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The Steps Not Yet Taken

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Introduction

The climate system of the planet Earth, and the energy system built by those who inhabit the Earth, are today seen as the integrated elements of a single problem: global warming. In turn, scientific inquiry, public concern, and policy prescription have given rise to an international regime for controlling the behavior of the climate through management of the global energy system. In this chapter, we explain why this regime, and in particular its codification through the Kyoto Protocol, is a failure. Our central point is simple: protecting people and the environment from the impacts of climate is a different problem from reducing greenhouse gas emissions to combat global warming. The policies that have resulted from combining these two problems are, as a consequence, failing to address either problem meaningfully. Policies to reduce global warming must be pursued independently of policies to reduce climate impacts.

First, we explain why the Kyoto Protocol is not achieving its environmentally modest goals, a failure that has no connection to the refusal of the United States to sign onto the treaty, but rather reflects the complexity of energy systems and their management. We then consider the impacts of climate on society through the lens of Hurricane Katrina. Such impacts are unrelated to global warming, and cannot be addressed by emissions reductions. Instead, they require policies specifically focused on reduction of socioeconomic vulnerability to climate.

But emissions reductions are a key societal goal, and next we discuss the role of technological innovation in pursuing that goal. Current policies, embodied in Kyoto, are inappropriate and insufficient for making the necessary progress. A cornerstone of our argument is that much of the failure to date of climate change policy originates in a misunderstanding of the appropriate roles of science and technology in social and political change. Proponents of action on global warming have treated scientific evidence as the central catalyst for motivating necessary change, while technological advance has been viewed as a second-order consequence of such change. We argue that this reasoning is backwards, and that technological innovation is a much more effective scaffolding upon which to address energy policies than scientific knowledge.

The Kyoto Protocol is not effectively addressing the climate impacts problem or the energy technology problem. Although Kyoto is often portrayed as only a first step toward establishing an effective international climate change regime, we conclude that it is a step in the wrong direction.

Bush Saves Kyoto!

US President George W. Bush saved the Kyoto Protocol. By refusing even to consider bringing the treaty before the US Senate for a debate and vote over ratification, Bush ostentatiously ceded the moral high ground to those other nations—all 163 of them—that signed onto the treaty and brought it into force. In so doing, he shifted the world's attention onto America's scurrilous role in refusing to take seriously the problem of global climate change, and away from the inevitable failure of the international governance regime that led to Kyoto. Benedick made a related point in suggesting that Bush's rejection of Kyoto motivated pro-Kyoto forces not to give up on the treaty (2001).

This regime emerged from the famous 1992 "Earth Summit" in Rio de Janeiro, and was formally enshrined in the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol was negotiated under the terms of the UNFCCC to give teeth to the regime by requiring affluent nations (known as "Annex I Parties") to reduce greenhouse gas emissions to specific levels relative to their 1990 emissions by the year 2012. For example, Western European nations must reduce emissions to 8% below their 1990

baselines; the original US reduction target was 7%. Developing countries, in light of both the economic challenges they face, and the fact that the rich nations created the problem to begin with, were exempted from mandated reductions. AU1

Even if all Annex I nations were to meet their reduction targets successfully, the effect on total greenhouse gas concentrations in the atmosphere would be inconsequential, and would have no discernible effect on the behavior of the climate. But supporters of Kyoto have always portrayed the treaty as only a first step toward a global regime for managing climate change.[1] This step would establish the international institutional and legal framework, and the economic incentives, necessary for making meaningful reductions over the longer term. Thus, if the direct environmental consequences of Kyoto were, even under the best of circumstances, trivial, in other ways this first step was a giant one, setting the initial conditions under which climate change would be debated and confronted in the 21st century, while mobilizing a global cadre of public servants, scientists, and activists for a period of fifteen years in pursuit of an international policy framework of unprecedented scope and complexity.

Most important, this first step has meant that action on climate change is framed in terms of Kyoto itself, where support for Kyoto means saving the world environment from catastrophe, and opposition means denial of the problem, perhaps combined with a preference for short-term profit over long-term sanity. This situation is perfectly suited for (and reinforced by) media coverage, which thrives on stark, simplistic dichotomies, but it means that a third option—that climate change is a serious problem, but that Kyoto and the broader UNFCCC regime are the wrong way to go about addressing it—has not been able to emerge into the marketplace of ideas. Independent analysts have been offering thoughtful, nonideological critiques of Kyoto since its earliest days, but with little effect on public debate (e.g. Rayner and Malone 1997; Laird 2000; Benedick 2001; Nordhaus 2001; Scheling 2002).

[1]E.g., "But Kyoto is, and has always been understood as, a first step, and a baby step at that." (Kolbert 2005); "Protection of the climate system will require substantial reductions in greenhouse gas emissions; hence, the Kyoto Protocol is recognized to be only the first step on a long journey to protect the climate system." (Watson 2003); "[A]s Bill Hare of Greenpeace describes it . . .'the Kyoto Protocol and the Bonn rules to implement it are the first step on what has to be a long climb.'" (Retallack 2001).

Had Bush and his advisors been a bit more clever, they would at the very least have voiced support for the treaty, and might even have pushed the Senate to ratify it. Besides fellow Kyoto-nonratifier Australia, many of the Annex I nations that actually have ratified Kyoto—including Canada, Japan, Spain, Portugal, Greece, Ireland, Italy, New Zealand, Finland, Norway, Denmark, and Austria—are failing to meet the treaty's requirements for greenhouse gas emissions reductions, and have little or no prospect of doing so before the treaty expires in 2012.[2] Had the United States, as the world's biggest energy user and greenhouse gas emitter, simply joined that group of scofflaws, the fact that Kyoto's emissions reduction goals were impossibly ambitious (even as they were, at the same time, environmentally inconsequential) would have become obvious to all the world, and the treaty could quickly have been pronounced dead, or at least abandoned to its death throes as the inertia stored up in the tens of thousands of people who depend on the international climate regime for a living and for ideological sustenance inexorably dissipated.

Instead, common wisdom has it that the failure of Kyoto can be laid at the feet of an organized right-wing political effort that has brought together conservative think tanks, politicians, corporate supporters (especially from the fossil fuel industry), and a few co-opted scientists, to oppose Kyoto specifically, and more generally to counter the notion that global warming is a problem worth worrying about (Austin 2002; McCright and Dunlap 2003). This effort, whose voice and power got a huge boost when Republicans gained control of the US Congress in 1994, made it futile for President Clinton to push for Senate ratification of Kyoto, and made it possible for President Bush to repudiate the treaty. The conservative strategy was, in fact, very effective in meeting its goals of making Kyoto a political liability in the United States. But if America's refusal to ratify Kyoto and cut its greenhouse gas emissions simply reflects the power of right-wing opponents, why are so many other countries that have ratified Kyoto failing to meet their emissions targets? The answer begins with an understanding that the question itself is incoherent: ratifying Kyoto and cutting emissions are not equivalent.

[2]The source for emissions data for all discussions in this chapter is the authoritative Web site of the United Nations Framework Convention on Climate Change; see: http://www.ghg.unfccc.int/index.html.

Energy systems are the metabolism of modernity; they cannot be managed in isolation from the political and economic conditions of a society. They include everything from automobiles and light bulbs (and the firms that manufacture them) to power plants, transmission lines, highways, buildings, research laboratories, regulatory bodies, and labor unions. A nation's geographic and climatic attributes, the structure of its workforce, the age of its manufacturing infrastructure, the organization of its tax code and regulatory structure, its patterns of immigration and demographics, the makeup of its transportation system and even its food system (among many other factors) constitute the complex conditions that determine both the structure of the energy system and the political context for modifying it. Changes in a nation's population, downturns or upturns in the economy, changes in political leadership, and changes in the price of various energy sources are among the unpredictable forces that can cause emissions to rise or decline independently of any actions taken to conform to Kyoto. For example, Australia, Canada, and the United States are all experiencing population growth rates of more than 10% per decade; in Germany, France, and the United Kingdom, the rates are between 3 and 4%. Over the past decade, the US GDP has increased an average of 3.4% per year; the UK rate was 1.85%; Germany, 1.39%. Yet, needless to say, Germany and the UK are not pursuing low population or economic growth rates as ways of lowering their carbon emissions.

Moreover, because of the huge complexity of energy systems, the connection between explicit energy policies and emissions levels is largely unpredictable. As Frank Laird (2000) noted shortly after Kyoto was negotiated, "no one knows in any precise sense how [policy options] are connected to emissions reductions . . . The instrument with the most direct effect on fossil fuel consumption—a carbon tax—is crude and imprecise. How big a tax would the United States need to achieve a 7% reduction in 1990 levels?" (Some economists think they can answer this question [e.g., Nordhaus 2001], but as 2005–06 gasoline price increases in the United States have shown, consumers are willing to absorb cost increases greater than any politically conceivable carbon tax, without appreciably reducing their fuel consumption, at least in the short term.) The policy cornerstone of the Kyoto approach is a market system to allow nations to establish emissions trading for greenhouse gases, but there is much disagreement about whether international trading can possibly work to reduce emis-

sions significantly (Victor, et al. 2005; Bell 2006). The new European Emissions Trading Scheme already seems to be failing because the emissions allowances that nations have agreed upon are too high to provide incentives to actually cut emissions (Open Europe 2006). To make matters worse, this approach may stimulate profiteering, as utilities sell credits for emissions that they would not have released in the first place (Gow 2006).

Because of the historical contingencies embedded in national energy systems, and the significant costs and uncertainties entailed in overcoming those contingencies, most nations simply cannot identify and follow a particular path to meeting Kyoto's targets. Those countries that are on path toward meeting their targets were well on their way to doing so without Kyoto. The twelve nations that have reduced emissions the most since 1990 are all former Eastern Bloc or Soviet Union countries that have undergone radical economic restructuring and, in some cases, near-collapse. Germany, which has also managed considerable reductions, has done so largely because it absorbed a former Eastern Bloc country, and Great Britain's reductions are principally the consequence of actions by Conservative Prime Minister Margaret Thatcher in the 1980s to break the British coal union and move that nation's energy system away from coal and toward gas—for reasons that were economic and political, not environmental. In 1993, four years before Kyoto was negotiated, German and British emission levels were already 9.5 and 5.1%, respectively, below their 1990 levels. Meanwhile, Russia's cynical decision to ratify Kyoto in 2005, made in the face of years of official denial that global warming was a problem, was motivated by the fact that it is greatly exceeding its reduction targets due to its economic collapse in the 1990s, and the hope that it (along with other Annex I countries of the former-Soviet sphere) can therefore make money selling carbon credits to countries that are unable to reduce their own emissions.

As the experienced international environmental diplomat Richard Benedick (2001) has noted, for many European and post-Soviet countries, 1990 was a very fortunate choice as a base year for measuring emissions reductions. Put somewhat differently, the ability of many European nations to meet their Kyoto targets is largely fortuitous. Given these practical realities, Kyoto may indeed be only a first step, but the question one must ask is: toward what?

Global Warming and the Logic of Katrina[3]

Unlike, say, cancer-causing toxic waste dumps, or smog-filled air that makes throats burn and eyes water, global warming is an abstraction: no one actually feels an increase in the global average temperature that scientists calculate. Any effective strategy aimed at mobilizing political action to forestall climate change needs to connect the abstract global phenomenon to the local realities of felt human experience. Where is the evidence that people can see and feel, which can impart the necessary urgency to the cause?

The most poignant connections are those based on scientific predictions that a warming climate may bring greater human suffering due to increasingly severe weather events such as hurricanes, heat waves, and droughts. Such predictions can be found in scientific research articles and assessments (always modified by appropriate qualifying statements), in hyperbolic fictional accounts of a world afflicted by climate-gone-wild (like the movie *The Day After Tomorrow*), and everything in between. QU1

The spectacle of real-world disasters has become powerful evidence for those making claims about the need to stop climate change. When Hurricane Mitch struck Central America and killed more than 10,000 people in October 1998, the delegates at the fourth Conference of Parties to the United Nations Framework Convention on Climate Change passed a resolution of "solidarity with Central America," expressing concern "that global warming may be contributing to the worsening of weather," and urging "governments. . .and society in general, to continue their efforts to find permanent solutions to the factors which cause or may cause climate events" (Conference of Parties 1998). (By "permanent solutions," of course, the delegates meant "the Kyoto approach to emissions reductions.") And despite the fact that the December 2004 Indian Ocean tsunami that killed more than 220,000 people was not a weather event, Britain's chief science advisor, Sir David King, made the connection to global warming: "What is happening in the Indian Ocean underlines the importance of the Earth's system to our ability to live safely. And what we are talking about in terms of climate change is something that is re-

[3]For more complete presentations of the data and arguments in this section, see: Pielke (2006); Pielke, et al. (2000); Sarewitz and Pielke (2000; 2005).

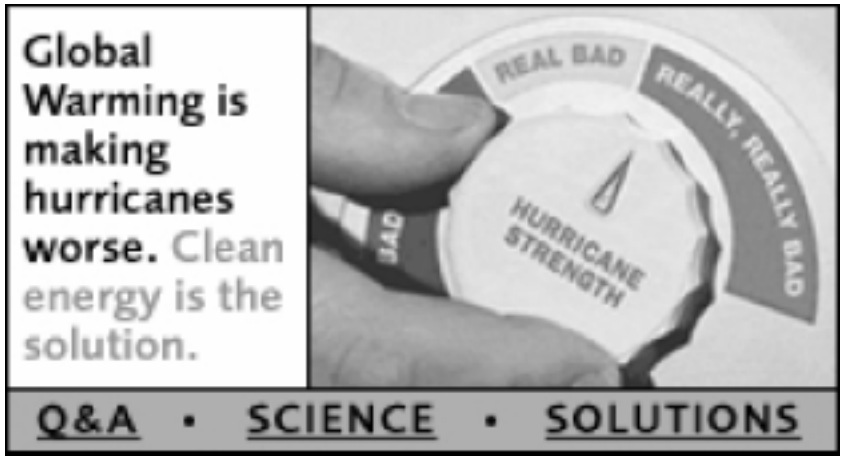

Figure 17.1 Climate change politics as a control fantasy: this image, used in a major promotional campaign by a leading environmental group, says that humans can dial in the weather they want by reducing greenhouse gas emissions.

ally driven by our own use of fossil fuels, so this is something we can manage" (Press Association 2004).

But the disaster that made the threat of a changing climate most palpable to all the world was of course Hurricane Katrina, which destroyed the city of New Orleans and unleashed social mayhem in the richest and apparently most environmentally profligate nation in the world—a cautionary event of almost biblical dimensions. While a few scientists and advocates directly blamed Katrina on human-caused global warming, many such voices upped the volume on the potential links between warming and future hurricanes, invoking Katrina as a harbinger of what was to come. Scientific claims and counterclaims began to get airtime, not just in the mass media but in technical journals—were hurricanes increasing in number and power? Was Katrina's severity exacerbated by a warming climate (Kerr 2005; Kerr 2006)?

The connection to Kyoto was irresistible. British Deputy Prime Minister John Prescott remarked in a speech that: "As a European negotiator at the Kyoto climate change convention, I was fully aware that climate change is changing weather patterns and raising sea levels. . . . The horrific flood of New Orleans brings home to us the concern of leaders of countries like the Maldives, whose nations are at risk of disappearing completely. There has been resistance by the US government to Kyoto—which I believe is wrong" (Jowit and Temko

2005). Similar comments were offered by Jürgen Trittin, Germany's Minister of the Environment, who also directly blamed the Bush Administration for Katrina (German Minister 2005).

The logic that connects Katrina and other disasters to Kyoto presumably goes something like this: human emission of greenhouse gases is changing the climate; these changes will cause more frequent and severe disasters; and, therefore, Kyoto is a first step toward protecting the world against ever-greater disasters. This logic depends on the idea that humans can control the behavior of climate to achieve particular social benefits by adjusting greenhouse gas emissions. The advocacy group Scientists and Engineers for Change apparently had this sort of control fantasy in mind when, in the midst of the 2004 US presidential election season and a disastrous Florida hurricane season, they posted billboards with the message, GLOBAL WARMING = WORSE HURRICANES. GEORGE BUSH JUST DOESN'T GET IT.

Katrina ripped the façade of civilization off a city—and a country—to expose a Hobbesian nightmare. While there was enough suffering and loss to ensure that most everyone living around New Orleans got a good dose, it was the poor, the disenfranchised, the infirm, and the historically discriminated-against who suffered most and were disproportionately left behind to fend for themselves. Of course, this concentration of suffering is to some extent tautological; it's no surprise that the most vulnerable members of society suffered the most. But the inescapable visibility, staring out from newspaper front pages and TV screens, of abject social and economic privation in the heart of the richest, most powerful nation that history has ever known, was a profoundly disheartening spectacle, to these authors at least.

Scientists have known—and warned for years—that the location of New Orleans on a rapidly subsiding river delta in the heart of the hurricane belt made some version of Katrina inevitable (Travis 2005). Indeed, the enormous destruction wrought by the disaster can mostly be blamed not on Katrina itself, which, by the time it struck the coast, was not an unusually powerful hurricane, but on the reality that New Orleans was built in harm's way, that the progressive development of the city and the environmental destruction of the surrounding wetlands rendered it increasingly vulnerable over time, and that the levees that were designed to protect the city under precisely the circumstances that Katrina presented were poorly designed and maintained (Schwartz 2006).

Was Katrina a harbinger of what global warming has in store for humanity if Kyoto is not implemented? The first and most obvious point is that Katrina was not a harbinger of anything—it was a real disaster, whose causes and consequences were fully anticipated, scientifically uncontroversial, and causally unrelated to "dangerous anthropogenic interference" with the climate. Transforming Katrina from an unequivocal indicator of persistent socioeconomic and racial inequality, developmental hubris, political ineptitude, and engineering incompetence into a symbol of global warming and the need for reduced carbon emissions demands some combination of factual ignorance, political cynicism, and moral nihilism.

Natural disasters have been rapidly increasing worldwide over the past century, in both number and severity, not because of increases in the frequency or severity of storms, earthquakes, or other extreme events, but because of growing populations, expanding economies, rapid urbanization, and migrations to coasts and other exposed regions. The number of disasters affecting at least 100 people or resulting in a call for international assistance has increased from an average of fewer than 100 per year in the early 1970s to more than 400 per year by the early 21st century. While economic losses from disasters are increasingly concentrated in the affluent world, as a percentage of GNP, the economic effects of natural disasters on poor countries can be hundreds of times greater (Guha-Sapir et al. 2004).

Disasters disproportionately harm poor people in poor countries because those countries typically have densely populated coastal regions, shoddily constructed buildings, sparse infrastructure, and inadequate public health capabilities. Poor land use leads to widespread environmental degradation, such as deforestation and wetlands destruction, which in turn exacerbates flooding and landslides. Emergency preparation and response capabilities are often inadequate, and hazard insurance is usually unavailable, further slowing recovery. New Orleans, with its stark juxtaposition of the affluent and the poor, provided a synoptic portrayal of this global situation.

Disparities in disaster vulnerability between rich and poor will continue to grow. About 97% of population growth is occurring in the developing world. This growth, in turn, helps drive urbanization and coastal migration. The result is that, in the next two decades, the population of urban areas in the developing world will increase by several billion people. This population is being added to cities that

are commonly located on coastal or flood plains that are vulnerable to climate hazards but are unable to provide the quality of housing, services, infrastructure, and environmental protection that can help reduce vulnerability.

Many well-tested policies are available to help reduce vulnerability to natural disasters. These range from building codes that can keep structures from collapsing in a storm, to land use regulations that limit construction in flood-prone areas, to environmental laws that preserve natural features, such as wetlands and forested slopes, that act as buffers against disasters. The rising toll of disasters demonstrates that nations are greatly underinvested in applying such policies (Guha-Sapir, et al. 2004), despite the certainty that they are effective, and that more disasters of greater magnitude will soon occur.

When advocates for the present climate policy regime connect natural disasters to global warming, presumably they hope to motivate policy makers to take action on emissions reductions as a way to help prevent future disasters. But if policy makers are not sufficiently motivated to apply relatively modest, well-proven interventions to help reduce vulnerability to the disasters happening today, why would they undertake extraordinarily complex, expensive, and long-term efforts to implement emissions reductions whose impacts on climate behavior won't be felt for 50 years or more, and whose benefits for disaster reduction are, at this point, completely unknown and are likely to be marginal compared to the common sense, near-term actions that policy makers refuse even now to take?

The idea that the UNFCCC climate regime, or the Kyoto Protocol specifically, amounts to a strategy to combat rising disaster vulnerability is both practically absurd and morally suspect. The problem isn't simply that Kyoto's marginal decreases in greenhouse gas emissions will have no effect on long-term climate behavior, although this is the case, but that emissions reduction programs don't reduce the entrenched social inequities, irresponsible development trends, and inadequate hazard reduction policies that led to the worst of Katrina's depredations and that are the cause of rising disaster vulnerability worldwide. In other words, the fact that science warns us that global warming may increase the severity of future weather events does not mean that reducing emissions is a reasonable or potentially effective way to prevent disasters. Reducing emissions is about as rel-

evant to controlling the impacts of natural disasters as a nuclear nonproliferation treaty is to protecting public health.

The Limits of Science and the Logic of Technology

In 1997, the lead author of this chapter participated in a conference on science and the environment in Tulsa, Oklahoma, deep in the heart of America's hydrocarbon belt.[4] One of his roles at the conference was to moderate a group discussion on global climate change. Most of the participants in this discussion worked at reasonably high levels in the hydrocarbon industry, and all shared a reactive skepticism about global warming and climate change science. A few of the participants were scientists who offered well-argued technical critiques of the view that climate change was a threat to humanity; the rest were clear that they distrusted the motives of environmentalists, of academic scientists who study climate change, and of the administration of Democratic President Bill Clinton and, especially, Vice President Al Gore. Most were sympathetic to the view that global warming was a scientific "hoax" intended to impose an environmentalist political agenda on the nation.

Eventually, the subject of discussion turned from global warming to energy efficiency. Amazingly, the strong sense of the group that global warming was just a disguised political agenda was matched by an equally strong sentiment in favor of national policies to stimulate energy efficiency through technological innovation—as long as the policies were not highly prescriptive. It turned out that the group shared an explicit proefficiency ethic, and a sense that the role of technology was to help implement this ethic. They did not see increased energy efficiency as contrary to their own interests, but as a typically American path to greater profitability and energy independence via inventiveness, innovation, and competition.

Science provides the rational basis for Kyoto. Environmental groups use scientific findings to justify their advocacy of action on climate change; legislative bodies call on scientists to present their findings as a basis for political deliberation; and the UNFCCC process itself depends for technical support on the Intergovernmental Panel on Climate Change, which brings together hundreds of scientists

[4]Redefining Environmental Protection: The Case for Change, Tulsa, OK, August 11, 1997: www.nelpi.org/events/caseforchange/brochure.asp.

from around the world to continually assess and update the latest scientific information related to climate change, its possible future impacts, and the avenues available for reducing such impacts. The idea, simply, is that the emerging force of scientific knowledge about human effects on the climate system should impel, or compel, the innumerably diverse perspectives, interests, values, and experiences implicated in the world's hydrocarbon-intensive energy system to converge on a single course of action. Kyoto thus became the rational embodiment of right action, a scientific demand for a particular type of behavior from a highly diverse set of players.

The difficulty, however, is that science is always connected to action via the values and interests of those who want to act in a particular way. When a scientific fact—say, that the Earth's atmosphere is warming—becomes associated with a political agenda that supports a particular type of action—say mandated emissions reductions—the science must shoulder the values and interests of those who are pushing that agenda. Science, in other words, becomes a tool of political persuasion, a lens for focusing many values and interests on a single type of action. This difficult task is further compounded because, as science approaches the cutting-edge, it tends to raise as many questions as it resolves, so there is always room for debate about what the science is actually saying. When new scientific results are published, some will claim that the results support their particular version of what needs to be done, but others may not see it that way (Nelkin 1995; Sarewitz 2004). And even if scientists could confidently predict the societal consequences of global warming (which they can't), such knowledge would not dictate any particular path of action.

Technology is different. Technology is itself the embodiment of reliable action. Indeed, as the story of the Tulsa meeting shows, what's especially powerful about technologies is that often they can serve a variety of preferences simultaneously. A commuter who wants to reduce spending on gasoline, an environmental group that wants to reduce greenhouse gas emissions, and an automobile manufacturer that wants to develop new, profitable product lines all find their interests converging in, say, the development of hybrid vehicles. This is a trivially obvious example, but it says something profound about the relationships between technology and politics. People holding diverse and even strongly divergent values and interests may unite around a particular technology that can advance multiple interests. Technology, that is, can overcome political conflict not by compelling diverse

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interests and values to converge—the job assigned to climate science—but by allowing them to coexist in a shared sense of practical benefits. Values can also converge in opposition to the effects of a technology, of course, as illustrated by the conflicts around genetically modified foods.

The ability of technology to facilitate unlikely ideological bedfellows is well illustrated by a new project to develop a wind farm in the Gulf of Mexico off Galveston, Texas. Technological advances in oil platform design and wind turbines are converging to allow wind farms to be situated in deep water environments. The project is supported by a heterogeneous coalition of environmental and energy industry players motivated by opposite ideals: the former hoping to help phase out hydrocarbon energy by creating viable substitutes; the latter hoping to extend its life by adding new flexibility to the energy grid (Joyce 2006).

Few would disagree that global greenhouse gas emissions will only be substantially reduced over the long term through a global transition to energy technologies that no longer depend on hydrocarbon fuels—to a decarbonized global energy system. Technological advances might also allow the direct capture of greenhouse gases from the atmosphere. The Kyoto approach to creating the necessary technological transition depends on the idea that the science of climate change will create a global political convergence on the need for emissions reductions—and then, that this political convergence will cause the public and politicians to pursue policies that increase the costs of emissions, which in turn will stimulate the complex behavioral changes that lead to the necessary levels of conservation and innovation.

This is backwards. Whereas the demand for emissions reductions is a politically divisive and rarefied basis for global technological transformation, technological transformation itself is a politically unifying and inclusive principle for pursuing many beneficial objectives, including emissions reductions. There are many good reasons, in addition to global warming, to move the planet rapidly toward an energy system that is more efficient, more dependable, more technologically diverse, more equitable, less polluting, and less geopolitically destabilizing than the current, hydrocarbon-based system, and—consequently and crucially—there are many diverse, and sometimes even competing, values and interests that can be served by the pursuit of such a transition.

While the types of policy tools encouraged under the UNFCCC and Kyoto are meant, in part, to stimulate adoption of more efficient technology, their overall effect is to encourage states to work within the status quo and game the system to meet short-term targets, rather than to reward long-term and high-risk investment aimed at encouraging technological change over a highly uncertain timeline. The clearest sign that Kyoto policy is aimed at science-motivated behavioral and ideological convergence, rather than innovation-led technological pluralism, is the absence of any provisions in the treaty to stimulate research and development (R&D) on energy technologies and systems. As articulated by Hoffert, et al. (2002, 981): "a broad range of intensive research and development is urgently needed to produce technological options that can allow both climate stabilization and economic development." Yet, one of the most stunning contradictions in the global politics of global warming is this: since the late 1970s, as scientific understanding of climate change—and concern about its consequences—has continued to rise, the total public investment in energy R&D by industrialized nations has progressively fallen, perhaps by as much as 65% in constant dollars. Reliable data on private-sector energy R&D are not available, but the trends are probably similar (Runci 2005; also see Nemet and Kammen, in press, who document sharp declines in US private sector investment in energy R&D between 1994 and 2003). Kyoto does nothing to confront this contradiction, a failure that can only be explained if the problem of stimulating technical change is largely irrelevant to the politics surrounding Kyoto.

Indeed, the whole idea of mandated national emissions reductions reflects insensitivity to the highly decentralized, historically contingent, uneven manner in which new technologies emerge and diffuse. Similarly, the early absence of the private sector from negotiation processes leading to Kyoto demonstrates an unwillingness to engage the one constituency without which the necessary technological innovation cannot occur.

The current international climate regime asks nations to shoulder significant up-front costs in return for unknowable and inconsequential long-term benefits, while calcifying the terms of political discussion and the bureaucratic process for addressing climate change, encouraging cynicism and short-term action, radically circumscribing the range of relevant stakeholders who need to be involved, alienating key stakeholders who should be involved, and pushing the cen-

tral component of any political and practical solution to the problem—technological change—to the back burner. The emerging symptoms of failure in the current climate regime painfully confirm that if Kyoto is only a first step—as its advocates continually insist—then it is a first step in the wrong direction.

Bush Saves Climate! . . . (Thousands Perish)

If the Bush Administration inadvertently saved the Kyoto Protocol, at least for a while, its intransigence on the global warming issue is having another, more salutary effect, particularly in the United States: stimulating new approaches to addressing climate change. While defibrillating Kyoto is still the name of the game for opposition politicians and mainstream environmental groups, a new environmental pragmatism is beginning to emerge from the margins. A widely distributed 2004 white paper by Shellenberger and Nordhaus, titled "The Death of Environmentalism," made the case for this pragmatism by highlighting an empirical embarrassment: "Over the last 15 years environmental foundations and organizations have invested hundreds of millions of dollars into combating global warming. . . . We have strikingly little to show for it" (2004, 6).

The white paper goes on to explain how the problem of reducing carbon emissions is inseparable from many other difficult political issues, such as the viability of the US auto manufacturing industry, and it is appropriately critical of policy fixes (such as tradable permit schemes, fuel efficiency standards, and carbon taxes) that are advanced without strategic consideration of their political context. Shellenberger and Nordhaus make the case for a climate change strategy "aimed at freeing the U.S. from oil and creating millions of good new jobs" (2004, 26) through the development of new energy technologies. In essence, they have recognized that technology is a much better organizing principle for mobilizing diverse interests than science-based policy prescriptions. The Apollo Alliance, a political coalition aimed at advancing the agenda laid out by Shellenberger and Nordhaus, makes no mention of global warming on its home page (www.apolloalliance.org) and talks instead of "rejuvenating our nation's economy by creating the next generation of American industrial jobs and treating clean energy as an economic and security mandate to rebuild America."

As a political strategy, this sort of oblique approach may be a bit too clever, yet the fact is that rising energy prices resulting from con-

tinuing instability in the Middle East has triggered a renewed interest in energy technology among mainstream politicians of both left and right in the United States. In addition, a recent National Academies report has managed to resuscitate some of the economic competitiveness hysteria of the 1980s, and in doing so singled out the need for a more robust investment in energy technology as a key element of a successful competitiveness strategy (Committee on Prospering in the Global Economy of the 21st Century, 2005). At a 2006 Congressional hearing stimulated by this report (Committee on Science, 2006), discussion of the need for energy-efficient technology was everywhere, while Kyoto and global warming were nowhere to be seen. Overall, the combination of high fuel prices, dependence on foreign oil, and concern about economic competitiveness are creating more attention for energy policy than has been seen in the United States since the early 1990s. Some of the proposals emerging from lawmakers even have a measure of pragmatic creativity, such as legislation (Senate bill S. 2045, "Health Care for Hybrids Act," introduced November 2005) offered by Democratic Senator Barack Obama to help struggling auto manufacturers cover the health-care costs of its retired workers in return for higher fuel-efficiency standards.

There is no simple recipe for catalyzing the technological transformation process necessary to reduce global greenhouse gas emissions significantly, but the history of technological change demonstrates that such pervasive transformations can occur in a matter of decades once the appropriate initial conditions exist. Furthermore, the history of energy technologies demonstrates a two-century trend toward decarbonization, while the more recent experience of agricultural, communication, and information technology revolutions demonstrates that conscious policy decisions can act to rapidly accelerate technological change (e.g., Nakicenovic 2002; Ruttan 2002). Of course knowing how to foster the appropriate initial conditions to nourish such change is precisely the problem, and the combination of relatively low hydrocarbon fuel prices, the need to replace existing energy technology infrastructure, and the rapid emergence of the energy-hungry Chinese and Indian economies compound the difficulties.

Nevertheless, the broad and diverse portfolio of policies and programs necessary to catalyze a long-term technological transformation to a low-carbon energy system is reasonably well understood, even if the path and timing of the transition cannot be precisely engineered. These measures include robust public funding for research spanning the gamut from exploratory to applied; pilot programs to test and

demonstrate promising new technologies; public-private partnerships to incentivize private-sector participation in high-risk ventures (such as those now used to induce pharmaceutical companies to develop tropical-disease vaccines); training programs to expand the number of scientists and engineers working on a wide variety of energy R&D projects; government procurement programs that can provide a predictable market for promising new technologies; prizes for the achievement of important technological thresholds; multilateral funds for collaborative international research; international research centers to help build a global innovation capacity (such as the agricultural research institutes at the heart of the Green Revolution); as well as policy incentives to encourage adoption of existing and new energy-efficient technologies, which in turn fosters incremental learning and innovation that often leads to rapidly improving performance and declining costs.

In fact, significant aspects of such a portfolio were proposed and modestly funded during the Clinton Administration in the mid-1990s (Holdren and Baldwin 2002), but they were politically doomed from the outset because they were too narrowly promoted as climate change policies, rather than as advancing a broad set of national interests and public goals and goods. They did not survive into the Bush Administration; nor did they significantly find their way into the international climate regime. Indeed, the Kyoto approach is a disincentive to implementing many of the sorts of measures listed above because they will not contribute to a nation's ability to meet its short-term targets.

The Bush Administration has begun discussions with Australia, China, India, Japan, and Korea to develop a voluntary, technology-focused Asia-Pacific Partnership on Clean Development and Climate, the details of which are as yet unspecified, but which has already been condemned by Kyoto supporters as nothing more than a sop to the energy industry (e.g., Flannery 2006). There are many good reasons to be suspicious of the motives and commitment of these nations, starting with the Bush Administration and its clear preference for energy policies that focus on boosting domestic oil production, combined with its absurd denials of the reality of climate change. Yet there are also compelling reasons to consider the Partnership as a promising vehicle for a new, innovation-based approach to the greenhouse gas problem. For one thing, the participating nations will have a particular political ability to move away from Kyoto because they were never committed to the treaty's targets in the first place (with the exception of Japan—which isn't meeting them). In addition, together they represent about half of the world's current carbon emis-

sions, are likely to account for the majority of future growth in energy demand, and are also likely to dominate the global technological innovation scene for the foreseeable future.

A particular international vehicle is probably less important, however, than sustained political attention on the need for more rapid innovation in the energy sector. In the United States, the question now is whether the political opportunity created by increasing competition for oil supplies, instability in the Middle East, the rising economic might of India and China, and (through 2009, at least) a highly unpopular president, can be translated into a strategic approach to transforming the world energy-technology system. Groups from outside the US environmental mainstream, such as the Apollo Alliance, the Clean Air Task Force and the Clean Energy Group, appear to have grasped the political potency of technological innovation as an organizing principle, but it is too early to say if these relatively modest seeds can flower into a significant and persistent political realignment.

The economic competitiveness angle, in particular, can be a powerful political organizing theme for accelerating investments in energy technologies worldwide. Consider that, when the United States decided, in the late 1990s, to begin to ramp up investments in R&D in the obscure field of nanotechnology, Japan and many European countries quickly followed suit to avoid being left behind. More broadly, as Steve Rayner (2004) has argued, the economic advantage that nations gain from more efficient energy systems could be a far more compelling inducement for other nations to pursue technological transformation than the cooperative approach that underlies Kyoto. One way for European nations to act on their rage over America's arrogant unilateralism would be to pursue aggressive energy innovation programs aimed at creating global leadership in energy technology—an approach that would have far more beneficial long-term environmental impacts than continued posturing over Kyoto. Such programs might also counter the inevitable loss of face that will occur when the difference between Europe's emissions reduction commitments and actual performance becomes obvious. British Prime Minister Tony Blair seems to have recognized the need to move beyond the Kyoto approach (Blair 2004), but it remains to be seen if fellow Kyoto-supporters in Europe are able to redirect their energies to this more pragmatic strategy.

And what of the victims of future Katrinas? Simply put, energy policies are an unconscionably inefficient and ineffectual approach to stemming the rising toll of natural disasters worldwide. In contrast

to the international coalition of interest groups and governments that has organized around climate change and the Kyoto Protocol, no similarly potent political alliance has risen to advance the cause of reducing global disaster vulnerability. One reason for this neglect surely is that those who suffer most from natural disasters are the poor and politically disenfranchised. Another is that reducing disaster vulnerability can be construed as social adaptation to climate, and leading practitioners of climate change politics have consciously rejected positions that take adaptation seriously. As Al Gore (1993) explained, adaptation is "an important part of the underlying problem. Do we have so much faith in our own adaptability that we will risk destroying the integrity of the entire global ecological system? If we try to adapt to the changes we are causing rather than prevent them in the first place, have we made an appropriate choice?" (1993, 240).

We are well aware that the structure of the Kyoto Protocol, with its binding emissions targets for affluent nations, and programs for technology transfer to poorer nations, is meant to recognize the principal contribution of the industrialized world to global warming, and to signal the commitment by rich nations to accept their moral responsibility by taking the lead on emissions reductions. Kyoto has thus become a symbol of ethical global action that will reduce societal inequities related to the environment. For those who see Kyoto as an effective first step toward addressing global climate change, then, perhaps the most difficult aspect of our argument to swallow is that Kyoto does not, in fact, offer a viable path to greater environmental and socioeconomic equity. Indeed, the politics surrounding Kyoto has had the practical effect of distracting attention, resources, and action from policies that really could protect poor countries and poor people from climate impacts.

By bringing disasters into the global warming debate to score political points, yet refusing to embrace an agenda for actually reducing disaster vulnerability—indeed, by rejecting the basis for such an agenda—climate change politics has explicitly turned its back on the very people it exploits as rhetorical fodder to advance its cause. This is a political strategy that robs the global warming movement of its moral legitimacy and leaves climate change policy, after its faltering first step, facing backwards.

As this chapter goes to press, President Bush has just announced his support for a new round of international negotiations leading to a post-Kyoto plan for reduced greenhouse gas emissions. The Pres-

ident's announcement, although short on details, nevertheless signals that global warming has become a consensus issue in the U.S. Between the new Democratic majority in Congress, the continuing unpopularity of the president, the widespread public belief that Katrina was a climate-change phenomenon, and the publication of the latest Intergovernmental Panel on Climate Change assessment documenting, once again, the reality of human-caused warming, there is no longer any political space for denial. Yet the underlying dynamics of the problem have not changed; in some ways, the political consensus freezes the convenient common wisdoms into place, and thus keeps the essence of the climate challenge outside of most discussions of climate policy.

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AU1
More complicated than this, not worth bringing up.

AU2
I have deleted this sentence because it will distract from the argument. STSers will argue that technologies do reflect ideologies, and this is not a point we need to engage here.

AU3
Double comma OK?

AU4
City it is published in goes in parentheses between "The" and "Observer"

AU5
Name of specific show can go here, if it is known.

QU1
Cite Fig. 1 in text