The Prospects for Copenhagen

More Realism Can Smooth the Way

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EXECUTIVE SUMMARY

As this year's negotiations wind their way to a conclusion in Copenhagen, Denmark, the prospect of a new international deal is not very bright, and it is not hard to see why.

Consider that the starting point for discussion is a 50% reduction in global greenhouse gas emissions by 2050. Endorsed by G8 leaders, this "50-by-50" goal is among the most aggressive of the 177 emissions reduction scenarios examined by the Intergovernmental Panel on Climate Change.

Meeting such a goal would require large and expensive emissions reductions and avoidances, most of which would have to occur in developing countries. Though ultimately non-binding and unenforceable, the long-term vision nonetheless drives expectations about technology readiness and commercial adoption, short-term goals, burden sharing by developing countries, finance and wealth transfers, and technology transfer, issues that are among the most contentious in the international negotiations. A 2008 report from the International Energy Agency (IEA) describes the scale of the technology breakthroughs that would be needed over the next 40 years to transform the energy sector and halve global carbon dioxide emissions from their 2005 level.

In the power sector, IEA estimates that carbon-free sources would have to boost their output over 550% and provide 95% of the electricity generated worldwide in 2050. To realize a shift of this magnitude, nuclear capacity would have to be added at an annual rate half again as large the historical high every year from 2010 to 2050. Renewable energy sources (excluding hydropower) also would have to be installed at a breakneck pace and grab 34% of an electricity market well more than twice the size it was in 2005, when these renewables claimed a meager 2% market share. Additionally, all coal plants and most natural gas plants would have to be fitted with carbon capture technology, which is not yet commercially available and may not be for many years.

The world's transportation sector, now dominated by oil-based fuels, would have to undergo similarly sweeping changes. For example, from virtually none today, IEA estimates that by 2050 nearly 1 billion electric and fuel cell cars would have to be on the world's roads.

Developing countries contend that as developed countries are responsible for most of the build-up of atmospheric carbon dioxide (a debatable claim), they should go first with emissions cuts of at least 40% to 45% below the 1990 level by 2020 and 80% to 95% below by 2050.

These targets are an extraordinary leap for developed countries; no developed country has proposed such reduction schemes to date. Even if developed countries could achieve these deep cuts, without meaningful commitments by developing countries, prospects for meaningful reductions in greenhouse gases remain dim. That is because about 80% or more of the expected growth in global carbon dioxide emissions to 2050 is expected to occur in developing countries, with China and India leading the way. As challenging as it is for developed countries to rein in emissions, the challenges for developing countries, which need cheap, reliable energy to raise living standards, are greater still.

Let us assume that developed countries succeeded in cutting emissions by 80% in 2050. To meet a 50% global target, total emissions from developing countries, after rising for decades, would have to return to or slightly below their 2000 level in 2050. What is more, because developing countries will have much larger populations 40 years hence, their per capita emissions, now about 2.5 tons, would have to be *lower*, too—and that would be the case even if developed countries slashed their emissions to zero.

With billions of people still lacking access to electricity, developing countries are unlikely to cap emissions if it hampers their economic development. Many sit on large reserves of fossil fuels and see no reason why they should forgo their use. They've made it plain that their cooperation will come only with significant financial contributions from other countries.

Developing countries are pressing the United States and other developed countries to transfer anywhere from 0.5% to 2.0% of their gross domestic product each year to bankroll climate change programs in developing countries. At that rate, in 2008 the cost to American taxpayers alone would have been $72 billion to $289 billion.

Business needs a predictable environment in which to operate and plan, and it would welcome an ambitious agreement.

But even that might not be enough. A Massachusetts Institute of Technology report warns that if developing countries are fully compensated for their efforts, implied financial transfers from developed countries could amount to over $400 billion annually in 2020 and about $3 trillion in 2050.

Developing countries also are trying to use the negotiations to weaken intellectual property protections through compulsory licensing of advanced energy technologies, ostensibly to remove barriers to "technology transfer." Without intellectual property rights, there is very little incentive for companies to invest in costly research and development that will lead to the technology breakthroughs required to meet reduction targets.

Just as worrisome are threats by some governments to impose carbon tariffs on goods coming from nations that don't take on comparable commitments, which would inevitably lead to a green trade war.

Every delegation at the U.N. negotiating table understands these numbers, so it is little wonder the Parties remain so far apart. Many countries are coming to realize that it is one thing to achieve 50-by-50 in a computer model, quite another in the real world.

How rapidly advanced energy technologies develop and are adopted commercially will be the most important factor in determining how quickly and at what cost greenhouse gas emissions can be reduced. An accelerated program to improve the performance and lower the costs of advanced alternate energy technologies can, if successful, broaden the range of economically and politically viable options available to policymakers. National and international climate policy should concentrate on supporting greater energy efficiency and commercialization of low-carbon technologies for energy supply. In addition, developed and large developing countries alike must make a larger commitment to technology development worldwide.

A new agreement should be flexible; recognize growing energy needs; set realistic goals; ensure global participation, including major developing countries; promote the development of and trade in clean energy technologies; protect intellectual property; and maintain U.S. competitiveness.

At the end of the day, all the "modalities" and "frameworks" erected in these negotiations cannot ward off failure if the goal itself is not practicable.

Business needs a predictable environment in which to operate and plan, and it would welcome an ambitious agreement. But that ambition needs to be tempered with a healthy dose of pragmatism. A realistic vision that encourages co-operation would be a good place to start

This paper explores some of the fault lines among the Parties in the negotiations, primarily the rift between developed and developing countries. It discusses the scale and scope of the technology challenge—which often gets overlooked in the public discussion—and some of the dynamics at work that hinder an agreement. And it offers the broad outlines of a technology-centered approach that could form the basis of a workable agreement.

State of Play

Climate change is among the most complex issues facing the international community. Negotiations are currently taking place under both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol with a goal of completing a new arrangement to address climate change in Copenhagen, Denmark at the end of 2009. However, despite the urgency governments attach to an agreement, the prospects for a comprehensive deal remain dim.

The ultimate long-term objective of the Convention, which was adopted in 1992 and entered into force in 1994, is the stabilization of greenhouse gas concentrations in the atmosphere at a level (undefined in the text) that would prevent dangerous anthropogenic interference with the climate system. This goal should be achieved within a time frame that would allow ecosystems to adapt and in a

manner that ensures food production is not threatened and that would promote sustainable economic development (UNFCCC 1992). Meeting these complementary objectives will require a sustained, long-term commitment by all nations over many generations.

The Kyoto Protocol completed in 1997 sets binding greenhouse gas emissions targets for 37 developed countries and the European Community that combined would reduce emissions for these countries as a whole 5% below the 1990 level over the period 2008 to 2012. Developing countries have no obligations to slow or reduce emissions under the Protocol. To date, 187 UNFCCC Parties have acceded to the Protocol, excluding the United States

The Bali Action Plan agreed to at the 13th Conference of the Parties in Indonesia in December 2007 launched a two-year negotiations process to strengthen the international response to climate change through the "full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision" at Copenhagen in 2009.

The Bali Action Plan set up two parallel negotiating tracks: (1) a Kyoto Protocol track, which is looking at a second commitment period under that treaty; and (2) a "Long-Term Cooperative Action" track under the UNFCCC. The U.S. observes in the former and participates in the latter. If or how these two tracks merge is the topic of considerable speculation. For procedural reasons it could only occur in Copenhagen at the earliest.

The negotiations revolve around a shared vision for long-term co-operation—including a global emissions goal—and four actions areas covering mitigation, adaptation, technology, and finance (UNFCCC 2007).

The success of these negotiations will depend in large part on the ability of the developed countries to entice large developing countries such as China, India, and Brazil into a binding agreement, but that will be easier said than done. The rift between developed and developing countries is wide, and it is difficult to see how it can be bridged in the remaining negotiating sessions.

Just how far apart the Parties remain can be seen in the leaders' statements on climate change emerging from the G8,[1] Major Economies Forum on Energy and Climate (MEF),[2] and G5[3] meetings in Italy last July. The matrix in table 1 breaks down the emissions targets each group of countries was able to agree on in Italy.

Matrix of Climate Change Declarations for the G8, MEF & G5

Issue	G8	MEF	G5
Average Global Temperature Limit	2°C above pre-industrial	2°C above pre-industrial	—
Peak Global Emissions	As soon as possible	As soon as possible, with developed countries peaking before developing countries	—
Short-Term Target (2020):			
Global	—	—	—
Developed Countries	"Robust" aggregate and individual reductions	"Robust" aggregate and individual reductions	-40% from 1990 baseline
Developing Countries	Reduce emissions below "business-as-usual" projections	"Meaningful" deviation from [Note: not "below"] business-as-usual	—
Long-Term Goal (2050):			
Global	-50% (no baseline provided)	—	—
Developed Countries	-80% from 1990 baseline	—	—
Developing Countries	—	—	—

Much has been made of the reference in the G8 and MEF declarations to limit the average global surface temperature to no more than a 2°C increase above the pre-industrial level.[4] Using the "best estimate" provided by the Intergovernmental Panel on Climate Change's *Fourth Assessment Report* (IPCC 2007), a 2°C target translates into an atmospheric carbon dioxide concentration in the range of 350 ppm to 400 ppm.[5] (To put this in perspective, the current atmospheric concentration of carbon dioxide is a little under 390 ppm, roughly 120 ppm above the pre-industrial level.) To get global emissions on a trajectory to stabilize atmospheric carbon dioxide concentrations within this range, IPCC estimates that global emissions would have to peak no later than 2015 and would have to be about 50% to 85% below their 2000 level in 2050.[6]

The G8 also reiterated its support specifically for a 50% reduction in global emissions by 2050 (with no baseline supplied), and it called on developed countries to commit to an 80% reduction from a 1990 baseline over the same period.

The G5 statement is noteworthy more for what it leaves unsaid. Developing countries as a group clearly are not interested in moving the discussion beyond midterm commitments for developed countries. As long as the discussion focuses on 2020, developing countries really see no reason to do much of anything. That is not the case when the discussion turns to a 2050 global goal.

In the U.N. negotiations, the idea of a 50% reduction in global emissions (from base years ranging from 1990 to 2005) by 2050—with developed countries pitching in at least 80%—has become the starting point of discussion of the long-term emissions goal.[7] The general view is that, as part of the shared vision, this "50-by-50" long-term goal will not be considered operational, but rather aspirational.

Though ultimately non-binding and unenforceable, the long-term vision nonetheless drives expectations about technology readiness and commercial adoption, short-term goals, burden sharing by developing countries, finance and wealth transfers, and technology transfer, issues that are among the most contentious in the international negotiations.

A Note About the Data

For simplicity, most of the 50-by-50 scenario data cited in this paper stem from IEA 2008 unless noted otherwise. The IEA's scenario results are consistent with those of other groups, such as the U.S. Climate Change Science Program's report on stabilization scenarios (CCSP 2007), which included scenario results from three different models. The IEA figures should be seen as an indication of the scale and scope of the changes in energy systems and reductions and avoidances in emissions that would be needed to meet a 50-by-50 target for energy-related carbon dioxide only (it does not consider emissions of carbon dioxide from land use change or industrial processes or emissions of other greenhouse gases). While mitigation scenarios from other groups yield somewhat different results, they are generally all of the same magnitude and tell essentially the same story.

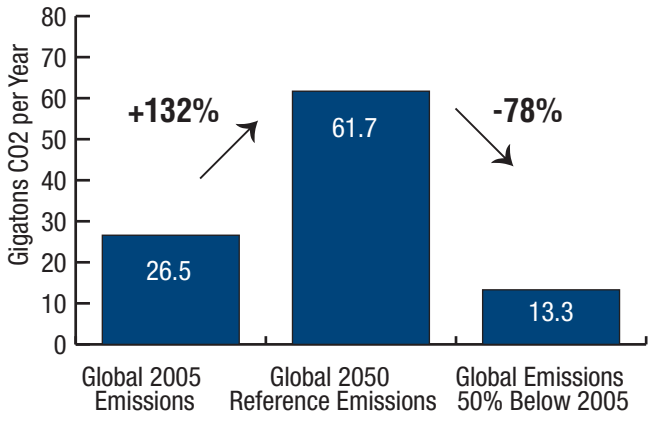
In addition, the definitions of "developed" and "developing" countries in the IEA report align with OECD and non-OECD countries, not the more familiar Annex I and Non-Annex I designation used in the UNFCCC. This does not impact the data in any meaningful way.

Technology Scale and Scope

As we consider the international negotiations, it is important to take stock of the technology challenge to achieve deep reductions in carbon dioxide emissions. A 50-by-50 global goal is among the most aggressive of the 177 emissions reduction scenarios examined by the Intergovernmental Panel on Climate Change. Meeting it would demand the almost complete transformation of the global energy system in just 40 years. It would require extremely large and expensive emissions reductions and avoidances, most of which would have to occur in developing countries, from where the lion's share of future emissions are expected to come.

Figure 1

Reductions Needed to Achieve a 50% Cut in Global Energy-Related Carbon Dioxide Emissions



Source: IEA 2008

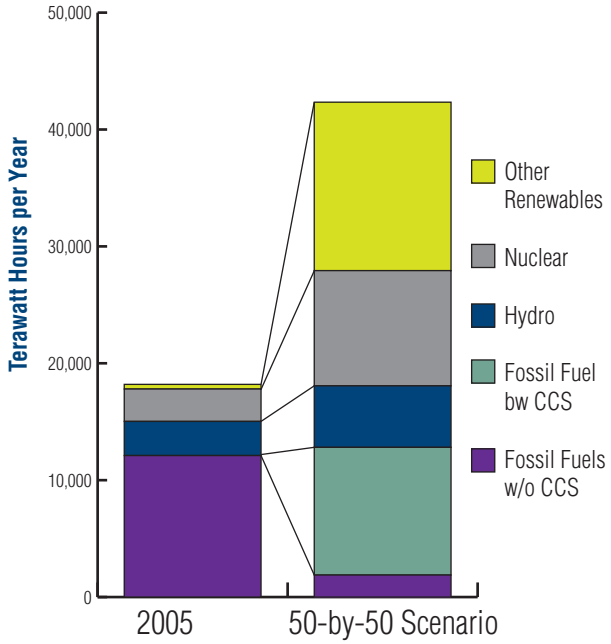
The scale of the changes required to meet a goal of this magnitude is not well appreciated. A 2008 report from the International Energy Agency (IEA) describes in detail the technology breakthroughs—in fossil fuel power generation; carbon capture and storage; nuclear energy; biomass, wind, solar, and other renewable energy; transportation fuels; batteries; electricity systems; and other technologies—that would be needed over the next 40 years to transform the energy sector and halve global energy-related carbon dioxide emissions from their 2005 level (IEA 2008).[8]

There is always a large element of uncertainty when peering into the future, and as IEA notes, many of the technologies demanded by a 50-by-50 scenario are still under development, and their progress is highly uncertain. Even under the most optimistic circumstances, however, 50-by-50 would be extraordinarily difficult to achieve.

In 2005, global emissions of carbon dioxide were around 26.6 gigatons.[9] IEA estimates that, assuming no additional climate policies and some "business as usual" technology and energy efficiency improvements, global carbon dioxide emissions could rise to 61.7 gigatons by 2050. To halve energy-related carbon dioxide emissions in 2050 relative to 2005—i.e., 13.3 gigatons—implies reductions and avoidances in excess of 48 gigatons, an amount about equal to 8 times current U.S. carbon dioxide emissions (figure 1).

Figure 2

Global Electricity Production by Source: 2005 & 2050 50-by-50 Scenario (tWh/Year)



Source: IEA 2008

Energy efficiency is the biggest source of emissions reductions in IEA's scenario. Immediately following the oil price shock of the 1970s, energy efficiency in developed countries improved at a rate of about 2.5% per year. More recently, however, yearly efficiency improvements have been lagging at well less than half that rate. To achieve 50-by-50, IEA requires energy efficiency to improve at a sustained rate of 1.7% from 2010 to 2050 compared to 0.9% in its baseline scenario. This represents an increase in rate of annual efficiency gains of 85% to 90% and would be very challenging to maintain. Under its 50-by-50 scenario, total global energy demand is one-third less than in the reference case.

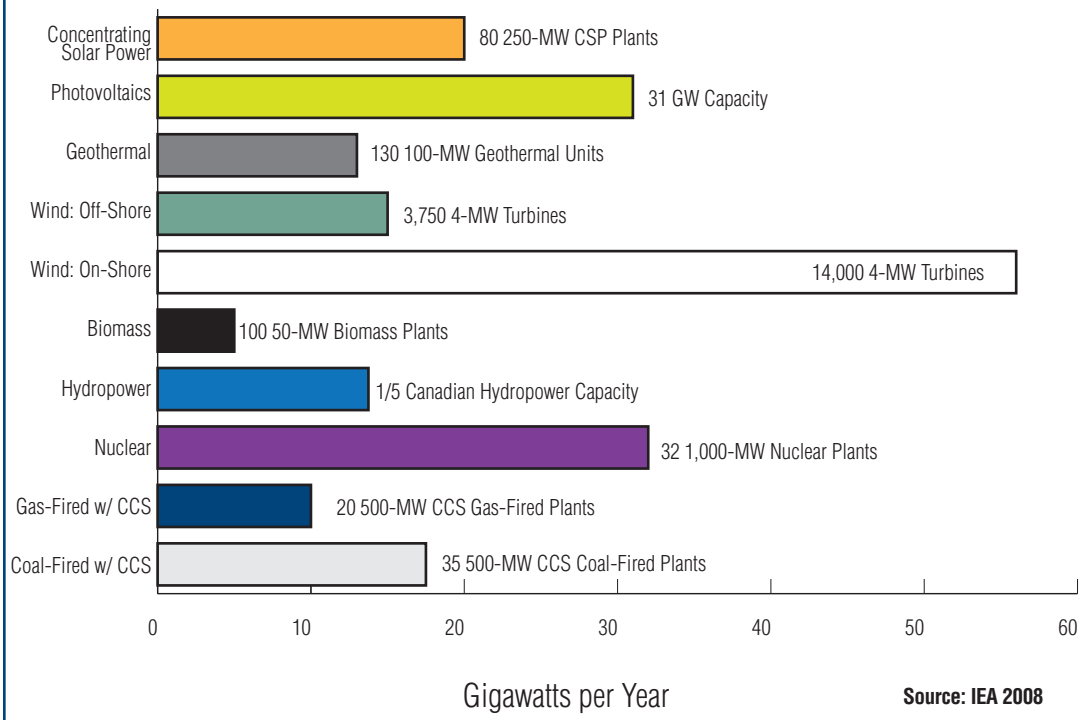
In the power sector, IEA estimates that electricity production will more than double from 2005 to 2050. In 2005, non-emitting sources of power accounted for about one-third of electricity generated worldwide, and just about all of that was from either nuclear or hydropower sources. To meet rising electricity demand and reduce carbon dioxide emissions, carbon-free sources would have to boost their output from 6 to 40 petawatt hours,[10] a jump of more than 550%, and provide 96% of the electricity generated worldwide in 2050 (figure 2).

To realize a shift of this magnitude, low-emission sources of power would have to be at added at an unprecedented rate (figure 3). Nuclear capacity would have to be added at an annual rate half again as large the historical high every year from 2010 to 2050. Renewable energy sources, excluding hydropower, would have to be installed at a breakneck pace—rising about 3,500%—and grab 34% of an electricity market well more than twice the size it was in 2005, when non-hydro renewables claimed a meager 2% market share. (For example, nearly 18,000 4-megawatt wind turbines would have to be installed each year from 2010 to 2050.[11]) By 2050, all coal plants and most natural gas plants would have to be fitted with carbon capture technology, which is not yet commercially available and may not be for many years.

The world's transportation sector, now dominated by oil-based fuels, would have to undergo similarly sweeping changes. Batteries and fuel cells are expected to be the main alternatives to the internal combustion engine in

Figure 3

Average Annual Power Capacity Additions to Halve 2005 Global CO2 Emissions by 2050: 2010 to 2050



Source: IEA 2008

automobiles. Because these alternatives are too expensive and impractical for trucks, ships, and planes, biofuels are expected to play a greater role in these transport modes.

On average, something on the order of 85% to 90% of all the cars and light trucks sold annually from 2010 to 2050 would have to be some sort of alternate vehicle, and by 2050, new conventional gasoline and diesel vehicles essentially would be unavailable. Figure 4 shows the dramatic change in global new car sales in 2050 under IEA's business as usual baseline and 50-by-50 scenarios. From virtually none today, IEA estimates that 40 years from now nearly 1 billion electric and fuel cell cars would have to be on the world's roads.

A 50-by-50 goal would demand, then, an unprecedented global transformation of existing and future energy systems away from fossil fuels—which in 2005 supplied nearly 90% of energy demand—on a massive scale and at a breathtaking pace.[12] IEA pegs the additional investment for all this at $45 trillion, a yearly average, it notes, equivalent to the (GDP) national product of Italy.[13] By 2050, the marginal costs for a ton of carbon dioxide would be $200. Under a more pessimistic technology outlook, the cost of carbon dioxide could climb to $500 to $800 a ton.

Sharing the Burden—After You

Studies on global emissions trends demonstrate that emissions reductions by the developed world alone cannot reduce global emissions appreciably. There is, however, a huge and perhaps unbridgeable divide between the developed countries and the developing countries. The UNFCCC did not create these divisions, but it does reflect and sustain them.

The blame game is played with great aplomb within the Convention. Developing countries assert that as developed countries bear "historical responsibility" for most of the build-up of atmospheric carbon dioxide,[14] they bear a responsibility to reduce emissions in their own countries and finance reductions in others. This notion of historical responsibility pervades much of the negotiations.

In addition, the Convention's preamble expresses the view that "the share of global emissions originating in developing countries will grow to meet their social and development needs" (UNFCCC 1992). The link between industrialization and increasing greenhouse gas emissions is strong, so it is expected that as these countries develop economically, they will emit more.

Parties to the UNFCCC also agreed in the treaty text that, as a matter of principle, protecting climate system should be "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof" (UNFCCC 1992). In other words,

developing countries are not expected to do as much as developed countries, which have greater economic and technological capabilities to curb emissions. This principle of common but differentiated responsibilities is on full display in the Kyoto Protocol, where only developed countries have binding obligations to reduce emissions, a state of affairs developing countries have no incentive to see changed.

While the gradation between developed and developing countries has always been murky, the Convention, nonetheless, established and maintains clear lines of differentiation among its Parties. The Convention divides Parties into three main categories, and it is through these designations that the commitments and responsibilities of the Parties largely have been determined.

Annex I includes countries that made up the Organization for Economic Co-operation and Development (OECD) in 1992 and countries with "economies in transition" (Russia, the Baltic states, and most Central and Eastern Europe states). In general, the Convention places a heavier burden on Annex I countries to report and reduce greenhouse gas emissions. The OECD countries listed in Annex I comprise Annex II. This subset of countries is obliged to provide financial support to developing countries for reporting, mitigation, and adaptation activities. All other countries—almost all of which can be viewed as developing—are designated Non-Annex I.

The world has changed considerably since the UNFCCC was launched in 1992. Mexico and South Korea, both Non- Annex I Parties, are OECD members. Singapore, another Non-Annex I party, has one of the highest levels of per capita income in the world. Major emitting countries like China, India, Brazil and other large and emerging economies are rapidly industrializing and becoming major players in the world's economies and its energy markets.

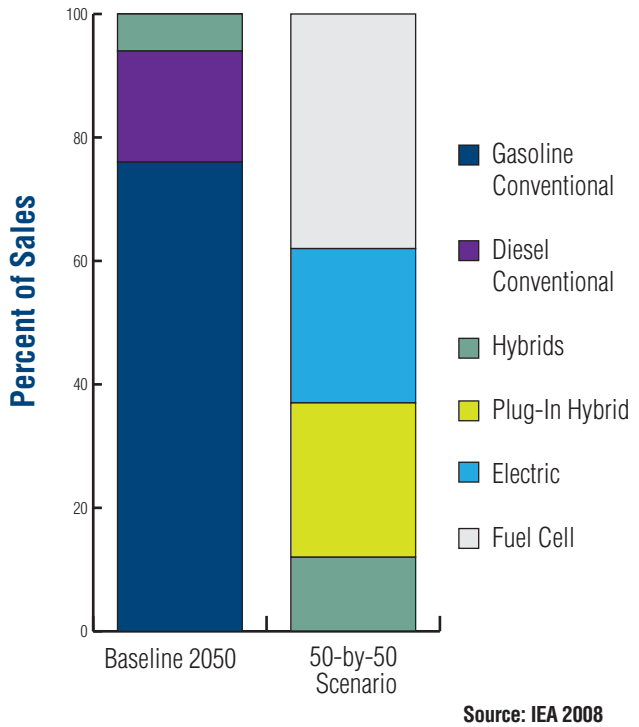
There are, however, no criteria or instruments in the Convention that would automatically move Parties, as they advance economically, from Non-Annex I to Annex I, or even to an intermediate status. The Convention does allow for changes to occur either voluntarily or through a treaty amendment, an arduous process requiring consensus of the Parties or, if that cannot be achieved, a three-fourths majority vote.[15]

Obviously, developed countries have a strong interest in supporting such a change, and Australia, for one has been pushing to introduce such a mechanism into the Kyoto Protocol. Just as obvious, developing countries have no incentive to agree to a more systematic and dynamic approach not only because of what this may mean for them in the UNFCCC, but in other U.N. and international venues as well. None of this alters the fact that to reduce global emissions appreciably, any new international arrangement addressing climate change must include active participation from developing countries, especially large economies like China and India. In this regard, the Bali Roadmap that emerged from the UNFCCC talks in Indonesia in 2007 was promising in that developing countries agreed to consider "nationally appropriate mitigation actions" that are "measurable, reportable, and verifiable". Such actions would be "supported and enabled by technology, financing and capacity-building" from developed countries (UNFCCC 2007).

It is within these broad parameters that the negotiations should be viewed, particularly the discussions about burden sharing to achieve a global emissions goal.

Figure 4

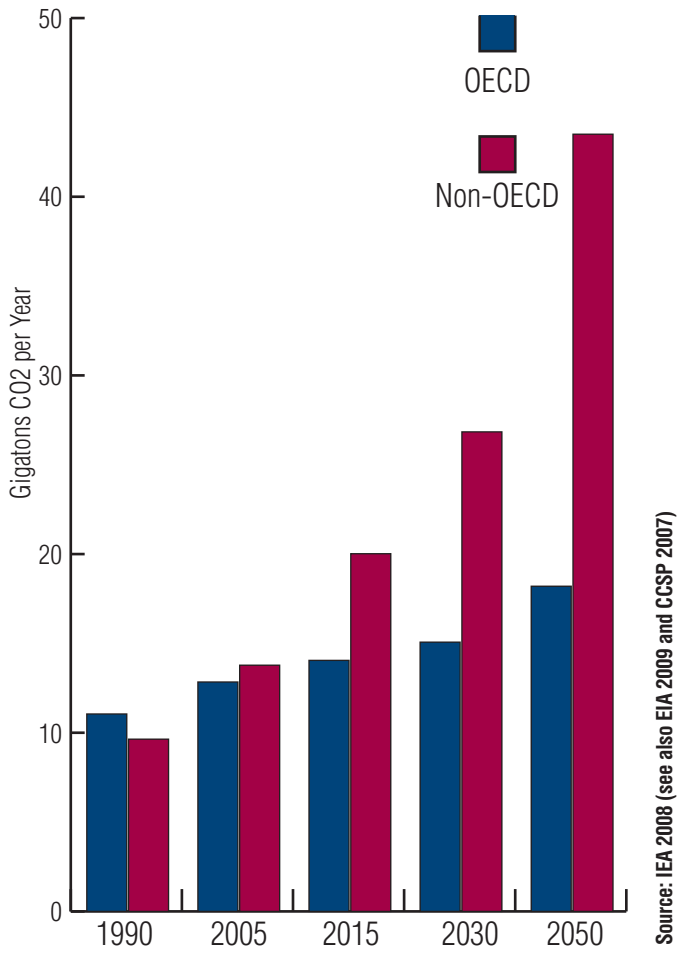
Share of Light Duty Vehicle Global Sales by Technology: 2050 Baseline & 2050 50-by-50



Source: IEA 2008

Figure 5

Energy-Related Carbon Dioxide Emissions by Region: 1990 to 2050



Developed countries have proposed a global goal of a 50-by-50 reduction, with developed countries kicking in an aggregate reduction of 80% through "comparable" reductions by individual states. Consistent with the concept of common but differentiated responsibilities and respective capabilities, more advanced developing countries (*e.g.*, South Korea, Singapore, Mexico) would undertake significant mitigation commitments, and major emitting developing and emerging economies (*e.g.*, China, India, Brazil, South Africa) would reduce their emissions growth below a business-as-usual baseline.

For their part, developing countries contend that because human-induced climate change has global impacts, the "carbon space" should be shared more equitably. This carbon space represents the historical and future amount of greenhouse gas emissions that would be consistent with a specific (and presumably agreed upon) concentration of carbon dioxide in the atmosphere. Citing historical responsibility, developing countries argue that developed countries have exceeded their fair share of the carbon space. Thus, developed countries have an obligation to go first with emissions cuts below their 1990 level of at least 40% to 45% by 2020 and 80% to 95% below by 2050.

The scale and transformation necessary to achieve a 40% to 45% reduction by 2020 has received far less evaluation than the targets themselves. In the United States, for example, no administration or congressional proposal under serious consideration comes anywhere near a 40% reduction by 2020. An 80% cut by 2050 would shrink the country's "carbon footprint," relative to its economy and population, to levels today seen only in countries like Haiti and North Korea.[16]

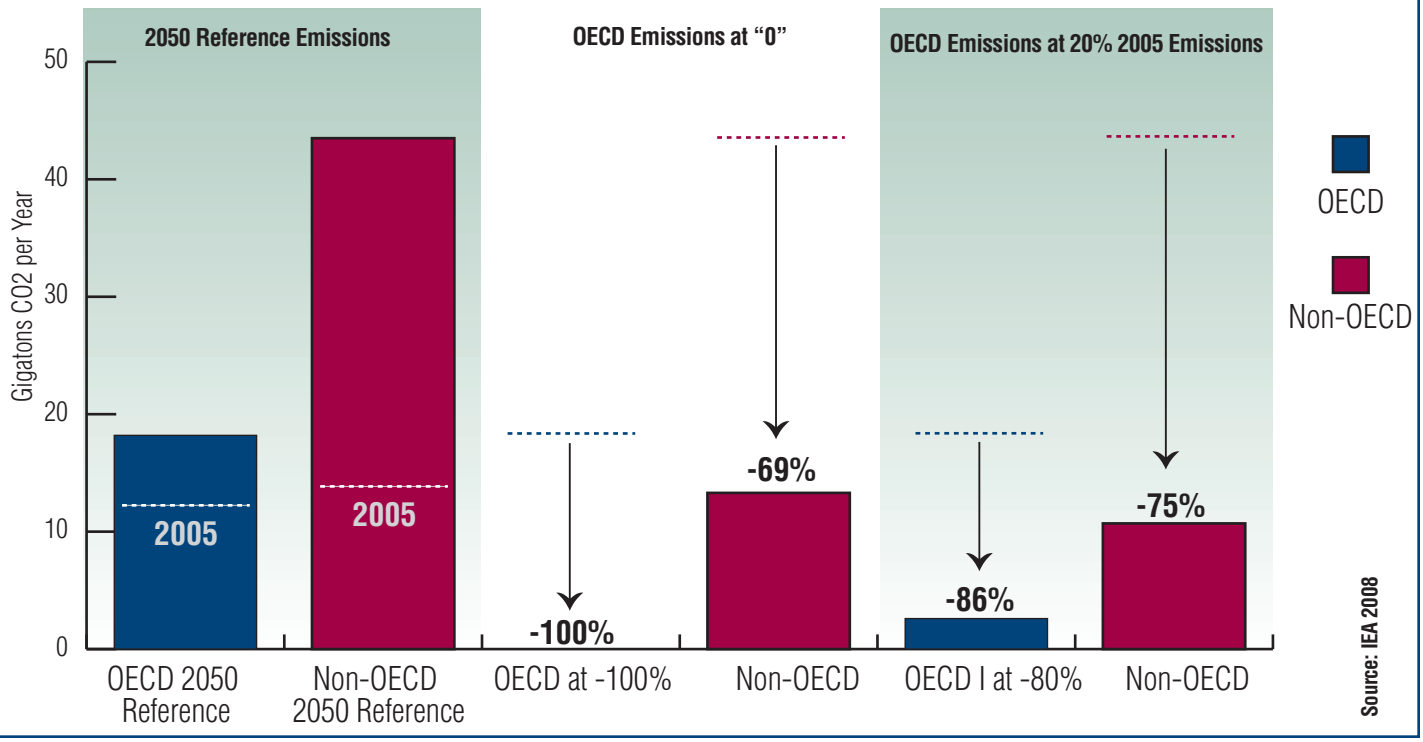
No other developed country is aiming for midterm targets approaching a 40% to 45% reduction, either. The European Union has pledged cuts of 20% by 2020 below a 1990 baseline (and allowing international offsets) and would be willing to go as high as 30% if other developed countries take on similar goals. Japan's new government announced its intention of reducing emissions 25% below from the 1990 level in 2020, contingent on an international deal. Australia has set a 2020 goal of 5% to 15% below its 2000 level and would be prepared to accept 25% if certain conditions are met as part of an international agreement. Canada is looking at a 20% reduction from its 2006 level by 2020. New Zealand announced its intention to limit emissions 10% to 20% below 1990 levels by provided certain conditions are met. And Russia said it would commit to 2020 goal of a 10% to 15% reduction from the 1990 level.[17]

Even if developed countries could deliver steep cuts in emissions, absent meaningful commitments by developing countries, it will be nearly impossible to achieve significant reductions in global emissions. That is because about 80% or more of the expected growth in global carbon dioxide emissions to 2050 is expected to occur in developing countries, with China, India, and Southeast Asia leading the way (figure 5).[18]

Brisk economic and population growth can be expected to increase greatly the demand for energy, primarily from fossil fuels, in developing countries. Between 2005 and

Figure 6

Sharing the Burden: Changes in Emissions of Energy-Related Carbon Dioxide Emissions to Achieve "50-by-50"



2050, IEA expects that GDP in China and India will grow nearly 900% and in Brazil nearly 300%.[19] Over the same period, the world's population is expected to soar from 6.5 billion to 9.2 billion, a rise of more than 40%, with most of the growth coming in Asia and Africa and almost none from developed countries. Out of a projected 2050 global population of over 9 billion people, only about 1 billion will be in OECD countries (IEA 2008).

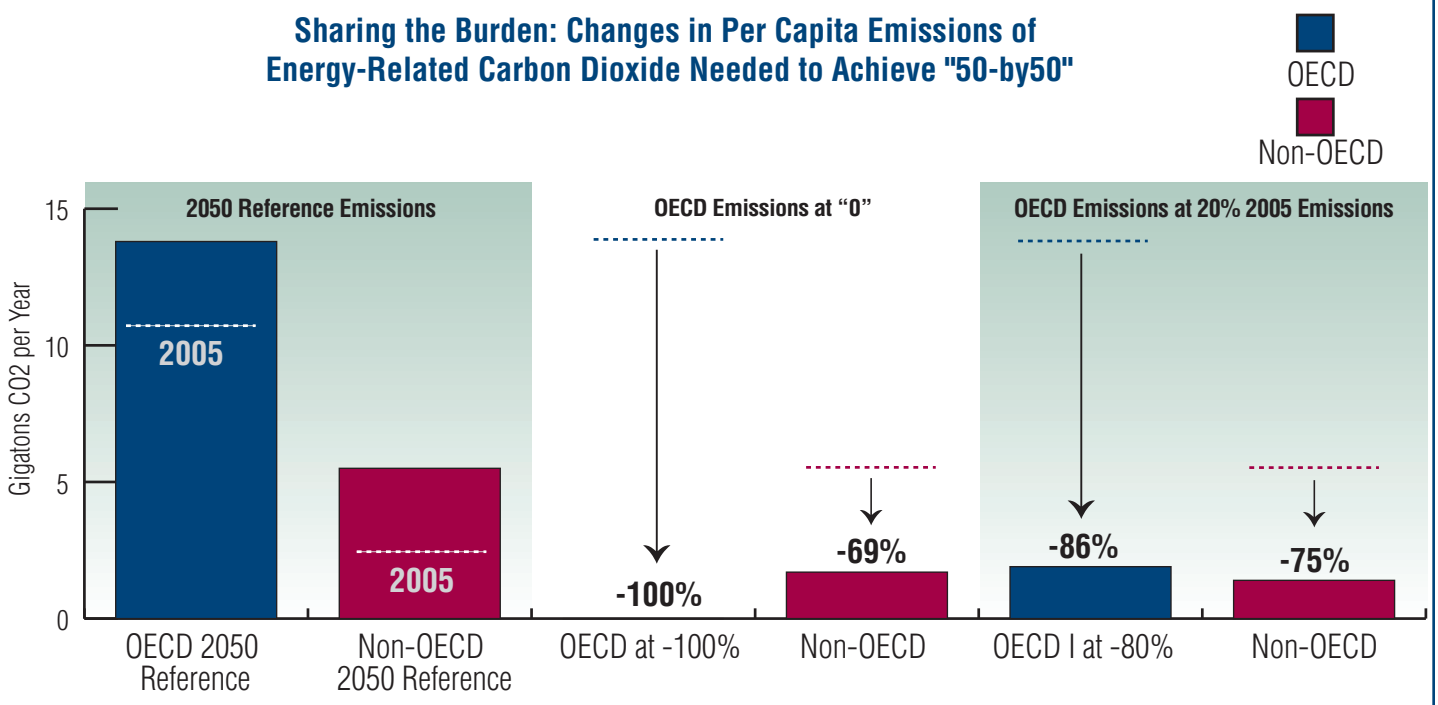
These trends are expected to lead to a huge appetite for energy that could see global demand more than double over the period, again with the vast majority of the increase occurring in developing countries.

To have any impact on greenhouse gas concentrations, therefore, the developing world also must act. So what would developing countries have to contribute to meet a 50-by-50 goal?

Let us assume that developed countries succeeded in cutting emissions by 80% in 2050. To meet a 50% global target, total emissions from developing countries, after rising for decades, would have to peak and subsequently return to or slightly below their 2000 level (figure 6).[20] What is more, because developing countries will have much larger populations 40 years hence, their combined per capita emissions also would have to be *lower* than today's—and that would be the case even if developed countries eliminated their emissions entirely (figure 7).

Developing countries are unwilling to accept restrictions on their development and energy use. Providing modern energy services to lift their people out of poverty is a much more pressing need than addressing climate change. With billions of people still lacking electricity, developing countries are understandably loath to cap emissions if it hampers their economic development and energy security. Much of the energy needed to power economic growth will likely be supplied by fossil fuels. Many developing countries sit atop large reserves of coal, oil, and gas, and it would be naive to expect them to forego their use in favor of more costly and less reliable energy options.

Figure 7



Many developing countries sit atop large reserves of coal, oil, and gas, and it would be naive to expect them to forego their use in favor of more costly and less reliable energy options.

Developing countries routinely point out that their per capita emissions, now at approximately 2.5 tons, are generally much lower than those in developed countries, now in the neighborhood of 11 to 12 tons. There is a wide range of per capita carbon dioxide emissions exhibited among developing countries. Some small developing states with large energy intensive industries, such as refining, have per capita emissions that are very high (greater than 30 tons), but for the vast majority of these countries, they are under 3 tons.

At about 4 tons, China's per capita emissions from energy, like its emissions as a whole, have experienced tremendous growth over the last decade in step with that country's rapid industrialization. Nevertheless, its emissions per person are still only about a third as much as that of the average person living in a developed country.

India's emissions per capita are quite low, and it is a major emitter largely by virtue of its sizeable population, not because its people consume an inordinate amount of fossil fuels. Carbon dioxide emissions for each Indian hover just over 1 ton, less than a tenth of the developed country average.

China and India, and other developing countries, have stated unequivocally that they are not in a position to take on legally binding emissions reductions, especially given their low per capita emissions. The Indian government, in particular, has said repeatedly that as a matter of equity it will not allow its per capita emissions to exceed the average for the developed world (Government of India 2009). Other countries have embraced this idea of a "fair sharing" of the carbon space and the "convergence" of per capita emissions between developed and developing countries.

But again, let us suppose that developed countries managed to slash their dioxide emissions 80% by 2050, which would place their combined per capita emissions at just about

2 tons per person. If every country in the world somehow matched this remarkably low level,[21] last seen globally on the eve of World War II, global carbon dioxide emissions from energy would decline to about 18.4 gigatons, an amount that is still well above the level needed to reach a 50% global reduction target.[22]

Money Talks

Although many developing countries, including China, India, Mexico, and South Africa, have issued or plan to issue national climate action plans, implementing a national plan is a different undertaking than accepting a binding commitment as part of an international treaty. Whereas developed countries are willing to offer their national plans as a basis for a binding international obligation, the position of the developing countries is that they are not prepared to do so.

Developing countries have been forthright in saying that their cooperation, in addition to being nonbinding, will only come with financial strings attached. The Convention directs Annex II Parties to provide financial resources, including transferring technologies, to cover the "agreed full incremental costs" to developing countries of complying with various articles implementing the treaty.[23]

In the Bali Roadmap,[24] developing countries agreed to consider nationally appropriate mitigation actions "in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner" (UNFCCC 2007). This language has been interpreted in various ways, but in general, the phrase "measureable, reportable, and verifiable" refers both to the nationally appropriate mitigation actions of developing countries *and* the support for "technology, financing and capacity-building" that developed countries are expected to provide. The G77 China group, for example, has stressed that nationally appropriate mitigation actions undertaken by developing countries would be voluntary and dependent upon adequate provision of financing.

These provisions have become fodder for all manner of demands by developing countries on the economies of developed countries. Developing countries are counting on huge direct transfers of wealth to support their efforts to mitigate emissions and fund adaptation efforts, and it is perhaps the case that developed countries have not done enough to temper these expectations.

China, India, South Africa, Bolivia, Colombia, among others, are pushing developed countries to transfer anywhere from 0.5% to 2.0% of their GDP each year to support climate change programs in developing countries. At that rate, the contribution from American taxpayers alone would have been $72 billion to $289 billion in 2008. Yet even that may not be enough. A report out of the Massachusetts Institute of Technology estimates that if developing countries are fully compensated for their mitigation activities[25] through a global emissions trading scheme, the implied financial transfers from developed countries to meet a 50-by-50 goal could amount to over $400 billion annually in 2020 and about $3 trillion in 2050 (Jacoby *et al.* 2008). The U.N.'s *World Economic and Social Survey 2009* suggests developing countries will need international support to the tune of 1% of *global* GDP a year, currently about $500 to $600 billion (UN 2009).

It was always very unlikely that developed country governments would agree to such vast sums in the best of times, much less in the midst of a severe crisis in world financial markets. In any event, most of this financing would have to come from the private sector, with government financing serving to spur and bolster these investments. There is a real concern that these financial flows could be used to underwrite the modernization and competitiveness of often state-run firms in developing countries, putting private firms at a distinct disadvantage.

Intellectual Property Protections Under Assault

The Convention also states that Annex II Parties "shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention" (UNFCCC 1992).

Developing countries have used this provision deftly to justify their attempts to weaken intellectual property protections, ostensibly to remove barriers to technology transfer. Compulsory licensing and a fund supported by developed countries to buy down intellectual property are two of many proposals being bruited.

Without intellectual property rights, there is precious little incentive for companies to invest in advanced technologies that could be expropriated outright by companies in developing countries.

There is, however, no justification for the view that intellectual property protections hinder technology diffusion. A review of the relevant literature by researchers at Colorado College found that intellectual property rights "do not constitute as significant a barrier as claimed since a variety of technologies exist for reducing emissions." The study also found that, "In many cases, IPR protected technologies are not necessarily more costly than those not covered" (Johnson and Lybecker 2009).

All the same, developing countries continue to call for weakened intellectual property regimes. The China/G77 group proposed treaty text that reads: "All necessary steps shall be immediately taken in all relevant fora to mandatorily exclude from patenting climate friendly technologies held by Annex II countries which can be used to adapt to or mitigate climate change." The Philippines put forward the following: "All necessary measures and actions shall be immediately taken to facilitate technology pools that include associated trade secrets and know-how on environmentally sound technologies and enable them to be accessed, including on royalty-free terms for developing countries." Bolivia offered similar language, suggesting that "nothing in any international agreement on intellectual property shall be interpreted or implemented in a manner that limits or prevents any Party from taking any measures to address adaptation or mitigation of climate change, in particular the development and transfer of and access to technologies" (UNFCCC 2009b).

If provisions such as these are included in a final climate change agreement, developing countries could claim the legal right to seize the "green" technologies developed by American and other companies. Without intellectual property rights, there is precious little incentive for companies to invest in advanced technologies if after years of research and development and millions or even billions of dollars invested, their inventions could be expropriated outright by companies in developing countries and manufactured and sold around the world at reduced cost.

If their incentives are removed through what would amount to legalized theft of their intellectual property, some of the most innovative companies in the developed world would simply abandon the development of clean energy technologies. U.S. negotiators were joined by their colleagues from Europe, Japan, and other developed countries in declaring that any weakening of intellectual property would be a deal-breaker.

A Green Trade War?

Just as worrisome as the assault on intellectual property rights are threats by some developed country governments to engage in protectionist practices to avoid "carbon leakage"—that is, the movement of energy-intensive industries, and thus their carbon dioxide emissions, to other countries. Many developed country governments, including the United States and the European Union, are considering imposing border adjustments on goods coming from nations that do not take on comparable commitments. (Remember, under the principle of common but differentiated responsibilities, developing countries are not expected to take on similar commitments.)

H.R. 2454, The American Clean Energy and Security Act of 2009, includes border adjustment measures that would impose carbon tariffs on goods imported from countries that, as determined by the government, have not adopted restrictions on emissions similar to those in the United States. The tariff would take effect in 2020 and fall on imports of carbon-intensive products, such as cement and steel.

These kinds of proposals are counterproductive. They do little to raise the level of trust between the developing and developed countries, and they are unnecessary if an international agreement eventually is reached. The U.S. proposal earned swift rebukes from China and India, both of whom object to putting up trade barriers under the guise of protecting the climate, and they have proposed treaty text that would prohibit the use of carbon tariffs.

One expects a little gamesmanship as the negotiations progress, but threats of trade sanctions set a dangerous precedent and—notwithstanding a recent World Trade Organization (WTO) and U.N. Environment Programme report (WTO/UNEP 2009)—could violate WTO rules if put into practice.[26] At the very least, border adjustments would inevitably invite retaliation and incite a green trade war, and because no one

wins a trade war, warnings of carbon tariffs have little value as negotiating leverage. Moreover, these types of proposals stand in stark contrast to the commitment made by the G20 countries in April 2009 to "refrain from raising new barriers to investment or to trade in goods and services" (Wenk & Westerman 2009).

It is important that the international climate negotiations not be used as an excuse to erect barriers to free and open trade, or as a way to gain competitive advantage or redistribute wealth. The WTO, not the UNFCCC, is the appropriate forum for intellectual property and trade discussions. Instead of raising barriers, governments should be pursuing the elimination of tariff and nontariff barriers to environmental goods and services to lower their costs and increase global access of clean energy technologies.

In a more constructive vein, developed countries have proposed the idea of sectoral approaches focused on specific industries (*e.g.*, steel, refining, and cement) as a way to ease competitiveness concerns, motivate action in developing countries, and bring them into international carbon markets (other than the market for offsets).

There are many different sectoral proposals being considered. Under sectoral crediting, a developing country could set a specific improvement in emissions intensity for a sector that if exceeded would generate internationally-tradable credits. If the sector failed to meet the target, no penalty would apply. Under sectoral trading, a developing country would commit a sector to an emissions cap for which it would receive tradable credits.

While promising, sectoral approaches are not without their detractors, and as with many other proposals, the devil is in the details. There is, for example, a real concern that sectoral agreements could be structured in such a way that the primary beneficiaries would wind up being inefficient state-run enterprises that dominate many industrial sectors in developing countries.

Sectoral agreements could be very difficult to reach given both the number of Parties involved and the almost complete lack of any mention of sectors in either the Convention or the Kyoto Protocol, both of which emphasize country-wide engagement.[27] Moreover, with but a few exceptions—notably South Korea and Mexico—developing countries have shown little interest in sectoral approaches, especially if doing so would involve binding commitments.

Whither Now?

Every delegation sitting around the U.N. negotiating table understands these numbers and their implications, so it is little wonder that the Parties are so far apart. It is one thing to achieve 50-by-50 in a computer model, quite another in the real world. The focus on an unenforceable target and timetable has made an already difficult negotiation that much more difficult by creating expectations that both developed and developing Parties are seemingly unprepared to fulfill.

As a practical matter, any long-range numeric goal makes assumptions about the pace of technology development and diffusion, an inherently unpredictable process. At its most fundamental level, reducing carbon dioxide emissions from energy is a technology challenge that, as a 2002 article in *Science* famously noted, "cannot be simply regulated away" (Hoffert *et al.* 2002). Neither can it be negotiated away.

Border adjustments would inevitably invite retaliation and incite a green trade war, and because no one wins a trade war, warnings of carbon tariffs have little value as negotiating leverage.

A 50-by-50 vision also takes for granted a degree of burden sharing that developing countries are not willing to accept, and that in turn compels unreasonable demands for assistance from developing countries. Even under the rosiest scenarios that include deep emissions cuts in developed countries, 50-by-50 still implies large emissions cuts by developing countries at some time in the future that in their view poses a threat to their industrial development. Right now, there is little reason for them to accept any sort of reduction commitment, binding or otherwise, without wealth and technology transfers worth hundreds of billions, and perhaps rising to trillions, of dollars each year.

The top-down approach embodied in the Kyoto Protocol is seriously flawed, and it is unlikely to supply the vehicle

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for a new, comprehensive international agreement. What is needed instead is a long-term vision that motivates and provides direction for national and regional co-operative activities, takes into account emerging science and technology development and turnover, recognizes growing energy needs, ensures the broadest participation, and does not undermine economic growth.[28]

An agreement that focuses on technology offers a path forward that developed and developing countries can embrace. How rapidly advanced energy technologies develop and are adopted commercially will be the most important factor in determining how quickly and at what cost greenhouse gas emissions can be reduced. Existing technologies can make an important contribution, but they alone are not capable of significantly reducing greenhouse gas emissions on a global scale and at an acceptable cost. New and in some cases revolutionary energy technologies, many still years if not decades over the horizon, will have to be developed and adopted commercially along with the infrastructure to support them. But there is a great deal of uncertainty about how fast, or even if, these technologies will progress.

An accelerated program to improve the performance and lower the costs of advanced alternate energy technologies can, if successful, broaden the range of economically and politically viable policy options available to decision makers. National and international climate policy should concentrate on supporting greater energy efficiency and commercialization of all low-emitting technologies for energy supply, including nuclear power.

Developed and developing countries alike must make a larger commitment to technology development worldwide. Together, the United States and Japan account for an estimated 80% of all energy research and development spending by national governments. That has to change. Research and development into the next generation of potentially transformational energy technologies needs a substantial boost in funding, and the Energy Institute has recommended doubling the federal budget for advanced energy technologies.

A successful new agreement, then, should promote new partnerships involving developed, emerging, and developing countries and the private sector that create opportunities for technology co-operation, public-private partnerships, innovative financing, and capacity building.

With a clear stake in the process, developing country governments can be convinced that intellectual property protections are in their interests as well as ours. Their businesses already know this—from less than 5% of patents in 1998, emerging economies now account for roughly 20% of patents worldwide (Copenhagen Economics 2009).

To be effective in reducing greenhouse gas emissions, a new arrangement should include realistically ambitious commitments by all countries in keeping with the principle of "common but differentiated responsibilities and respective capabilities." Large developing economies, like China, India, and Brazil, must be a part of any new international accord for it to be credible. This is not to say that we should expect developing countries to take on commitments similar in scope to developed countries. While the character of the commitments in developing countries should be similar to those in developed countries in terms of ambition, the content of those commitments could be quite different depending on national circumstances.

The emphasis, therefore, should be on co-operation to assess the mitigation potential of different countries and develop cost-effective action plans that are "measurable, reportable, and verifiable." A bottom-up approach that recognizes the results of domestic, bilateral, and multilateral activities and incorporates sufficient leeway to permit new ideas and approaches to be introduced as they emerge is one that could garner a broad support. It is also important that these commitments evolve as economic circumstances change.

Governments also should be taking take steps outside of the Framework Convention to overcome barriers to technology

transfer and commerce. Eliminating tariff and non-tariff barriers to environmental goods and services should be pursued vigorously to lower costs and increase global access of clean energy technologies. Although WTO, not UNFCCC, is the appropriate forum for these discussions, it is an example of how the international discussion on climate change can catalyze action in other areas.

In addition, the energy supply sectors in many countries suffer from extensive and lengthy regulations that delay new energy projects. National governments also can ensure that energy projects move ahead with greater predictability by streamlining siting, permitting, and other regulatory requirements. It is inexplicable that governments have not taken these relatively simple but extremely effective steps.

Finally, the range of voices in the negotiations needs to be expanded. To get a workable agreement, the energy, industry, and finance ministries must get fully engaged. It is these ministries, after all, that will be responsible for implementing key aspects of any agreement. Governments also should recognize and embrace business engagement so the international process can take better advantage of the range of technical expertise that business can provide.

At the end of the day, all the "modalities" and "frameworks" erected in these negotiations cannot ward off failure if the vision is not realistic—unreasonable expectations only breed unreasonable demands and finger-pointing.

Business needs a predictable environment in which to operate and plan, and it would welcome an ambitious international climate change agreement. But that ambition needs to be tempered with a healthy dose of pragmatism. A realistic vision focused on technology that encourages co-operation, not confrontation, would be a good place to start.

REFERENCES

CCSP. 2007. *Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations*, Synthesis and Assessment Product 2.1a. CCSP and the Subcommittee on Global Change Research. Department of Energy, Office of Biological & Environmental Research, Washington, DC. Available at: http://www.climatescience.gov/Library/sap/sap2-1/finalreport/sap2-1a-final-all.pdf.

Copenhagen Economics A/S and The IPR Company APS. 2009. *Are IPR a Barrier to the Transfer of Climate Change Technology?* (Report commissioned by the European Commission (DG Trade)). Available at: http://trade.ec.europa.eu/doclib/docs/2009/february/tradoc_142371.pdf.

Energy Information Administration. 2009. *International Energy Outlook 2009*. Report #:DOE/EIA-0484(2009). Release Date: May 27, 2009. Available at: http://www.eia.doe.gov/oiaf/ieo/index.html.

Government of India. 2009. *The Road to Copenhagen: India's Position on Climate Change Issues*. Public Diplomacy Division, Ministry of External Affairs Government of India. 27 February 2009. Available at: http://pmindia.nic.in/Climate%20Change_16.03.09.pdf .

Harbert, K. 2009. *Testimony of Karen A. Harbert, President & CEO, Institute for 21st Century Energy, U.S. Chamber of Commerce before the U.S. House of Representatives Select Committee on Energy Independence and Global Warming*. Wednesday, February 4, 2009. Available at: http://www.energyxxi.org/articles/Testimony_of_Karen_Harbert_on_International_Climate_Negotiations_Before_House_Select_Committee.aspx.

Hoffert, M.I. *et al*. 2002. "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," *Science* 298 (2002): 981. Available at: http://www.sciencemag.org/cgi/content/abstract/298/5595/981?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=existing+technologies+can+contribute&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT.

IEA. 2008. *Energy Technology Perspectives 2008: Scenarios and Strategies to 2050*. OECD/IEA, Paris, France.

IPCC. 2007. *IPCC Fourth Assessment Report: Climate Change 2007*, Cambridge University Press, Cambridge, U.K. Available at: http://www.ipcc.ch/.

Jacoby, H.D., *et al*. 2008. *Sharing the Burden of GHG Reductions*. MIT Joint Program on the Science and Policy of Global Change. Report No. 16, November 2008. Available at: http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt167.pdf.

Johnson, D.N.K. and Kristina M. Lybecker. 2009. Challenges to technology transfer: A literature review of the constraints on

environmental technology dissemination. Colorado College Department of Economics and Business, Colorado Springs, CO. July 29, 2009. Available at: http://www.thecied.org/portal/cied/resources/default.

MATCH. 2007. Ad hoc group for the modelling and assessment of contributions of climate change (MATCH), Presentation of Final Report, SBSTA Special Side Event on scientific and methodological aspects of the proposal by Brazil, 5 December 2007. Available at: http://www.match-info.net/data/MATCH_Bali_DEC05.ppt#259,1,Final report Bali, Indonesia 5 December 2007.

Pielke Jr., R., T. Wigley and C. Green. 2008. "Dangerous assumptions," *Nature* 452 (3 April 2008.): 531-532. Available at: http://sciencepolicy.colorado.edu/admin/publication_files/resource-2593-2008.08.pdf.

UN. 2009. *World Economic and Social Survey 2009*. UN Department of Economic and Social Affairs, E/2009/50/Rev.1, ST/ESA/319, New York, 2009. Available at: http://www.un.org/esa/policy/wess/.

UNFCCC. 1992. *United Nations Framework Convention on Climate Change*. FCCC/INFORMAL/84, GE.05-62220 (E) 200705. Available at: http://unfccc.int/resource/docs/convkp/conveng.pdf.

UNFCCC. 2007. *Bali Action Plan*. Decision 1/CP.13. FCCC/CP/2007/6/Add.1*. Available at: http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=3.

UNFCCC. 2009a. Ad Hoc Working Group on Long-Term Cooperative Action Under the Convention, *Revised negotiating text*, FCCC/AWGLCA/2009/INF.1, 22 June 2009. Available at: http://unfccc.int/resource/docs/2009/awglca6/eng/inf01.pdf.

UNFCCC. 2009b. Ad hoc Working Group on Long-term Cooperative Action. *Notes on sources for FCCC/AWGLCA/2009/INF.1, Part II*. 14 August 2009. Available at: http://unfccc.int/files/kyoto_protocol/application/pdf/part2rntsourcescorrected.pdf.

Wenk, C. and S. Westerman. 2009. *The Nexus of Climate Change and Trade: Don't Break the Rules*. U.S. Chamber of Commerce International Policy Backgrounder, April 2009. Available at: http://www.uschamber.com/NR/rdonlyres/

ENDNOTES

1 The Group of Eight includes the United States, Canada, France, Germany, Italy, Japan, Russia, and the United Kingdom.

2 The MEF includes the United States, Australia, Brazil, Canada, China, the European Union, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, Russia, South Africa, and the United Kingdom.

3 The Group of Five includes Brazil, China, India, Mexico and South Africa.

4 Both the G8 and the MEF declarations state that it is the "scientific view" that the average global temperature "ought not" exceed 2°C above the pre-industrial level. The IPCC is barred, however, from offering policy recommendations in its reports. The IPCC presents a range of possible emissions pathways to stabilize the atmospheric carbon dioxide concentration.

5 This is based on a best estimate of climate sensitivity whereby a doubling of the atmospheric concentration of carbon dioxide would lead to a 3°C average global temperature rise from the preindustrial average (IPCC 2007, WGIII SPM Table SPM.5). IPCC, however, gives a range of climate sensitivities from about 2.0°C to 4.5°C. Thus, there is a range of possible atmospheric carbon dioxide concentrations, roughly from about 300 ppm to 550 ppm, corresponding to a 2°C average rise. The emissions trajectories needed to meet either end of this range are very different.

6 A 50% cut in carbon dioxide emissions by 2050 would *not* stabilize atmospheric carbon dioxide concentrations in the 350ppm to 400ppm range. Further cuts and avoidances would be needed after 2050. In fact, IPCC notes that many scenarios aimed at meeting the most aggressive carbon dioxide stabilization targets—440 ppm and lower—call for net *negative* global emissions sometime before 2100 (IPCC 2007).

7 Draft U.N. negotiating text in the Ad Hoc Working Group on Long-Term Cooperative Action has a number of different proposals—stabilizing greenhouse gases (in carbon dioxide equivalents) from 350 ppm to 450 ppm, limiting the temperature rise from 1.5°C to 2°C, and reducing global emissions anywhere from 50% to 95% below the 1990 level by 2050 (UNFCCC 2009a)—all of which imply a minimum global reduction of 50% by 2050.

8 Using IEA's "BLUE Map" scenario. The IEA "50-by-50" scenario described is compared to a no-policy "reference case." This reference scenario assumes that some technology and efficiency improvements will occur even in the absence of any additional climate change policies. Thus projected emissions are lower than they would be under a scenario where technology and efficiency were "frozen" over the

next 40 years. The 50-by-50 mitigation scenario focuses on determining the amount of additional emissions reductions needed beyond the reference scenario.

9 A gigaton equals 1 billion metric tons.

10 A petawatt hour equals one quadrillion watt hours.

11 Most wind turbines in service and available today are rated well below 4 megawatts.

12 The technology challenge may be even greater than many models suggest. An analysis of the IPCC's mitigation scenarios appearing in *Nature* found that two-thirds or more of the emissions reductions from technology change and efficiency improvements are built in to the no-policy reference cases. The amounts of "spontaneous decarbonization" assumed in the IPCC reference cases, the authors argue, are "optimistic at best and unachievable at worst, potentially seriously underestimating the scale of the technological challenge." They conclude that "if most decarbonization does not occur automatically, then the challenge to stabilization could in fact be much larger than presented by the IPCC" (Pielke Jr. *et al.* 2008). Recent trends in global emissions lend credence to this view. IPCC, for example, reports that, "The long-term trend of a declining carbon intensity of energy supply reversed after 2000" (IPCC WGIII 2007).

13 IEA did not measure global GDP impacts, noting that, "This expenditure represents a re-direction of economic activity and employment, and not necessarily a reduction in GDP" (IEA 2008).

14 This is a debatable claim. An analysis commissioned by the UNFCCC and presented at the COP-14 in Bali, Indonesia suggests that when land use change is factored in, total emissions from large developing countries have contributed appreciably to the stock of atmospheric carbon dioxide (though their per capita contribution would still be relatively low) (MATCH 2007).

15 Provision was made in the UNFCCC to consider additions to Annex I by 1998, and six European countries were added.

16 Based on data from the Energy Information Administration, World Carbon Intensity—World Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels Using Purchasing Power Parities, 1980—2006 (available at: http://www.eia.doe.gov/pub/international/iealf/tableh1pco2.xls) and World Per Capita Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 1980—2006 (available at: http://www.eia.doe.gov/pub/international/iealf/tableh1cco2.xls).

17 Russia's emissions in 2007 were roughly a third below 1990's level, so its goal actually represents an *increase* in emissions of 29% to 36% from 2007's level.

18 While much of the focus is on large emerging economies such as China, India, and Brazil, we should not lose sight of the fact that a great deal of emissions growth is expected to occur in other regions of the world. Non-MEF countries, for example, could see their carbon dioxide emissions rise by 6 gigatons between 2005 and 2050. That is roughly equivalent to total gross carbon dioxide emissions from the United States in 2007, a not insignificant amount.

19 Per capita GDP of developing and emerging economies, however, will remain well below those of OECD countries.

20 Nationally appropriate mitigation actions that reduce emissions below a business as usual baseline have been proposed for developing countries. However, even if these were successful in slowing emissions growth, at some point carbon dioxide emissions from these countries still would have to peak and decline sharply for a 50% global reduction to be realized.

21 Estimates vary, but developing country per capita emissions are expected to exceed 4 and possibly 5 tons by 2050 under various business as usual scenarios.

22 Using IEA's global population projection of 9.2 billion (IEA 2008, Table B.1, Population Projections, 2005—2050). At 9.3 billion, the U.S. Census Bureau's forecast for global population is about the same as IEA's (see: http://www.census.gov/ipc/www/idb/worldpop.php). With global per capita emissions at 2 tons per person, to meet a 50-by-50 emissions target, the world's population would have to be a little above its level in *2005* (6.5 billion people), a completely unrealistic scenario given current population projections.

23 UNFCCC Article 4.3.

24 Paragraph (1)(b)(ii).

25 The MIT study did not consider transfers for adaptation.

26 The WTO/UNEP report states: "The general approach under WTO rules has been to acknowledge that some degree of trade restriction may be necessary to achieve certain policy objectives, as long as a number of carefully crafted conditions are respected." However, the report also includes a disclaimer that "opinions reflected in this publication are the sole responsibility of the World Trade Organization (WTO) Secretariat. They do not purport to reflect the opinions or views of Members of the WTO." The 153 Members of the WTO have varied views on the relationship between trade rules and climate change, as seen in recent warnings by China and India.

27 The exceptions being forestry, shipping, and aviation.

28 For more on the Energy Institute's principles for a sound international agreement, see Harbert, K. 2009.

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