CLIMATE CHANGE: THE CASE FOR LONG TERM TARGETS

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Human-induced climate change is without doubt the most troubling and complex environmental problem facing most countries individually as well as the world as a whole. Consideration of the unique scientific, economic, and political characteristics of climate change strongly suggests that a long-term international objective would be a key element of any effective solution of the problem. Here we present the rationale for choosing such a target, discuss alternative formulations, and consider how a target might be adopted and implemented.

– The Problem

Greenhouse gases, particularly carbon dioxide from fossil fuel (oil, natural gas, coal) burning, trap heat that would otherwise escape into space. Their atmospheric accumulation has increased markedly since pre-industrial times due to human activity. The natural greenhouse effect (due to natural levels of these gases) maintains an equable climate by keeping Earth about 30 degrees Celsius warmer than it would otherwise be. The enhanced greenhouse effect resulting from industrial emissions and other sources will inevitably lead to a yet warmer Earth. If emissions are not constrained, Earth will likely warm well beyond temperatures experienced in the 10,000-year history of civilization, and much faster than previous sustained global climate changes of that era. Earth has warmed about 1 degree F (about 0.6 degree C) over the past 140 years and the Northern Hemisphere is probably warmer than any time in the past 2,000 years at least; the buildup of greenhouse gases is very likely the major contributor to these changes. Pro-

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jected growth in fossil fuel combustion represents an unprecedented environmental risk. While the pre-industrial concentration remained relatively stable at 280 ppm it has since grown to 370 ppm and could approach 1000 ppm in this century if no policies or measures are undertaken to restrain its increase. In order to limit the corresponding risk it makes sense to bring those who understand the relevant atmospheric processes together with economic and political decision makers, and other stakeholders. The challenge is to define a target which is commensurate with the risk given substantial uncertainties, in accordance with the common agreement binding all parties:

Almost all countries (including the US, China, India, the EU and Russia) have ratified the UN Framework Convention on Climate Change (UNFCCC), whose Article 2 describes its long-term objective as avoidance of "dangerous anthropogenic interference" with the climate system. The following discussion provides the rationale for implementing Article 2 in terms of a quantified long-term target, to be determined on a preliminary basis within this decade.

– Troublesome Characteristics

Four characteristics of the science of climate change provide the rationale for a long-term view.

1. The gases *persist in the atmosphere* for periods ranging from a decade to more than a millennium after emission. As a result, policies, which take decades to implement fully in any case, can only gradually slow the greenhouse gas accumulation. A related consequence of persistence is that relatively large emissions decreases, on the order of half or more, would be required to quickly halt the growth of greenhouse gases in the atmosphere.
2. There is a *lag between emission and consequence*: The full effect of the gases is not felt for several decades or longer after their emission due to the thermal inertia of oceans and ice

sheets. Analogy has been made to the relative coolness of coastal areas on warm spring days. Putting these two characteristics together, we note that limiting climate change is NOT like dialing a thermostat. It is more like steering a supertanker, with much anticipatory decision-making needed.

3. Warming is expected to be continuous until emissions are markedly reduced. *There is no* known *limit to warming until the sources of the gases, like oil and coal supplies, begin to shrink*. In the meantime, absent policy, atmospheric carbon dioxide amounts, now 30% above pre-industrial levels, could more than quadruple compared to pre-industrial levels.
4. Due to the first three characteristics, short-term emissions goals considered in isolation provide no test of the ultimate climate response. Furthermore, uncertainty in projection of changes is very large and the time for progress in understanding is measured in decades not years. *Unpredicted, surprise outcomes are almost inevitable*, becoming more likely as the accumulation of greenhouse gases increases.

Beyond the science of the problem, analogous difficulties arise. Emissions growth may be slowed with existing technology but multi-decadal time scales will be needed for development and implementation of new technologies to substantially reduce emissions (or capture gases post-combustion). Multi-decadal time scales will also be needed to fully develop and implement innovative policies needed to bring these changes about. Taken together, these characteristics argue strongly for defining long-term objectives for climate stabilization (as discussed below) rather than implementing policy piecemeal.

Short-term international *emissions* objectives (and accompanying national emissions obligations), like those embodied in the Kyoto Protocol, are determined fundamentally by political and economic feasibility. A long-term international target would be fundamentally determined by an assessment of environmental risk from *the* accumulation of emissions. An appropriate target (for example, as outlined in Article 2 UNFCCC) would allow decision-makers to *synchronize* near term

steps to assure that their cumulative effect would be consistent with the avoidance of excessive long-term risk. In other words, it would make clear what options are preserved for the long term at every step, which risks are increased or decreased by particular near-term choices.

– Political Rationale

A long-term target may satisfy three objections raised against the Kyoto Protocol that have proven to be serious political obstacles. The business community is divided over climate policy. Some firms stand to gain substantially from the nascent market in emissions allowances for greenhouse gases and have implemented measures that reduce emissions and will ultimately lead to their possessing significant numbers of tradable emissions allowances. Some firms stand to lose, particularly those in the coal industry. For yet other firms, the result of implementing Kyoto is mixed, at least in the near-term.

But nearly every firm, whether a supporter or opponent of emissions reduction, has argued that a long-term goal (i.e., 25 years or longer) would improve its ability to plan capital turnover. The lack of one has led firms that are otherwise supportive of action to refrain from supporting the Kyoto Protocol, which has a ten-year time frame for obligations. It has certainly stiffened the backs of Kyoto's opponents.

Another objection to Kyoto is the lack of mandatory obligations for developing countries. The latter is one of the two ostensible rationales for US rejection, the other being concerns over cost. Yet developing countries are highly unlikely to assume such obligations absent a long-term objective that indicates roughly how large is the limited size of the atmospheric resource to be used. How many total tons of carbon dioxide will ultimately be emitted? The answer to this question depends on a definition of how large a greenhouse effect may be considered to be "safe" (or "dangerous"). Until a goal is determined, developing countries are unlikely to enter into a negotiation over burden sharing. By taking a global view, a long-term target based on risk al-

lows questions of equity of the solution (as expressed in near-term targets) to be separated to some extent from quantitative issues of size and distribution of impacts, a separation that may facilitate negotiation of both long- and near-term obligations.

Finally, multiple long-term *domestic* targets would be insufficient because there is a need to assure a uniform international standard against which to measure domestic action. Otherwise, questions of fairness, particularly with regard to trade relationships and competition on investment, will arise continually. Through an international long term obligation, each party receives a modicum of assurance that its near term domestic action is both appropriate to the long-term risk, and proportional to the activities of other nations.

– Technical Issues

Views differ on whether to define a target in terms of greenhouse gas concentrations, temperature change, rate of warming, or other quantities. No one measure is perfect, but greenhouse gas concentrations have several advantages:

1. From a legal perspective, this choice would be consistent with the explicit language of Article 2 of the UNFCCC.
2. Concentration is a routinely measured, spatially uniform quantity for the major human-made greenhouse gases, carbon dioxide and methane, as well as for several of the minor ones. It has little year-to-year or decade-to-decade variability compared to its long-term trend. Annual, decadal, and spatial variability of temperature change is greater compared to its trend.
3. Although it is often said that temperature is more closely related to impacts than concentration, this is only true for local or regional temperature near the point of impact. Global temperature changes are not necessarily more easily related to local temperature changes than are concentrations. Furthermore, temperature change does not encompass the full range of climate effects, like precipitation and runoff, that determine impacts.

4. A set of near term limits for global emissions can be derived that are consistent with a long term upper limit on greenhouse gas concentrations. This approach establishes a necessary scheme for emission restrictions and burden sharing.

A second problem is whether to define a target in terms of carbon dioxide alone or in terms of the equivalent effect of all the measured greenhouse gases. The language of the UNFCCC would mitigate in favor of expressing the target in terms of all gases (i.e., CO_2-equaivalents). The scientific perspective would argue for counting the effect of all gases since all gases will determine the ultimate risk. The technical obstacles to doing so arise from the spatial non-uniformity of ozone and particle concentrations, which result in spatial variation of climate effects. A compromise position would be to develop a target in terms of carbon-dioxide equivalents of the spatially uniform gases, but with awareness that its effect is contingent to some extent upon the behavior of the other forcing agents. Given the various uncertainties in determining a target, this is not the largest.

– Is Agreement on a Quantitative Target Feasible?

The most vexing issue is whether a quantitative target can be defined at all in the context of scientific uncertainties, and how such a globally uniform objective could be achieved and the necessary burden sharing be enforced on individual parties. Solution to both problems can be envisioned through a process of iterative implementation via near-term emissions budgets of the sort embodied in the Kyoto Protocol. A long-term objective, however, is indispensable in order that these near-term emission budgets not miss the target.

It would be preferable to begin an informal process immediately (involving scientists and other experts, NGO's and other stakeholders, and the business community) that can stimulate and inform a governmental negotiation beginning in a matter of years. The IPCC would have an important role to play in evaluating vulnerabilities and options germane to implementation of Article 2. Formal choice of a target

would be seen as a first step subject to periodic revision, perhaps every ten years, to accommodate current uncertainty and future learning.

Negotiation of near-term emissions obligations would be carried out with the objective of maintaining consistency with the current long-term target. Only in this way can plausible options, such as a limits in the range of 450 ppm CO_2, be maintained as viable options. At the same time, choice of a quantitative long-term target does not uniquely determine near term obligations. Rather, it allows a range of choices that have a substantial chance of meeting the long-term objective when coupled with plausible options for subsequent periods.

An important objection that has been raised to the proposed approach is the degree of effort needed to reach agreement on such a target in the context of very large uncertainties. An alternative approach has been discussed which would involve an informal target, not binding on negotiators in any sense. The difficulty here is that a target that is not regarded as binding on negotiators is likely to be diluted in implementation, or totally ignored. It also would lose its function as an orientation for those who take the risk of long-term investment.

One sensible approach to dealing with uncertainty would be a precautionary one. Focus first on those outcomes, like collapse of the thermohaline circulation, disintegration of the West Antarctic ice sheet, or loss of the Greenland ice sheet, for which general agreement on the importance of avoidance could be more easily achieved. Then define a long-term target according to the lowest concentration that could plausibly generate the undesired outcome.

The world seems to be at a decision point. Countries can either determine future commitments to emissions limitations or emission-reducing policies in a context detached from long-term environmental risk, or they can choose to engage in a complex negotiation of an initial target, one that would be updated over time. In the former case, it would be pure happenstance if the accumulation of unguided near-term steps were to avoid "dangerous" climate change. A serious political

obstacle to developing country participation would remain in place. The business community may continually bridle at near-term commitments defined without any notion of ultimate objective. While the latter choice may present serious difficulties to negotiators, the former option is almost sure to fail to successfully rein in global warming.