Confronting Global Climate Change – The Technology Imperative

Richard E. Benedick

Introduction: Four Fundamental Mistakes

By any reasonable assessment of risk, the dangers of major climate change occurring from rising greenhouse gas concentrations causes by unprecedented global industrialization, use of energy, expansion of agriculture and destruction of forests, will present unprecedented challenges to human society in the foreseeable future.

A crucial factor that is generally ignored in the climate debate is that all of these developments are driven by the continued rapid growth of world population. Nothing like this combination of factors has occurred in the history of human development. According to United Nations projections, even assuming further birth rate declines, the world's population will grow by over 50 percent within the first half of this century -- from 6 billion in 2000 to more than 9 billion in 2050. This increase of over 3 billion people exceeds the total population of the planet as recently as 1960. If future fertility rates decline by less than UN forecasts, 2050 world population could reach almost 11 billion.

Virtually all of this population growth will be in the developing countries, whose inhabitants increasingly demand living standards that will require more energy, more industrialization, and more food production. Population growth and the accompanying pressure for economic development will drive greenhouse gas concentrations into historically uncharted levels -- unless there is a paradigm shift.

For years the international response to the climate issue has been languid. Until relatively recently, most political leaders worldwide have been stronger on platitudes than hard actions, most of industry has downplayed the threat and resisted changing their ways of doing business, and public opinion has been largely apathetic. These trends have recently begun to change in the face of sterner warnings from scientists, growing evidence from melting polar ice, and a rash of extreme weather events that have aroused public unease.

It is now approaching two decades since governments commenced global negotiations under United Nations auspices in early 1991 in Chantilly, Virginia, on an international agreement to address the threat of human-induced climate change. Before we can plan effective future approaches to climate change, we need to assess lessons learned from the past 17 years and try to learn from this experience.

In attempting to address the challenge, global climate diplomacy has made four fundamental mistakes that reflect a failure to understand key lessons from the international negotiations in the 1980s that, against all expectations, produced the successful Montreal Protocol on protecting the stratospheric ozone layer:

(1) Many of the most populous nations, biggest economic powers, and highest emitters of greenhouse gases were allowed a free pass solely on the grounds that they were "developing countries."

(2) Unwilling to confront powerful industrial interests head-on by enacting sector-specific policy measures to limit use of fossil fuels, e.g., in transportation or utilities, the climate negotiators opted instead for short-term national targets that were either too weak to make a difference, or so unrealistically strong for some nations that complex treaty provisions were negotiated that limited any meaningful impact on emissions.

(3) The climate negotiations have been too large and cumbersome to be effective, annually assembling nearly 200 national delegations with thousands of government officials, supplemented by more thousands of nongovernmental and media observers, in megaconferences that most resemble a medieval trade fair. This atmosphere is not conducive to sober analysis of complex long-term scientific, economic, and technological issues, but rather to political posturing and media sound-bites. In contrast, the successful negotiations in 1986-87 that produced the Montreal Protocol, and that generated an enduring "spirit of Montreal" that permeated its future development, seldom comprised more than 60 individuals and a handful of governments.

(4) Technology, the most crucial factor of all, was ignored. In order to hold future concentrations of long-lived greenhouse gases to levels that would not trigger irreversible climate changes, it will be necessary to drastically reduce still-climbing emissions within the next few decades. This will require a global technology revolution – the paradigm shift that is essential to transform the world's energy needs into a virtually carbon-free system.

Ozone and Climate Treaties

The initial result of the 1991 Chantilly conference and subsequent negotiations was the United Nations Framework Convention on Climate Change (UNFCCC), signed by more than 150 nations at the 1992 Earth Summit in Rio de Janeiro. The treaty set a sensible goal of stabilizing concentrations of greenhouse gases in the atmosphere at a level that would "prevent dangerous anthropogenic interference with the climate system." This goal depended on cutting back the world's rapidly rising emissions, but since the "dangerous" concentration level unfortunately could not be specified on the basis of existing science, the extent and timing of necessary emissions reductions of long-lived greenhouse gases – in particular carbon dioxide -- could not be determined.

The UNFCCC had no binding commitments, but rather contained numerous verbose clauses elaborating the many factors to be considered in establishing national climate policies. In 1995, the parties to the convention agreed to establish a supplementary treaty

with binding national targets to reduce greenhouse gas emissions, and after over two years of difficult negotiations, the Kyoto Protocol was signed in December 1997.

The two climate treaties were clearly inspired by the spectacularly successful international approach in the 1980s and 1990s to the problem of depletion of Earth's stratospheric ozone layer. But unfortunately, the climate negotiators misinterpreted or ignored lessons from the ozone history.

The 1985 Vienna Convention on Protection of the Ozone Layer, like the UNFCCC, established the dimensions of a global problem without prescribing specific solutions. Two years later, the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer was signed -- a treaty later characterized by the heads of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) as "one of the great international achievements of the century." In light of the dangers that were averted and the extraordinary international cooperation that was mobilized, few observers would consider their appraisal as hyperbole.

While the ozone and climate problems differ in size and scope, the success of the Montreal Protocol was by no means a foregone conclusion. The scientific case for action was, at the time, even more uncertain for ozone depletion than it is now for climate change. Projections of future ozone layer levels bounced up and down with each model run and, at the time the protocol was being negotiated, measurements of harmful ultraviolet radiation reaching Earth's surface actually showed a decrease.

Over a hundred different ozone depleting substances had to be phased out, affecting thousands of products and processes in scores of major industries, including telecommunications, food and agriculture, transportation, defense, construction and pharmaceuticals. There were implications for billions of dollars in investments and hundreds of thousands of jobs worldwide. Business opposition was initially fierce, and most of the world's governments were unwilling to accept meaningful commitments to rein in this family of chemicals that had become practically synonymous with modern standards of living and were continually finding new uses.

Like the Montreal Protocol, Kyoto was also designed to begin a process. But it suffers from its short-term approach to a long-term problem that involves very large fixed investments. By focusing only on emissions reduction targets 11-15 years into the future, the Kyoto Protocol would stimulate governments and industry to adopt short-term technical solutions. As a result, complying with these reductions could lock capital prematurely into long-lived investments (e.g., power plants, buildings, transportation and storage infrastructure) that would inhibit the development, and raise the costs, of the next generation of technologies that is needed to achieve much more substantial emissions reductions within 40-50 years. Opting for overall national reduction targets also made it easier for individual sectors, such as the automobile industry, to resist specific policy measures (e.g., stricter vehicle emission standards).

We had forgotten that the first international action to protect the ozone layer was *not* the establishment of reduction targets in the 1987 Montreal Protocol. It was not even an international treaty. Rather, it consisted of loosely coordinated policy decisions made approximately ten years previously by a handful of countries to ban the use of CFCs in aerosol spray cans. This sectoral policy measure engendered new technologies that soon reduced total global CFC consumption by about thirty percent and provided an impetus to the coming international protocol negotiation. However, if someone at that time had proposed a formal target of that magnitude, it is doubtful that any government would have embraced it. The relevant lesson is that policy measures can lead the way by stimulating technology even in the absence of formal targets.

The Kyoto Approach

The 1997 Kyoto Protocol manages, unfortunately, to be simultaneously too strong and too weak. Too strong because its short-term targets, negotiated in early morning hours before the closing deadline, bore no relation to economic or technological realities. It was clear even at the time that they could not be met by many of the world's major industrialized nations, including not only the U.S., but also Australia, Canada, Japan, and several European Union countries.

Yet the climate protocol was inherently too weak, its impotence cloaked by complicated mechanisms that diluted the publicized targets. One such example was the negotiation in 2001 -- four years after the treaty was signed -- of arbitrary amounts, specifically for Australia, Canada, Japan and Russia, for carbon dioxide absorption ("sinks") from land-use and forestry practices. This would enable these nations to offset actual measured emissions from industry and other sources, and thereby help to maintain ostensible compliance with their treaty target (or, in the case of Russia, to have even more emissions rights to sell). The land-use provisions were in fact designed to encourage these countries to ratify the treaty at a time when there were doubts whether the required number of parties would join to enable the protocol to become international law.

A similarly motivated technique was emissions trading: allowing parties that could not lower emissions sufficiently through internal measures to purchase emissions permits from other nations. For this purpose, Russia, Ukraine and other former communist nations had been deliberately assigned unrealistically high future emissions levels that they would never reach because of economic collapse after the 1990 base-year. Hence they had "hot air" (pre-treaty emissions reductions) to sell to less-lucky countries. The emissions trading provision was insisted upon in Kyoto by the United States delegation, which realized that strong domestic economic growth, combined with exceptionally high immigration since the 1990 base year, would continue to drive U.S emissions up, rather than down, thereby necessitating some kind of *trompe l'oeil* to ensure pro-forma compliance. Ironically, the U.S. never ratified the protocol.

Another contrived mechanism was to allow the then-15-nation European Union to meet a <u>combined</u> EU target for 2008-2012 rather than individual country targets. This permitted several countries within this EU "bubble" – including such major economies as France,

Spain, and Sweden -- to maintain or even increase their individual emissions and still be in "compliance." Through this averaging effect, other EU nations could benefit from the fact that emissions of the EU's highest emitters, Germany and the United Kingdom, were by 1997 (similar to Russia) already far below their negotiated official future treaty targets. Reunified Germany benefited from the 1990 base year that incorporated high emissions from the inefficient German Democratic Republic before they soon plummeted due to economic collapse. The 1990 base year was also kind to Britain, where the Thatcher Government's campaign to weaken the power of coal miners' unions subsidized a switch to natural gas, which is much less carbon-intensive.

What did such provisions, which helped to expand the original Kyoto Protocol from 40 pages in 1997 to hundreds of pages of complicated text at present, add up to? Simply this: if all of the industrialized countries were to meet their various targets, so arduously negotiated in 1997, their total combined emissions by the 2008-12 target period would be just about where they stood in 1997 – i.e., about five percent below 1990. In effect, the treaty merely reassigned emissions reductions from the 1990 base year, which had already occurred by 1997 in such countries as Germany, Russia, Ukraine and the United Kingdom, to other industrialized nations such as Canada, Japan, Spain, and the United States, whose emissions had continued to rise. Net result for the industrialized world: no change.

The Developing Country Problem

In the case of ozone, the industrialized nations in 1987 accounted for 88 percent of CFC consumption and 98 percent of production. Therefore, their actions were determining, while the role of developing countries was clearly secondary. In contrast, while carbon dioxide emissions from fossil fuels and cement production in industrialized countries as a whole have been relatively stable in recent years, emissions from developing nations are on a steep upward trend.

A crucial weakness of the Kyoto Protocol was that, unlike Montreal, developing countries were exempt from reduction targets. No distinction was made between small and truly poor developing countries and rapidly industrializing nations that are among the world's largest greenhouse gas emitters -- including China, which by now has surpassed the U.S. in first place; India, which has higher emissions than Germany; and South Korea, which outranks France. Indeed, half of the world's top 25 emitters are so-called "developing" countries that were completely exempted in the Kyoto target schedules. The result is that unhindered steeply rising energy-source emissions from such countries as Brazil, China, India, Indonesia, Mexico, Saudi Arabia, South Korea and others, combined with their growing emissions from agriculture and loss of forests, inspired an even faster increase in total global greenhouse gas emissions, and hence concentrations, after the Kyoto Protocol than before.

Throughout the climate negotiations, the "Group of 77" (which actually includes over 150 developing nations varying in size from St. Kitts and Nevis to China) adamantly refused to discuss even *voluntary* measures to reduce their rapidly increasing greenhouse

gas emissions. The wealthy industrialized countries acquiesced in this charade, perhaps because their own record in addressing climate change was so unimpressive.

It may be understandable that developing nations refused to consider any shared responsibilities as long as industrialized countries, which brought about the current climate predicament in the course of becoming rich, appeared unwilling or unable to undertake credible actions to rein in their own emissions. However, because energy production and consumption involve sizable long-term investments, the South risks getting locked into a fossil fuel economy in future decades that would make it progressively harder for them to modernize.

Under the Montreal Protocol, developing countries were treated quite differently, accepting commitments on the basis of "common but differentiated responsibilities." They were required to follow the same phase-down and phase-out schedules for ozone-depleting substances as the industrialized countries, but with grace periods before the schedules would enter into force. In the interim, major efforts were undertaken by industrialized nations, in cooperation with private industry and UNEP, to develop new technologies and to transfer them, with appropriate training and funding from the protocol's "Multilateral Fund," to the developing nations.

Needed: An Energy Technology Revolution

Throughout seventeen years of climate negotiations, the world's governments unfortunately did not focus on the most fundamental issue of all. Technology innovation at its current pace simply cannot produce a significant reduction of greenhouse gas concentrations in Earth's atmosphere. Inexplicably, most of the industrialized countries were actually *reducing* their national budgets for energy technology research and development while they were negotiating the Kyoto Protocol.

Governments failed to recognize that, in the face of growing world population and rapidly increasing overall demand for energy and food, reversing the trend of rising greenhouse gas emissions would require an historic transformation of the global energy economy – greater even than such earlier technological revolutions as the invention and diffusion of electric power, telecommunications and the internet, mass transportation, and the space program.

The long atmospheric lifetime of carbon dioxide means that *concentration* levels for the next hundred years are to a great extent already predetermined by past *emissions*. They are not, therefore, significantly affected by short-term emissions cuts. Even if the modest emissions reductions targeted for 2008-2012 (the Kyoto commitment period) were to be attained, they are insignificant compared to the much steeper emissions cuts of at least 50 percent and more that are necessary later in this century in order to stabilize concentrations at a hopefully safe level. But future reductions of such magnitude cannot be achieved with the current array of energy technologies; they are only possible through new technology breakthroughs.

It is important in this context to emphasize that the "business as usual" projections of the Intergovernmental Panel on Climate Change (IPCC) already incorporate aggressive assumptions about the development and diffusion of non-fossil energy sources worldwide. Thus, even with the assumptions in this IPCC model of greater global energy efficiency, substantial fuel switching from coal and oil to less carbon-intensive natural gas, and significant expansion of renewable energy, an unacceptable growth in carbon dioxide concentrations to over 700 *ppm* would not be prevented. To limit concentrations to substantially lower, less risky levels, we will need to develop and deploy new technologies that can produce deep emissions reductions in the coming decades. Most of these technologies are currently only in the conceptual or basic research stages.

Future climate-related technology research must therefore focus intensively on producing and diffusing an array of affordable sources of low carbon or carbon-free energy, with related infrastructure. There is no easy solution. Rather, a massive and manifold global effort must encompass a broad suite of research on solar, photovoltaic, wind, hydrogen, geothermal, tidal, nuclear fission and fusion, biomass (with biotechnology), as well as carbon capture and sequestration (which would enable use of existing cheap and plentiful coal supplies), innovative end-use efficiency technologies such as "smart buildings," lighting, appliances, and strong but lightweight vehicle structural materials, and soil carbon sequestration through improved agriculture and forestry. Expanded international research programs must also explore technologies for adaptation to changing climate, as well as geo-engineering to offset unexpected rapid climate changes.

A Technology-Based Strategy for the Future

The Kyoto Protocol has become the victim of polarized debate over essentially inconsequential short-term emissions, compounded by large uncertainties about the costs of compliance. The existing treaty provides inadequate emphasis on the technological imperative and on securing the cooperation of developing nations. The current debates distract attention from the real challenge, which is to set the stage for much steeper emission declines before the end of the current century

The dangers of long-term global warming can only be averted if we (1) bring to market a new generation of technologies that will drastically reduce dependence on fossil fuels and/or will capture and sequester carbon, and (2) gain the cooperation of key developing countries to limit their rapidly rising emissions.

Fortunately, the two conditions are interrelated: as we achieve the first, we will get the second. The Montreal Protocol demonstrated that when cost-effective options start becoming available, developing nations are more likely to join the bandwagon and adopt modern technologies. Technology functions as the "enabler," without which the high emissions reductions required in the latter half of this century will not materialize. We need a new strategic vision that explicitly addresses the issues of technology research, development, and diffusion.

Investment in technology would be much less expensive than the probable future costs of climate-induced dislocations and catastrophes. New technologies would also significantly lower mitigation costs, which would otherwise be prohibitive for both North and South. Analyses by the Pacific Northwest National Laboratory indicate that technology can make a difference of trillions of dollars in the global cost of achieving a given future greenhouse gas concentration goal to mitigate climate change.

A technology strategy is only defensible, however, if it is does not become an invitation to delay. Much must be done right now to start the process. Here is a possible program of action for the new negotiators.

1. Revise and simplify the emissions targets.

To begin, I recommend that governments streamline Kyoto emissions commitments to make them more credible. Future near-term targets should be achievable in magnitude and should focus on measurable *gross* carbon dioxide emissions. More realistic and verifiable targets for industrialized countries would have a better chance of being implemented. Hence, they would be taken more seriously by industry as well as by the onlooking developing world. As new technologies emerge, it will be politically easier to strengthen targets over time.

2. Postpone the sinks.

While the attempt to use net emissions targets is scientifically justifiable, the complexities surrounding the land-use and forestry provisions of article 3 are, in my opinion, a formula for delay and deception. Therefore, the comprehensive approach should be abandoned, at least temporarily. The net emissions concept could be re-introduced after technical experts have made it implementable, including prevention of perverse incentives to cut old-growth forests in order to gain or sell emissions credits from replanting. Action on reducing gross carbon emissions should not, however, wait for these refinements.

3. Defer international emissions trading.

I believe that the modalities for a verifiable and equitable international emissions trading scheme still need more work. Domestic emissions trading would be left open to national decisions.

4. *Accelerate technology transfer and joint implementation.*

Governments and industry in the industrialized countries should become serious – as they were under the Montreal Protocol – about expeditiously transferring new energy-related technologies to the developing world, and should help build indigenous capacity to develop local energy solutions. North-South and West-East joint implementation investments make sense from the standpoints of both economic efficiency and technology transfer. The Clean Development Mechanism should be activated to promote greater energy efficiency and expansion of renewable energy in the developing nations. The North should provide climate-relevant assistance as a cost-effective form of foreign aid rather than primarily to earn emissions offset credits. All of this would probably be far

less costly and more productive than large wealth transfers to buy emissions "rights" from developing countries.

5. *Get serious about policy measures*.

Emissions targets should be reinforced, or even preceded, by harmonized policy measures. Indeed, policy measures – as in the Montreal Protocol example discussed earlier – provide a test of what targets might be feasible in the near future.

Stricter vehicular fuel-efficiency standards (which everyone, including the automakers, knows are feasible), and energy-related government procurement policies, building and appliance standards, are examples of measures that could provide strong impetus to innovation.

Existing market distortions and subsidies that favor fossil fuels should finally be eliminated.

Incentives should be adopted to promote further development and market penetration of renewable energies, in order to realize economies of scale that would make them more competitive.

State and local governments should be assisted in joint programs to foster energy efficiency and renewable energy solutions.

Up until now, the half-hearted performance of most governments with respect to policy measures has not matched their political rhetoric about the urgency of the climate problem. A requirement for transparent and rigorous reporting on such measures could, as demonstrated by experience in the IMF and OECD, provide an added stimulus.

6. *Adopt technology-based objectives*.

Pacific Northwest National Laboratory analysts are examining possible technology-based goals that governments could employ to stimulate future-oriented R&D. Since virtually all carbon in modern energy economies flows through power generation and fuel refining/processing, such policies could be quite specific in their focus.

For example, new power generation plants constructed after a certain date could be required either to use renewable energy, or to capture and sequester carbon byproducts.

New fossil fuel refining and processing facilities after a given date would also have to be carbon neutral. (To encourage R&D before the phase-out deadline, interim targets could be scheduled for new plants, as well as credits provided for early compliance.)

Net imports of carbon-based fuels could gradually be phased down.

Initially, fossil fuels could be employed as a feedstock for hydrogen, but any residual carbon would have to be sequestered.

Because all these measures apply to sizable industrial facilities, they are conducive to transparency, reporting, and monitoring for compliance. These actions would provide the market with strong signals for focused research and innovation.

Annex I technology targets could also provide a bridge to developing country commitments by de-linking their participation from difficult negotiations focused on per-capita income or emissions. It could take decades for China or India to catch up with per capita income of even the poorest member of OECD. But if the industrialized nations agree to technology goals as described above, it is reasonable to assume that the technologies will be available by the target date. Per capita indices then become irrelevant, as they proved to be in the case of the ozone treaty. Instead, the problem is

limited to assuring that the technologies are transferred and deployed in developing nations. To provide developing country nations with some security, any emissions reduction targets could be made dependent on the effective transfer of new technologies and the financing of any incremental costs involved, as was successfully accomplished under the Montreal Protocol's Multilateral Fund.

7. *Invest in a technological revolution.*

Most important of all, governments must ensure that sufficient financial resources are made available to achieve the needed technological revolution. Reaching a critical mass of R&D is basic to fostering technological breakthroughs. Governments cannot expect that the private sector, with its relatively short time horizon, will make all the required long-term R&D investments. Although credible targets and policy measures can help to stimulate industry's creativity, the scale of the climate/energy challenge requires that the public sector take the lead role. A small carbon tax could raise substantial revenues for funding new technology research.

OECD members should commit themselves to raising their grossly inadequate level of basic and applied energy research by a significant and annually rising percentage of civilian research programs. And they should collaborate in R&D, especially with developing nations and with the private sector. Given the stakes, energy research arguably merits a degree of public sector commitment comparable to that devoted not long ago to aerospace and telecommunications. Promoting technology should not prove politically unpopular because it creates economic growth and job opportunities. The leverage from such research in reducing the costs of addressing climate change makes it an eminently sound investment.

8. *Negotiate in a more efficient forum.*

There is no moral stricture that requires governments to deliberate and negotiate every relevant action within the unwieldy context of over 190 nations and thousands of observers. In the interest of efficiency, most if not all of these actions – especially the research initiatives, policy measures, technology transfer, and technology goals -- could be discussed, negotiated and implemented by relatively small numbers of like-minded governments, North and South, in much smaller forums outside of the formal United Nations treaty context. They could also include, as appropriate, participation of industry, universities, civil society, and state and local governments. It is imperative to closely involve the handful of large developing nations whose emissions are critical. The Group of 8, Group of 8 plus 5, existing or new regional groups, or *ad hoc* forums are all plausible venues where new options could be explored in an informal, problem-solving atmosphere. Results and issues arising in these various forums could be shared with the larger community at the annual UNFCCC Conference of Parties.

While these ideas present undoubted challenges for political will and for diplomacy, I believe they would increase the likelihood of making existing renewable energy more competitive, creating the future energy technologies that are indispensable, and motivating developing nations to limit their emissions. Perhaps by making a fresh start with new concepts we could achieve the progress that has been so elusive up until now.