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Technology Is Not Enough: Climate Change, Population, Affluence, and Consumption

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Abstract

Reducing human emissions of carbon dioxide by 80% by 2100 requires more than technological innovation. Historical rates of emissions decline due to such innovation of about 0.7% are insufficient to offset the 3% growth in emissions that stems from population and per capita income growth. Existing scientific and political debates are dominated by a "technophilic optimism" that projects emission reductions from technological improvement that are not supported by the evidence. If we fail to develop policies proactively to constrain population, affluence, and consumption while respecting other human values, we will almost certainly face impacts from climate change that constrain population, affluence, and consumption for us.

Keywords

climate change, economic growth, IPAT equation, population, technological innovation

In addressing climate change, policies that foster technological innovation will be crucial but inadequate unless they are coupled with policies that reduce population, affluence, and consumption. Without the latter policies, we necessarily place the Earth on a trajectory toward far higher global temperatures with troubling human and environmental implications. Ehrlich and Holdren's four-decade-old IPAT equation (1971)

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highlights that carbon emissions are driven by population, affluence, consumption patterns, and production technologies (Chertow, 2002). These drivers, in turn, reflect economic, political, social, and cultural forces that are sometimes, but not always, shaped by local or national policies. They do, however, constitute the set of possible targets for policies designed to reduce emissions by 80% by 2100 and thereby stabilize global temperature increases to 2 °C. Such reductions will depend on technological innovation, certainly, but will also require policies that constrain population, affluence, and consumption, despite the challenges doing so will pose.

What's Driving Emissions? Economic Growth, Consumption, and Population

Between 1996 and 2006, global CO_2 emissions grew by 2.4% per year. That trend was driven by annual per capita GDP growth of 1.8% and annual population growth of 1.3%, generating aggregate GDP growth of 3.1% that was only partially offset by technological improvements that decreased emissions per dollar by 0.7% (World Bank, 2011). In both developed and developing countries since 2000 (including during the recent global recession), production techniques have led to *higher* emissions per unit of energy at the same time that affluence (per capita income) *and* consumption (energy used per dollar) have increased (International Energy Agency, 2011; Raupach et al., 2007, p. 10292). These trajectories exceed "the most fossil-fuel intensive of the Intergovernmental Panel on Climate Change emissions scenarios developed in the late 1990s" (Raupach et al., 2007, p. 10288) and document that technology cannot keep up with growth in population, affluence, and consumption.

Technology and Technophilic Optimism

Yet mainstream policy and scholarly discussions of climate change accept growth in population and affluence as a given and view technological innovation as the only available policy lever. In 1988, Gus Speth (1988, cited in Chertow, 2002, p. 20) of the World Resources Institute not only urged acceptance of economic growth but called for technologies to foster it. Waggoner and Ausubel (2002, p. 7861) argue for accepting "the drive for a better life embodied in the forces of population and income." In promoting climate policy "wedges," Socolow and Pacala (2006) seek to curb emissions "without choking off economic growth," mention the need for lower birth rates only in passing, and propose policies that all but ignore consumption. Galiana and Green (2009, p. 570) call for a "technology revolution" in lieu of emissions targets without questioning the maintenance of 2.2% annual economic growth.

Indeed, mainstream discussions—both scholarly and political—reflect a "technophilic optimism" that assumes future technological improvements can outpace historical experience. Socolow and Pacala (2006, p. 52) note that CO_2 per unit of energy "will need to fall . . . fully as fast as the global economy grows" to stabilize emissions. To adequately address climate change will require sustained emission reductions of about 5% per year: about 3% to offset emission increases due to aggregate economic growth and another 1.5% to 2.0% per year to generate net reductions. Even scholars who recognize that technological improvements will need to be 3 times past experience consider such a "revolution in energy technology" possible (Galiana & Green, 2009, p. 570; Waggoner & Ausubel, 2002, p. 7865).

Yet neither empirical nor theoretical considerations support the view that such improvements can be achieved in the short term, let alone sustained over the long term. Empirically, when energy intensity and carbon intensity *were* declining (before 2000), they were not doing so at rates that could offset economic growth (Raupach et al., 2007). Indeed, from 1990 to 2007, no OECD country reduced CO_2 emissions per dollar faster than 5% per year and 80% (27 of 34) of OECD countries had reduction rates below the 3% needed to offset economic growth and thereby stabilize emissions (World Bank, 2011). And technological innovation in developing countries is even weaker (Raupach et al., 2007, p. 10292).

Theoretically, several considerations explain why we should not expect technological innovation to produce emission reductions adequate to address climate change. First, emission reductions "in the lab" regularly exceed those "on the ground." Second, emission-reducing innovations in one sector may have little relevance for other sectors; for example, solar power may work well for factories and vehicles but less well for aircraft. Third, people and countries adopt climate-friendly technology innovations in light of numerous nonclimate concerns that include but are not limited to costs, convenience, cultural preferences, and perceived risks. The last of these, for example, can lead to major changes in energy policy, as seen in nuclear plant cancellations and shutdowns after the 2011 Fukushima disaster. Fourth, even attractive innovations take time to be adopted and deployed, particularly for the infrastructure investments of governments and the durable good purchases of individuals. Finally, innovations that reduce carbon intensity will become more difficult to achieve as we harvest early "low-hanging fruit" and then face later, more challenging, technological hurdles.

The Need for—and Challenges of—Addressing Population and Affluence

Reducing *average global* carbon intensity by 5% in a *single* year by technology alone will be challenging; doing so annually until 2100 will prove even harder. If "technology is not enough," the IPAT equation highlights that we must make up the difference by addressing affluence, consumption, and population. Policies to reduce population will need to navigate issues of individual freedom, religious commitments, and national interests with respect to birth rates, health, and expected lifespan. Policies to reduce economic growth, affluence, and consumption will face embedded economic and political interests and individual perceptions of what constitutes a "good life" for one's self and such children as one may have. Both industrialized and developing countries will need to develop proactive policies that constrain economic growth, promote low-carbon and no-carbon consumption, and reduce or reverse population growth rates. Success will depend on countries developing such policies in ways that respect other important human values. Failure will foster continuation of current emission trajectories, generating climate impacts that also will reduce global population and economic growth.

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Bio

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