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STATE OF THE WORLD

Into a Warming World

THE WORLDWATCH INSTITUTE

Sealing the Deal to Save the Climate

Robert Engelman

The atmosphere is kind. It takes the carbon dioxide (CO₂) and other heat-trapping greenhouse gases that humans create and disperses them equally all over the world. But that is also its cruelty. The accumulation of these waste gases over the decades, disproportionately from industrial countries but increasingly from some rapidly developing ones, is overwhelming the planet's energy balance and heating up its surface. This accumulation must end, but how that will happen is hard to imagine. The mechanisms needed must engage all humanity in ways that are manifestly fair to all.

Saving the global climate and protecting ecosystems in a warming world must become a national interest for each of nearly 200 sovereign states. Negotiating a successful treaty that achieves this will be a diplomatic feat unlike any in history, given the stark inequalities in per capita emissions levels and income—and all the harder given that solving the climate problem will likely require some real sacrifice.

This is nothing like war, in which military

might defeats the enemy and dictates the peace. Rather it is an emergency with long-term risks comparable to world war but requiring the surrender of no one and the cooperation of all. An economically and demographically diverse world of 6.7 billion people reaches for more energy, food, mobility, and creature comforts even as it enters the early stages of human-driven warming. And that world grows by 78 million people each year.¹

In a tragedy of the commons as big as all outdoors, each country benefits directly from actions within its borders that release greenhouse gases, but the emissions themselves dissipate into thin air and spread their impacts globally. The atmosphere recognizes no borders and considers no molecule an illegal immigrant. And there is an added twist of inequity to this commons: the people least responsible for loading the air with heat-trapping gases tend also to be the ones most vulnerable to the impacts of the warming now beginning. (See Box 6–1.)²

Defying the natural imbalance of national

Box 6–1. Equity and the Response to a Changing Climate

Many scientists expect that poor countries with little responsibility for today's climate instability will be hit hard by climate change. This asymmetry of circumstance prompts a pressing question: Can climate treaties be built on strong principles of fairness?

In truth, equity already plays a role, albeit a limited one, in climate agreements. The Kyoto Protocol, for example, is based on the principle of "common but differentiated responsibilities," which recognizes different obligations for parties in different economic and emissions positions. And the Kyoto negotiating positions of many countries—from France and Iran to Brazil and Estonia—incorporated specific equity dimensions.

But fairness concerns are likely to assume a higher profile in future climate negotiations as the demands of climate stabilization become more burdensome. Two nagging questions in particular have equity at their core: How should rights to emit greenhouse gases be allocated? And who should bear the costs of emissions reductions and adaptation to climate change?

A broad range of answers is given to these

questions—each grounded in one or more climate equity principles. On emissions rights, for example, two very different principles are often cited by proponents of allocation schemes:

- The Egalitarian Principle states that every person worldwide should have the same emission allowance. This principle gives populous countries the greatest number of emissions rights. India, for example, with 3.8 times as many people as the United States, would be entitled to 3.8 times the emissions allowance available to the United States.
- The Sovereignty Principle argues that all nations should reduce their emissions by the same percentage amount. Large emitters would make large absolute reductions of greenhouse gases, while low-volume emitters would make smaller absolute reductions. Thus under an agreement to reduce emissions of carbon dioxide by, say, 10 percent, the United States would cut output by some 579 million tons of CO₂, while India would reduce its emissions by 141 million tons.

Two other principles are often invoked to determine the economic burden of curbing

and global interests, many countries—especially those of the European Union (EU) and, impressively, China—have been acting in recent years to slow the growth of their emissions. Representatives of most of the world's governments have been meeting regularly since the late 1980s to craft ways in which all countries can agree to stop changing the planet's climate. Most nations—although not the historically largest emitter, the United States—ratified an international climate agreement termed the Kyoto Protocol, which went into force in 2005. The agreement requires industrial-country signatories to control emissions of carbon dioxide and five other key greenhouse gases to levels somewhat below (or in a few cases somewhat above) those recorded in 1990.³

What Will It Cost?

The requirements to control greenhouse gases have economically benefited some developing countries that signed the Kyoto Protocol but are not obligated by it to cut their own emissions. And they probably have meant the avoidance of some emissions that would have occurred. By official count, trading in 2006 and 2007 in emerging worldwide carbon markets—a novel mechanism that has arisen from international climate agreements—will prevent an estimated 1.5 billion tons of CO₂-equivalent emissions. This is less than 2 percent of global emissions in those two years—not enough to noticeably slow the warming in progress, but possibly a start.⁴

In working toward the Kyoto goals, about \$19.5 billion moved from industrial to devel-

Box 6–1. continued

climate change for different nations:

- The Polluter Pays Principle asserts that climate-related economic burdens should be borne by nations according to their contribution of greenhouse gases over the years. Since 1950 the United States has emitted about 10 times as much CO₂ as India; using this historical baseline suggests that the U.S. bill for dealing with climate costs should be about 10 times greater than India's. (The difference would be greater still if the baseline were set at 1750, roughly the start of the Industrial Revolution.)
- The Ability to Pay Principle argues that the burden should be borne by nations according to their level of wealth. If gross domestic product figures are used to determine how much each country pays, the U.S. responsibility would be some 12 times greater than that of India.

A 2006 survey of climate negotiators from a broad range of nations revealed that the vast majority believe equity considerations should figure in climate negotiations. The survey found a relatively high degree of support for the Polluter Pays and the Ability to Pay Principles, and a rela-

tively low degree of support for the Sovereignty Principle, consistent with a general sense in the international community that wealthy historical emitters should pay more and poor countries should pay less.

In the end, agreement on emissions allocations may require a mixture of different principles. Some analysts, for example, see egalitarianism as a desirable long-term equity goal, with other principles used to transition to an egalitarian outcome.

These four equity principles address only the distributional dimension of climate equity concerns. Other principles are used to assess the equity of outcomes (how fair is the result of climate negotiations?) and of process (how fair is the procedure by which deals are negotiated?). The result is a thicket of principles, often conflicting, that will compete for policymakers' attention as climate negotiations unfold in the years ahead.

—Gary Gardner

Source: See endnote 2.

oping countries during those two years. (This figure, while impressive, is less than a fifth as much as the money transferred annually from industrial countries in development assistance—\$107 billion in 2005—and is dwarfed by the remittances that immigrants send to their home countries, which totaled \$300 billion in 2006). These payments have come through the Kyoto Protocol's Clean Development Mechanism (CDM), designed to reward industrial nations for emissions reductions they effectively purchase from developing countries by sponsoring energy development projects that are less emissions-intensive than would have been constructed otherwise.⁵

A worldwide network of carbon markets worth \$64 billion in 2007 has developed, with \$50 billion of that moving through the

European Union's Emissions Trading Scheme. Both these numbers are more than double their values in the previous year. Officially they imply the retirement, avoidance, or other offsetting of 3.0 billion tons of CO₂-equivalent emissions. As with other high-finance instruments, however, emissions credits are often held and resold multiple times, so the emissions avoidance that underlies many credits might not become real for years.⁶

One little-noted source of greenhouse emissions reductions is an international environmental agreement not directly related to climate change: the Montreal Protocol, which went into force in 1989. Countries agreed to phase out the production of gases that eat away the atmospheric ozone shield—the world from hazardous levels of the

sun's ultraviolet radiation. Since these gases powerfully add to the warming of Earth's surface, phasing them out offers a double benefit. Some of the gases now moving into production to replace those that deplete ozone also trap heat, however. So the final impact of the Montreal Protocol on climate depends to a large extent on future production levels of these newer greenhouse gases.

All this said, greenhouse gas emissions have been rising significantly—and, in recent years, at an accelerating pace—despite ongoing diplomatic efforts and the growth of a market designed to reduce CO₂ emissions. The leading economy in this greenhouse emissions boom is now China, the world's most populous and economically dynamic country. The government there has given priority to the development of renewable energy and has committed to reducing the carbon-dioxide intensity of its economy. Yet coal-reliant China has singlehandedly accounted for two thirds of the world's growth in carbon dioxide emissions from electric power generation since 2000. This is probably the best example of one of the problems that most hinders a global climate solution. The United States and other industrial countries account for an estimated 76 percent of all greenhouse gas emissions from 1850 to 2002. But developing countries—with their more rapidly growing population and economies—will drive the bulk of the buildup expected in the future.⁷

Vast tracts of new forests and a conversion of most of the world's farms to practices that allow soil to capture and store atmospheric carbon could remove some of the buildup of carbon dioxide. (See Chapter 3.) As climate change raises the risk of forest fires and droughts, however, it will be hard to be certain that carbon stays securely locked away in farms and forests. Such approaches nonetheless offer one exit strategy for the CO₂ already

in the atmosphere. But they need to be paid for by the wealthier countries that are responsible for most past emissions. And to prevent as many future emissions as possible, the world's wealthier countries will need to finance much or even most of the reductions needed in poorer countries—whether these reductions come from avoiding deforestation and land degradation or constructing wind turbines rather than coal-fired power plants—as well as those achieved within their own borders.

The \$19.5 billion provided in 2006 and 2007 by a few industrial countries for emissions reductions in a few developing countries helps blaze a path toward the reductions the world needs. But the path must very soon become—to use an inappropriate metaphor—a multilane highway. And this highway awaits construction, even as industrial countries themselves need to invest massively to boost energy efficiency at home, shift from fossil fuels, and develop climate-friendly ways to produce food, goods, and services.⁸

Among the most respected estimators of the total global costs of this transition is Nicholas Stern of the London School of Economics and Political Science, who pegs the needed spending at 2 percent of gross global product for decades to come. That works out to more than \$1 trillion a year—a daunting figure, but smaller than the \$1.5 trillion that oil consumers send annually to oil producers, and much less than the \$4.1 trillion the world spends on health. These comparisons help put in perspective the public relations challenge of financing a truly significant reduction of climate change risk. Yes, improving energy efficiency and shifting from fossil fuels helps countries deal with high energy prices, avoid pollution, and build energy independence. But based on current experience, these motivations fall far short of what will be needed to really “save the climate.” Will most

people come to see reducing that risk as comparable in importance to their own need for good health?⁹

Without more insistent public outcries about the risks climate change poses, that will not happen soon—maybe not until impacts are much more severe and the process is all the harder to stop. In that future, the world may face the real and incalculable long-term costs of past inaction and think wistfully about lost opportunities to invest in emissions prevention. Still, the upfront costs of effective prevention today seem huge, with uncertain benefits. And the size of the needed financing is only one among many obstacles to arriving at a workable world climate pact.

Who Will Emit?

Given the challenges, it is not surprising that the current negotiating process on climate change is forbidding in its complexity and far from any certainty of success. Even on financial issues that many governments take more seriously than climate change, negotiations sometimes founder. In July 2007 a round of world trade talks that had continued for seven years suddenly collapsed in unbridgeable disagreement, with no prospect they would start up again anytime soon.¹⁰

But the round of intergovernmental climate talks now in progress under the auspices of the United Nations is the only game on the planet likely to lead to cuts in global emissions on the scale needed. It deserves public attention and political support despite the seemingly impenetrable raft of proposed mechanisms and the tortuous frustrations of working toward an agreement. Given the past resistance of the U.S. government to any international action or commitments on emissions reductions, the new president taking office in January 2009 has an important opportunity. He can demonstrate the leadership the world needs to work

out an effective agreement to save not just the global climate but perhaps human civilization itself, in negotiations that will culminate in Copenhagen in late November 2009.

No one knows how much the world can warm above preindustrial levels before the changes become truly catastrophic. But some scientific assessments and their acceptance by the European Union, the U.N. Development Programme, and others suggests that the risk of climate catastrophe approaches an intolerable level if the world's average temperature fails to stay within 2 degrees Celsius (3.6 degrees Fahrenheit) of the preindustrial global average. This is about 1.2 degrees Celsius above the current average temperature. Significant climate risks may lurk even in more-modest temperature increases, especially if they are sustained over time. (See Chapter 2.) Most of that possible safety valve of 1.2 degrees may literally already be baked into the world's existing system, however, continuing to drive more storms, droughts, and sea level rise even if emissions ended immediately. The window of avoiding potential climate catastrophe is thus closing quickly.¹¹

Humanity needs eventually to shrink net greenhouse gas emissions to zero, with flows out of the atmosphere balancing flows in. And since the biosphere cannot infinitely absorb these gases out of the atmosphere, in order to avoid continued human-induced climate change the world presumably must someday have negligible emissions of greenhouse gases. Yet all combustion releases heat-trapping CO₂ into the air. All molecules of more than two atoms—from water vapor to methane to the polyatomic industrial gases used in refrigerators and air conditioners—trap Earth's solar heat before it escapes into space and send it back down to the surface. Most people would consider a zero-emission society impossible if it were not essential to a rea-

sonable hope that civilization will continue.

Suppose the world collectively decided to allow 500 billion more tons of CO₂-equivalent emissions before reaching that zero-emissions point. If the world then fairly allocated those precious remaining tons, who would get what? Who would do the allocating, who would enforce it, and how?

Since the vast majority of greenhouse gas emissions now come from the countries and regions that are demographic and economic giants—the United States, the EU, Russia, and Japan among industrial countries and China, India, and Brazil among developing ones—the early participation of these countries in a global atmospheric stabilization program is essential. Over the long term, however, there is no alternative to engaging all countries in a global climate alliance. Absolving smaller or less economically significant ones from the task would risk the evolution of a two-tiered world that would inevitably draw greenhouse-gas-intensive development and possibly even people to the excluded countries. That could not work for long. And besides, all countries and all people have a right and a need to participate in deciding how to resolve this crisis.

Lessons Learned, Time Lost

The upward trends in greenhouse gas emissions over the last two decades trace tracks of lost time. More than two decades have passed since prominent climate scientists first began calling news media and public attention to the growing urgency of the problem. While the signature of human-induced warming is now clearer than it was then, the basic science and the riskiness of stuffing ever more heat-trapping gases into the atmosphere has never been in doubt among the world's leading scientists.

In the late 1980s, the world experienced a test run for the climate talks to come, as

nations negotiated and then ratified the Vienna Convention for the Protection of the Ozone Layer and then its subsidiary, the Montreal Protocol on Substances that Deplete the Ozone Layer. With the backing of President Ronald Reagan and most of the world's major producers of the regulated gases, the protocol provided a system by which industrial countries phased out the ozone-depleting gases quickly.¹²

Though rarely recalled today, the Montreal Protocol offers lessons for the climate negotiations of 2009. The U.S. government and chemical manufacturers strongly supported the phaseout of ozone-depleting gases. The agreement allowed developing countries a later timetable and established a global fund to funnel them needed financing from industrial countries. The fund to date has spent \$2.3 billion. The agreement defined the dividing line between the two groups by per capita production and consumption. Although the climate problem is far larger and more complex than ozone depletion, each of the elements that help this treaty succeed could contribute to an effective climate agreement.¹³

By 1994, most of the world's nations, including the United States, had ratified and put into force the United Nations Framework Convention on Climate Change, first agreed to at the United Nations Conference on Environment and Development in 1992. That treaty expressed two key principles that have guided global climate negotiations ever since. First, humanity should “achieve...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [human-induced] interference with the climate system.” Second, countries should respond “in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions.” In short, stop climate

change before it is too late, and expect the longest-running and worst climate offenders—the wealthier and more industrialized countries—to step up to the head of the line to fix the problem.¹⁴

Three years later, most of the world's nations agreed in Kyoto, Japan, to the protocol to the climate change convention. (In diplomacy, protocols are supplements or amendments to existing conventions; either may be called a treaty.) The Kyoto Protocol aimed to drive down the greenhouse gas emissions of industrial countries as a first step in what was planned to be a two-phase process comparable to that of the Montreal Protocol.¹⁵

In negotiating the agreement, industrial countries volunteered emission targets in 2012 based on a percentage of what each country's emissions had been in 1990. These targets—averaging a 5-percent emissions reduction among participating countries—were originally intended to be achieved by actual emissions cuts in those countries. To ease fears that such cuts might be too onerous and expensive, however, more flexible mechanisms were allowed—and these quickly became the favored approaches to compliance.¹⁶

Under the terms of the Protocol, participating industrial countries can trade unneeded emission allotments among themselves or work together jointly on projects that promise to cut emissions in any other participating industrial country. (These cuts, called Joint Implementation, are done within the European Union and in formerly communist countries like Russia and the Ukraine, where aging and energy-inefficient capital equipment can be improved at a relatively low cost.) Or they can invest in projects that achieve the needed reductions in developing countries through the Clean Development Mechanism, which then can sell those reductions as carbon credits to the investing country.

The CDM is the only inducement for emissions reductions in developing countries. For understandable reasons, purchasers of the emissions credits it offers have been drawn mostly to large-scale projects in countries capable of offering such opportunities. Practically speaking, this means a heavy tilt toward China, India, and a handful of other Asian powers, with little activity in Latin America or sub-Saharan Africa. On top of that, critics have noted that the CDM has produced windfall profits for some investors while failing so far to take much of a bite out of global greenhouse gas emissions. These problems are now well recognized, however, and any new climate agreement is likely to reform this mechanism so that it covers many more emissions-saving activities and reaches many more countries. Or perhaps negotiators will craft new approaches altogether to encourage emissions reductions in developing countries that industrial ones will pay for.¹⁷

Though rarely recalled today, the Montreal Protocol offers lessons for the climate negotiations of 2009.

Like all treaties, the protocol is binding, but penalties for unachieved emissions reductions were deferred into an unknown future. Those who fail to comply must face proportionally greater emissions-reduction obligations following the first “commitment period” from 2008 to 2012. But those obligations and any later commitment period, of course, remain to be negotiated. Some countries, especially in Europe, with its mature economies and generally stable populations, are on track to meet their commitments. Others are experiencing emissions growth that will make the objective much harder. Environmentalists are suing the government of Canada, for example, in an effort to get

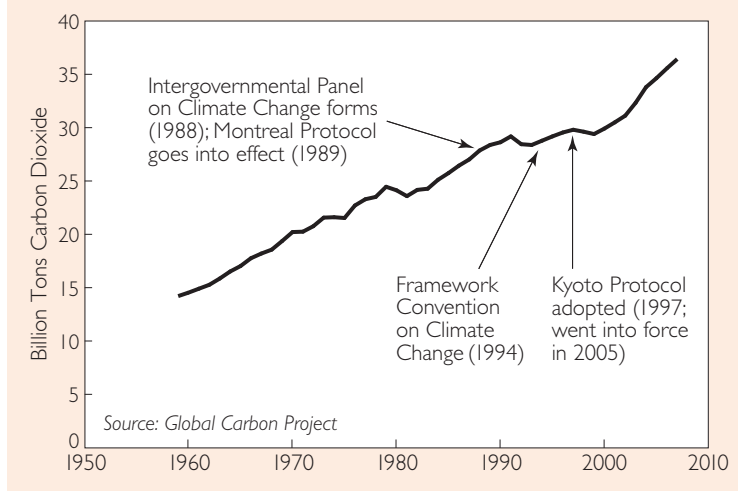
Sealing the Deal to Save the Climate

it to take its Kyoto promises more seriously.¹⁸

The idea that industrial countries would move first on climate change was firmly rooted in principles accepted in the Montreal Protocol and the Framework Convention on Climate Change. But the Kyoto Protocol's perceived "free ride" for developing countries—some of them now becoming major emitters—provided a rationale for the United States to reject the protocol after initially signing it. The country's substantial emissions were thus left unfettered. U.S. ratification would have been far from easy anyway. Even before U.S. delegates in Kyoto signed the new document, back in Washington the Senate voted 95–0 to oppose its ratification on the grounds it would hurt the U.S. economy and leave developing countries, without comparable commitments, at an unfair economic advantage.¹⁹

At the time, U.S. emissions were tops in the world. China, rapidly industrializing and with four times the U.S. population of 305 million, has since overtaken the United States in CO₂ emissions from fossil fuel combustion and cement production. But it will be many years before any nation approaches the United States in cumulative greenhouse gas emissions. The country's unwillingness to commit to emissions reductions despite this fact is undoubtedly the greatest single obstacle to international action on the problem. Yet with a new president in office already having declared his willingness to limit emissions,

Figure 6–1. Global Carbon Dioxide Emissions, All Sources, 1959–2007



2009 is the most promising year for real action since ratification of the climate convention in 1994.²⁰

Although some emissions have undoubtedly been avoided, none of the scientific and diplomatic efforts on climate has had an obvious impact on the overall global increase in carbon dioxide emissions. (See Figure 6–1.) Although less well documented, the story is similar for other gases and for carbon dioxide from deforestation and land degradation.²¹

There is, however, a real victory for which both the Montreal and Kyoto Protocols deserve thanks. Atmospheric concentrations of greenhouse gases would have grown even faster had neither treaty gone into effect. New international institutions and financial instruments designed to reduce global emissions are riding gingerly forward on training wheels. Chief among the Kyoto Protocol's accomplishments is the remarkable emergence of carbon markets described earlier, which has as its valued commodity, in effect,

bad things—carbon dioxide emissions—that are not happening. Global emissions levels have nonetheless so far responded more to the vagaries of the global economy than to diplomacy. The world needs much more effective mechanisms for reversing course in greenhouse gas emissions as rapidly and dramatically as possible, beginning now.²²

State of Play

Seemingly undaunted by these challenges, today's climate negotiators are building on the mixed outcomes of the Kyoto Protocol to craft a strategy for moving forward. Despite the absence of the United States, parties to the protocol continue to strengthen its provisions and have committed to improving and expanding the carbon trading, Clean Development Mechanism, and other emissions-reducing tools to which it gave birth. The CDM and its governing board, for example, already are moving to shift toward ongoing programs of emissions reductions in a diversity of developing countries.

The European Union, for its part, is modifying its ambitious Emissions Trading Scheme. This is a cap and trade approach in which total industrial emissions (amounting to about 45 percent of CO₂ emissions in the EU) are restricted, the limited emissions are allocated among companies, and unused allocations can be traded for whatever the market will bear. The system has drawn outrage from environmentalists and consumers because of its free allocations of emissions among electric utilities and industries, which provided windfall profits to companies as the value of carbon credits rose. Architects of the system have promised to shift to one of auctioning allocations, with any revenue to be used for climate or other public benefits.²³

Japan, Canada, and New Zealand also participate in Kyoto Protocol-based carbon

trading. And states, provinces, and cities in the United States and other industrial nations are experimenting with their own Kyoto-style emissions-reducing mechanisms and commitments. The province of British Columbia and the city of Boulder in Colorado are taxing carbon, returning the revenue to residents through reductions in other taxes. A carbon-trading exchange in Chicago deals with voluntary but binding commitments from a range of companies, communities, and organizations. In September 2008, six northeastern states in the United States sponsored a regional auction of carbon dioxide emission rights for the power generation sector. New South Wales in Australia since 2003 has been requiring utilities to offset any emissions that occur beyond regulated limits. Although these subnational efforts exclude transportation and other greenhouse emissions and the cost of emissions are generally low (little more than \$3 per ton of carbon in the U.S. example), it is worth noting that jurisdictions are working to reduce their emissions with no certainty of global or national mechanisms to reward such early efforts.²⁴

In December 2007, climate negotiators agreed at a major conference in Bali, Indonesia, on a plan and timetable for working toward a protocol to succeed Kyoto when its first commitment period ends in 2012. One resolution of the Bali Action Plan was to continue the focus of global climate negotiations on four main areas:

- mitigation, a term covering efforts to reduce emissions below what they would otherwise be, especially through energy efficiency and a transition to low-carbon energy production, as well as avoiding deforestation in developing countries;
- adaptation to the climate change that is already on the way, bringing rising sea levels and more-severe weather patterns;

Sealing the Deal to Save the Climate

- technology transfer from industrial to developing countries to facilitate and help pay for these efforts in countries that otherwise may not be able to afford them, or in some cases transfers between developing countries; and
 - financing for poorer countries provided by wealthier ones and potentially a pool of all nations, for the three activities agreed upon.
- Some analysts of the state of play add to this list “vision,” an overarching statement about what the negotiations are designed to achieve and how they will do so.²⁵

The Bali Action Plan for the first time expressed the objective that all parties—indeed, all human beings—will reduce emissions.

The conference also clarified that major departures from the overall architecture of the climate change convention and the Kyoto Protocol were unlikely. Thus the major division of responsibilities to act between industrial and developing countries would remain.

Yet the Bali Action Plan also for the first time expressed the objective that all parties—indeed, all human beings—will reduce emissions. Given how much variation exists in emissions and development within each group, some proposals aired at Bali envision breaking the two groups into subcategories—at least in terms of the commitments they would be asked to make. These could distinguish former communist states in Eastern Europe from wealthier industrial countries, for instance, or rapidly industrializing or oil-producing developing nations from those of sub-Saharan Africa. Such subgroups might have their own differentiated responsibilities and timetables.

One way or another, the Bali conference reiterated, poorer and less industrialized coun-

tries are not likely to move as soon as wealthier and more industrialized ones must in committing to emissions cuts or taking responsibility for the financing needed when they do make such cuts. Conferees at a follow-up workshop in Bangkok supported continuation of the market-based carbon trading mechanisms of Kyoto, such as the CDM, while pledging to refine them to improve their reach and effectiveness. Those decisions signaled to the world’s business leaders, noted Yvo de Boer, executive secretary of the U.N. secretariat administering the climate negotiations, that “long-term certainty [will] guide their investments over the coming years.”²⁶

Knowing a new U.S. president would take office in January 2009, the negotiators fast-tracked the issues of financing and technology transfer for a climate conference in Poznan, Poland, in December 2008 and saved most details of the more crucial and difficult issues of mitigation and adaptation for Copenhagen in late 2009. When the U.S. delegation in Bali blocked consensus on the imperative for emissions caps in industrial countries, the negotiators regrouped and instead established a working group to address critical issue areas prior to Copenhagen. (Such working groups often do the time-consuming brainstorming and bargaining needed to pave the way for negotiating conferences.) The Bali Action Plan made clear to governments and to global capital markets that the basic Kyoto approach of setting binding national emissions targets would move forward, but with more stringent targets and longer timelines, that the international carbon market would be expanded, and that the controversial Clean Development Mechanism would be reviewed and modified.

Some concepts moved forward in evolutionary leaps at Bali. More engagement in the carbon market from developing countries seemed likely after a reiterated commitment

to financing climate change adaptation activities through a 2-percent levy on CDM transactions. Discussion moved forward on the idea of emissions cuts negotiated within important industrial sectors—electric utilities, steel and aluminum production, aviation, shipping, or even land transportation. Helped by governments, companies in these sectors would pledge an overall emissions cap for their industry and then work together across national borders to invest in and secure the needed reductions where they could be achieved most cheaply—most often, probably, in less wealthy countries, where the industrial infrastructure is less modern and efficient. By May 2008, China indicated its interest in this approach—a breakthrough from the developing country with by far the largest industrial sectors.²⁷

The sector concept, while controversial because it could undermine more comprehensive emissions reduction strategies, is appealing on several fronts. Almost all global greenhouse gas emissions can be categorized by sector (although some fit into more than one sector). About a fifth of all emissions can be attributed to the production processes of specific industries, such as chemicals, cement, and iron and steel. A cap and trade approach within such sectors could thus produce significant emissions savings while funneling private investment into the industrial capital stock of developing countries.²⁸

In many sectors, a small handful of countries are responsible for the majority of emissions, reducing the number of actors and simplifying the mechanism's structure. And sectoral agreements and mechanisms can provide important guidance for the more comprehensive and ambitious cap and trade approaches likely to form the basis of long-term efforts to reduce greenhouse gas emissions. Although the details of such agreements remain to be worked out, there is enough

support for the idea that a sectoral approach seems a plausible candidate as an element in a future protocol.

The development that provided the most excitement at Bali was a new willingness by developing countries to consider reductions in the destruction of forests and land degradation if these could be financed by industrial countries. Again, the details remain to be worked out. The most contentious question is whether to allow such reductions to compete with reductions in fossil fuel emissions in international carbon markets. But the potential for synergistic benefits is obvious. An estimated 23 percent of all global carbon dioxide emissions come from deforestation and other changes in land use, a proportion just a bit larger than the CO₂ emissions of the United States or China (which account for about 20 percent of the world total each). Reducing the emissions associated with these activities would directly contribute to the preservation of forest-based biodiversity, reductions in soil erosion, and reductions in landslides and flooding in mountain communities. (See Chapter 3.) The need for reductions in fossil fuel and comparable industrial emissions would nonetheless remain.²⁹

New Directions

In the Bali discussions and in the months that followed, central themes emerged or gained momentum. Outside of the United States, most countries appeared to support a timetable under which industrial countries focus in the years after 2012 on “hard” emissions caps, which have been made easier to attain through carbon trading mechanisms such as the strengthened Clean Development Mechanism. The 2007 report of the Intergovernmental Panel on Climate Change suggested that in order to have a reasonable chance of permanently restraining global

warming to no more than 2.4 degrees Celsius (4.3 degrees Fahrenheit) above preindustrial levels. As noted earlier, some scientists believe this is too high a threshold, but even by this standard the world must reduce its CO₂ equivalent emissions by 50–85 percent of 2000 levels by the middle of this century.³⁰

To make that possible, industrial countries would need to slash their own emissions by 25–40 percent by 2020. The European Union has committed to 20 percent cuts from a 1990 emissions base by that year, while saying it would aim for a 30-percent cut if joined in comparable efforts by the United States and other industrial powers. (The lack of consensus that the EU commitment reflects about what year to use as a basis for future reductions is just one of the complicating factors in acting globally on climate change.) Such commitments are crucial, because it is these rather than international treaties per se that will lead to real emissions reductions through the legislation that countries enact—with the European Union’s emissions trading scheme the best model of this dynamic.³¹

The U.S. Congress, despite the Senate’s refusal to ratify the Kyoto Protocol, briefly considered legislation in 2008 that would have capped a significant proportion of U.S. carbon dioxide emissions while rewarding developing countries for reducing greenhouse gas emissions from deforestation and land degradation. Many U.S. climate activists found the proposed legislation flawed, but its consideration was a sign that the United States will someday enact emissions-reducing laws, especially as a new administration puts its stamp on U.S. policy. (Both major presidential candidates in 2008 supported a U.S. commitment to emissions reductions, with cap and trade mechanisms the preferred approach.)³²

At whatever point industrial countries

make binding commitments, rapidly developing countries such as China, India, and Brazil will find themselves under pressure to declare their own pledges—though perhaps with a few years’ allowance before taking specific actions. “Commitment” is a difficult word for most developing countries to use, given their proportionally smaller responsibility for filling the atmosphere with heat-trapping gases. By taking on “no lose” objectives, at least to slow the growth of greenhouse gas emissions, developing countries can engage in the global process. They might pledge to reduce the “carbon intensity” of each unit of economic activity, as China has. Such efforts can defuse accusations from wealthier countries that the poorer ones are increasing their emissions rapidly but face no obligations whatsoever.

The ideal mechanisms for developing countries would offer strong incentives, with financing provided mostly by wealthy countries, eventually perhaps backed by modest prodding “sticks” such as trade restrictions or finance “carrots.” And, as described further later, one concept worth exploring is for developing countries to contribute climate-related financing in proportion to their well-off populations, above certain generous thresholds.

Some analysts speak hopefully, borrowing a phrase from the U.S.-led occupation of Iraq, of a “coalition of the willing,” implying a voluntary approach to emissions reductions even by industrial countries. Developing countries and environmental organizations, however, tend to see the voluntary approach in wealthy countries as too little, too late. Long-time major emitters that decline to push down their emissions as rapidly as possible will need to “lose” something, beyond the respect of other countries and unspecified future penalties along the lines described in the Kyoto Protocol, given how critical these emissions reductions are. But what those

“sticks” would be remains to be debated.³³

On the positive side, an obvious synchronicity between emissions cuts and new sources of financing arises in the concept of cap and trade—if countries auction the allocation of emissions rights. Those auctions, supplemented possibly by revenue from a parallel carbon tax, could raise substantial revenue, which could then be directed toward both domestic and foreign efforts to reduce emissions further and to adapt to ongoing climate change.

Meanwhile, critical questions await discussion at the 2009 Copenhagen meeting and the working conferences leading up to it. How is climate change adaptation defined, for example? How is the concept separate from overall economic development, which certainly would help countries better adapt to all environmental change, including climate change? How can developing countries be assured that funding provided specifically for their climate change adaptation efforts is not simply subtracted from existing development assistance? And what specific investments and activities will truly enable countries to improve their resilience to the possibly devastating impacts of human-induced global warming?

The questions are equally challenging on the issue of technology transfer. Most technology transfer is a business matter. Willing sellers of a new technology find willing buyers who can afford it. But technology that facilitates reduction of greenhouse gas emissions is a different matter altogether. Clearly, affordability should not be an obstacle if the technology serves the global good of emissions reductions.

Just as clearly, inventors and others need incentives to innovate. Someone will need to fund technology transfers, and a balance will need to be struck on such critical issues as patent law and intellectual property rights to secure the widest dissemination of useful

technologies at the lowest possible costs. Progress made on such questions in distributing anti-retroviral drugs to treat HIV/AIDS in developing countries offers hopeful signs, and innovative climate-related technology deployment mechanisms are now the subject of negotiations ahead of the Copenhagen conference.

Near the end of 2008, formal country and regional proposals began to emerge that were aimed at both the reduction of greenhouse gas emissions and the financing of adaptation to inevitable climate change. (See Box 6–2.) Academics and nongovernmental organizations (NGOs) were putting forward ideas as well, and an even greater number and variety will emerge in the months leading up to Copenhagen.³⁴

Recognition of the importance of adaptation financing is growing rapidly, even among climate activists who once saw attention to this issue as a distraction from the needed preventive measures to stop climate change. The reason for this shift is sobering: there is no avoiding significant and damaging impacts from the greenhouse gases already in the atmosphere, and the poorest and least responsible will fare the worst. They will need much help. The just solution to this dilemma is that historic emitters must not just help but must compensate those who suffer through little or no fault of their own. Turning this obvious principle into actual financing instruments and real money, however, is another matter.

The Real Deal

To step onto an emissions path likely to offer some safety, humanity needs to cap and then start shrinking global emissions within just over a decade, however much the world grows demographically and economically. Every country will need to do its part. But

Box 6–2. Government Proposals for Climate Change Mitigation, Adaptation, and Technology Transfer

Government proposals for financing climate change programs that could be included in a new protocol to the Framework Convention on Climate Change began emerging after the Bali Conference of the Parties in late 2007.

China and the Group of 77 (G-77, a U.N. coalition of developing countries, now with 130 members) propose a financial mechanism that would link private and public funding sources to the spending needs of governments, in order to reduce potential fragmentation in financing related to climate change needs. A governing board with equal representation from developing and industrial nations would determine how much funding would be allocated for programs on adaptation, mitigation, and technology transfer.

Funding would be additional to current official development assistance (which generally consists of direct grants and comparable support to promote economic development in developing countries). The majority of funds would come from industrial nations and would be offered as grants rather than loans. The level of funding would be set at 0.5–1 percent of the gross national product of industrial countries as a group.

In addition, China and the G-77 propose a separate technology transfer financing mechanism called the Multilateral Climate Technology Fund. This would finance activities in developing countries related to clean energy technology research,

development, diffusion, and transfer. The fund would operate under the Conference of the Parties to the climate change treaty.

Mexico proposes a Comprehensive World Climate Change Fund, which would include mitigation, adaptation, and technology transfer activities. All countries—industrial and developing—would contribute to this fund. Withdrawals would be limited to countries that contribute and would be determined by a formula based on current GHG emissions, population, and gross domestic product.

In its initial phase, the Comprehensive World Climate Change Fund would aim to mobilize and spend no less than \$10 billion a year. Mechanisms that could mobilize financial resources include auctioning permits in domestic cap and trade systems in industrial countries and taxing air travel. Mexico proposes that part of the fund be set aside for the benefit of the poorest countries, as they will be most affected by climate change. Governance of the fund would be transparent and inclusive: all countries would have an equal voice in the governing structure.

Switzerland proposes a funding scheme for climate adaptation based on a global carbon tax of \$2 per ton of carbon dioxide emitted, in accordance with “common but differentiated responsibilities,” a phrase that harks back to the climate change convention. Countries emitting

what is each country’s part? That is what negotiators must decide—and keep deciding as both the global climate and the world’s nations evolve. And negotiators must weigh the relative importance of past, present, and future emissions in assigning responsibility for the problem. They must also decide how to weigh the economic capacity of each country when asking for commitments to act.

Well-verified data on emissions is critically important—where they come from, how they influence atmospheric concentrations of greenhouse gases, what sinks remove green-

house gases from the air, and how securely they do so. The emerging currency for the negotiations is carbon dioxide equivalence, but as yet there are no databases that carefully track emissions from all nations using this measure. It will take effort to produce an authoritative database. But until that is accomplished, how can the world’s countries be assured that their collective emissions reduction efforts are succeeding?

The Kyoto Protocol addresses the six most important greenhouse gases and gas categories—carbon dioxide, the number one

Box 6–2. continued

less than 1.5 tons of carbon dioxide per person per year would be exempt from the tax. Estimated overall revenues from the funding scheme would be \$48.5 billion annually. Of that, \$18.4 billion would be for a Multilateral Adaptation Fund. Revenues collected in each country from a global carbon tax would be paid into the fund based on its level of economic development. High-income countries would pay 60 percent of their revenues to the fund. Medium-income countries would pay 30 percent, and low-income countries would pay 15 percent.

India proposes a New Global Fund for Adaptation. Industrial nations would contribute 0.3–1 percent of their gross domestic product and the monies would be especially used for adaptation activities in developing countries. The fund would be financed by both private and public sources.

South Africa, representing a coalition of African governments called the Africa Group, proposes scaling up adaptation funding by more than 100 times what is now available. Financial resources would be beyond existing funds under the United Nations Convention. The Africa Group proposes that a work program on adaptation be based on an assessment of its costs for developing countries, and the group would facilitate the implementation of adaptation strategies and programs through financing and capacity building.

In terms of adaptation financing, the *European Union* would focus on expanding the global

carbon market, leveraging private investment flows, and making financing predictable and timed to the needs of developing countries. In addition, the EU strategy would consider auctioning emissions allowances, introducing taxes on aviation and shipping, and instituting a global tax on CO₂ emissions.

Norway proposes that adaptation needs under the climate convention be met through auctioning a share of “assigned amount units”—portions of allowed emissions—of all industrial countries. Companies in countries obliged to cap national emissions could buy these certificates to help them reach their emissions targets. Revenues from a system of auctioning emission allowances in the shipping sector would fund adaptation activities in developing countries.

Under a proposal by *Brazil*, industrial countries would finance a new Clean Development Fund that would aim to finance the costs of climate adaptation for developing countries. Brazil proposes that adaptation funding be increased considerably and focus on building the capacity of developing countries to translate climate adaptation information into actions, designating national and regional centers of vulnerability, and mapping climate vulnerability in light of national economic and social indicators.

—Ambika Chawla

Source: See endnote 34.

offender, released during numerous human activities; methane, released by agriculture and from landfills and leaky natural gas pipes; nitrous oxide, released in agriculture production; sulfur hexafluoride, used in electricity production; hydrofluorocarbons, which replaced chlorofluorocarbons in cooling and refrigeration; and perfluorocarbons, used in medical applications. Many other industrial gases that trap atmospheric heat remain outside of any negotiated framework and are not currently even monitored. Some have quite high global warming potentials

molecule per molecule, but all are now so thinly distributed in the atmosphere that they collectively make relatively insignificant contributions to global warming in comparison to the main regulated gases. This could change, however, as production of any of these gases grows.

A new protocol to specify what will follow the Kyoto first commitment period could engage all countries in a globally transparent effort to monitor emissions of as many significant greenhouse gases as possible. Financed primarily by industrial countries,

the effort could capture the imagination of young people concerned about the global climate they will inherit, and it could stimulate education and scientific advancement all over the world.

As these efforts proceed, the world will need to evolve beyond the antiquated and overly simplistic division of all countries into the categories “industrial” and “developing” that has characterized climate negotiations since the drafting of the Framework Convention in the early 1990s. A relic of the post-colonial landscape that took shape after World War II, this bifurcation fails to capture the wide diversity of responsibility (past and current emissions, including on a per capita basis) and capability (national and per capita income and wealth) of the world’s nearly 200 nations. In particular, it fails to distinguish rapidly industrializing countries such as China and India from those more slowly developing countries that are still far from contributing substantially to Earth’s greenhouse gas buildup.

Dealing with global climate change in a world of nations will require industrial and rapidly industrializing countries to cap their greenhouse gas emissions within the next decade—and then to steadily reduce the totals toward zero. Even poorer countries would eventually need to follow. But how many national leaders will agree to an emissions allotment that allows their citizens a lower average level of emissions than those of other countries—especially if those countries earlier contributed much more to the atmosphere’s total greenhouse gas load?

Many observers who peer far enough into the future of global climate regulation have acknowledged that ultimately either climate emissions will need to be roughly equal on a per capita basis or countries that emit more than the global per capita average will need to compensate those that emit less. Nicholas

Stern has acknowledged that annual “global average per capita emissions...will—as a matter of basic arithmetic—need to be around two tons by 2050,” based on a world population of 9 billion by then and using carbon dioxide equivalence as his measurement unit. “This figure is so low that there is little scope for any large group to depart significantly above or below it.”³⁵

The leaders of India and Germany called attention in the summer of 2007 to the importance of per capita emissions parity—or at least fairness. Both suggested that a new climate pact allow emissions from developing countries to rise until they converged with those of industrial countries (which would presumably be decreasing rapidly), at which point both groups of countries could reduce their per capita emissions in tandem. “What kind of measure do we use to create a just world?” German Chancellor Angela Merkel asked.³⁶

Moreover, given the historically greater responsibility of industrial countries for most of the buildup of greenhouse gases in the atmosphere, could even a true convergence of future per capita emission levels constitute “full payment” to the less wealthy countries for a changed climate? In 1997, Brazil proposed a plan by which country responsibilities to address climate change were made proportional to their historical contribution to the problem. The idea made no headway on the international stage. In 2005, researchers at the World Resources Institute revisited the suggestion and concluded that assigning historic responsibility depends significantly on the starting date of the history selected. Global data would not support a definitive comparison for periods earlier than 1990, the researchers added, as that is when systematic national emissions monitoring began.³⁷

Most analysts who follow the process would argue that a climate agreement based on either

per capita emissions allocations or historical cumulative emissions is unlikely to emerge from the Copenhagen conference. Not only would industrial countries understandably fear the implications for them, but even some developing countries have reason to worry they would join the ranks of the “high emitters” if the per capita emission dividing line were set low enough to force radical emissions reductions. The urgency of rapidly slashing emissions will need to become much more obvious to many more people before such approaches can be taken seriously.

Over the long term, as Nicholas Stern recognized, there is no real alternative to convergence on roughly equal per capita emissions at very low levels. Zero net emissions globally at some point in the future will, of course, mean zero net emissions per person. So it becomes all the more critical to keep thinking about how this convergence could eventually come to be—and, if possible, to help the process along.

Equity and the End of Emissions

We have choices to make. Bringing greenhouse gas emissions down to a fraction of current levels will take an ongoing worldwide effort that engages all nations and touches all lives. We can fail to slash emissions, or fail even to try. We can try risky geoengineering schemes or simply hope to brave the heat and storms to come. Or we can adopt a positive attitude about preventing future emissions and adapting collectively to past ones, and we can get to work.

We live in exciting times and can rise to the occasion. We have handed ourselves a problem we can solve only by learning new ways to live and to cooperate for a common goal. It could be a good thing. But by any measure the 10 months leading up to the Copen-

hagen negotiations on the next climate agreement offer one last opening—any other 10 months might come too late—to seal a deal that can save the global climate for the next century and beyond.

One proposal gaining attention in advance of Copenhagen sets out to integrate emissions reductions and climate change adaptation with a “right to sustainable development.” Called Greenhouse Development Rights and jointly developed by a U.S. group, EcoEquity, and the Stockholm Environment Institute, the concept is designed to share in fair ways the burden of cutting greenhouse gas emissions while shielding the poor from potentially high costs. It would base climate-related obligations on a national Responsibility and Capacity Indicator. Responsibility would reflect each country’s contribution to the climate problem and be defined in terms of cumulative per capita greenhouse gas emissions from a specific date, perhaps 1990. Capacity would reflect each country’s ability to help deal with the climate problem without sacrificing necessities and be defined in terms of national income.³⁸

The indicator index combines these two pillars of the climate convention with a simple but critical adjustment: income below a “development threshold” of \$7,500 per capita does not count in the calculation of capacity, and emissions corresponding to consumption below that income threshold do not count in the calculation of responsibility. This figure, the proposal developers note, is modestly higher than a global poverty line, to reflect a level of welfare that is beyond basic needs, though well short of today’s levels of “affluent” consumption.³⁹

The Greenhouse Development Rights framework thereby accommodates developing countries’ claim that their development and poverty eradication must trump solving the climate problem. But it does so in a

nuanced way. It assesses capacity and responsibility at the level of individuals, in a manner that takes explicit account of the unequal distribution of income within countries. It thus confronts a key obstacle to negotiating an agreement that few other proposals even acknowledge: many reasonably wealthy and high-emitting individuals live in poor countries. Their income above \$7,500 per person per year would count in assessing each country's capacity to respond to climate change.

This graduated approach to climate-change-related obligations eliminates the need for a simplistic division of the world into industrial and developing countries. While it deviates from a division of the world's countries established in the Framework Convention on Climate Change and fortified in subsequent negotiations, it also takes the negotiations beyond one of the key stumbling blocks. After all, there is no reason why living in a country with an average income at the poverty level should excuse wealthy and high-emitting people from curtailing their emissions and contributing toward climate change adaptation efforts.

The nuanced treatment of countries' real differences, and the focus on a right to development and the principles of capacity and responsibility, may prove the ultimate strength of this and similar future approaches. Requiring developing countries to take on commitments only in proportion to the responsibilities and capacities of their wealthy and high-emitting populations offers the potential for a compromise that a diversity of countries could eventually endorse.

In practical terms, the emissions cuts needed to avoid a warming in the range of 2 degrees Celsius or more would be so radical that under the Greenhouse Development Rights proposal the world's wealthier countries and individuals would have to finance emissions reductions in low-income coun-

tries long after the emissions in industrial nations bottomed out near zero. Will the wealthy and fortunate ever take on such obligations to save the world's climate? As the proposal's authors note, if they won't, no one else will.

Taking on such obligations will be more likely if wealthier countries and a climate pact itself can ease and make economically attractive a rapid transition to energy efficiency and renewable sources. There are plenty of attractive options governments and private-sector investors can move forward aggressively and immediately—especially improvements in energy efficiency and electrical power generation through wind, solar energy, and geothermal energy. (See Chapter 4.) People do not really want carbon-based power per se, after all; what they want is power itself, whether at the flip of a light switch or the turn of a key in the ignition of the family car.

One promising mechanism to kick-start this shift, at least in the electricity production sector, is a concept known as feed-in tariffs or renewable energy payments. Already more than 40 nations, states, and provinces have enacted feed-in laws. These generally guarantee anyone who produces electricity with renewable sources priority access to the electricity grid and long-term premium payments for their electricity, thus reducing the insecurity of investment in renewable sources and technologies. Another approach, even simpler, is to root out and close off all government incentives that boost combustion of carbon-based fuels and other greenhouse-gas-intense activities. In the 1990s, a World Bank report estimated that such subsidies cost taxpayers an estimated \$210 billion a year and prompted 7 percent of all global CO₂ emissions.⁴⁰

An idea that still waits to be more prominently touted is the concept of "shadow carbon pricing." Ideally, a climate agreement

should contribute to a uniform high and rising global price for carbon dioxide that would both discourage release of the gases into the air and raise revenues for adaptation and further emissions reductions. But until the world's nations are ready for such a step, institutions from the World Bank to NGOs should pick a number—any number, almost—to define an imaginary or shadow price for a ton of the gas. Then the shadow carbon cost of any activity, from building a power plant to driving a gas-guzzler to the local convenience store, could be calculated and publicized. The point? Simply to educate the public about how deeply greenhouse gas emissions are embedded in daily living and the global economy and to prepare the way for eventual real costs applied to these emissions.

As human-induced climate change becomes increasingly palpable everywhere, people in all walks of life will grow weary of unfulfilled promises to reduce greenhouse gases at the margins. With enough public pressure, nations may find ways to push each other into action commensurate to the threat. In today's globalized society, few countries can manage without free trade, but trade should be freest among the nations that jointly commit to act forcefully to save the climate. The task is doable; of all the hundreds of scientists presenting diverse opinions on the climate problem, no prominent one has spoken up to say it is already too late to act.

The world needs to prepare to work cooperatively to adapt for serious and disruptive climate change beyond what has already been seen—while still preventing potentially cataclysmic changes. The approach may combine both cap and trade mechanisms, within and among countries and industrial sectors, and domestically focused carbon taxes. The latter may be refunded to people as dividends, thereby softening the regressive nature of the tax and building a constituency for the

needed global anti-carbon price tilt. Also needed, even in an era of higher prices on carbon, may be some old-fashioned regulation of energy and industry practices where such governmental nudges can make an important difference at low cost.

Ideally, a climate agreement should contribute to a uniform high and rising global price for carbon dioxide that would discourage release of the gases and raise revenues for adaptation and further emissions reductions.

There is nothing inherently incompatible about applying all three of these diverse approaches—cap and trade, carbon taxes, and regulation—to the task of wringing carbon dioxide and other greenhouse gases out of the growing global economy. Nor is there any reason that industrial countries should not take on the lion's share of the load in helping developing countries reduce both their emissions and their vulnerability to human-induced climate change—with an understanding that wealthy people in developing countries have special responsibilities as well and that eventually economic development will both empower and obligate most of the world to radically reduce greenhouse gas emissions.

Perhaps this will turn into a world of fortified nations dealing individually with a warming climate and rising seas as best as they can while defending themselves against desperate neighbors. But as Hurricane Katrina in 2005 and the heat wave that killed thousands in France two years earlier demonstrate, the wealthiest nations are quite vulnerable to extreme weather events. Ultimately, to reduce climate risk the world will need to work toward a negotiated framework based on the equal right of all people to use the

common atmosphere while advancing themselves economically. Even in the near term, the climate negotiating process could inspire—perhaps among a coalition of NGOs—development of a metric similar to shadow carbon pricing that builds an ongoing tally of who uses what “atmospheric space” on a per capita basis for a future allocation process that remains to be imagined.

This approach could be called “no loss—for the present—but no promises about the future.” Simply by raising public awareness that everyone will need some day to contribute financing in proportion to excessive emissions today, and by developing an accounting system to illustrate and measure the growing burden of future payments, it may be possible to stimulate new pressure to shift away from carbon-based energies and create new innovations in carbon trading. That is just one unconventional idea to help unravel the post-Kyoto Protocol negotiations puzzle. There will be many more.

It helps that shifting away from fossil fuels will also mean shifting away from their rising costs as demand outstrips shrinking supplies as well as shifting away from the immense

human and environmental costs of coal mining (and mining accidents), oil drilling, oil spills, and air pollution and the respiratory problems it causes. It helps, too, that some of the most abundant renewable energy resources—intense sun and high winds—can be found in developing countries.

In addressing the climate change that humans are causing, people may learn lessons to help them face the many other problems that stem from humanity’s growing presence and appetite on a resource-constrained planet. While Earth and its envelope of air are fixed, there are no known limitations on the social sphere. In the century to come, people may well have to retreat from rising seas, to recycle most wastewater, to restore and cultivate ravaged soils, and to build cities that can survive brutal storms.

But if we act soon, shrewdly and with a commitment to fairness for all, there may still be time to keep nature and ourselves intact and even thriving despite the changes we will see. We may step safely into a manageably warming world, with a new appreciation of our common humanity and what we can accomplish together.

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