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# CLIMATE POLICY ARCHITECTURES FOR THE POST-KYOTO WORLD

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The global climate has changed and will continue to change as a result of greenhouse gas emissions from a broad variety of human activities. In 2007, the Intergovernmental Panel on Climate Change determined that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."[1] If greenhouse gas emissions continue to grow unabated, the global average temperature will likely increase between 1.1°C and 6.4°C.[2] This warming will unleash a myriad of impacts, the vast majority of which will adversely affect water availability, agricultural and forestry productivity, the spread of infectious diseases, extreme weather events, unique ecosystems and rare species, and the built environment in coastal areas. The risks of global climate change clearly necessitate an international effort.

As an initial attempt to address these risks, the Kyoto Protocol's commitment period officially began in January 2008. A number of countries are undertaking substantial actions to limit their emissions. The European Union moved into the second phase of its Emission Trading Scheme (EU ETS), now the world's largest carbon dioxide ($CO_2$) cap-and-trade program, covering approximately half of all EU $CO_2$ emissions. Efforts to promote climate-friendly development in low-income countries have delivered projected emissions reductions in excess of 1.75 billion tonnes of $CO_2$ equivalent through the Clean Development Mechanism (CDM).[3]

The Kyoto Protocol can only serve as the first step in addressing the risks posed by global climate change. The next step in international climate change policy drew substantial attention in 2007. At the Group of Eight industrialized countries meeting in Germany, which was joined by five major developing countries, world leaders called for moving forward through the UN process with the successor to Kyoto. Secretary-General Ban Ki-moon hosted a special high-level session on climate change policy in the UN General Assembly in September and has called for negotiations on this next step to culminate with an agreement by 2009. U.S. President George W. Bush hosted a meeting of 16 major countries from the developed and developing world to address this question in September as well.

In December 2007, the international community came together in Bali to craft a two-year roadmap to guide work in developing the agreement to build on the Kyoto Protocol.[4] This roadmap, officially referred to as the Bali Action Plan, identifies a number of issues that negotiators will have to address to achieve a successful agreement at the 2009 Copenhagen climate change conference. The plan prompts some very important policy questions: What form should the next international agreement take? Should it build on the existing Kyoto Protocol policy architecture or develop a new policy infrastructure? How can it stimulate more substantial emissions abatement while ensuring that society gets the biggest bang for the buck? How can it facilitate adaptation to a climate that is already changing? How can the next step stimulate technological innovation? How can it promote broader participation in the effort to meet the challenge of climate change?

## Existing Policy Architecture

The current international climate policy architecture reflects more than a decade of efforts, starting with several international conferences in the late 1980s. This work culminated with agreement on the UN Framework Convention on Climate Change (UNFCCC), signed at the 1992 Rio de Janeiro Earth Summit and entered into force in 1994 (see the box on page 9 for a guide to this and other climate policy terminology). The framework convention advanced four key elements: a long-term goal of stabilizing greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system";[5] near-term nonbinding quantitative emissions goals for industrialized countries; equity-based differentiation of required efforts among industrialized and developing nations; and preference for cost-effective implementation. The international climate policy architecture has been largely defined by these elements since 1992.

Recognizing the need to take more ambitious efforts, the approximately 190 parties to the UNFCCC negotiated the Kyoto Protocol in 1997. This agreement took a first step toward the UNFCCC's ultimate objective through cost-effective implementation of near-term quantitative targets for industrialized countries. At the time, the protocol was expected to limit industrialized countries' emissions to 5.2 percent below 1990 levels over the 2008–2012 period.

A series of negotiations after the 1997 conference resolved various implementation details in the agreement, and industrialized countries began to ratify the Kyoto Protocol after the 2001 Conference of the Parties in Marrakech, Morocco. By that time, however, President George W. Bush had rejected the Kyoto Protocol and declared that the United States would not ratify it.[6] Despite the withdrawal of the United States, the Kyoto Protocol entered into force in 2005, only after the reluctant ratification by Russia.

### *Strengths of the Kyoto Protocol*

The Kyoto Protocol is the product of intense, long, and politically challenging international negotiations, and the decision by the international community to move forward with it reflects several strengths of the agreement. Substantial investments have been made in developing a variety of institutions under Kyoto—from the more mundane emissions monitoring, inventorying, and reporting to the establishment of a novel market for emissions reductions in the developing world—and this experience can benefit subsequent policy design.

The Kyoto Protocol promotes emissions abatement through a variety of market-oriented institutions and rules—including international emissions trading, broad coverage of emissions sources and sinks, and some temporal flexibility in complying with emissions commitments. These market-based approaches, by lowering marginal and total costs of a climate change policy, can deliver environmental benefits at a lower cost than without such provisions. These cost savings would reduce the economic burden of quantitative emissions commitments that could support compliance.

With its emphasis on commitments of industrialized countries, the Kyoto Protocol embodies several concepts of distributional equity, but it boils down to this: the rich and responsible are expected to lead. In other words, it calls for action by those with higher per capita emissions and higher per capita contributions to the build up of anthropogenic greenhouse gases in the atmosphere, and it also targets those with a much greater ability to pay for emissions mitigation.

### *Weaknesses of the Kyoto Protocol*

The downfall of this approach is that it has contributed to the Kyoto Protocol's primary weakness: the agreement has failed to promote more substantial participation among the world's largest emitters. Three of the five largest do not face binding emissions constraints, despite the fact that they have ratified the Kyoto Protocol: China and India do not have quantitative emissions targets, and Russia's Kyoto commitment is so lax that it likely will not necessitate any abatement for Russian compliance. In addition, the largest greenhouse gas contributor, the United States, has not ratified the agreement. These four countries represented half of global $CO_2$ emissions in 2004, and their share is expected to grow without efforts to limit their emissions.[7]

As a result of this nonparticipation, much of the potential gains from trade are lost, and the total cost of the Kyoto Protocol emissions mitigation effort is higher than it would be with broader participation. The difference in costs across countries can also cause emissions leakage: carbon-intensive firms in countries with emissions commitments and high costs may relocate some operations to countries without commitments, where costs are therefore less. Not only can this so-called leakage reduce the environmental benefit of emissions mitigation in industrialized countries participating under the Kyoto agreement, it can also stir up opposition to climate change policy on competitiveness grounds.

## DEFINITIONS OF KEY TERMS IN THE CLIMATE POLICY DEBATE

**Annex B**: The list of countries taking on legally binding commitments along with a listing of their actual commitments as defined in the Kyoto Protocol.

**Annex I**: Annex I Parties in the UN Framework Convention on Climate Change (UNFCCC) consist of most Organisation for Economic Co-operation and Development countries and those with economies in transition, almost all of which have Annex B commitments.

**Banking**: Saving emissions permits for future use.

**Basket**: Kyoto commitments are denominated in a basket of the six types of greenhouse gases: carbon dioxide ($CO_2$), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

**Bubble**: The Kyoto Protocol allows for aggregate compliance among countries, such as the European Union, that pool their commitments under a bubble.

**Cap-and-trade**: A policy that sets an aggregate emissions cap, establishes emissions allowances that sum to the cap, allocates the allowances to private firms, and allows firms to buy and sell emissions allowances.

**$CO_2$ equivalent**: The $CO_2$ concentration that would cause the same amount of radiative forcing as a given mixture of all greenhouse gases over a specified time horizon.

**Carbon sink**: Any reservoir that takes up carbon released from some other part of the carbon cycle. The atmosphere, oceans, and forests are major carbon sinks because much of the produced $CO_2$ on Earth ends up in these bodies.

**Clean Development Mechanism (CDM)**: Through the Kyoto Protocol's CDM, Annex B parties invest in climate-friendly projects in developing countries that allow them to facilitate compliance with their emissions targets.

**Commitment period**: The Kyoto Protocol commitment covers a five-year period from 2008 through 2012.

**Conference of the Parties (COP)**: The supreme body of the UNFCCC, comprised of member countries to the convention, that holds annual negotiations.

**Emissions leakage**: Emissions abatement achieved in one location may be offset by increased emissions in unregulated locations as firms relocate away from countries with costly emissions mitigation policies.

**The European Union Emission Trading Scheme (EU ETS)**: Specified by Directive 2003/87/EC, the EU ETS creates a $CO_2$ emissions cap over major stationary sources (power plants, cement facilities, steel plants, and other industrial facilities), allocates emissions allowances to regulated firms, and permits allowance trading.

**Geoengineering**: The "deliberate modification of the global climate by means other than by changing the atmospheric concentration of greenhouse gases."[1]

**Hot air**: The amount by which some Eastern European countries' Kyoto Protocol emissions commitments exceed their expected emissions over 2008–2012 without any abatement actions.

**Intergovernmental Panel on Climate Change (IPCC)**: The UN Environment Programme and the World Meteorological Organization created the IPCC in 1988 to advise the international community on the latest research on climate change.

**Joint Implementation (JI)**: Emissions mitigation projects carried out between two or more industrialized countries as defined in Article 6 of the Kyoto Protocol.

**Kyoto Mechanisms**: Generic term for bubbles, JI, CDM, and international emissions trading.

**Meeting of the Parties (MOP)**: The supreme body of the Kyoto Protocol, comprised of member countries to the protocol, that holds annual negotiations.

**Non-Annex I**: All countries that do not belong to Annex I of the UNFCCC—that is, the developing countries and some countries with economies in transition.

**Targets and timetables**: Targets refer to the emissions caps for countries and timetables refer to the timing of the commitment period.

**UN Framework Convention on Climate Change (UNFCCC)**: The multilateral agreement that provides the foundation for international climate negotiations.

1. S. Barrett, "The Incredible Economics of Geoengineering," *Environmental and Resource Economics* 39 (2008): 45–54.

Moreover, the climate benefits of the Kyoto Protocol without U.S. participation are likely to be quite modest.[8] This reflects, in part, the agreement's short-term targets; it does not stipulate medium- or long-term emissions goals. While setting commitments only through 2012 allows the international policy community to learn and adapt policy tools and goals over time, this approach may be inferior to one that sets long-term goals and allows for policy flexibility in deciding on short-term goals and means of implementation.

Another crucial weakness of the protocol is that it not only provides poor incentives for participation among the large industrialized countries, it effectively prohibits developing country participation. At the Kyoto Conference, a provision to create a mechanism to allow developing countries to voluntarily adopt emissions commitments in the future was rejected. Argentina challenged this prohibition with a proposal for an emissions commitment in 1999,[9] but it received no support for modifying the protocol to allow for voluntary accession. Even if countries initially participate under the agreement, it may not provide strong incentives for their compliance: a provision allows countries to withdraw, suggesting that "legally binding commitments" may not be so binding after all. Some countries' emissions are so high now that it is difficult to envision their compliance with their Kyoto Protocol target.[10]

## Potential Architectures for the Post-Kyoto World

Some policymakers and scholars have been critical of the Kyoto Protocol, noting that because of specific deficiencies, it will be ineffective for the problem and relatively costly for the little it accomplishes. Others have been more supportive, noting that it is essentially the "only game in town."[11] Both sides agree, however, that whether this first step is good or bad, a second step will be required. Given the global commons nature of the climate change problem, a central element of the second step will most likely be an international agreement.[12]

The Bali roadmap calls for a series of international negotiations to design the post-2012 climate policy architecture, culminating with the Copenhagen climate change talks scheduled for December 2009. In launching this process, the Bali agreement identifies a number of topics that merit consideration in the negotiations: a long-term global goal, mitigation commitments and actions, adaptation, technology transfer, and financial mechanisms to support policies across these issues.

The potential shape and structure of an international agreement—its architecture—can best be understood by considering specific ideas for successors to the Kyoto Protocol that address these topics in the Bali roadmap. To frame the broad policy space, in May 2006, a workshop hosted by the Harvard Environmental Economics Program commissioned six papers. Some ideas build on the foundation established by the UNFCCC and the Kyoto Protocol, while others clearly focus on the need to develop substantially different approaches to international cooperation and coordination on climate policy. The six proposals can be categorized into three principle types of architectures: targets and timetables, harmonized domestic actions, and coordinated and unilateral policies.

### *Targets and Timetables*

The existing international climate policy framework focuses countries' efforts through targets and timetables—quantitative country-level emissions goals over a specified timeframe. Proposals based on targets and timetables for the post-2012 world would maintain the international emissions trading and clean development project institutions that have received broad support in Europe and developing countries. They attempt to remedy the primary drawback in the Kyoto Protocol by explicitly addressing participation by the United States and developing countries.

Jeffrey Frankel of Harvard University proposes "An Economist's Kyoto."[13] In contrast to the current international regime of periodic, ad hoc negotiations, his proposal sets country-level quantitative targets through formulas based on income, population, historic emissions, resource endowments, and other variables. In the short run, these formulas would yield progressive targets and converge to equal per capita emissions targets in the long term. Frankel supports international emissions trading and sufficiently generous commitments for developing countries to ensure that they would enjoy net benefits, not net costs, from near-term participation in the global climate policy regime. Emissions targets for developing countries could also be indexed to their economic growth, like the 1999 Argentine proposal, to minimize the potential for a target to become unexpectedly stringent or lax if a country's economy grew faster or slower than expected.[14]

Axel Michaelowa of Perspectives Climate Change (Germany) proposes a "Son of Kyoto" approach that builds on the Kyoto framework by deepening and expanding quantitative emissions targets.[15] He advocates a global long-term atmospheric stabilization goal of 550 parts per million $CO_2$ to be achieved through quantitative, legally binding, country-specific targets. Countries with emissions commitments could engage in international

emissions trading. Developing countries would take on emissions targets through a graduation mechanism: as their per capita emissions and per capita gross domestic product exceed certain thresholds, they would have to take on more and more ambitious targets. Upon graduating to a higher threshold, a country's target would tighten to match that of countries with similar emissions and income profiles.

### Harmonized Domestic Actions

Some academics and policymakers argue that because national governments maintain their sovereignty when they establish international institutions, the design of policy architectures should focus on national and—in some cases—regional institutions. Top-down architectures, such as those based on multilateral agreements on targets and timetables, may not provide robust incentives for participation and compliance. Some visions of the successor to the Kyoto Protocol attempt to circumvent the disadvantages of global institutions by harmonizing actions across much stronger national and regional institutions.

David Victor of Stanford University proposes a "Climate Clubs" policy architecture that focuses on a varying geometry of participation, limited initially to the few most pivotal countries in climate change.[16] He recommends the development of an agreement in a smaller negotiating venue, such as former Canadian Prime Minister Paul Martin's proposal for an "L20"—a forum of the leaders of 20 key industrialized and developing countries. These countries would pledge a package of domestic climate policies and measures, and they could establish regional carbon markets, such as the EU ETS, to harmonize the price of carbon across participating countries. Such regional emissions trading regimes could emerge much like regional trade agreements for goods and services that evolved into the current, top-down World Trade Organization. Industrialized countries also should directly fund large climate-friendly projects that align with the development interests of developing countries.

Warwick McKibbin of Australian National University and Peter Wilcoxen of Syracuse University propose a "Coordinated National Cap-and-Trade" architecture that relies on the strength of domestic institutions.[17] All participating countries would implement the same domestic policy—national-level cap-and-trade—although they would have discretion over how to set their domestic emissions targets. They propose giving away all permits to regulated firms, which would constitute a major subsidy,[18] to elicit private sector support for climate policy. In contrast to the current EU ETS, this proposal would forbid international emissions trading but allow for some price coordination. Countries would agree on an internationally harmonized safety valve: regulated firms could buy additional emissions permits from their governments at a pre-determined price that effectively imposes a price ceiling in the permit market.

Some have suggested that the effort to develop a comprehensive, elegant, top-down architecture is not viable in a world in which incentives are driving a bottom-up international climate policy.

### Coordinated and Unilateral Policies

Some have suggested that the effort to develop a comprehensive, elegant, top-down architecture, akin to a gothic cathedral, is not viable in a world in which incentives are driving a bottom-up international climate policy, like *favelas*—the ramshackle neighborhoods that have emerged outside of Rio de Janeiro.[19] Proposals that dismiss the status quo approach of dictating the goals countries should pursue instead would rely on individual countries to coordinate policies or to implement unilateral policies. These bottom-up architectures could eventually evolve into a more cohesive international architecture, as countries gain more experience with their domestic efforts and understanding of other countries' activities.

Scott Barrett of Johns Hopkins University proposes a mix of coordinated and unilateral country-level policies through his "Multi-Track Approach."[20] He calls for such measures as emissions mitigation actions with subsequent multilateral reviews and enforcement through moral suasion. To promote the development and deployment of climate-friendly technologies, Barrett recommends a protocol in which countries contribute funds to a coordinated international research and development program, coupled with a technology standards protocol that would mandate deployment of new technologies. Rich countries should also finance technology transfer to developing countries. Barrett proposes more substantial adaptation assistance for developing countries, with a focus on the investment of global public goods for development, such as investments in malaria prevention and control. He also advocates for research and development in various geoengineering responses as an insurance policy in case we learn that climate change will be more severe than currently believed.[21]

William Pizer of Resources for the Future takes a pragmatic approach with his "Pledge and Review" proposal.[22] He calls for the largest emitters to pledge specific actions and policy commitments based on strong domestic political support, which can take any form (such as cap-and-trade, taxes, or a suite of technology standards). These commitments would be nonbinding, and there would

be no minimum commitment necessary to participate; they would rely on naming and shaming to promote serious action. Countries could link their activities, such as among EU member states. Rolling five-year reviews of national policies, patterned on the Organisation for Economic Co-operation and Development (OECD) country review process, would serve as the means for evaluating effort. These reviews would focus on emissions mitigation, technology development, and developing country engagement. Every five years, a major evaluation of progress would be undertaken and a new round of commitments put forward.

## From Bali to the Post-Kyoto World

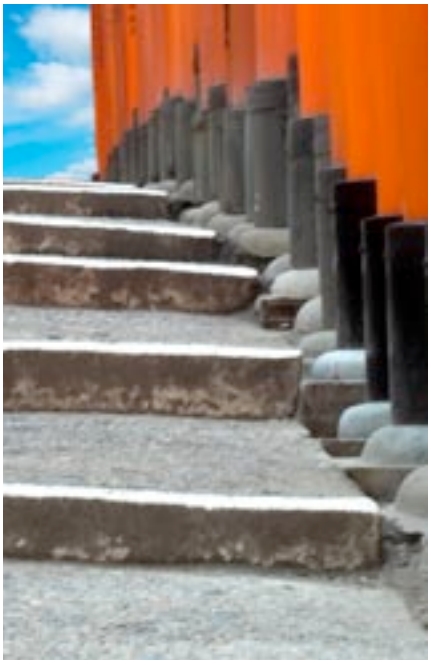
What form should the next international agreement take? The Bali roadmap frames the negotiations to draft the successor to the Kyoto Protocol and raises a number of important questions:

- Should we build on the existing Kyoto Protocol policy architecture? Or should we develop a new policy infrastructure?
- How can the next agreement stimulate more substantial, cost-effective emissions abatement?
- How can the next architecture facilitate adaptation to climate change?
- How can the next step stimulate technological innovation?
- How can the post-2012 climate policy architecture promote broader participation?

### *Build on Kyoto or Make a New Policy?*

Because the Kyoto Protocol and its associated implementation agreements reflect a tremendous investment and commitment by much of the international policy community, some have argued the Kyoto framework should be modified only slightly to provide an avenue for developing country participation while moving forward with even more ambitious emissions caps for developed countries, including the United States.[23] Others challenge that the top-down approach is not viable in a world where no supranational authority exists to enforce such an agreement.[24]

Proponents of the top-down approach believe that setting binding country-level emissions targets is critical to achieving long-term quantitative goals, such as stabilization of atmospheric concentrations of greenhouse gases. This style of policy also explicitly delineates the goals for various countries and can aim to differentiate efforts across classes of countries. It can also be expanded to specify the types of actions, such as various policies



and measures to mitigate emissions, for participating countries.

On some matters, a common global standard can greatly facilitate many aspects of climate change mitigation. The UNFCCC and the Kyoto Protocol have established standards and methods for monitoring, inventorying, and reporting greenhouse gas emissions. Such common standards could be critical to the evolution of either top-down or bottom-up emissions trading. Understanding and communicating the effects of climate change as well as the efficacy of climate change policies through regular, standard reporting obligations can also ensure that policymakers are well informed as they consider next steps in mitigating climate change. Coordinating efforts on technology transfer, to ensure that redundant efforts are not pursued and that important options are not inadvertently neglected, would also appear superior to unilateral, bottom-up efforts.

Reflecting the concern that a top-down multinational cap-and-trade program is simply not viable in a world with national sovereignty, a number of analysts have focused on bottom-up, pledge-and-review approaches to climate policy architecture. Climate change policy could evolve from national actions through small groups of like-minded countries.[25] Whether such an approach will yield more than unilateral, uncoordinated efforts depends on whether it will evolve into a cohesive process. It has been argued that climate change policy focused on regional and fragmented programs could evolve in an analogous way to regional trade blocs,[26] which permitted countries to understand and inform the development of the world trade regime, and also provided an opportunity for countries to develop trust in one another. This bottom-up approach, however, may be broad in terms of participation, but very shallow in terms of actions.[27]

Decentralized pledge and review efforts may provide one more benefit beyond securing broader participation. The heterogeneity in policy approaches taken at national and regional levels can serve as a large set of case studies on policy design and implementation that can inform industrialized and developing countries alike about what does and does not work.[28] Many countries may prefer the discretion to design and implement climate change mitigation policies more attuned to their norms, polity, and economic characteristics instead of a one-size-fits-all approach.[29]

It should be clear that the apparent stark binary choice of simply replicating Kyoto with tweaks or starting all over from the bottom up does not appropriately capture the array of options. In a sense, the world community can build on Kyoto *and* develop a new policy infrastructure. Or,

framed another way, the world is already pursuing a hybrid bottom-up and top-down approach. Parts of the world have pursued the top-down Kyoto approach, while others, such as the United States, have taken unilateral action on climate policy. Modest plurilateral efforts, such as the Asia Pacific Partnership focused primarily on developing new climate-friendly technologies for use in the energy and industrial sectors, also reflect the emergence of bottom-up, multicountry agreements on climate-related issues. A number of unilateral commitments with serious climate change impacts have been made, from the EU's January 2008 package of energy and environmental policies[30] to China's Five Year Plan goal to cut the energy intensity of economic output by 20 percent.[31] These kinds of domestic policy goals could serve as the basis for a bottom-up pledge and review or as the starting points for negotiations over top-down commitments. Which approach should be pursued could be simply evaluated by the question of which one can deliver more climate change mitigation now and lay the foundation for more substantial efforts in the future.

To support such an endeavor, it will be valuable to improve our capacity to assess the comparability of effort accomplished from one country to the next and the adequacy of the total effort in mitigating climate change risks. The world cannot go on assessing "effort" as a country's emissions relative to 1990, since many countries (especially the economies in transition) have emissions well below 1990 levels for reasons completely unrelated to climate policy. In the future, effort may be better measured by the economic burden or cost of climate change policies, such as is evident in emissions permit prices, the cost of performance or technology standards, or carbon taxes. Economic modeling may provide estimates of emissions abatement across countries and inform this comparison. This may require the establishment of a formal institution with a professional bureaucracy, akin to the OECD, with its reviews of member states' economic policies, and the International Monetary Fund, with its Article IV consultations on member countries' fiscal and monetary policies.

### *Stimulating More Substantial, Cost-Effective Abatement*

Few would argue that society ought to spend more than necessary to address the risks posed by global climate change. Market-based instruments, such as emissions trading or emissions taxes, can serve as the means for achieving climate policy goals at relatively low cost. In a world with scarce resources, the more cost-effective the means are, the more feasible an ambitious goal is. In addition, lower costs of implementation can facilitate greater participation and compliance with climate goals.

Proponents of the top-down approach believe that setting binding country-level emissions targets is critical to achieving long-term quantitative goals.

International emissions trading serves as the cornerstone of several proposed international policy architectures.[32] In addition to yielding least-cost emissions mitigation, such international emissions trading can serve as a vehicle for transferring funds to developing countries. This provides compensation that may be necessary to secure participation by developing countries and could entice countries with low costs of emissions abatement to join the international regime.[33]

Despite the advantages of international emissions trading, national sovereignty means that countries cannot legally be coerced to take actions against their self-interest. Hence, the integrity and stability of an international emissions trading regime may be in doubt. What happens if a low-cost supplier of emissions permits decides to drop out of the regime? Or if a country with high abatement costs, and thus significant demand for permits, decides to drop out? To circumvent these potential problems, some scholars advocate a set of national-level cap-and-trade programs.[34] To promote cost-effective global abatement, countries could coordinate their domestic programs by harmonizing the price of permits offered by governments. This implicit agreement on a safety valve price would serve as the basis for equating costs across countries. Such a set of national cap-and-trade programs could comprise a system of pledge and review commitments by proponents of bottom-up policy design.[35] These national cap-and-trade programs could also create links with other such programs and allow for a bottom-up emergence of an international emissions trading regime.[36]

The immediate gains from linking national-level cap-and-trade programs may be modest, because permit prices of existing emissions trading programs are similar.[37] Even if this holds in the long term, however, the value of the cap-and-trade approach remains. First, because domestic and regional cap-and-trade programs would exploit the low-cost abatement opportunities within their markets, cost-effective implementation would characterize domestic actions. Second, a set of domestic and regional cap-and-trade programs with similar permit prices but little or no interprogram linkage is comparable to coordinated but insulated national programs or harmonized carbon tax policies. In each case, firms and households across participating countries would bear similar costs for emitting greenhouse gases, and modest, if any, international transfers would be involved.

Even those who are highly skeptical of international emissions trading still support some form of cost-effective implementation. As an alternative to emissions trading, some have called for an internationally harmonized carbon tax.[38] As mentioned, this would provide similar incentives for abatement as an emissions

trading regime. However, a tax may have less appeal because it eliminates the potential for an implementation mechanism to transfer resources to low-income countries that may otherwise be reluctant to undertake emissions mitigation activities.

Meeting the challenge of addressing climate change will be expensive. In the long term, it will require a substantial reworking of the energy foundation of industrial economies. A successful climate policy architecture should promote cost-effective climate change mitigation, and market-based approaches, such as emissions trading and emissions taxes, are the best means to that end. The unresolved question is whether such systems can be imposed from the top down, as in the Kyoto Protocol, or whether a more viable framework would evolve organically from a variety of national and regional regimes.

### Adaptation

The Kyoto Protocol only references climate change adaptation in two paragraphs,[39] and in the 1990s, many environmentalists expressed concern that attention focused on adaptation would weaken the support for ambitious emissions mitigation goals. The interest in promoting adaptation has grown substantially since 1997, however, and the next agreement will need to do more to address this issue. Even if the world undertakes dramatic emissions mitigation, the climate will still undergo further change, and some of the most vulnerable populations may suffer from climate-related shocks, such as drought, more intense extreme storms, or increased range of infectious diseases.

In identifying the appropriate international policy response to adaptation needs, the international policy community should make two kinds of assessments. First, adaptation policy should focus on producing public, not private goods, and international adaptation policy should focus on producing global public goods. For example, farmers and the agribusinesses that support farmers have incentives to create and use seeds that are more resilient to the changing climate. The government does not need to step in to promote the development of these new seeds. The government can, however, facilitate adaptation by providing information, a public good, about the likely effects of climate change on growing conditions through continued climate and agronomic research. In some cases, the public good is not international in nature; national governments should have adequate incentives for providing them. For example, the sea walls, dikes, and levees that the Netherlands currently employs all produce benefits for the Dutch population, but the Netherlands has sufficient incentive to provide this public good without an international policy. Global public goods for development, such as through improved international public health infrastructure, would merit support through international adaptation policy.

Second, international adaptation policy focused on national and local public goods may be reasonable in the context of facilitating adaptation among the most vulnerable with the least capacity to adapt. Developing countries have fewer resources, less human capital, less technological capacity, inadequate public health infrastructure, and weaker governance institutions to adapt to climate change than industrialized countries.[40] Developing countries also tend to have a larger share of their economies in climate-sensitive sectors, such as agriculture, forestry, and fisheries.[41] For example, although Bangladesh may have the incentive to build a system of sea walls and levees to protect the large share of its population at risk to sea level rise, the country may not have sufficient resources to make such adaptation investments, nor may it have access to the appropriate technology to adapt to the changing climate.

Effective international adaptation policy then would be intricately linked with development policy. Sustainable development policies and measures could incorporate climate change efforts into development priorities.[42] Revenues from industrialized countries, for example, through emissions permit auctions or carbon taxes, could finance such measures. Commitments from industrialized countries to mitigate climate change risks could be structured more broadly than simply emissions mitigation goals; they could also include commitments to finance adaptation in and to transfer appropriate technologies to the developing world. While additional work needs to be undertaken to inform the design of adaptation policy, the challenge appears to lie in making development more climate friendly *and* making climate policy more development friendly.

### Technological Innovation

An adequate, long-term effort to address climate change will require the development and deployment of zero-emitting technologies. To stimulate the innovation necessary to deliver these new technologies, international climate policy should create both push and pull incentives. The most effective incentives to pull new technology into the market are those that put a price on greenhouse gas emissions, like a cap-and-trade system and a carbon tax. These policy instruments would induce technological change and discourage the continued investment in carbon-intensive capital.

An alternative approach could subsidize investment in new, climate-friendly technologies. For example, the United States, United Kingdom, and Japan announced in early 2008 their intent to finance a new clean technology fund for developing countries. Some have described this as part of the "climate change Marshall Plan" necessary to reorient economic development along a less emissions-intensive path.[43] Interestingly, proponents of a bottom-up approach to international climate policy have also alluded to the Marshall Plan because of its focus on actions and "reciprocal multilateral scrutiny."[44] Implementing a multibillion dollar technology fund will necessitate an efficient mechanism for disbursing funds and allocating technologies. One approach that could merit attention would be a reverse auction.[45]

Instead of directing government funds for the deployment of climate-friendly technologies in developing countries, countries could fund directly the develop-

ment of technologies through a research and development protocol.[46] Focused efforts to improve quality and lower the costs of climate-friendly goods and services can help push new, innovative technologies into the marketplace. As long as a sufficient number of large countries employ the new technologies, they would become the de facto world standard. The challenge for this proposal is twofold: securing sufficient funds for collaborative research and development, and developing a streamlined process for negotiating international technology standards.

### *Broader Participation*

A policy architecture that cannot secure broad participation cannot deliver environmental benefits in the long run in a cost-effective or equitable manner. Promoting participation may be the greatest challenge for the design of climate policy architecture. No policy architecture can be successful without the United States, Russia, China, and India taking meaningful actions to slow their greenhouse gas emissions growth and eventually reduce their emissions.

One approach is to engage domestic constituencies. For example, the free allocation of permits in a cap-and-trade program can create vested interests in maintaining national emissions programs.[47] Implementation policies can be tailored to provide incentives for participation. Giving "headroom emissions" allocations to developing countries—that is, granting them permits to more than cover their forecast business-as-usual emissions—can reduce downside risk of high compliance costs.[48] Combined with a system of international emissions trading, these less stringent targets can allow developing countries to become net exporters of emissions permits. The trading regime becomes the mechanism for the side payments necessary to secure developing country participation.

Other approaches could be pursued to minimize downside risk to developing countries. The current climate policy architecture, as embodied in the UNFCCC and the Kyoto Protocol, calls for climate change mitigation efforts consistent with the principle of "common but differentiated responsibilities,"[49] which has been translated in practice into a set of specific, quantitative emissions commitments for industrialized countries and no emissions mitigation obligations for developing countries. But there are two reasons why developing countries will have to take action. First, the substantial majority of forecast greenhouse gas emissions in the twenty-first century will occur in developing countries. Even if the developed countries reduce their emissions to zero, such growth in emissions in developing countries would preclude atmospheric stabilization of greenhouse gas concentrations in this century. Second, many developing countries are emerging economically and surpassing some of the poorest countries with Kyoto Protocol targets. For example, Romania, the poorest country with a Kyoto target, has lower per capita income than more than 50 countries without such targets. We cannot expect some countries to adopt targets and limit their emissions while others pass them by economically. The Kyoto Protocol provides no option for developing countries to take on quantitative targets, but future climate policy architecture will need to establish a fair process for securing developing country participation.

> Few would argue that society ought to spend more than necessary to address the risks posed by global climate change.

Along these lines, several analysts have proposed rules for graduating into a system of quantitative emissions commitments.[50] The graduation and stringency criteria typically employ per capita income or per capita emissions as the basis for determining when individual developing countries should be obligated to take on commitments. This notion of progressivity is implicit in the Kyoto Protocol commitments, which increase in stringency with per capita income. Although this outcome resulted from an ad hoc negotiating process, future agreements could be based on formulas that maintain such progressivity.[51] Emissions targets also can be indexed to economic output to ensure that greenhouse gas limits do not constrain economic growth. This approach reduces the likelihood that developing country participation would relax the aggregate cap on participating countries' emissions via international emissions trading.[52]

The problem with such approaches to promoting participation is that they assume there are some countries willing to take on more stringent targets and make side payments. For example, if the United States does not want to take on an ambitious emissions target, there will be much less demand and thus lower prices for the permits developing countries would aspire to export. Creating the incentive for some countries to participate should not simultaneously create the disincentive for others to do so. Alternatively, developing country participation could be promoted with direct payments, as in the Montreal Protocol.[53] The challenge lies in whether governments of developed countries would be willing to finance substantial transfers to developing countries.

It may be possible to promote more participation by enlarging the issues under consideration. Integrating climate change measures in the development agenda and the trade agenda may serve as opportunities for effective issue linkage. Some have suggested that countries without emissions commitments should have their exports subjected to border tax adjustments based on the carbon content of their goods. The Montreal Protocol allowed for trade sanctions, and climate change policies could also incorporate such penalties.[54]

In contrast, it has also been suggested that negotiations should be reformed to

a more manageable number of countries. The UNFCCC process, with some 190 member countries, is slow and bureaucratic. A smaller group of the most important industrialized and developing countries could agree on a new climate change policy architecture through a simpler, more efficient negotiating process.[55]

## Conclusion

The global, long-term nature of climate change necessitates a robust climate policy architecture that can provide the basis for multilateral and national actions. Richard Schmalensee at MIT highlighted this need for a long-term policy architecture in his 1998 review of the Intergovernmental Panel on Climate Change's assessment of policy instruments. There, he called for the "establishment of effective institutions for policymaking, as well as a policy architecture that permits efficient transitions between particular policies. 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."[56]

The next step in building international climate policy should be broader than the Kyoto Protocol, both in terms of the number of countries with obligations and perhaps the suite of policies to be employed. An important challenge is determining whether a bottom-up approach is superior to a top-down approach. If negotiations over a comprehensive, top-down approach hinder the development of domestic cap-and-trade programs or other serious efforts, then the international community should consider transitioning to a pledge and review of mitigation efforts. An effective policy architecture is one that facilitates action, not imposes paralysis through a slow process.

Second, a climate policy architecture should support adaptation efforts. Climate change is occurring and will continue to occur to some extent regardless of efforts to mitigate greenhouse gas emissions. A climate policy architecture could focus on leveraging research and development efforts to meet the needs of those countries that are most vulnerable and lack the technology and human capital to invest in efforts to reduce their exposure to climate change.

Third, continued investment in research and development is necessary, especially that focus on emissions mitigation, adaptation technologies, and geoengineering. Stabilizing long-term atmospheric greenhouse gas concentrations will require the development and deployment of low-carbon and, eventually, zero-carbon emitting technologies on an extensive scale. Continued research and development efforts can ensure that these technologies are both feasible and commercially viable at modest costs in the future. Such emissions mitigation efforts should focus on zero-carbon energy sources, improvements in energy efficiency, and carbon capture and storage technologies.

Finally, an effective climate policy architecture should be flexible enough to adapt to new information about climate science, as well as development and other economic and technological factors. It should allow for informed updating of objectives in response to new information. Continued research on climate science and economics can inform the stringency of policies, and learning about the efficacy and costs of various policy mechanisms can inform subsequent policy design. This flexible policy framework might also provide the opportunity for fruitful linkages with trade, development, and other policy agendas.

The Kyoto Protocol, the world's first step to address global climate change, was not perfect. The next step does not need to be perfect either, but it ought to be an improvement. A next step needs to be taken, and it should reflect what has been learned through the experience thus far in the design and implementation of international climate change policy. There is no simple, universally accepted way for the world to move forward on this exceptionally difficult set of challenges. The climate policy architecture built for the second commitment period and beyond needs to provide the basis for continued efforts to address the problem, as well as the flexibility to adapt to new information. A policy architecture with these characteristics may be one that can secure sufficient international political support to move forward.

Focused efforts to improve quality and lower the costs of climate-friendly goods and services can help push new, innovative technologies into the marketplace.

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The Harvard Project on International Climate Agreements helps identify key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for global climate change. The project is supported by a grant from the Doris Duke Charitable Foundation's Climate Change Initiative. It draws upon leading thinkers from academia, private industry, government, and nongovernmental organ-

izations to construct promising policy frameworks, and then disseminate and discuss the design elements and frameworks with U.S. and international decisionmakers. For more information, please refer to the Project's Web site at http://www.belfercenter.org/climate.

## NOTES

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