Global Climate Change and Energy Technology: The Long View

In addition to the political and economic aspects of the Kyoto Protocol that have hindered its adoption, questions concerning the agreement's effectiveness in combatting climate change also loom large in the minds of politicians and scientists. Such questions arise from the fact that the climate change problem is unfolding on a century-scale, yet the mitigative actions encompassed by the Kyoto Protocol are often viewed as a "quick fix" to be implemented over the short span of the coming decade. The short implementation schedule of the Kyoto Protocol essentially dictates that the world address climate change with those technologies currently available. Consequently, poor results could be purchased at high cost.

A more favorable, alternative approach to climate change would consider that continued advances in the state of the art of energy technology, which are in large part a function of energy R&D investment levels, will expand the problem's solution set. Thus, the state of energy R&D will also determine to a large extent the cost of attaining any stabilized "safe" atmospheric concentration of greenhouse gases over the coming century.[1] Based on this logic, sustained energy R&D investment must be viewed as a vital component of a century scale strategy designed both to address the problem effectively and to minimize associated costs. Considering also that the majority of growth in world energy consumption expected in the next century will occur in the developing world, an effective strategy must include provisions ensuring the participation of key developing states. Countries such as China, India, and Brazil should be encouraged and assisted to become future producers of energy R&D and energy technologies and ought not be expected to remain contented consumers of Western expertise and hardware throughout the next century.

Moreover, the motivation for major developing countries to develop indigenous energy R&D infrastructures extends beyond climate change. Local environmental conditions, particularly air quality, is already a severe problem in many industrializing areas. The impetus for the deployment of newer and cleaner energy technologies will also grow as the levels of industrial activity and energy demand rise in developing countries.

To understand the increasingly significant role of developing countries in strategies to address climate change, it is useful to consider some anticipated global energy and economic trends. Figure 1 shows regional projections of gross domestic product (GDP) for the period 1990-2095.[2] Most recent data show, for example, that China's economy is now less than half the size of the United States' economy. Yet if China's economic growth persist at its current rate, it will likely become one of the world's largest economies towards the middle of the next century. By the middle of the century, China might also be significantly wealthier when measured in terms of GDP per capita. These figures also show that several other countries currently regarded as "developing," and that currently lack an advanced and extensive technology R&D infrastructure, are likely to experience significant growth in wealth during the next century.

---

[1] It is important to note that the Framework Convention on Climate Change is silent on what would be a "safe" atmospheric concentration for greenhouse gases and that these levels remain a subject of debate. The lower the "safe concentration" is judged to be the more difficult the challenge of climate change becomes and the more critical advances in energy R&D will become.

[2] These data were generated from the "B2F" non-intervention scenario generated as a part of the Intergovernmental Panel on Climate Change, Working Group III's forthcoming Special Report on Emissions Scenarios (SRES). B2F is a conservative growth scenario over the course of the next century.

Figure 1 Gross Domestic Product by Region

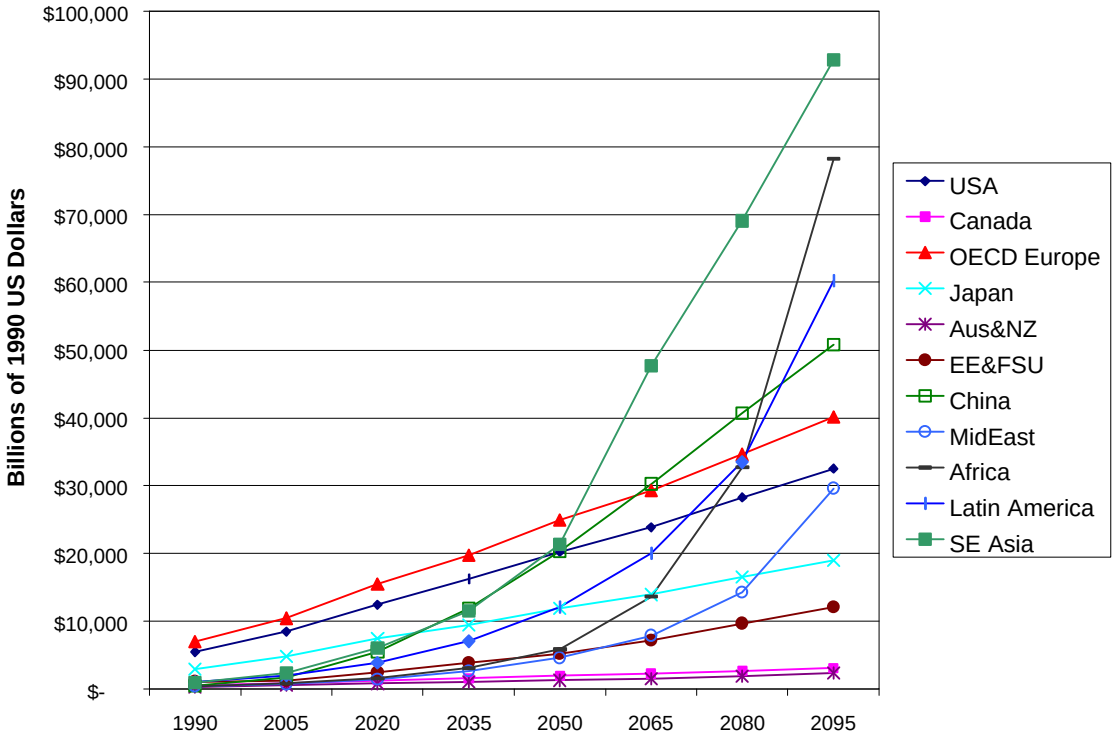
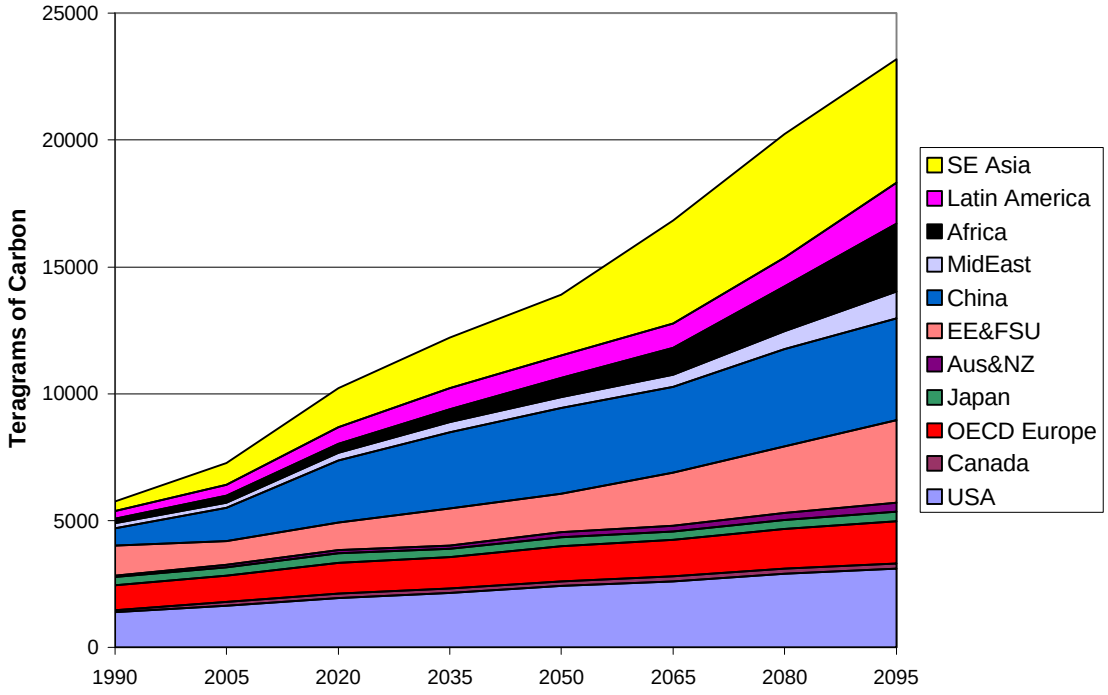


Figure 2 shows projected carbon equivalent greenhouse gas emissions over the period 1990 to 2095 for the same regions included in Figure 1. The percentage of global carbon emissions attributable to OECD countries is expected to decline rapidly--from 49% of global emissions in 1990 to less than a third of global emissions by 2035 and to less than one quarter of global emissions by the end of the next century as developing countries' energy use rises. While on the other hand, China's share of global carbon emissions, for example, is expected to grow from 12% in 1990 to some 25% by 2020. Similarly, Southeast Asia's carbon emissions are likely to rise from under 7% in 1990 to 25% by 2065.

The actual development trajectories that the world's regions will follow in coming decades will, of course, diverge from those projected under any modeling scenario. Nonetheless, given the momentum of demographic and economic drivers already in motion, the continued growth of developing countries' wealth and energy use should be anticipated even if the precise slopes of their growth trajectories are uncertain. That said, it is now appropriate to consider ways by which to propagate a robust and more geographically distributed global energy R&D infrastructure to ensure that sufficient resources are devoted to energy technology development worldwide to meet the climate challenge throughout the coming century. As the following section shows in some detail, trends in the national energy R&D programs of key industrialized countries argue in favor of the development of a more distributed global energy R&D capability.

Figure 2: Carbon Dioxide (CO_2) Emissions by Region


Teragrams of Carbon
25000
20000
15000
10000
5000
0
1990
2005
2020
2035
2050
2065
2080
2095
SE Asia
Latin America
Africa
MidEast
China
EE&FSU
Aus&NZ
Japan
OECD Europe
Canada
USA