with their targets under the Protocol. For example, Canada's GHG emissions in 2006 exceeded that country's 1990 levels by nearly 55 percent, making it very unlikely that Canada could comply with an emissions target set at 6 percent *below* 1990 levels, averaged over the 2008–2012 commitment period. In short, the enforcement mechanism negotiated for the Kyoto Protocol does not appear to induce policy responses consistent with agreed-upon targets.

Alternative policy architectures for the post-Kyoto period

In our earlier book, *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World*, we characterized potential post-Kyoto international policy architectures as falling within three principal categories: targets and timetables, harmonized national policies, and coordinated and unilateral national policies (Aldy and Stavins 2007). The policy architectures that have subsequently been examined as part of the Harvard Project on International Climate Agreements – while falling within the same three categories – move substantially beyond what was articulated in our 2007 book. Nevertheless, an overview of international policy architectures through the lens of these three categories, together with some concrete examples, is helpful.

The first category – targets and timetables – is the most familiar. At its heart is a centralized international agreement, top-down in form. This is the basic architecture underlying the Kyoto Protocol: essentially country-level quantitative emission targets established over specified time frames. An example of an approach that would be within this realm of targets and timetables,

but would address some of the perceived deficiencies of the Kyoto Protocol, would be a regime that established emission targets based on formulas rather than specified fixed quantities (see Frankel, "Formulas"). In lieu of *ad hoc* negotiations over emission caps, this formula approach would establish principles that could be translated into quantitative metrics for determining emission obligations. These formulas could be structured to have some of the appealing properties of indexed growth targets: setting targets as a function of a country's gross domestic product (GDP) per capita, for example. As countries became wealthier, their targets would become more stringent.[6] Conversely, when and if countries faced difficult economic periods, the stringency of their targets would be automatically reduced.

Such an approach does not divide the world simply into two categories of countries, as in the Kyoto Protocol. Rather, it allows for a continuous differentiation among the countries of the world while including all of them. In this way it reduces – if not eliminates – problems of emission leakage, yet still addresses the key criterion of distributional equity and does so in a more careful, sophisticated manner.

The second category – harmonized domestic policies – focuses more on national policy actions than on goals and is less centralized than the first set of approaches. In this case, countries agree on similar domestic policies. This reflects the view that national governments have much more control over their countries' policies than over their emissions. One example is a set of harmonized national carbon taxes (Cooper).[7] With this approach, each participating country sets a domestic tax on the carbon content of fossil fuels, thereby achieving cost-effective control of emissions within its borders. Taxes would be set by nations, and nations would have complete discretion over the revenues they generate. Countries could design their tax policies to be revenue-neutral – for example, by returning the revenues raised to the economy through proportional cuts in other, distortionary taxes, such as those on labor and capital. In order to achieve global cost-effectiveness, carbon taxes would need to be set at the same level in all countries. This would presumably not be acceptable to the poorer countries of the world.

[6] Such a mechanism was proposed by Frankel (2007) and is similar to the graduation mechanism proposed by Michaelowa (2007). As developing countries realize growth in per capita income and per capita emissions on par with Annex I countries, they would be expected to take on binding emission targets. In Appendix 1, Frankel ("Formulas"); Ellerman; Karp and Zhao; and Cao provide examples of the targets-and-timetables approach.

[7] McKibbin and Wilcoxen (2007) advance the idea of parallel, unlinked domestic cap-and-trade programs as a way to move forward in international climate policy. They recommend a harmonized safety-valve price mechanism in their domestic cap-and-trade programs. In Appendix 1, Cooper; Jaffe and Stavins; and Sawa provide examples of harmonized domestic policies.

Therefore, significant side deals would most likely need to accompany such a system of harmonized carbon taxes to make it distributionally equitable and hence politically feasible. This could take the form of large financial transfers through side payments from the industrialized world to the developing world, or agreements in the trade or development agenda that effectively compensate developing countries for implementing carbon taxes.

The third and final category that we have used to classify potential post-Kyoto climate policy architectures is coordinated and unilateral national policies. This category includes the least centralized approaches that we have considered – essentially bottom-up policies that rely on domestic politics to drive incentives for participation and compliance (Pizer 2007).[8] Although these approaches are the least centralized, they should not be thought of as necessarily the least effective. One example of a bottom-up approach – linking independent national and regional tradable permit systems – may already be evolving (see Jaffe and Stavins).

The Bali road map and the path ahead

At the December 2007 UN-sponsored climate change talks in Bali, Indonesia (COP 13), the international community reached agreement on the Bali Action Plan, a two-year road map to guide the negotiation of a framework that builds on and succeeds the Kyoto Protocol. This road map identifies many important issues that merit consideration and resolution in the design of an international climate policy architecture. While the Bali Action Plan is intended to yield an international framework at the 2009 climate change talks in Copenhagen, Denmark (COP 15), the road map also provides something of a framework for the international climate policy debate – and thus for actions undertaken domestically by participating countries – for some years beyond the Copenhagen meetings.

The research program pursued by the Harvard Project on International Climate Agreements addresses key issues in the Bali road map with the aim of informing the design and evaluation of various policies that would be included in the next international climate regime. Specifically, Harvard Project research teams have brought their scholarship to bear on each of the five major elements of the Bali Action Plan: a long-term global climate policy goal, emission mitigation, adaptation, technology transfer, and financing.

[8] In Appendix 1, Jaffe and Stavins, and Barrett describe examples of the third type of architecture: bottom-up, coordinated and unilateral national policies.

The Bali road map calls for a "shared vision for long-term cooperative action" that would include "a long-term global goal for emission reductions" as a means to implement the ultimate objective of the UNFCCC. The issue of setting long-term goals has received considerable attention from policymakers around the world. While we recognize that national leaders, rather than scholars, will ultimately decide on a long-term global climate policy goal, our work can still inform the identification and review of various long-term emission objectives. The research undertaken for this project and in writing *Architectures for Agreement* identifies a variety of means for constructing a long-term international climate policy architecture – for example, Bosetti, *et al.* evaluate the long-term GHG concentration and temperature implications of a half dozen approaches to climate policy. Additional analyses highlight the challenge of achieving long-term stabilization targets with incomplete participation (Jacoby, *et al.*; Blanford, *et al.*) as well as the need to improve the technology options available for achieving ambitious long-term emission-reduction goals (Clarke, *et al.*).

The role of emission mitigation continues to be central in international climate change negotiations. The Bali Action Plan calls for "mitigation commitments or actions" by developed countries and "mitigation actions" by developing countries, the latter with support for capacity-building and technology transfer from developed countries. In both cases, mitigation efforts should be "measurable, reportable, and verifiable," a requirement that is addressed by Project research aimed at evaluating various kinds of metrics for assessing mitigation activities (Fischer and Morgenstern) and at describing a surveillance institution that can independently review the comparability of effort among participating countries.

The Bali road map provides guidance for these efforts by identifying several specific forms of mitigation, including reducing deforestation and emissions from changes in land use, an issue investigated by Plantinga and Richards. Sectoral approaches to mitigating emissions also receive attention in the Bali road map; accordingly, Sawa and Barrett, among others, explore the prospects and pitfalls of a sector-specific approach. Finally, the negotiators in Bali also agreed on the general proposition that market-based approaches should be pursued – an issue that receives attention in many contributions to this project (Agarwala; Cooper; Ellerman; Frankel, "Formulas"; Jaffe and Stavins; Karp and Zhao; and Keohane and Raustiala).

The Kyoto Protocol only mentions the word "adaptation" twice. In contrast, the Bali road map elevates the importance of this issue. Several contributors to the Project recognize the need to effectively integrate climate