THE CARBON-NEUTRAL INDIVIDUAL

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Reducing the risk of catastrophic climate change will require leveling off greenhouse gas emissions over the short term and reducing emissions by an estimated 60–80% over the long term. To achieve these reductions, we argue that policymakers and regulators should focus not only on factories and other industrial sources of emissions but also on individuals. We construct a model that demonstrates that individuals contribute roughly one-third of carbon dioxide emissions in the United States. This one-third share accounts for roughly 8% of the world's total, more than the total emissions of any other country except China, and more than several continents. We contend that it is desirable, if not imperative, that governments address emissions from individual behavior. This task will be difficult because individual behaviors, including idling cars and wasting electricity, are resistant to change, even when the change is rational. Mindful of the costs, we propose measures that have a high likelihood of success. We draw on norms theory and empirical studies to demonstrate how legal reforms can tie the widely held abstract norm of personal responsibility to the emerging concrete norm of carbon neutrality. We suggest that these legal reforms could push carbon neutrality past a tipping point, directly influencing many carbon-emitting individual behaviors and building the public support necessary for policymakers to address the remaining sources.

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INTRODUCTION

Climate change is one of the most contentious and important challenges facing modern society. As Judge Richard Posner has noted, we face a nontrivial risk of abrupt catastrophic climate change,

and estimates that its costs will exceed 22% of the U.S. gross domestic product "may be too low."[1]

This Article proposes a new regulatory response. Rather than focusing on reducing greenhouse gas emissions from factories and other industrial sources, the Article focuses on reducing the contributions of individuals. The Article shows that reducing individuals' greenhouse gas emissions in the United States can make a meaningful contribution to the global effort to reduce the risk of catastrophic climate change. Furthermore, it argues that the law has a central role to play in reducing emissions attributable to individuals by activating the emerging norm of carbon neutrality. As the Article explains, an individual can achieve carbon neutrality through a combination of emissions reductions and offsets. Emissions reductions can be achieved through a wide range of individual behavior changes, many of which may yield large reductions at surprisingly low costs. Offsets can be generated by inducing other sources to reduce greenhouse gas emissions,[2] such as through investments in renewable energy sources or through the capture of methane from landfills.[3]

Although their specific estimates vary, many climate scientists and policymakers agree that avoiding catastrophic climate change requires leveling off carbon dioxide emissions over the next decade and reducing emissions by 60–80% by around 2050.[4] Changes in individual behaviors can play an important role in achieving these short- and long-term targets, although this Article focuses principally on the short-term targets. Short-term reductions function like an option, providing the time to make massive additional reductions if the data in the interim confirm that long-term reductions will be necessary.[5] If we fail to purchase the option, we may lose the ability to reduce the

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[1] *See* RICHARD A. POSNER, CATASTROPHE: RISK AND RESPONSE 5, 49 (2004) (citing WILLIAM D. NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING 90 (2000)).

[2] *See, e.g.*, CARBON TRUST, CARBON FOOTPRINTS IN THE SUPPLY CHAIN: THE NEXT STEP FOR BUSINESS 5 (2006), *available at* http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC616 (noting that carbon offset can be created when one party "buys credits associated with environmental projects that reduce emissions of carbon dioxide or other greenhouse gases around the world, as a way of offsetting [the party's] own carbon emissions"); EcoBusinessLinks, Carbon Emissions Offset, http://www.ecobusinesslinks.com/carbon_offset_wind_credits_carbon_reduction.htm (last visited Oct. 5, 2007) ("Carbon offsets enable individuals and businesses to reduce the CO2 emissions they are responsible for by offsetting, reducing or displacing the CO2 in another place, typically where it is more economical to do so.").

[3] *See* TerraPass Additionality Project, Tontitown LFG Project Review Document v1.1 (2007), http://terrapass.pbwiki.com/Project%20Review%20Document (evaluating effectiveness of carbon dioxide offset program involving methane capture from landfill).

[4] *See infra* text accompanying notes 47–55.

[5] POSNER, *supra* note 1, at 161–63.

risk of catastrophic climate change once climate predictions are more certain. At that point, the uncertainty about the effects of climate change will be gone, but so will the opportunity to avoid them.

We cannot know whether the predictions about catastrophic climate change and the emissions reductions necessary to reduce the risk—or to preserve the ability to decide later to reduce the risk—are accurate. Yet we recognize that scientists and policymakers cannot afford to be wrong. Even if there is only a small chance that the predictions are accurate, the harms of catastrophic climate change are so great, the required emissions reductions must be so prompt, and the potential costs of emissions reductions are so great, that no major source of greenhouse gases can be ignored.

This Article first demonstrates that individual behavior is a tremendous and overlooked source of greenhouse gases, accounting for one-third of all U.S. carbon dioxide emissions. The Article then explores the prospect of reducing emissions from individual behavior at low cost through measures that foster the emerging norm of carbon neutrality.

Despite the importance of individuals and households to the study of economics, environmental regulation, and other fields,[6] scholars are only beginning to focus on these entities as a discrete field of study in legal scholarship. Perhaps as a result, to the extent that federal policymakers have focused on climate change at all, they have directed far more attention toward large industrial sources. States have been more active in addressing climate change, but they too have

[6] *See, e.g.*, Ann E. Carlson, *Recycling Norms*, 89 CAL. L. REV. 1231, 1297–99 (2001) (arguing that in some large-number, small-payoff collective action problems, individual behaviors are more effectively altered by improving convenience than by influencing social norms); Robert C. Ellickson, *Unpacking the Household: Informal Property Rights Around the Hearth*, 116 YALE L.J. 226, 327–28 (2006) (emphasizing importance of studying individual household dynamics in numerous academic fields); Andrew Green, *You Can't Pay Them Enough: Subsidies, Environmental Law, and Social Norms*, 30 HARV. ENVTL. L. REV. 407, 428–49 (2006) (arguing that government subsidies for "green" behaviors do not necessarily enhance development of environmental social norms); Anne C. Steinemann, *Rethinking Human Health Impact Assessment*, 20 ENVTL. IMPACT ASSESSMENT REV. 627, 638 (2000) (highlighting need to include individual health effects in environmental impact assessments); Michael P. Vandenbergh, *Order Without Social Norms: How Personal Norm Activation Can Protect the Environment*, 99 NW. U. L. REV. 1101 (2005) (examining influence of personal and social norms on environmentally significant individual behavior); *see also* NAT'L RESEARCH COUNCIL, DECISION MAKING FOR THE ENVIRONMENT: SOCIAL AND BEHAVIORAL SCIENCE RESEARCH PRIORITIES 69–84 (Garry D. Brewer & Paul C. Stern eds., 2005) [hereinafter NRC, DECISION MAKING] (examining importance of studying environmentally significant individual behavior).

focused principally on large industrial sources.[7] Some states have addressed emissions from individuals indirectly by regulating emissions from manufacturers of consumer products.[8] The federal government, for its part, has not only failed to address individual behavior directly, but it also has sought to block state efforts by asserting that states do not have the authority either to impose greenhouse gas tailpipe standards on auto manufacturers[9] or to force the federal government to do so.[10]

Part I of this Article examines the threat posed by global warming and identifies the short- and long-term emissions reductions necessary to reduce the risk of catastrophic climate change. Part II presents a model of carbon dioxide emissions from individual behavior, which we define conservatively to include only those behaviors that are substantially and directly controlled by individuals, such as personal driving and household energy use. Even under this conservative approach, the model's results are remarkable: The average American individual's share of total emissions in 2000 was more than 14,000 pounds of carbon dioxide, for a total of 4.1 trillion pounds for all Americans. By comparison, all of American industry emitted 3.9 trillion pounds in 2000. The 4.1 trillion pounds attributable to American individuals comprise roughly 32% of total U.S. annual emissions[11] and 8% of the world total. It is larger than the emissions from all of Africa, Central America, and South America combined, and larger than the emissions of every foreign country besides China. Thus, small shifts in individual behavior in the United States can generate emissions reductions that exceed the total emissions of entire industry sectors, countries, and continents.

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[7] John C. Dernbach, *Harnessing Individual Behavior to Address Climate Change: Options for Congress*, 26 VA. ENVTL. L.J. (forthcoming 2007) (manuscript at 3, 7), *available at* http://ssrn.com/abstract=983632.

[8] *See, e.g.*, CAL. CODE REGS. tit. 13, § 2175 (2007) (regulating automobile tailpipe emissions); FLA. ADMIN. CODE ANN. r. 62-242.400 (2007) (same).

[9] *See, e.g.*, Cent. Valley Chrysler-Jeep, Inc. v. Witherspoon, No. 04-6663, 2007 WL 135688, at *2, *11 & n.2 (E.D. Cal. Jan. 16, 2007) (describing EPA effort to overturn state law regulating tailpipe emissions); Average Fuel Economy Standards for Light Trucks Model Years 2008–2011, 71 Fed. Reg. 17,566, 17,656 (Apr. 6, 2006) (executive summary of rule codified at 49 C.F.R. pts. 523, 533, 537) ("[W]e [the National Highway Transportation Safety Administration] have re-analyzed all issues carefully as set forth below, and determined, based on existing and foreseeable technologies for reducing CO_2 emissions from motor vehicles, that the effect under EPCA and the Supremacy Clause of the U.S. Constitution is that State regulation of those emissions is preempted.").

[10] *See* Massachusetts v. EPA, 127 S. Ct. 1438, 1450–51 (2007) (describing EPA's argument that Clean Air Act does not require it to regulate tailpipe emissions).

[11] The remaining two-thirds of emissions come from industry, commercial sources, and nonindividual transportation. *See infra* notes 85–89 and accompanying text.

Part III of this Article identifies the most important carbon-emitting individual behaviors. Some of these behaviors can be easily modified to generate large emissions reductions in the short term. We call these behaviors the "low-hanging fruit." Many legal, economic, and social regulatory measures can influence carbon-emitting individual behaviors. Part IV focuses on one such measure: norm activation. This Part demonstrates how legal reforms can activate norms that (1) directly influence the "low-hanging fruit" behaviors and (2) build the public support necessary to adopt measures that address behaviors that are more difficult to modify. Drawing on insights from law and social psychology, this Part argues that the carbon-neutrality norm can be linked to the norm of personal responsibility, which entails the commitment not to take actions that harm others. Scholars discount this norm's application to climate change,[12] but we show how it can work to change carbon-emitting behaviors.

The norm of carbon neutrality suggests that an individual's obligation not to harm others can be fulfilled by achieving a carbon footprint of zero, which can be accomplished by reducing carbon emissions and purchasing offsets for the remaining emissions. Carbon neutrality is already becoming widespread; it was the "word of the year" for 2006,[13] and it has been adopted by numerous individuals, governments, corporations, sports leagues, and nongovernmental organizations.[14] Although the term has already begun to spread, particularly among those who hold strong environmental norms, policymakers can enhance the influence of carbon neutrality by disseminating information that ties carbon neutrality to personal responsibility.

Information disclosure targeted at such norm activation also may complement more traditional regulatory measures, such as taxes, subsidies, efficiency standards, cap-and-trade schemes, and investments in technology and infrastructure. Many of these traditional measures are grounded in the belief that individuals are rational actors with adequate information. Empirical studies of carbon-emitting behaviors demonstrate, however, that individuals often lack information, are influenced by cognitive biases in decisionmaking processes, face infra-

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[12] *See, e.g.*, Walter Sinnott-Armstrong, *It's Not* My *Fault: Global Warming and Individual Moral Obligations*, *in* 5 ADVANCES IN THE ECONOMICS OF ENVIRONMENTAL RESOURCES 285, 289–94 (Walter Sinnott-Armstrong & Richard B. Howarth eds., 2005) (arguing that individuals have no moral obligation to reduce greenhouse gas emissions).

[13] The editors of the New Oxford American Dictionary named "carbon neutral" their Word of the Year for 2006. Oxford University Press Blog, Carbon Neutral: Oxford Word of the Year (Nov. 13, 2006), http://blog.oup.com/2006/11/carbon_neutral_.

[14] *See infra* text accompanying notes 201–15.

structure or resource barriers, and, in some circumstances, act in socially, rather than individually, interested ways. Information disclosure may enable the traditional measures to account for many of these decisional lacunae and may build public support for the adoption of the measures in the first place.

Part V contains our policy recommendations. It argues that legal measures and information disclosure can push the emerging carbon-neutrality norm toward a tipping point without triggering understandable concerns about government involvement in propaganda. This Part suggests that disclosure of accurate information on the adverse consequences of carbon-emitting behaviors—and on the steps that can be taken to ameliorate those consequences—can activate climate-relevant norms. For example, Part V proposes an Individual Carbon Release Inventory that would collect, assess, and provide the public with information about the aggregate and mean carbon dioxide emissions from individual behaviors. Similarly, efforts to identify and disclose the economic and health effects of climate change might be necessary to reduce carbon-emitting behaviors by linking carbon neutrality to personal responsibility. Government also may be able to promote carbon neutrality by facilitating development of standards for personal carbon calculators and emissions offsets.

The Article concludes by recommending an intensive research effort by environmental engineers, social scientists, and law and policy scholars to identify the behaviors that contribute to carbon emissions, the social and economic influences on those behaviors, and the optimal legal and policy responses. Treating individual behavior as a discrete source of carbon emissions will require regulatory scholars and policymakers to leave their comfort zone, but reducing the risk of catastrophic climate change may require no less.

I
THE IMPLICATIONS OF CLIMATE CHANGE

The science of climate change is daunting. Yet evaluating the appropriate regulatory response requires understanding what contributes to climate change, the likelihood and magnitude of the harms it will cause, and the emissions reductions necessary to reduce the risk of those harms. This Part provides a brief overview of these issues.

A. Climate Change Science

Growing numbers of scientists have become concerned about the possibility of catastrophic climate change. In 2007, the

Intergovernmental Panel on Climate Change (IPCC)[15] concluded that there is a greater than 90% probability that climate changes observed in the last fifty years cannot be explained without accounting for human emissions of greenhouse gases.[16] Although changes in the earth's orbit have influenced climate changes in the past, including the ice ages of the last several hundred thousand years, the IPCC concluded that anthropogenic gases are driving the recent changes.[17] Several anthropogenic greenhouse gases contribute to these changes, but carbon dioxide accounts for roughly 85% of the climate-forcing effect of these gases[18] and is the principal focus of this Article.

The IPCC report's conclusions are consistent with statements by other respected scientific bodies. For example, in 2005 the national academies of science of the United States and the other Group of Eight (G8) nations issued an unprecedented joint statement blaming greenhouse gases for the earth's recent warming trend.[19] Similarly, a 1997 statement issued by a majority of the living winners of the Nobel Prizes in the sciences identified global warming as "one of the most serious threats to the planet and to future generations."[20]

Although much has been made of the state of the scientific debate regarding climate change,[21] a recent assessment of relevant scientific papers published in peer-reviewed journals between 1993 and 2003 concluded that none disagreed with the statement that the

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15 The IPCC is composed of hundreds of scientists organized by the United Nations Environment Programme and the World Meteorological Organization, and its most recent report was approved by the governments of the United States and 112 other countries. Elisabeth Rosenthal & Andrew C. Revkin, *Science Panel Says Global Warming is "Unequivocal,"* N.Y. TIMES, Feb. 3, 2007, at A1.

16 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 10 (2007).

17 *Id.* at 10–12.

18 Carbon dioxide accounted for 84.6% of the carbon dioxide equivalent gases emitted in 2004. John C. Dernbach, *Stabilizing and Then Reducing U.S. Energy Consumption: Legal and Policy Tools for Efficiency and Conservation*, 37 ENVTL. L. REP. 10,003, 10,010–11 n.76 (2007); *see also* James Hansen & Makiko Sato, *Greenhouse Gas Growth Rates*, 101 PROC. NAT'L ACAD. SCI. 16,109, 16,111 (2004) (concluding that climate-forcing effects of greenhouse gases in 2003 were result of carbon dioxide (90%), nitrous oxide (5%), methane (4%), and Montreal Protocol trace gases (e.g., chlorofluorocarbons) and other trace gases (1%)).

19 Joint Science Academies' Statement: Global Response to Climate Change (June 7, 2005), *available at* http://nationalacademies.org/onpi/06072005.pdf.

20 Petition from the Union of Concerned Scientists, World Scientists' Call for Action (1997), *available at* http://www.ucsusa.org/global_warming/science/world-scientists-call-for-action-at-the-kyoto-climate-summit.html.

21 *See* Julia B. Corbett & Jessica L. Durfee, *Testing Public (Un)certainty of Science: Media Representations of Global Warming*, 26 SCI. COMM. 129, 130–37 (2004) (discussing ways in which media communicates or constructs scientific uncertainty regarding global warming).

"[e]arth's climate is being affected by human activities."[22] Furthermore, even the Bush Administration, which has declined to adopt mandatory controls on greenhouse gas emissions and has opposed state regulation of such emissions,[23] has accepted the conclusions of the IPCC report.[24] In addition, the U.S. Climate Change Science Program concluded in 2006 not only that the earth is warming but that human emissions of greenhouse gases are driving the warming.[25]

Modeling is an important part of the scientific understanding of climate change, but perhaps the most compelling example of the climate change data arises from the long-term relationship between carbon dioxide and temperature. Looking backward does not require scientists to account for the prospective activities of complex systems, as modeling does. Rather, it requires them to identify how those complex systems have responded to comparable stresses in the past.[26] Figure 1 demonstrates the historical relationship between carbon dioxide and temperature over the past 420,000 years.[27]

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22 Naomi Oreskes, *The Scientific Consensus on Climate Change*, 306 SCIENCE 1686, 1686 (2004).

23 *See supra* notes 9–10 and accompanying text.

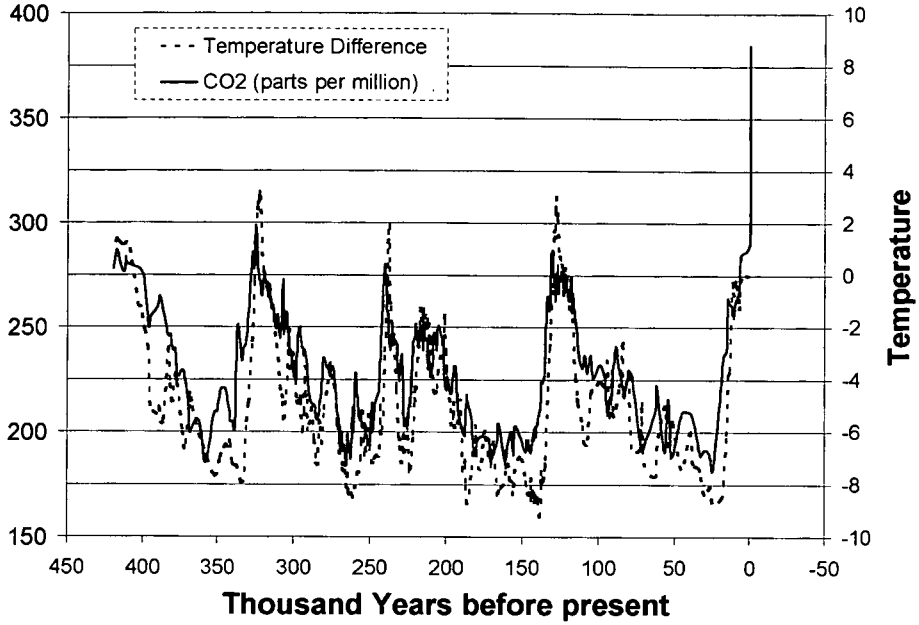
24 Rosenthal & Revkin, *supra* note 15.

25 U.S. CLIMATE CHANGE SCI. PROGRAM, TEMPERATURE TRENDS IN THE LOWER ATMOSPHERE: STEPS FOR UNDERSTANDING AND RECONCILING DIFFERENCES 2 (2006), *available at* http://www.climatescience.gov/Library/sap/sap1-1/finalreport/sap1-1-final-all.pdf ("Studies to detect climate change and attribute its causes using patterns of observed temperature change in space and time show clear evidence of human influences on the climate system . . . ."); *see also* Press Release, Nat'l Oceanic & Atmospheric Admin., Report Reconciles Atmospheric Temperature Trends (May 2, 2006), *available at* http://www.climatescience.gov/Library/pressreleases/pressrelease2may2006.htm ("[T]he observed patterns of [climate] change over the past 50 years cannot be explained by natural processes alone . . . ."), *quoted in* Juliet Eilperin, *Study Reconciles Data in Measuring Climate Change*, WASH. POST, May 3, 2006, at A3.

26 Both carbon dioxide and temperature can be measured from air bubbles captured in glaciers, and through this method scientists have collected data reaching back at least 420,000 years. *See, e.g.*, Nicolas Caillon et al., *Timing of Atmospheric CO_2 and Antarctic Temperature Changes Across Termination III*, 299 SCIENCE 1728 (2003) (discussing analysis of temperature and carbon dioxide concentrations in Vostok ice core in Antarctica); J.R. Petit et al., *Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica*, 399 NATURE 429 (1999) (same).

27 The chart was prepared by Jonathan Gilligan, Senior Lecturer in the Earth and Environmental Sciences Department at Vanderbilt University. The chart is based on data available from Jean Robert Petit et al., NOAA/NGDC Paleoclimatology Program, Vostok Ice Core Data for 420,000 Years, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2001-076 (2001), ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/vostok/deutnat.txt, ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/vostok/co2nat.txt, which was used for Petit et al., *supra* note 26, and is used here by permission.

FIGURE 1



As Figure 1 suggests, the relationship between carbon dioxide levels and temperature is complex. In some time periods, carbon dioxide increases precede temperature increases, but in others, temperature increases precede carbon dioxide increases.[28] Nevertheless, during this 420,000 year period, the data demonstrate a remarkable relationship between temperature and carbon dioxide. As shown in Figure 1, today's carbon dioxide levels, at roughly 380 parts per million (ppm), are higher than they have been at any time during this period. If atmospheric concentrations continue to increase at the current rate, total emissions will reach 560 ppm, roughly double pre–Industrial Revolution levels, by the end of this century.[29]

The historical relationship between carbon dioxide levels and temperature is striking. This relationship suggests two plausible

[28] Changes in Earth's orbit and other influences are thought to affect both temperature and carbon dioxide levels. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 16, at 9.

[29] Atmospheric carbon dioxide levels were roughly 380 ppm in 2006 and have been increasing at a rate of about 2.0 ppm per year since 2000. James E. Hansen, *A Slippery Slope: How Much Global Warming Constitutes "Dangerous Anthropogenic Interference?,"* 68 CLIMATIC CHANGE 269, 277 (2005). Increases of 2.0 ppm per year would generate levels of 560 ppm by roughly 2096. Carbon dioxide concentrations were roughly 280 ppm in 1750. *See* H. Friedli et al., *Ice Core Record of the $^{13}C/^{12}C$ Ratio of Atmospheric CO_2 in the Past Two Centuries*, 324 NATURE 237, 237 fig. 1 (1986); A. Neftel et al., *Evidence from Polar Ice Cores for the Increase in Atmospheric CO_2 in the Past Two Centuries*, 315 NATURE 45, 45 fig.1 (1985).

scenarios for the future: Either the relationship between carbon dioxide and temperature that has existed for at least 420,000 years will no longer continue, or temperature will once again catch up with carbon dioxide levels, meaning substantial temperature increases are on the horizon. Given the conclusions of the IPCC and many prominent scientists, we believe that it is prudent to understand and respond to the potential harms that may arise from a substantial temperature increase.

B. Potential Harms of Climate Change

One potential harm of climate change is a sea level increase that could fundamentally reshape human and other life on the planet. For example, the 2007 IPCC report predicts that if carbon dioxide levels reach 560 ppm, global average temperature increases of 3.5–8°F are likely, with a "best estimate" increase of just over 5°F.[30] The report notes that polar regions will warm more quickly than nonpolar regions,[31] and that polar average temperatures at the lower end of its predicted range for global average temperatures last occurred 125,000 years ago, when sea levels were thirteen to twenty feet higher than today.[32]

The IPCC report only projects sea level increases of up to two feet by 2100, but it notes that its short-term estimate excludes ice sheet flows from Greenland, and it does not estimate longer-term sea-level rises.[33] Several leading scientists have argued that, based on recent studies of the Greenland ice cap, the risk of a sea-level rise of thirteen feet or more this century is now "within the realm of possibility."[34] Furthermore, James Hansen, a leading climate scientist, has

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30 *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 16, at 12 (based on estimate of 2–4.5°C range and "best estimate" of 3°C). We have converted all temperature change estimates in this Article from degrees Celsius to degrees Fahrenheit by multiplying degrees Celsius by 1.8.

31 *See id.* at 7, 15 (noting that Arctic warming rate has been higher than global average over past century and predicting future warming to be similar to recent patterns).

32 *See id.* at 9 (noting that polar average temperatures were 5.4–9°F higher about 125,000 years ago, when sea levels were likely thirteen to twenty feet higher). Although the 5.4–9°F range for polar average temperature increases is higher than the IPCC's prediction for global average increases of 3.5–8°F, the IPCC's best estimate for global average temperature increases (5°F) may yield polar average increases of 10°F. *See* James Hansen, *The Threat to the Planet*, N.Y. REV. BOOKS, July 13, 2006, at 12, 13 ("The business-as-usual scenario, with five degrees Fahrenheit global warming and ten degrees Fahrenheit at the ice sheets, certainly would cause the disintegration of the ice sheets.").

33 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 16, at 13–14 & tbl.SPM.3.

34 *See* Hansen, *supra* note 29, at 274 (asserting that recent studies suggest risk of rapid disintegration of Greenland ice cap); Roger Harrabin, *Top Scientist's Fears for Climate*, BBC NEWS, Aug. 31, 2006, http://news.bbc.co.uk/2/hi/science/nature/5303574.stm (quoting

noted that three million years ago, when global average temperatures were 5°F warmer than today's temperatures (and equal to the IPCC's best estimate if carbon dioxide concentrations double), sea levels were roughly eighty feet higher.[35] Sea-level increases of eighty feet would inundate many of the major cities on the east coast of the United States, and most of Florida, with similar effects around the world.[36] Although these increases would not occur immediately, once the process begins it may be inexorable, with levels rising as much as three feet or more every few decades for centuries.[37] Other possible effects of climate change include increased storm intensity, more frequent and intense floods and droughts, redistribution of current rainfall patterns, bleaching of coral reefs, ocean acidification, and species loss.[38]

A long-term objective to prevent these harms can be defined as the avoidance of "dangerous anthropogenic interference with the climate system," as stated in the U.N. Framework Convention on Climate Change.[39] Although critics have derided the ambiguity of this objective, scientists have identified a number of outcomes that meet the definition of dangerous, such as "warming involving risk to unique and threatened systems and warming engendering a risk of large-scale discontinuities in the climate system."[40] An example of the first type of outcome is the destruction of coral reef systems on a large scale,

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Professor John Holdren as stating that complete melting of Greenland ice cap "could increase world-wide sea levels by 7m (23ft), swamping many cities").

[35] Hansen, *supra* note 32, at 13; *see also* James E. Hansen, *Can We Still Avoid Dangerous Human-Made Climate Change?*, 73 SOC. RES. 949, 966–67 (2006) [hereinafter Hansen, *Can We Avoid?*] (arguing that rate of CO_2 emissions must level off soon and decline substantially before midcentury, while non-CO_2 forcings must decrease to achieve no more than 1°C temperature increase); James Hansen, *Defusing the Global Warming Time Bomb*, SCI. AM., Mar. 2004, at 68, 74–75 (positing that "highest prudent level of additional global warming is not more than about one degree C" to avoid large-scale ice-sheet breakup).

[36] Hansen, *supra* note 32, at 13 (estimating that sea-level rise of eighty feet would inundate Boston, New York, Philadelphia, and most of Florida, and would displace 250 million people in China, 120 million people in Bangladesh, and 150 million people in India).

[37] *See id.* (noting that in past, "once ice sheets began to collapse, [sea levels] rose one meter [about three feet] every twenty years for centuries"); *see also* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 16, at 13 tbl.SPM.3 (projecting future sea-level rises).

[38] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 16, at 7 ("At continental, regional and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones."); Brian C. O'Neill & Michael Oppenheimer, *Dangerous Climate Impacts and the Kyoto Protocol*, 296 SCIENCE 1971, 1971 (2002) (discussing coral bleaching).

[39] United Nations Framework Convention on Climate Change art. 2, May 9, 1992, S. TREATY DOC. NO. 102-38, 1771 U.N.T.S. 107.

[40] O'Neill & Oppenheimer, *supra* note 38, at 1971.

which appears to be occurring in a number of regions and is likely to become severe if global warming exceeds roughly 2°F,[41] a temperature increase below the IPCC's projected range if carbon dioxide concentrations double.[42] Examples of the second type of outcome include several events that have a low probability of occurring, at least in the short term, but which would cause substantial harm: the disintegration of the West Antarctic Ice Sheet (which could cause a sea-level rise of roughly thirteen to twenty feet worldwide) or a disruption of the thermohaline circulation in the oceans (which could cause wide swings in temperature in Europe and elsewhere).[43] These changes may be catastrophic not only because of their severity but also because they may occur abruptly, providing little time for adaptation.[44] Perhaps as troubling as the first-order environmental impacts of climate change are the ways in which people might react to these impacts, whether through migration, social conflict, or other means. A recent study prepared for the Department of Defense raises concerns about the possibility of armed conflict.[45]

Media reports frame this science by asking whether doubts exist about climate change.[46] But given the possible magnitude of the harms, the issue is not whether any doubts exist, but whether there is sufficient likelihood to justify some responses, and if so, at what cost. Our view is that even assuming there is only a small chance that some of the more catastrophic outcomes will occur (for example, that sea levels will rise thirteen to twenty feet in the next hundred years and that we will lose Florida over the longer term), the outcomes are sufficiently awful that a concerted response is prudent.

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41 *Id.*

42 *See supra* note 30 and accompanying text.

43 O'Neill & Oppenheimer, *supra* note 38, at 1971–72.

44 *See* POSNER, *supra* note 1, at 253–54 (arguing that "a wait-and-see policy would be perilous" because of possibility that "atmospheric concentrations [of carbon dioxide] may reach a level that triggers abrupt, catastrophic global warming"). Although we agree with Judge Posner that abruptness is important because it reduces our ability to adapt, we conclude that abruptness is not a necessary predicate for action regarding some of the low-probability and serious-consequence harms of climate change. For example, sea-level rises in the tens of feet, even if gradual, will not allow for human adaptation on any meaningful level.

45 *See* PETER SCHWARTZ & DOUG RANDALL, DEP'T OF DEF., AN ABRUPT CLIMATE CHANGE SCENARIO AND ITS IMPLICATIONS FOR UNITED STATES NATIONAL SECURITY 14–19 (2003), *available at* http://www.fas.org/irp/agency/dod/schwartz.pdf (discussing potential national-security implications of climate change).

46 *See* Corbett & Durfee, *supra* note 21, at 132–36 (discussing ways in which media presents scientific uncertainty that tend to underplay degree of scientific consensus).

C. Emissions Reduction Targets

If we assume that there is a nontrivial risk of catastrophic climate change, we must next determine what level of emissions reductions will reduce the risk of the most serious harms.[47] Determination of this level requires assumptions about the target level for global average temperature, the concentration of carbon dioxide in the atmosphere that will generate the target level, and the emissions of carbon dioxide that will generate the requisite concentration in the atmosphere. These are difficult judgments. For the purposes of this Article, we draw on the conclusions of several leading climate scientists. For example, James Hansen and a growing number of other experts have argued that to avoid the dangerous impacts of climate change, temperature increases over year 2000 temperatures should be limited to roughly 2°F.[48] To reduce the risk that temperature increases will exceed this threshold, total concentrations of carbon dioxide—currently at 380 ppm—should be kept below roughly 500 ppm.[49] Even this will only improve the chances of avoiding catastrophic events like widespread flooding, but it will not ensure that substantial climate change effects will not occur.[50]

To keep atmospheric concentrations of carbon dioxide below roughly 500 ppm, many scientists have argued that we should level off emissions growth in the near term to enable time for technological developments to generate large reductions over the longer term. In the absence of near-term reductions, the long-term reductions necessary to avoid the most dangerous climate impacts are unrealistically large.[51] For example, Hansen has argued that measures should be

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[47] O'Neill & Oppenheimer, *supra* note 38, at 1972 (discussing possible dangerous impacts of climate change and emissions reductions needed to avoid them).

[48] Hansen, *Can We Avoid?*, *supra* note 35, at 965–66 (expressing target temperature change as 1°C, roughly equivalent to 2°F); *cf.* INT'L CLIMATE CHANGE TASKFORCE, MEETING THE CLIMATE CHALLENGE: RECOMMENDATIONS OF THE INTERNATIONAL CLIMATE CHANGE TASKFORCE 3 (2005), *available at* http://www.whrc.org/resources/published_literature/pdf/ByersetalInstPubPolRes.1.05.pdf (concluding that increases of 2°C (3.6°F) above recent temperature levels will increase "the risks of abrupt, accelerated, or runaway climate change").

[49] *See* INT'L CLIMATE CHANGE TASKFORCE, *supra* note 48, at 4 (suggesting 400 ppm target carbon dioxide level); Hansen & Sato, *supra* note 18, at 16,114 (concluding that stabilization will require carbon dioxide levels not to exceed 440 to 520 ppm); O'Neill & Oppenheimer, *supra* note 38, at 1972 (concluding that stabilization will require carbon dioxide levels not to exceed 450 ppm target).

[50] *See* O'Neill & Oppenheimer, *supra* note 38, at 1972 (pointing out that it is not certain that stabilization at 450 ppm would forestall disintegration of West Antarctic Ice Sheet).

[51] *Id.* (suggesting that delaying achievement of Kyoto Protocol cumulative emissions target from 2010 to 2020 may require up to "staggering" 8% reduction per year to begin before 2040 and concluding that "such high rates of reduction may be prohibitively

adopted to achieve a short-term goal of leveling off carbon dioxide emissions by roughly 2015 and a long-term goal of a rapid decrease from current levels by roughly 2050.[52] Climate scientists differ on the precise reductions necessary, but the estimated reductions by 2050 tend to cluster in the 60–80% range.[53] Although policymakers have proposed various emissions-reduction targets, many of their proposals also reflect the need to achieve a near-term leveling off in carbon dioxide emissions and a substantial decrease by roughly 2050.[54] Achieving these reductions will be particularly difficult because, in the absence of extraordinary measures, emissions are expected to increase substantially during this period. In fact, researchers such as Stephen Pacala and Robert Socolow predict that if we continue "business as usual," emissions will double by the middle of this century.[55]

II
THE CONTRIBUTION OF INDIVIDUAL BEHAVIOR

A recent *New York Times* editorial on climate change referred to the sources of carbon emissions as "industrial emissions,"[56] as if industrial emissions are synonymous with all emissions. This Part demonstrates that individual behavior is a discrete, overlooked source of enormous quantities of carbon dioxide emissions. It then presents a model that estimates the releases of carbon dioxide attributable to the average individual in the United States and to all individuals in the

costly"); *see also* Stephen Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCIENCE 968, 968–69 (2004) (concluding that near- and mid-term reductions are necessary as stop-gap measure to provide time for "revolutionary technologies" to be developed to achieve more dramatic reductions).

52 Hansen, *Can We Avoid?*, *supra* note 35, at 966.

53 *See, e.g.*, ROYAL COMM'N ON ENVTL. POLLUTION, ENERGY—THE CHANGING CLIMATE 182 (2000), *available at* http://www.rcep.org.uk/pdf/chp10.pdf (recommending 60% reductions in emissions by 2050); UNION OF CONCERNED SCIENTISTS, HOW TO AVOID DANGEROUS CLIMATE CHANGE: A TARGET FOR U.S. EMISSIONS REDUCTIONS 1 (2007), *available at* http://www.ucsusa.org/assets/documents/global_warming/emissions-target-report.pdf (recommending that industrialized nations reduce emissions 70–80% from year 2000 levels by 2050); *see also* T.M.L. Wigley, *The Climate Change Commitment*, 307 SCIENCE 1766, 1768–69 (2005) (concluding that reducing emissions substantially below present levels will be necessary to stabilize global mean temperatures).

54 *See* CONG. RESEARCH SERV., CLIMATE CHANGE: GREENHOUSE GAS REDUCTION BILLS IN THE 110TH CONGRESS 2–3 (2007), *available at* http://www.ncseonline.org/nle/crsreports/07May/RL33846.pdf (discussing bills introduced in 110th Congress that would impose controls on emissions through declining emissions caps).

55 Pacala & Socolow, *supra* note 51, at 968. Pacala and Socolow focus only on carbon dioxide.

56 Editorial, *Global Warming and the Courts*, N.Y. TIMES, July 8, 2006, at A12.

aggregate. The Part concludes by evaluating the significance of these emissions.

A. *Individual Behavior as a Source Category*

The framing of pollution sources exerts a powerful influence on the regulatory and social forces brought to bear on them.[57] Identifying a source begins the process of attributing a quantity of emissions to that source, assigning blame for the harms caused by those emissions, and directing regulatory resources toward emissions reductions. Sources that are perceived as the largest emitters naturally attract the most public and regulatory attention.

Since the explosion of environmental regulation in the early 1970s, policymakers have focused most regulatory prescriptions on large industrial sources.[58] In contrast, they have focused little regulatory attention on individuals and households.[59] Framing pollution as an industrial problem generates remedies that involve industrial regulation. Thus, controlling emissions from automobiles becomes a matter of adopting technology-based standards on motor vehicle emissions, with little emphasis on the number and use of the vehicles.[60] Controlling emissions from residential electricity use becomes a matter of adopting technology-based or market-allowance-based controls on electrical utilities, with far less emphasis on the amount of energy consumed in the home.[61]

Assessments of the sources of carbon dioxide emissions have followed this traditional pattern. The presentation of 2004 carbon dioxide emissions data by the Energy Information Administration (EIA) of the Department of Energy demonstrates the point. Although the EIA identified industrial, commercial, transportation, and residential categories of emitters, it failed to identify individual behavior as a discrete source.[62] Rather, it distributed the emissions

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57 *See* Steinemann, *supra* note 6, at 635 (noting that public concern about health hazards can prompt government agencies to conduct human-health impact assessments); Michael P. Vandenbergh, *From Smokestack to SUV: The Individual as Regulated Entity in the New Era of Environmental Law*, 57 VAND. L. REV. 515, 610 (2004) (arguing that providing consumers with information about products' environmental impact pressures manufacturers to create more ecofriendly products).

58 Vandenbergh, *supra* note 57, at 517–18.

59 *Id.* at 524–35.

60 *See, e.g.*, Clean Air Act § 202, 42 U.S.C. § 7521(a)(1) (2000) (requiring EPA to impose pollution control requirements on motor vehicles).

61 *See generally* Vandenbergh, *supra* note 57, at 524–29 (discussing traditional regulatory focus on command-and-control regulations and economic incentives aimed at industrial sources).

62 ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, 2004 ANNUAL ENERGY REVIEW 340 fig.12.2, *available at* http://tonto.eia.doe.gov/FTPROOT/multifuel/038404.pdf [hereinafter

attributable to individual behavior among at least two sectors: (1) residential (e.g., household electricity and direct energy use), and (2) transportation (personal driving, flying, and mass transportation). By dividing the emissions from individual behavior into two categories, one of which (transportation) includes emissions from many types of sources other than individuals, this framing obscures the size of the total emissions from individuals as a discrete source category. Other organizations that report emissions data also follow this approach. For example, a 2006 UN report divided greenhouse gas sources into several categories, none of which includes individual behavior as a discrete category.[63]

A viable alternative is to begin by framing the sources of carbon emissions based on the types of policies or regulatory measures that might be effective in controlling them, and to work backward to determine the emissions that may be generated by these types of sources.[64] If regulators begin by assuming that changing individual behavior is a viable means of achieving desired environmental outcomes, the analysis shifts. Then the question becomes, What behaviors are under the individual's control? With this framing in mind, the magnitude of the total contribution from individual behavior will come into focus as emissions from household activities and personal transportation are aggregated. The model presented below estimates the contribution of individual behavior using this approach.

B. A Model of Individual Carbon Dioxide Emissions

Not surprisingly, given the lack of attention to individuals' contributions to global warming, policymakers and scholars have developed few tools to assess the aggregate contribution of individual behavior to greenhouse gas emissions.[65] To evaluate whether the carbon emis-

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EIA, 2004 REVIEW]; *see also* EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2004, at 2-22 to 2-26 (2006), *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR6MBSC3/$File/06_Complete_Report.pdf [hereinafter EPA, 2006 INVENTORY] (offering similar breakdown of emissions source categories).

[63] UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, KEY GREENHOUSE GAS DATA 44–45 figs.II-12 to II-20 (2005), *available at* http://unfccc.int/resource/docs/publications/key_ghg.pdf.

[64] *See* Paul C. Stern et al., *Strategies for Setting Research Priorities*, *in* ENVIRONMENTALLY SIGNIFICANT CONSUMPTION: RESEARCH DIRECTIONS 124, 133 (Paul C. Stern et al. eds., 1997) (noting that in analyzing sources of pollution "[o]ne useful strategy is to begin with possible policy interventions").

[65] For models of the environmental impact of individuals' behavior as consumers, see MICHAEL BROWER & WARREN LEON, THE CONSUMER'S GUIDE TO EFFECTIVE ENVIRONMENTAL CHOICES: PRACTICAL ADVICE FROM THE UNION OF CONCERNED SCIENTISTS 216–48 (1999), and Shui Bin & Hadi Dowlatabadi, *Consumer Lifestyle Approach to U.S.*

sions from individual behavior are worthy of regulatory attention, we present the results of a model that estimates the carbon dioxide emissions in 2000 from the average individual in the United States and the aggregate emissions from all individuals.[66] We provide an overview of the model here and a detailed description in the Appendix.

1. *Individual Behavior Defined*

We define individual behavior to include only those behaviors that are under the direct, substantial control of the individual and that are not undertaken in the scope of the individual's employment. As a result, we include emissions from personal motor vehicle use, personal air travel, and mass transport. We exclude emissions from motor vehicle use and air travel undertaken in the course of employment (e.g., driving for a delivery service or flying on a business trip). Similarly, we include emissions attributable to household electricity use, but we exclude emissions attributable to the industrial production of household goods (e.g., the emissions resulting from the production, shipping, and retailing of appliances and food).

Although this conservative approach excludes many activities that contribute to climate change (e.g., the releases attributable to household appliance production), the emissions from these activities often vary widely depending on where and how the goods are produced, and the degree of individual control over them is often very limited.[67] Furthermore, making individuals responsible for all emissions derived from consumer choices would make it possible to attribute virtually all emissions to individuals, yet it would not satisfy the initial objective of including only emissions that can be changed

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Energy Use and the Related CO_2 Emissions, 33 ENERGY POL'Y 197 (2005). Our model does not consider the impact of individuals' consumer behavior, *see infra* note 67, but instead examines the emissions attributable to all behavior under an individual's direct control.

[66] We look exclusively at carbon dioxide because approximately 85% of climate forcing is caused by carbon dioxide, *see supra* note 18, and the data on carbon dioxide are more accessible and reliable across source categories than data on other greenhouse gases.

[67] Experts disagree as to whether the carbon dioxide that results from the manufacture of consumed products should count towards an individuals' emissions. *Compare* The Personal Environmental Impact Calculator, http://ans.engr.wisc.edu/eic/home.html (last visited Oct. 12, 2007) (limiting calculations of individuals' environmental impact to activities over which they have direct control, including transportation choices, recycling habits, home water use, and home energy use), *with* BROWER & LEON, *supra* note 65, at 14 ("[W]e vote with our dollars when we choose to buy or not to buy particular products."). Our rationale for including electricity purchased by consumers in the model, but excluding other consumer goods, is consumers' uncertainty regarding the carbon releases from those other goods. For example, it may be difficult for a consumer to know how the emissions from the purchase of a pound of organic chicken from a distant poultry farm compare to the emissions from a pound of pork from a local farm.

through laws and policies directed at individual behavior.[68] For ease of analysis, we divide the emissions from individual behavior into household and transportation emissions.

a. Household Emissions

We estimate household emissions by using both top-down and bottom-up approaches.[69] For the top-down approach, we calculate household energy consumption using EIA data for residential fuel consumption.[70] We then convert household energy use into individual energy use. We use U.S. Census data indicating that the U.S. population in 2000 was roughly 281 million, and our calculation that the United States had just under 109 million households.[71]

We divide household energy use into two categories: primary use and electricity use. The primary use category includes household energy consumption that does not require an external power generation source. Examples include space and water heaters, washing machines, and stoves that utilize coal, natural gas, petroleum, or wood. The EIA provides data on primary use.[72] Using EIA conversion coefficients,[73] we convert these forms of energy use into the amount of carbon dioxide emitted per household and per person.

We next obtain the total residential electricity use for 2000 using EIA data.[74] We convert this electricity use into carbon emissions using the EIA coefficients, accounting for the fuel type used in the electricity generation. For example, electricity generated from fossil fuels generates carbon dioxide emissions, but sources such as nuclear energy and hydropower do not. We then calculate the total amount of

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68 *See* Vandenbergh, *supra* note 57, at 539 (arguing that including all emissions generated in course of individuals' employment or in production of consumer goods and services would negate category's utility by enabling all pollution to be attributed to individuals).

69 *See infra* app.

70 EIA, 2004 REVIEW, *supra* note 62, at 39.

71 The U.S. Census Bureau states that there were 281,421,906 persons in the United States in 2000 and an average household size of 2.59 persons per household. U.S. Census Bureau, American Factfinder, http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=01000US&-_box_head_nbr=GCT-H6&-ds_name=DEC_2000_SF1_U&-format=US-9 (last visited Aug. 8, 2007). Dividing the total population by persons per household returns 108.7 million households.

72 EIA, 2004 REVIEW, *supra* note 62, at 39.

73 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, LONG FORM FOR VOLUNTARY REPORTING OF GREENHOUSE GASES: INSTRUCTIONS 47–48 (2006), *available at* ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/FormEIA-1605_2005_Instructions.pdf [hereinafter EIA, LONG FORM] (listing coefficients used to determine amount of carbon dioxide generated by various fuels).

74 EIA, 2004 REVIEW, *supra* note 62, at 39.

carbon dioxide emissions from electricity consumption in pounds per household and pounds per individual.[75]

To validate the top-down approach, we also calculate household carbon dioxide emissions using a bottom-up approach. We use EIA data on end-use electricity consumption for households in 2001 (2000 data were unavailable).[76] For large numbers of household appliances, EIA data include the average use per household in kilowatt hours and the number of households utilizing these appliances. Thus, we can determine the amount of carbon dioxide emission–producing electricity used by each appliance and convert these values into total carbon dioxide emissions, emissions per household, and emissions per individual using the EIA conversion coefficients.

Our individual figure is a blended individual average that allocates to every person a share of carbon dioxide emissions regardless of behavior.[77] The totals for the top-down and bottom-up approaches are remarkably similar, suggesting that the household estimate is reliable. We use the top-down approach in calculating the overall individual total.

b. Transportation Emissions

We divide individual transportation into three categories: automotive, air, and other.[78] We include in the automotive category all personal vehicle use. We include in the air transportation category all air travel except business travel and freight. We assign rail and mass transit to the "other" category.

We translate EIA data on motor fuel consumed by personal vehicle use[79] into pounds of carbon dioxide using the same conversion factors used in the household calculations,[80] and we then convert the totals into pounds per person. We calculate emissions for domestic passenger air travel by multiplying energy intensity per passenger mile by the total number of domestic passenger miles,[81] after reducing the

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75 We do not account for inefficiency in electricity generation and line loss, making individuals responsible only for their direct energy consumption.

76 *See* Energy Info. Admin., U.S. Dep't of Energy, Electricity Consumption by End Use in U.S. Households, 2001, http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html [hereinafter EIA, End Use] (last visited Aug. 30, 2007).

77 *See infra* app.

78 *See infra* app.

79 EIA, 2004 REVIEW, *supra* note 62, at 57.

80 EIA, LONG FORM, *supra* note 73, at 47–48.

81 BUREAU OF TRANSP. STATISTICS, U.S. DEP'T OF TRANSP., NATIONAL TRANSPORTATION STATISTICS 2003 tbl.4-21 (2004), *available at* http://www.bts.gov/publications/national_transportation_statistics/2003.

total number of miles to exclude business travel.[82] We convert the resulting figure into total pounds of carbon dioxide for all passenger air travel using the EIA coefficients. We then divide the total by the U.S. population to yield pounds of carbon dioxide per person. We calculate the rail and mass transit totals using a similar approach, although we do not reduce these totals for business travel.

2. *Results*

Table 1 presents the results of the individual behavior model. As it indicates, by merely including the behaviors over which individuals have direct, substantial control, the total emissions for the average American in 2000 equaled over 14,000 pounds (seven tons) of carbon dioxide.

TABLE 1: INDIVIDUAL CARBON DIOXIDE EMISSIONS

Household	**Pounds of CO_2 per Person**
Primary	3494
Electricity	1922
Subtotal	5416
Transportation	
Automotive	7869
Air	857
Other	381
Subtotal	9107
Total (Mean Individual)	14,523
Total (All Individuals)	4.1 trillion

The total emissions for all 281 million Americans in 2000 was 4.1 trillion pounds. If calculated using 2006 data, the figure would likely be higher. The U.S. population reached roughly 300 million in 2006,[83] while per-capita emissions have decreased only slightly since 2000.[84]

[82] Seventy-seven percent of passengers reported that their most recent air travel was for nonbusiness purposes. Bureau of Transp. Statistics, U.S. Dep't of Transp., *Airline Passenger Travel*, OMNISTATS, Sept. 2003, at 1, 2, *available at* http://www.bts.gov/publications/omnistats/volume_03_issue_03/pdf/entire.pdf.

[83] As of July 1, 2006, the U.S. Census Bureau estimated the U.S. population at 298,217,000. U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2007, at 8 (2006), *available at* http://www.census.gov/prod/2006pubs/07statab/pop.pdf.

[84] The EIA reports that per-capita CO_2 emissions in the United States were 20.60 metric tons in 2000. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, WORLD PER CAPITA CARBON DIOXIDE EMISSIONS FROM THE CONSUMPTION AND FLARING OF FOSSIL FUELS, 1980–PRESENT (2006), *available at* http://www.eia.doe.gov/iea/carbon.html. The EIA recently issued a press release estimating 2006 carbon dioxide emissions at 5877 million metric tons. Press Release, Energy Info. Admin., U.S. Dep't of Energy, U.S. Carbon

C. Implications

Although the 4.1 trillion pound total is a tremendous amount, its importance is even more apparent in context. The 4.1 trillion pounds emitted by individuals constitute 32% of the roughly 12.7 trillion pounds emitted annually in the United States.[85] By comparison, the entire industrial sector released 3.9 trillion pounds in 2000.[86] The individual behavior figures also dwarf the subsectors that constitute the industrial sector.[87] For example, the chemical-manufacturing and petroleum-refining industries, which were the top emitters among the manufacturing industries, emitted 686 *billion* pounds and 672 *billion* pounds of carbon, respectively, in 2002.[88] Other industrial sectors had even lower totals, including iron and steel production (143.9 billion pounds), cement manufacture (90.8 billion), and aluminum production (13.7 billion).[89]

Even more striking is the comparison of emissions from individual behavior in the United States with other sources worldwide. The United States released 24.4% of the world's carbon dioxide in 2000,[90] suggesting that individual behavior in the United States accounted for roughly 8% of the world's carbon dioxide emissions. The significance of the 8% is clear when compared to the emissions of other continents and countries. The 4.1 trillion pounds attributable to

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Dioxide Emissions from Fossil Fuels Declined by 1.3 Percent in 2006 (May 23, 2007), *available at* http://www.eia.doe.gov/neic/press/press284.html. Dividing 5877 million metric tons by the 2006 population estimate of 298,217,000, *see supra* note 83, yields per-capita emissions of 19.70 metric tons of carbon dioxide.

85 *See* World Res. Inst., Climate Analysis Indicators Tool Version 4.0, http://cait.wri.org/cait.php?page=gases (last visited Aug. 31, 2007) (requires log-in registration) (providing total of 5,791.1 mega tons, or 12.7 trillion pounds, of U.S. emissions).

86 *See* EIA, 2004 REVIEW, *supra* note 62, at 341 (listing emissions for industrial sector). The 32% share for individual behavior compares favorably to an estimate that households accounted for 32.4% of direct U.S. energy use in 2000, GERALD T. GARDNER & PAUL C. STERN, ENVIRONMENTAL PROBLEMS AND HUMAN BEHAVIOR 258 tbl.10-1 (2d ed. 2002), and to a study that concluded that individual behavior consumed roughly one-third of U.S. energy and accounted for roughly 40% of U.S. carbon dioxide emissions in 1997, Bin & Dowlatabadi, *supra* note 65, at 205.

87 *See* EIA, 2004 REVIEW, *supra* note 62, at 386 (defining industrial sector in detail).

88 *See id.* at 345 tbl.12-4 (giving energy consumption for manufacturing industries using data from 2000 in metric tons, which we converted to pounds).

89 *See* EPA, 2006 INVENTORY, *supra* note 62, at 2-7 tbl.2-4 (using data from 2000 in metric tons, which we converted to pounds).

90 *See* EIA, 2004 REVIEW, *supra* note 62, at 335 tbl.11.19. The United States' contribution of carbon dioxide emissions to the world total decreased from 24.4% in 2000 to 23.1% in 2003. *Id.* This reduction appears to be largely due to an increase of emissions from China. Over this period, U.S. emissions decreased by 13 million tons, a 0.002% decrease, while China's emissions increased by 508 million tons, or 16.7%. *Id.* A recent report by the Netherlands Environment Assessment Agency concluded that China passed the United States in 2006 as the world's largest emitter of carbon dioxide. Graphic Detail, *China Overtakes US in CO_2 Emissions*, 447 NATURE 1038, 1038 (2007).

U.S. individual behavior is larger than the total for sub-Saharan Africa (1.1 trillion pounds), South America (1.6 trillion), and Central America (1.0 trillion, including the Caribbean) combined, and it is roughly a third of all carbon dioxide emissions in Asia (15.6 trillion) and Europe (12.1 trillion).[91]

As Table 2 demonstrates, the emissions by U.S. individuals also are larger than the total emissions from every other nation but China.

TABLE 2: TOP TEN NATIONS BY 2000 CARBON DIOXIDE EMISSIONS[92]

Country	Emissions (in billions of lbs.)
United States	11,582
China	6938
U.S. Individual Share	4090
Russian Federation	3074
Japan	2478
India	2108
Germany	1716
United Kingdom	1112
Canada	1058
South Korea	932

III
EMISSIONS REDUCTIONS FROM INDIVIDUAL BEHAVIOR

The model results demonstrate the substantial contribution of individual behavior to carbon dioxide emissions on both an average and aggregate basis. Indeed, the emissions are so large that every 1% decrease in emissions from individual behavior represents a reduction of roughly forty-one billion pounds of carbon dioxide. Individual behavior changes thus have the potential to contribute significantly to the reductions needed to reduce the risk of catastrophic climate change.[93]

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[91] World Res. Inst., *supra* note 85. The conversion was performed by multiplying the data available in tons from the Climate Analysis Indicators Tool by 2000 pounds per ton.

[92] The data in this table were gathered from World Res. Inst., *supra* note 85. All figures were converted from tons to pounds by multiplying by 2000 pounds per ton.

[93] Individual behavior change is an important explicit and implicit part of the "stabilization wedges" approach to emissions reductions proposed by Stephen Pacala and Robert Socolow. *See* Pacala & Sokolow, *supra* note 51, at 968 (emphasizing human action over reliance on advancement in emission-reducing technologies). They have argued that emissions reductions should be approached by thinking of the reductions as a series of wedges, with each wedge representing an activity that reduces carbon emissions by zero in 2004 but increasing in linear fashion each year for fifty years. *Id.* By the year 2054, each wedge

If policymakers are to respond to the emissions from individual behavior appropriately, however, they need to know which individual behaviors to target. The targeting problem requires policymakers to identify the behaviors that cause the greatest emissions, those that are most easily changed, and the optimal regulatory instruments for affecting emitting behaviors. This Part explores the first and second issues, while Parts IV and V explore the third issue.

A. Behavior Types

Individual behaviors differ based on the quantity of carbon emissions they generate and the barriers to their change. A number of behaviors yield a disproportionate share of the total carbon dioxide emissions. Although the model provides a first step in identifying these behaviors, more fine-grained work remains to be done. Unfortunately, much of the literature on the contributions from individual behavior is woefully out of date. After a burst of research focused on household energy use in the late 1970s and early 1980s, such studies in the academic literature in the United States largely disappeared.[94] For now, all we can do is use the new model and earlier studies to give an initial indication of the types of behavior changes that are most likely to yield large emissions reductions. In most cases, energy use has a direct relationship to carbon emissions because the energy is generated from fossil fuels, and thus we treat energy-consuming behaviors as carbon-emitting behaviors here.

The optimal regulatory response requires that we account not only for the size of the emissions from a particular behavior but also for the barriers to behavior change. Social psychologists use several categories to distinguish among behaviors. For example, Paul Stern and colleagues identify three principal types of environmental behavior: consumer (e.g., purchasing a fuel-efficient car or appliance), direct (e.g., changing one's driving style or turning off lights),

represents one billion tons of reduced carbon emissions. *Id.* Pacala and Socolow identify fifteen approaches that each can generate a stabilization wedge. *Id.* at 969–71, 970 tbl.1. Although the focus of many of their wedges is on the new deployment of existing industrial technologies, several also explicitly involve lifestyle changes. For example, a wedge is available from reducing the average annual miles traveled by cars from 10,000 to 5000. *Id.* at 969. Another wedge is available from pursuing "known and established approaches" to more efficient heating and cooling, water heating, lighting, and refrigeration in commercial and residential buildings, which implies that consumers will purchase more efficient goods. *Id.*

[94] *See* NRC, DECISION MAKING, *supra* note 6, at 81 (noting lack of funding for studies on social influences on energy consumption after early 1980s); *see also* Telephone Interview with Paul C. Stern, Staff Dir., Nat'l Research Council, in Wash., D.C. (Dec. 14, 2006) (describing resumption of interest in household energy consumption as "Rip Van Winkle experience") (notes on file with the *New York University Law Review*).

and civic (e.g., voting, writing to a policymaker, or joining a civic group).[95] Of these, consumer behavior is often the most resistant to change.[96]

Similarly, social psychologists distinguish between conservation behaviors (e.g., turning down thermostats) and efficiency-enhancing behaviors (e.g., purchasing more efficient motor vehicles and home appliances).[97] Conservation behaviors typically involve high-visibility actions that are intuitively the most appealing for psychologists to study but that require frequent action and ongoing behavior modification. Efficiency-enhancing behaviors often involve one-time consumer choices, such as motor vehicle purchases, that are often overlooked by psychologists. A leading assessment of this research concludes that many of the largest gains are achievable from efficiency-enhancing behaviors,[98] but that efforts directed at carbon emissions reductions should not ignore conservation behaviors either. Unfortunately, efficiency-enhancing behaviors are often consumer behaviors and thus may be particularly resistant to change.[99]

In contrast to the approach taken by psychologists, the rational-actor theorists who study law and social norms focus on the payoffs of behavior change to the individual.[100] These theorists typically suggest that optimal regulatory policies change the individual's opportunity set through taxes, subsidies, efficiency standards for consumer products, and other traditional measures. They reason that many behavior changes have a positive payoff for the individual, and that a rational actor—in theory—should change behavior in response to information about its payoff. Even these nominally positive-payoff behaviors, however, often face important barriers. Information may not be available or may not be noticed or understood by the individual. The individual may have adequate information but may act habitually without

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[95] Paul C. Stern et al., *A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism*, 6 HUM. ECOLOGY REV. 81, 82 (1999).

[96] *See* Paul C. Stern, *Information, Incentives, and Proenvironmental Consumer Behavior*, 22 J. CONSUMER POL'Y 461, 461–63 (1999) (emphasizing numerous external constraints on consumer behavior). Habits, inconvenience, and resource restraints may be important barriers to consumer behavior change. *See* GARDNER & STERN, *supra* note 86, at 111–12, 162–63 (noting examples where programs making conservation more convenient increased proenvironmental behavior); NRC, DECISION MAKING, *supra* note 6, at 78–79 (pointing to studies finding constraints on consumer behavior).

[97] *See* Paul C. Stern & Gerald T. Gardner, *Psychological Research and Energy Policy*, 36 AM. PSYCHOLOGIST 329, 333–34 (1981) (noting distinction between constant "curtailment" behavior and one-time "efficiency" behavior).

[98] *Id.* at 331–34.

[99] *See supra* note 96 and accompanying text.

[100] *See, e.g.*, Carlson, *supra* note 6, at 1235 (criticizing overemphasis on social norms to solve environmental problems).

engaging cognitive processes. The individual may have adequate information, but her cognitive processes may suffer from bounded rationality. Even if monetary benefits will exceed costs, the effort necessary to change the behavior may outweigh such benefits. Social costs may tip a seemingly positive-payoff behavior into negative territory. Some behavior changes may be impossible for the individual because the necessary infrastructure or financial resources are not available. Other behaviors are possible but require sacrifice by the individual.

Far more work remains to be done to understand the economic, legal, and social influences on individuals' emissions-causing behaviors. For the purposes of this analysis, we identify emissions from individual behavior in several ways. We first identify the largest emitting behaviors regardless of the difficulty of behavior change. We then identify a number of "low-hanging fruit" behaviors that the psychological and legal literatures suggest are likely to confront the fewest barriers to change.

B. High-Yielding Behaviors

The model demonstrates that transportation accounts for 9107 pounds of carbon dioxide per person (63% of total annual emissions),[101] and that personal motor vehicle use accounts for the vast majority of that total. The model results also highlight the importance of both total miles driven and vehicle choice. For example, a 10% reduction in personal vehicle miles traveled would reduce aggregate emissions from all individual behavior by roughly 225 billion pounds, or 6% of vehicle emissions. This reduction dwarfs the total emissions for many industrial sectors, such as iron and steel (144 billion pounds), cement manufacturing (90.8 billion), and petrochemical production (6.6 billion).[102] Similarly, the model demonstrates that sport utility vehicles (SUVs) are responsible for roughly one-third more carbon dioxide emissions than their proportionate share of all personal motor vehicles.[103] Changes in consumer vehicle selection thus also could

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101 *See supra* tbl.1.

102 EPA, 2006 INVENTORY, *supra* note 62, at 2-7 tbl.2-4. We convert gigagrams (Gg) to pounds. One Gg is equal to 1100 tons, or 2.2 million pounds.

103 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, DOE/EIA-0464 (2005), HOUSEHOLD VEHICLES ENERGY USE: LATEST DATA & TRENDS 53–56 tbl.A1 (2005), *available at* http://www.eia.doe.gov/emeu/rtecs/nhts_survey/2001/index.html (using 2001 data demonstrating that SUVs comprise 12% (23.2 million) of total of 191 million vehicles in personal motor vehicle inventory but emit 16% (364 million of 2213 billion pounds) of all carbon dioxide from personal motor vehicles, or 35% more than their share of personal motor vehicle inventory).

have large effects on the total emissions attributable to individual behavior.

The model also demonstrates that household activities account for 5416 pounds, or 37%, of emissions from the mean individual, much of which arises from appliance use. Based on the EIA data that formed the basis of our bottom-up analysis for households,[104] the top eight categories of appliances in terms of total carbon emissions are refrigeration/freezing (89.2 billion pounds), air conditioning (83.2 billion), space heating (52.8 billion), water heating (47.6 billion), lighting (46 billion), home electronics (37.6 billion), clothes drying (30.2 billion), and stoves/ovens (24.2 billion).[105]

In a prior work, Gerald Gardner and Paul Stern identified the steps that would generate the largest reductions in energy consumption. We list their top fifteen steps in Table 3. Although Gardner and Stern conducted their work in the early 1980s, it provides the best analysis available of the highest-yielding behavior changes.[106]

Taken together, the model results and the Gardner and Stern analysis demonstrate that there is no shortage of plausible behavior changes that could yield large emissions reductions. In fact, the list demonstrates that relatively minor steps could reduce the contribution of emissions from individual behavior by almost two-thirds. Some of the behaviors identified by Gardner and Stern will be difficult to change, however, because they have negative monetary or psychic payoffs for the individual, require substantial upfront expenditures, or face other barriers. Below we focus on the behaviors that are most amenable to change.

C. *Low-Hanging Fruit*

We describe behavior changes that have positive monetary payoffs for the individual and that require little effort or sacrifice to implement as changes to "low-hanging-fruit" behaviors. These behaviors do not require significant upfront financial expenditure or sophisticated cognitive processing, and they are not subject to major expenditures of effort or psychic cost. Behaviors with these qualities should be the most malleable.

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104 *See supra* note 76 and accompanying text.

105 EIA, End Use, *supra* note 76. The data are for 2001 but should closely resemble 2000 data. It is important to assess emissions from production of new products, but estimates are not available for many household products. We have assumed that products will be replaced as existing equipment wears out.

106 GARDNER & STERN, *supra* note 86, at 259–60 tbl.10-3.

TABLE 3: TOP FIFTEEN STEPS FOR REDUCING TOTAL HOUSEHOLD ENERGY CONSUMPTION

Transportation Activity	**Energy Reduction**
Buy More Efficient Car	20%
Carpool with Two Others	4–6%
Cut Shopping Trips by Half	2%
Alter Driving Habits	2%
Get Frequent Tune-ups	2%
Maintain Tire Pressure	1%
Subtotal	**31–33%**
Household Activity	**Energy Reduction**
Insulate and Weatherize House	10%
Install More Efficient Heating Equipment	8%
Reduce Inside Temp. from 72°F to 68°F Days, 65°F Nights	4%
Install More Efficient Water Heater	2%
Install More Efficient Refrigerator/Freezer	1.6%
Water Heat Reduced by 20°F	1%
Change Half of Bulbs to Fluorescent	1%
Install More Efficient Stove	0.9%
Install More Efficient Air Conditioner	0.7%
Subtotal	**29.2%**
Total	**60.2–62.2%**

Table 3 above includes a number of easily changed behaviors in the transportation and household areas, such as altering driving habits, maintaining tire pressure, and changing to fluorescent bulbs. Each of these behaviors accounts for at least 1% of the aggregate emissions from individual behavior. Thus, changing any one behavior could generate reductions of up to forty-one billion pounds of carbon dioxide—more than the amount emitted by many entire industry sectors. Numerous other behavior changes can have meaningful effects, such as using low-flow showerheads (to reduce hot water use),[107]

[107] *See* GARDNER & STERN, *supra* note 86, at 113 (noting that program giving away low-flow showerheads proved effective because it combined convenience with provision of free goods).

reducing electricity "leakage,"[108] and opting to fly in the daytime rather than at night.[109]

Although numerous other low-hanging-fruit behaviors are worthy of study and attention by policymakers, we demonstrate the importance of these behaviors by focusing on one unlikely source of massive emissions: idling by personal motor vehicles. Remarkably little has been published about optimal idling times and the emissions reductions that could be achieved by reducing idling. Regulators have focused on heavy-truck idling in recent years because of its contribution to smog,[110] but they have focused almost no attention on carbon dioxide emissions from personal-vehicle idling. Not surprisingly, given the lack of regulatory attention, little research is available on these emissions. One recent study concluded that many people believe that they should allow their cars to idle for several minutes during a cold start in the winter, and that idling is usually more fuel efficient than stopping and restarting the engine.[111] Car design has improved dramatically, however, and one regulatory agency now recommends idling for no longer than thirty seconds for a winter start and no longer than ten seconds in general driving conditions.[112]

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[108] Electricity use by appliances that are turned off but still plugged in may amount to 5% of household electricity use in the United States and may cost consumers over $3.5 billion annually. JENNIFER THORNE & MARGARET SUOZZO, AM. COUNCIL FOR AN ENERGY EFFICIENT ECON., LEAKING ELECTRICITY: STANDBY AND OFF-MODE POWER CONSUMPTION IN CONSUMER ELECTRONICS AND HOUSEHOLD APPLIANCES 1 (1998).

[109] Airplane contrails trap the heat radiating from the earth at night, but during the day they both trap the earth's heat and reflect the radiant energy from the sun. *See* David J. Travis et al., *Contrails Reduce Daily Temperature Range*, 418 NATURE 601, 601 (2002) (explaining that contrails reduce both "solar and outgoing" heat transfer).

[110] *See* U.S. Envtl. Prot. Agency, Idling Reduction: National Transportation Idle-Free Corridors, http://www.epa.gov/smartwaylogistics/idling.htm (last visited Aug. 16, 2007) (identifying harms from truck idling).

[111] *See* MCKENZIE-MOHR ASSOCS., EARTHCARE SUDBURY, ANTI-IDLING FINAL REPORT 7–8, 13 (2003), *available at* http://www.city.greatersudbury.on.ca/content/div_earthcare/documents/sudbury_finalreport.pdf [hereinafter MMA, IDLING] (noting that survey participants believed that they could idle their vehicle for three minutes before they began using more fuel than they would by stopping and starting); MCKENZIE-MOHR ASSOCS. ET AL., BARRIERS TO INDIVIDUAL PARTICIPATION IN GREENHOUSE GAS REDUCTION ACTIVITIES—AN EVALUATION 40–41 (2006), *available at* http://oee.nrcan.gc.ca/transportation/idling/material/reports-research/barriers-1999-report.cfm?attr=16 [hereinafter MMA, BARRIERS] (noting consistent findings of idling misinformation).

[112] Office of Energy Efficiency, Natural Res. Can., Idling: Myths Versus Reality, http://oee.nrcan.gc.ca/communities-government/transportation/municipal-communities/articles/idling-myths.cfm?attr=8 (last visited Aug. 16, 2007). These recommendations are consistent with those of many automakers. For example, a British owner's manual for the 2006 Mercedes-Benz C-Class advises drivers to "[s]witch off the engine in stationary traffic" and to "not warm up the engine with the vehicle stationary." Mercedes-Benz, Interactive Owner's Manual: C-Class Coupe, Introduction Section: Protection of the Environment, http://www4.mercedes-benz.com/e/cars/c-class-c/betriebsanleitung/vertiefen/N101F1.html (last visited Oct. 17, 2007). A Nissan manual advises drivers to "[a]llow the engine to idle

Idling for longer periods burns more fuel, releasing carbon dioxide into the atmosphere. It also may cause more harm to the engine than turning it on and off.[113] Idling often occurs in situations in which it is safe and convenient to turn off the vehicle.[114] As a result, a reduction in idling may not only reduce emissions but may also have net benefits to the individual from reduced engine wear and fuel consumption.[115]

To assess the emissions reductions that could be achieved from changing idling behavior, we estimate the total amount of carbon dioxide emitted from personal motor vehicle idling in the United States. Although complete data are not available on idling behavior in America, a study has examined idling behavior in Canada.[116] If Americans have the same personal motor vehicle idling patterns as Canadians, then the 191 million drivers in the United States in 2000[117] released 45.9 billion pounds of carbon dioxide from cold-start idling and 22.9 billion pounds from idling while waiting, for a total of more than 68 billion pounds.[118] Even if we assume that the Canadian

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for at least 30 seconds after starting" but also advises drivers to "[a]void unnecessary engine idling." NISSAN USA, 2006 NISSAN ALTIMA OWNER'S MANUAL 5-6, 5-15 to -16 (2005), *available at* http://www.courtesyparts.com/nissan-manual/pdf/2006-Nissan-Altima.pdf; *see also* OFFICE OF MOBILE SOURCES, U.S. ENVTL. PROT. AGENCY, EPA 420-F-93-002, YOUR CAR AND CLEAN AIR: WHAT YOU CAN DO TO REDUCE POLLUTION 3 (1994), *available at* http://www.epa.gov/otaq/consumer/18-youdo.pdf (emphasizing that car owners need not warm up cold engines and should not idle longer than thirty seconds).

113 *See* Office of Energy Efficiency, *supra* note 112 ("The notion that idling is good for your vehicle is passé—in fact, it hasn't been the right thing to do since the advent of electronic engines. The truth is that excessive idling can damage the engine.").

114 Canadian drivers reported idling their vehicles for the longest average periods of time when picking up friends or family members (233 seconds), when waiting at a fast-food or ATM drive-through window (160 seconds), and when waiting in the household driveway for a family member (139 seconds). MMA, IDLING, *supra* note 111, at 7.

115 Office of Energy Efficiency, Natural Res. Can., Idling and Climate Change Go Hand in Hand, http://www.oee.nrcan.gc.ca/transportation/idling/issues/why-idling-problem.cfm? (last visited Sept. 1, 2007).

116 We identify the amount of carbon dioxide released per second while idling by averaging data provided in Christopher Frey et al., *On-Road Measurement of Vehicle Tailpipe Emissions Using a Portable Instrument*, 53 J. AIR & WASTE MGMT. 992, 999 (2003). We then develop estimates of the amount of idling per week that occurs from individuals warming their vehicles from a cold start (6.5 minutes) and from individuals idling while waiting (3.25 minutes). We base our estimates on a Canadian survey that reports an average of 4.2 idling events per week at an average of 6.2 minutes per event, for a total of 26 minutes per week for individuals warming their vehicles from a cold start. MMA, BARRIERS, *supra* note 111, at 37–38. The Canadian survey finds an average of 2.5 idling events per week at an average of 5.2 minutes per event, for a total of 13 minutes per week for individuals idling while waiting. *Id.* at 39. We multiply both values by the carbon dioxide released per second and convert the results into pounds per year.

117 FED. HIGHWAY ADMIN., U.S. DEPT. OF TRANSP., HIGHWAY STATISTICS 2000 (2001), *available at* http://www.fhwa.dot.gov/ohim/hs00/dlchrt.htm.

118 *See supra* note 102.

figures far overestimate idling in the United States, if Americans idle 75% less than Canadians, for instance, then Americans' personal motor vehicle idling in 2000 released 11.4 billion pounds of carbon dioxide from cold-start idling and 5.8 billion pounds from idling while waiting, for a total of 17.2 billion pounds. Using this conservative estimate of a total of 17.2 billion pounds, if Americans could be induced to idle for only thirty seconds from a cold start and ten seconds while waiting, 12.8 billion pounds of carbon dioxide emissions could be eliminated per year. This behavior change also would generate savings of roughly 640 million gallons of gas.[119] The 12.8 billion pound reduction possible from such a change in idling behavior roughly equals the total annual emissions from the aluminum production sector (13.7 billion pounds), and it exceeds the total emissions from industry sectors such as soda-ash manufacturing (9.2 billion) and petrochemical production (6.6 billion).[120] The reduction also exceeds the total annual emissions from countries such as Costa Rica (10.6 billion) and Honduras (10.2 billion).[121]

In sum, although the model and literature identify only general information about specific behavior changes, a wide range of low-hanging-fruit behaviors exist. Many of these are not the highest carbon-emitting behaviors, but because they are more amenable to change, they may yield the most substantial reductions in the short term. Changing these behaviors could be a critical component of the short- and long-term emissions reductions necessary to reduce the risk of catastrophic climate change.

IV
THE ROLE OF NORM ACTIVATION

Even if policymakers are aware of the large contributions of emissions from individual behavior, they still might choose not to regulate if individual behavior cannot be changed at acceptable levels of economic or political cost. Skepticism about direct behavior change is not unfounded: Taxes and direct regulation to reduce the environmental impacts of individual behavior have generated a fierce backlash in the past,[122] and—at least on the surface—informational efforts

[119] Burning a gallon of gas generates roughly 19.6 pounds of carbon dioxide; thus, a reduction in idling that generates 12.8 billion pounds of carbon dioxide emissions also would save roughly 640 million gallons of gasoline.

[120] EPA, 2006 INVENTORY, *supra* note 62, at 2-7 tbl.2-4. Values are given by the Inventory in gigagrams (Gg). One Gg is equal to 1100 tons, or 2.2 million pounds.

[121] World Res. Inst., *supra* note 85.

[122] *See* Vandenbergh, *supra* note 57, at 554–56 (describing backlash against motor vehicle driving restrictions designed to protect environment).

seem no more promising. In fact, a 2005 report by the National Research Council (NRC) of the National Academies concluded that information campaigns often have been "notoriously ineffective."[123] The nascent regulatory regimes at the federal and state levels largely reflect this skepticism, seeking to reduce emissions from individual behavior only indirectly, through traditional regulatory measures such as emissions caps for industrial sources and efficiency standards for consumer-product manufacturers.[124] The 2005 NRC report also reached a second conclusion, however: The problem is not the inherent weakness of informational efforts, but rather how agencies implement those efforts and integrate them with other regulations.[125]

A range of legal, economic, and social regulatory measures to reduce emissions from individual behaviors are available to policymakers, and a great deal of work remains to be done to evaluate their costs and benefits. This Part explores one such measure. It draws on norms theory and empirical studies to demonstrate how dissemination of information that activates norms can change the low-hanging-fruit behaviors. Norm activation not only may change low-hanging-fruit behaviors directly, but it also may be indispensable for changing the civic behaviors necessary for the adoption of the tax, regulatory, technology, and infrastructure measures that will influence the more difficult behaviors to change. To develop effective information-disclosure measures, policymakers need to know the type of information that is most likely to activate the norms that influence carbon-emitting behaviors.

A. Norm Activation

Media reports and commentators often frame environmental behavior changes as dichotomous choices between all or nothing. In the "all" category are major lifestyle changes that require massive sacrifice by the individual. Not surprisingly, individuals who engage in these major lifestyle changes are characterized as eccentric and out of the mainstream. For example, a recent *New York Times* article pointed out that actor Ed Begley, Jr., the lead in a new television reality series about his own life, makes fences out of used milk jugs.[126]

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123 NRC, DECISION MAKING, *supra* note 6, at 74.

124 *See, e.g.*, 10 C.F.R. § 430.32(c) (2007) (imposing efficiency standards on manufacturers of central air conditioners and heat pumps).

125 NRC, DECISION MAKING, *supra* note 6, at 74–78.

126 Ginia Bellafante, *With Ed, All's Green on the Domestic Front*, N.Y. TIMES, Jan. 5, 2007, at E1. Climate-change believers and skeptics both often downplay the role of individual behavior. *Compare* Hansen, *supra* note 32, at 16 (criticizing one scientist's call for individual behavior change because "while appropriate," it "diverts attention from the essential requirement: government leadership"), *with* Anne Paine, *Global Warming Activ-*

In the "nothing" category are those who are unwilling to make the major lifestyle changes. These individuals are characterized as being in the mainstream, a little guilty perhaps, but understandably unwilling to adopt a radical lifestyle change. Begley's new television series portrays his wife as the mainstream character who would probably prefer a little less composting, a bigger car, and a house with a little more square footage.[127]

Social psychology research suggests that these characterizations are remarkably important. Individuals are strongly influenced by what they perceive to be the behavior of others, a phenomenon described by Robert Cialdini as a descriptive norm.[128] Other studies corroborate the influence of perceptions that others also are engaging in a prosocial behavior.[129] Thus, if people perceive carbon-reducing behavior changes as the exclusive province of eccentric, committed environmentalists, they will be less likely to engage in those behaviors themselves. If these carbon-reducing behaviors are perceived as widespread, however, more people are likely to adopt them.

How does behavior change begin and become sufficiently widespread that descriptive-norm effects push it toward a tipping point? One mechanism is through the activation of injunctive norms.[130] Information that induces individuals to make personal judgments about what behavior is right or wrong, or what behavior will be socially sanctioned or rewarded by others, can influence a wide range of behaviors. To develop effective information-disclosure measures, policymakers need to know the type of information that is most likely to activate the norms that influence low-hanging-fruit behaviors and civic behaviors. Theoretical and empirical studies have identified the types of information that hold the greatest prospects for such success. We begin with the theory and then turn to the empirical studies.

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ists Unite, TENNESSEAN (Nashville), Jan. 8, 2007, at A1 (noting comment from Conservative Enterprise Institute senior fellow that seeking to induce individual behavior change to address climate change is "really silly").

127 Bellafante, *supra* note 126.

128 Robert B. Cialdini et al., *A Focus Theory of Normative Conduct: A Theoretical Refinement and Reevaluation of the Role of Norms in Human Behavior*, *in* 24 ADVANCES IN EXPERIMENTAL SOCIAL PSYCHOLOGY 201, 203 (Mark P. Zanna ed., 1991).

129 *See, e.g.*, Dan M. Kahan, *The Logic of Reciprocity: Trust, Collective Action, and Law*, 102 MICH. L. REV. 71 (2003) (discussing "logic of reciprocity," in which those perceiving that others are cooperating will contribute to public goods, while those perceiving that others are shirking will not cooperate and may engage in costly retaliation); Lior Jacob Strahilevitz, *Social Norms from Close-Knit Groups to Loose-Knit Groups*, 70 U. CHI. L. REV. 359, 366–67 (2003) (introducing "close-knit" and "loose-knit" accounts explaining cooperative behavior and citing Matthew Rabin, *Psychology and Economics*, 36 J. ECON. LITERATURE 11, 21 (1998), which notes empirical evidence suggesting that people reciprocate water conservation efforts of their neighbors).

130 *See* Cialdini et al., *supra* note 128, at 203–04, 230–31.

1. *Norms Theory*

As one of us has discussed in earlier works, legal scholars and social psychologists identify two common categories of norms that are important to understanding norm activation: social norms and personal norms.[131] Social norms are informal obligations that are enforced through social sanctions or rewards.[132] Personal norms are informal obligations that are enforced through an internalized sense of duty to act, as well as guilt or related emotions for a failure to act.[133] Legal scholars have emphasized that social norms can influence the utility calculus by affecting the expected costs of a given behavior, whether in terms of physical effort or monetary or social costs.[134] For example, one might avoid a behavior with an immediate positive monetary payoff that violates a social norm out of concern that social sanctioning will lead to future monetary costs or lost social opportunities. Similarly, personal norms may influence the utility calculus. For example, one might weigh the psychic costs and benefits of some behaviors, such as the guilt of knowing that one acted immorally or the increased esteem of knowing that one acted appropriately or even altruistically.[135]

Norms scholars have begun to converge on several fundamental understandings regarding norms and norm activation.[136] Most important, scholars have maintained that norms include both specific, concrete norms and generalized, abstract norms.[137] The abstract norms or values are internalized, personal norms.[138] Many of the concrete norms are also internalized, but some concrete norms may be social

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131 *See* Vandenbergh, *supra* note 6, at 1104 (distinguishing between personal and social norms); Michael P. Vandenbergh, *Beyond Elegance: A Testable Typology of Social Norms in Corporate Environmental Compliance*, 22 STAN. ENVTL. L.J. 55, 67–72 (2003) (distinguishing between internal and external norms). For an overview of norm activation, see Vandenbergh, *supra* note 6, at 1120–26.

132 Vandenbergh, *supra* note 6, at 1120–26.

133 Shalom H. Schwartz, *Normative Influences on Altruism*, *in* 10 ADVANCES IN EXPERIMENTAL SOCIAL PSYCHOLOGY 221, 231–32 (Leonard Berkowitz ed., 1977); *see also* Richard H. McAdams, *Comment: Accounting for Norms*, 1997 WIS. L. REV. 625, 631–37 (summarizing recent literature on norms within field of law and economics).

134 *See, e.g.*, Carlson, *supra* note 6, at 1237–41 (analyzing norms literature and explaining that norms operate either through "sanctions from others" or through "guilt[ ] for failing to conform").

135 *See id.* at 1238–39 (considering application of personal norms to recycling behavior).

136 *E.g.*, Eric A. Posner, *Law and Social Norms: The Case of Tax Compliance*, 86 VA. L. REV. 1781, 1781 (2000).

137 *E.g.*, Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338, 340 (1997).

138 *Id.*

norms—norms that are followed not because they are internalized by the individual but because of expected social sanctions or rewards.[139]

In a recent climate change study, social psychologists used phrases such as "I feel personally obliged to save as much energy as possible" to test for concrete norms.[140] Another social psychological study identified abstract norms by testing support for terms such as "preventing pollution" and "conserving natural resources."[141] In the legal literature, Richard McAdams has identified the concrete norm of "friends don't let friends drive drunk" and the abstract norm of "be a loyal friend."[142]

Many legal scholars and social psychologists agree that behavior change frequently arises from shifts in beliefs that connect concrete and abstract norms.[143] For example, the enactment of a law may change beliefs about the risks of drunk driving, tying the "be a loyal friend" abstract norm to the concrete norm regarding not letting friends drive drunk.[144] The belief change may occur because of information the individual intuits from the passage of the law or from information disclosure required by the law (e.g., labeling requirements or public information campaigns).[145]

In the social psychology literature, Paul Stern and colleagues have proposed a Values-Beliefs-Norms (VBN) theory that is consistent with the legal literature.[146] VBN theory suggests that information can activate norms and induce behavior change if it creates a new belief that a value is threatened and that the individual can act to reduce the threat.[147] Perhaps most importantly, VBN theory identifies the specific belief changes that activate norms. The theory suggests that the formation of two types of beliefs increase the likelihood that a concrete norm will be activated: (1) an awareness of the consequences of the individual's act regarding the objects of an abstract norm (referred to as "AC"), and (2) an ascription of personal responsibility for causing or preventing those consequences (referred to as

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139 Carlson, *supra* note 6, at 1241.

140 Linda Steg et al., *Factors Influencing the Acceptability of Energy Policies: A Test of VBN Theory*, 25 J. ENVTL. PSYCHOL. 415, 419 tbl.2 (2005) (examining environmental norms and beliefs among 112 Dutch respondents).

141 Stern et al., *supra* note 95, at 95.

142 McAdams, *supra* note 137, at 385.

143 *E.g.*, *id.* at 395–96.

144 *Id.* at 384–85; *see also id.* at 407–08 (examining connection between abstract norm of good parenting and concrete norm of using child safety seat).

145 *Id.* at 400–08.

146 Stern, *supra* note 96, at 462–63.

147 Stern et al., *supra* note 95, at 83–86, 92.

"AR").[148] One recent study evaluated AC regarding climate change by testing responses to phrases such as "[g]lobal warming is a problem for society," and "[i]t is not certain whether global warming is a real problem."[149] The study examined the corresponding AR by testing phrases such as "I feel jointly responsible for global warming," "[m]y contribution to the energy problem is negligible," and "[i]n principle, individuals [on] their own cannot contribute to the reduction of energy problems."[150]

The norm activation modeled by Stern involves personal norms.[151] As a result, if the norm activation process occurs, a sense of obligation may arise even in the absence of social norm pressures.[152] Of course, the norm activation process also may affect behavior by changing the individual's perception about the likelihood that others will be willing to enforce the norm.[153]

Legal scholars have developed a robust literature suggesting that increases in perceptions of social-norm enforcement can then lead to norm cascades, causing norms to affect large portions of the population.[154] On the other hand, a sense of obligation may lead to the formation of a behavioral intention without actually changing behavior. Other barriers may exist, such as the effort involved, a lack of infrastructure, social costs, or financial costs.[155] Other social norms also can serve as barriers. As one study noted, someone who grew up in poverty may want to show that she has "made it" by not being influenced by the cost of home heating, or a business executive may use a

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148 Shalom H. Schwartz, *Moral Decision Making and Behavior*, *in* ALTRUISM AND HELPING BEHAVIOR: SOCIAL PSYCHOLOGICAL STUDIES OF SOME ANTECEDENTS AND CONSEQUENCES 127, 127–39 (Jacqueline R. Macauley & Leonard Berkowitz eds., 1970); Stern et al., *supra* note 95, at 83–86, 92.

149 Steg et al., *supra* note 140, at 419 tbl.2.

150 *Id.*; *see also* Kent D. Van Liere & Riley E. Dunlap, *Moral Norms and Environmental Behavior: An Application of Schwartz's Norm-Activation Model to Yard Burning*, 8 J. APPLIED SOC. PSYCHOL. 174, 178–81 (1978) (examining strength of AR regarding air pollution from backyard burning).

151 *See* Vandenbergh, *supra* note 6, at 1104 (distinguishing social norms and personal norms).

152 *See* Paul C. Stern, *Toward a Coherent Theory of Environmentally Significant Behavior*, 56 J. SOC. ISSUES 407, 412 (2000) (summarizing literature on how altruistic behavior occurs in response to personal norms).

153 *See* McAdams, *supra* note 137, at 400–07 (noting importance of perceived likelihood of enforcement).

154 *See, e.g.*, Cass R. Sunstein, *Social Norms and Social Roles*, 96 COLUM. L. REV. 903, 909 (1996) (defining "norm bandwagons" and "norm cascades").

155 J. Stanley Black et al., *Personal and Contextual Influences on Household Energy Adaptations*, 70 J. APPLIED PSYCHOL. 3, 11–14 (1985); Stern et al., *supra* note 95, at 86.

large car, air travel, and a large office to demonstrate her importance.[156]

2. *Empirical Studies*

Numerous empirical studies demonstrate that norm activation could have a substantial effect on low-hanging-fruit behaviors.[157] Many of the studies on norms and carbon-relevant behaviors involve household energy use. These studies examine the relationship between abstract norms favoring environmental protection, beliefs about energy use, and behaviors related to energy conservation. One study concluded that a belief that energy conservation has beneficial environmental effects activated a concrete norm in favor of conservation.[158] Another study concluded that awareness of the social and environmental consequences of energy conservation decreased energy use through curtailed activities.[159] Similarly, a third study concluded that a proenvironmental norm accounted for 11% of the variation in energy conservation activities, while the price of energy only accounted for 2% of the variation.[160]

Studies suggest that individuals respond to information not just about the harms arising from their specific activities but also about the harms arising from the aggregate activities of all individuals.[161] For example, a study of utility customers demonstrated that those who felt

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156 NAT'L RESEARCH COUNCIL, ENERGY USE: THE HUMAN DIMENSION 39, 71 (Paul C. Stern & Elliott Aronson eds., 1984) [hereinafter NRC, ENERGY]. External barriers to behavioral change may explain the price inelasticity of gasoline. *See* NAT'L RESEARCH COUNCIL, ENERGY EFFICIENCY IN BUILDINGS: BEHAVIORAL ISSUES 18–20 (Paul C. Stern ed., 1985) (examining influence of information on individual energy use); NAT'L RESEARCH COUNCIL, IMPROVING ENERGY DEMAND ANALYSIS 27–42 (Paul C. Stern ed., 1984) (examining role of price changes as form of information that influences behavior by gaining individuals' attention and inducing them to reconsider default choices); *infra* note 198.

157 *See* NRC, ENERGY, *supra* note 156, at 73 (concluding that understanding norms is "useful for forecasting trends in energy consumption" and for "understanding public support and opposition to energy policies and programs"); Stern et al., *supra* note 95, at 85–86, 89–90 (concluding that norms influence low-cost behaviors and civic behaviors). *But see* H.J. Staats et al., *Communicating the Greenhouse Effect to the Public: Evaluation of a Mass Media Campaign from a Social Dilemma Perspective*, 45 J. ENVTL. MGMT. 189 (1996) (suggesting that knowledge and awareness may be less instrumental in inducing behavioral change than some expect).

158 J. Stanley Black, Attitudinal, Normative and Economic Factors in Early Response to an Energy-Use Field Experiment 272–74 (1978) (unpublished Ph.D. dissertation, University of Wisconsin–Madison) (on file with University of Wisconsin Library).

159 Black et al., *supra* note 155, at 17 (concluding that norms have greater influence on noneconomically constrained behaviors than on economically constrained behaviors).

160 Stern, *supra* note 96, at 469.

161 *See, e.g.*, Steg et al., *supra* note 140, at 423 (noting that individuals feel more responsible for environmental consequences when they are aware of those consequences); Vandenbergh, *supra* note 6, at 1127–28 ("Several studies of environmental behavior sup-

that reduced demand would be good for people in general and believed that "households as a group could make a big difference in peak demand" reported that they felt a moral obligation to lower electricity use during periods of peak demand.[162] The study concluded that the sense of moral obligation was more influential than price, and that, "In fact, this effect was greater than that of price even when the price differentials between peak and off-peak hours ranged as high as 8 to 1."[163] Other studies have concluded that personal norms are reliable predictors of temperature setbacks (lower thermostat settings in winter).[164] Studies in Europe have reached similar conclusions.[165]

Moreover, an extensive body of research suggests that norm activation affects recycling behavior, which can reduce individual carbon emissions by saving energy.[166] For example, personal and social norm effects may explain why recycling programs involving block captains have more success than programs that do not, increasing recycling by 28%.[167] The block leaders may remind individuals of their personal norms regarding recycling and may call attention to a social norm regarding recycling. A survey of participants showed that perceptions of personal and social norms favoring recycling increased in groups with block leaders but not in the others.[168] Another study found that personal norms explained 35% of the variance in recycling behavior.[169]

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port the hypothesis that information about the aggregate effects of individual behavior can activate norms and change behavior.").

162 NRC, ENERGY, *supra* note 156, at 72 (citing Black, *supra* note 158).

163 *Id.*

164 *See* Paul C. Stern et al., *Responses to Changing Energy Conditions Among Massachusetts Households*, 8 ENERGY 515, 522–23 (1983) (concluding that personal norms are reliable predictors of temperature setbacks but less reliable predictors of low-cost actions, such as weather stripping and minor curtailments, and have weakest relationship to major household investments).

165 *See, e.g.*, Annika M. Nordlund & Jörgen Garvill, *Value Structures Behind Proenvironmental Behavior*, 34 ENV'T & BEHAV. 740, 751–54 (2002) (finding relationship between abstract proenvironmental norms and feelings of obligation to engage in proenvironmental actions); Steg et al., *supra* note 140, at 423 (concluding that personal norms have more influence on less costly behaviors such as recycling and energy policy changes than on more costly behaviors such as changes in car or subway use).

166 For a recent overview of the recycling literature, see generally P. Wesley Schultz, *Knowledge, Information, and Household Recycling: Examining the Knowledge-Deficit Model of Behavior Change*, *in* NAT'L RESEARCH COUNCIL, NEW TOOLS FOR ENVIRONMENTAL PROTECTION: EDUCATION, INFORMATION, AND VOLUNTARY MEASURES 67 (Thomas Dietz & Paul C. Stern eds., 2002).

167 GARDNER & STERN, *supra* note 86, at 88.

168 *Id.* at 88–89. Focusing an individual's attention on descriptive and injunctive norms can also influence littering behavior. Cialdini et al., *supra* note 128, at 206–32.

169 Joanne Vining & Angela Ebreo, *Predicting Recycling Behavior from Global and Specific Environmental Attitudes and Changes in Recycling Opportunities*, 22 J. APPLIED SOC. PSYCHOL. 1580, 1602 tbl.10 (1992).

More recently, studies have examined the effects of environmental norms on transportation behaviors. A study by Annika Nordlund and Jörgen Garvill, for example, concluded that activation of abstract environmental norms through increased awareness of consequences had a positive effect on willingness to reduce personal car use.[170] Other studies have identified more muted environmental norm effects regarding transportation.[171]

A recent analysis by Joni Hersch and W. Kip Viscusi of a survey of more than 15,000 Europeans demonstrates that individuals who believe that global warming requires immediate attention are more likely to reduce their car fuel usage, increase their public transportation usage, insulate their homes, and reduce their lighting and appliance use.[172] Similarly, individuals who believe that fossil fuels contribute to global warming are more likely to take the first three steps, as are those who believe that transport contributes to global warming.[173] Although the study did not explicitly test the VBN theory, it concluded that beliefs regarding the harms that may arise from global warming (awareness of consequences, or AC) and the linkages between particular individual behaviors or sources and global warming (ascription of responsibility, or AR) are associated with energy-saving activities.[174] Conversely, individuals with inaccurate beliefs about the causes of global warming (such as believing that nuclear power contributes to climate change) are less likely to take ameliorative actions.[175]

In addition to changing carbon-emitting behaviors, norm activation can influence civic behaviors, such as voting and joining advocacy groups. In fact, studies suggest that norm activation often has a greater effect on civic behavior than on direct or consumer behavior.[176] For example, one study concluded that norm activation explains 30% of the variance in environmental citizenship activities, such as voting or contacting policymakers, but only 19% of the variance in consumer behavior.[177] Similar conclusions have been reached

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170 Annika M. Nordlund & Jörgen Garvill, *Effects of Values, Problem Awareness, and Personal Norm on Willingness to Reduce Personal Car Use*, 23 J. ENVTL. PSYCHOL. 339, 345 (2003).

171 *See, e.g.*, GARDNER & STERN, *supra* note 86, at 103–04, 162 (noting that structural barriers to transportation choices can impede proenvironmental behavior even when paired with existence of environmental norms).

172 Joni Hersch & W. Kip Viscusi, *Allocating Responsibility for the Failure of Global Warming Policies*, 155 U. PA. L. REV. 1657, 1682–83 (2007).

173 *Id.* at 1683.

174 *Id.*

175 *Id.*

176 Stern et al., *supra* note 95, at 91.

177 *Id.*

in studies that examined support for energy conservation policies in Europe.[178] Norm activation thus may be an important foundation for adoption of more traditional regulatory measures.

B. Norm Activation and Climate Change

The timing and magnitude of the emissions reductions necessary to achieve the short- and long-term targets discussed earlier in the Article[179] require that norm activation occur not only among those who strongly value environmental protection but also among those who do not. Critics suggest that strategies for regulation built around personal norms hold little prospect for success because norms differ widely among individuals, making it difficult to develop generalizable insights regarding the effects of law on behavior.[180] This limitation can be seen in the norm-activation studies discussed above, which focused in large part on activating concrete energy-conservation norms by linking them to abstract norms favoring environmental protection.[181] Although environmental protection norms are widespread, they are not universally held.[182] To influence the behavior of individuals across the political spectrum, norm activation must link concrete norms favoring carbon-emissions reductions to abstract norms that are more widespread than environmental protection.

One such norm is the personal responsibility not to harm others. If the abstract norm of personal responsibility is widespread, and if it can be tied to a concrete norm of carbon neutrality, large numbers of individuals may feel an obligation to change their behavior. When they do, cascades in behavior may arise as individuals perceive that the personal norms of a few have become widespread social norms.

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178 *See, e.g.*, Steg et al., *supra* note 140, at 421–22 (testing VBN model and concluding that "the stronger the personal norm, the more people supported policies aimed at reducing CO_2 emissions").

179 *See supra* Part I.C.

180 *See* Posner, *supra* note 136, at 1786–91 (concluding that personal norms are uncertain dependent variables not valuable for explaining or predicting behavior); Robert E. Scott, *The Limits of Behavioral Theories of Law and Social Norms*, 86 VA. L. REV. 1603, 1638–39 (2000) (noting that norms are highly context-sensitive and vary across particular environments, populations, and circumstances).

181 *See, e.g.*, Steg et al., *supra* note 140, at 424 (concluding that biospheric and altruistic value clusters are distinct, and that biospheric value clusters are associated with proenvironmental abstract norms); *id.* at 423 ("VBN theory has been developed to explain behavior taken with proenvironmental intent. It may well be that behaviors such as car and subway use are hardly taken with proenvironmental intent.").

182 *See* NRC, ENERGY, *supra* note 156, at 64, 71–73 (discussing how variability in personal values affects energy use); Vandenbergh, *supra* note 6, at 1119–20 ("[T]he notions that individuals have an obligation to refrain from pouring toxic chemicals into a stream or killing bald eagles or other endangered species are widely (although not universally) held.").

1. *The Abstract Norm of Personal Responsibility*

Norm-activation theory suggests that the two types of belief change (AC and AR) can inform individuals about how an abstract norm is threatened and can activate a concrete norm to reduce the threat.[183] Given the vast number of people who must change their behavior, the challenge posed by climate change is to identify abstract norms that are sufficiently widespread to influence individuals who do not identify with environmentalism.

The personal responsibility norm appears to be remarkably widespread across the political spectrum, and it resonates even with those who oppose regulatory solutions to social problems.[184] In this Article, we do not address whether an individual has a moral obligation to reduce carbon emissions.[185] Instead, we demonstrate that the norm of personal responsibility is widespread and, through belief change, can be associated with concrete norms that induce carbon-emitting behavior changes.

The case for the widespread existence of the personal responsibility norm is strong, although its existence is so commonly assumed that it is rarely tested explicitly.[186] Empirical studies in the psychological literature also routinely conclude that personal responsibility has both personal-norm effects (influencing behavior even in the absence of social interactions) and social-norm effects (influencing behavior in

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183 *See supra* text accompanying note 174.

184 *See, e.g.*, Sarah Krakoff, *Arnold Schwarzenegger and Our Common Future*, 53 BUFF. L. REV. 925, 925–26 (2005) (noting that although "he is the antithesis of the stereotype of the parsimonious environmentalist," California Governor Arnold Schwarzenegger has stated that "the debate is over[, w]e know the science[, w]e see the threat[, a]nd we know the time for action is now"); Mark Sanford, Op-Ed., *A Conservative Conservationist? Why the Right Needs to Get Invested in the Search for Climate Change Solutions*, WASH. POST, Feb. 23, 2007, at A19 (Republican governor of South Carolina advocating that climate change debate be reframed to draw on "conservative principles such as responsibility and stewardship").

185 Whether such a moral obligation exists is a contestable point. *See* Sinnott-Armstrong, *supra* note 12, at 285–304 (surveying general moral principles and concluding that they do not support derivative moral principle against wasteful driving that emits greenhouse gases).

186 In the criminal and tort law literatures, scholars routinely use the term, often assuming that it is almost uniformly held. *See* John C.P. Goldberg & Benjamin C. Zipursky, *Accidents of the Great Society*, 64 MD. L. REV. 364, 368 (2005) (discussing role of responsibility in tort law); Paul H. Robinson & John M. Darley, *The Utility of Desert*, 91 NW. U. L. REV. 453, 468–69 (1997) (discussing role of moral obligation and personal responsibility in compliance with criminal law). Holly Doremus has noted the importance of building a sense of "individual responsibility" toward the environment. Holly Doremus, *Shaping the Future: The Dialectic of Law and Environmental Values*, 37 U.C. DAVIS L. REV. 233, 234, 253–56 (2003).

social settings).[187] Personal responsibility is associated with the ability to control behavior, and studies demonstrate not only that individuals routinely hold themselves out as having the ability to control their own behavior,[188] but also that they evaluate more highly others who do the same.[189]

Although the broad existence of the personal responsibility norm suggests that it has enormous potential to affect behavior, the connection between the norm and individual carbon emissions reductions has received little attention. An informal examination of Internet postings by conservative and liberal commentators may help explain why.

Personal responsibility is certainly a popular concept among conservatives. Conservative commentators have used the term "personal responsibility" in more than 1300 articles and speeches posted on just one think tank's website,[190] stressing the importance of personal responsibility for behaviors that affect health care, welfare, crime, obesity, social security, and other social issues.[191] Not surprisingly, the phrase "personal responsibility" also has appeared in the titles of leg-

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[187] *See, e.g.*, Jerald M. Jellison and Jane Green, *A Self-Presentation Approach to the Fundamental Attribution Error: The Norm of Internality*, 40 J. PERSONALITY & SOC. PSYCHOL. 643, 645 (1981) (showing that social approval increases linearly with expressed internality); Gifford Weary et al., *The Attributional Norm of Internality and Depressive Sensitivity to Social Information*, 49 J. PERSONALITY & SOC. PSYCHOL. 1283, 1286 (1985) (concluding that "the greater the personal responsibility accepted by the actor for his outcome, the more favorably he was evaluated by observer-subjects").

[188] *See* Pascal Pansu & Daniel Gilibert, *Effect of Causal Explanations on Work-Related Judgments*, 51 APPLIED PSYCHOL.: AN INT'L REV. 505, 513 (2002) ("[W]hen attempting to present a favorable self-image, participants selected more internal explanations that were effort-related than trait-related.").

[189] Individuals look more favorably upon others who take personal responsibility for their behavior, whether in the form of stating that those individuals can control their behavior (efficacy) or that their actions affect outcomes (locus of control). *See, e.g.*, Jellison & Green, *supra* note 187, at 645 (showing that social approval increases linearly with expressed internality); Kenneth A. Wallston et al., *Hocus-Pocus, the Focus Isn't Strictly on Locus: Rotter's Social Learning Theory Modified for Health*, 16 COGNITIVE THERAPY & RES. 183, 193–94 (1992) (noting influence of efficacy as well as locus of control); Weary et al., *supra* note 187, at 1286 (finding observers evaluate actors more favorably the higher the degree of personal responsibility attributed by the actor).

[190] A search in July 2006 using the Google search engine and the search term "personal responsibility site: Heritage.org" yielded 1330 hits on the website of the Heritage Foundation, http://www.heritage.org. We did not attempt to develop a denominator for this figure, and we make no assertion about the relative rate with which conservative and liberal commentators reference personal responsibility.

[191] *See, e.g.*, Dennis Prager, Co-Director, Empower Am., Lecture at the Heritage Foundation: The American Tradition of Personal Responsibility (Sept. 20, 1994), *available at* http://www.heritage.org/Research/PoliticalPhilosophy/HL515.cfm (arguing that Founders exhibited commitment to personal responsibility).

islation, such as the Personal Responsibility and Work Opportunity Reconciliation Act of 1996.[192]

Conservative commentators often use the term "personal responsibility" to mean that an individual has an obligation to fend for herself in order to avoid calling upon government or community assistance.[193] In this view, not taking responsibility imposes the costs of one's behavior on others. Conservative commentators frequently assert that government policies should be designed to promote personal responsibility. We found no example, however, where a conservative commentator asserted that individuals should take responsibility for reducing carbon emissions to avoid imposing harms on others. In fact, we found almost no examples of conservative commentators connecting the concept of personal responsibility with environmental protection.[194]

In contrast to conservative commentators, liberal commentators do sometimes discuss personal responsibility in connection with the environment.[195] They often do so, however, in the context of expressing concern that, by focusing on personal responsibility, policymakers will undermine efforts to assert corporate responsibility.[196]

Liberal commentators tend to focus on the socioeconomic and physical constraints that limit many individuals' ability to practice personal responsibility as it is envisioned by conservatives.[197] Liberals' reluctance to assign personal responsibility for the environmental harms caused by individual behavior may arise from the view that

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192 Pub. L. No. 104-193, 110 Stat. 2105 (codified as amended in scattered sections of 7, 8, 21, 25, and 42 U.S.C.).

193 *See, e.g.*, Radley Balko, *Beyond Personal Responsibility*, CATO INST., May 17, 2004, http://www.cato.org/pub_display.php?pub_id=4530 (criticizing efforts by lawmakers to expand healthcare coverage).

194 In an op-ed published after we conducted our research, Mark Sanford, the Republican governor of South Carolina, linked personal responsibility and climate change. *See* Sanford, *supra* note 184 (noting that climate change is causing some people to lose "their rights and freedoms because of the actions of others").

195 In general, personal responsibility was less commonly referenced by liberal commentators in our study, although we did not attempt to account for the total number of publications generated. A July 2006 search using the term "personal responsibility" on two liberal think tanks' websites (the Open Society Institute, http://www.soros.org, and the Center for American Progress, http://www.americanprogress.org) yielded only ninety-five hits.

196 For example, Ralph Nader's website has argued that although the Republican Party "routinely calls for personal responsibility on the part of the people, it seems to have little interest in corporate responsibility." *Eroding Americans' Last Defense: The Civil Justice System*, NADER PAGE, Feb. 4, 2005, http://www.nader.org/interest/020405.html.

197 *See, e.g.*, Peter Edelman et al., *Reconnecting Disadvantaged Young Men: An Introduction*, CENTER FOR AM. PROGRESS, Jan. 20, 2006, http://www.americanprogress.org/issues/kfiles/b1549629.html (arguing that social policies must be enacted to widen disadvantaged youth's educational and economic opportunities before personal choice has real value).

many individuals have insufficient control over the environmental effects of their behavior to support an obligation to change. This lack of control regarding climate change can arise from structural limitations. For example, many people live far from their worksite and shopping areas and do not have access to mass transportation.[198]

A second concern of liberal commentators links control with equity. Many individuals do not have the financial resources to make the efficiency investments necessary to respond to the personal responsibility norm.[199] Increased energy efficiency costs can cause individuals to fall below socially acceptable levels of expenditures on food, health care, and other items.

In our view, conservatives are correct in noting that the personal responsibility norm is likely to influence behavior and that promoting the norm is an appropriate concern of government. They fall short, however, in failing to acknowledge the role of personal responsibility in ameliorating environmental harms, and climate change in particular. At the same time, liberals are correct to highlight the importance of environmental harms and to worry that assertions of personal responsibility assume unrealistic levels of personal control and could undercut efforts to regulate corporations. Where liberals fall short is in failing to acknowledge that individuals do control many activities that are important contributors to carbon emissions. They also are too quick to assume that efforts to change individual behavior will reduce the public appetite for regulatory measures and that these efforts cannot account for equity concerns.

If our analysis is accurate, the linkage between personal responsibility and carbon neutrality has been ignored because of different

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198 Structural limitations may be particularly responsible for the growing inelasticity of gas consumption. A recent study concluded that the rise in gas prices over the 2001–06 period reduced consumption by only 4%, as compared to the more than 30% reduction generated by similar increases in 1975–80. Jonathan E. Hughes et al., *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand* (Inst. of Transp. Studies, Working Paper No. UCD-ITS-RR-06-16, 2006), *available at* http://pubs.its.ucdavis.edu/publication_detail.php?id=1050; *see also* NRC, ENERGY, *supra* note 156, at 39 (noting in 1984 that "gasoline consumption is more responsive to price signals than energy for residential consumption"). The difference may have been that the U.S. population became much more suburbanized and reliant on cars between 1975 and 2001. The average annual miles driven per household increased from 12,036 in 1977 to 21,171 in 2001. Lisa Margonelli, Pipeline Blog, *Who Cares About the Price of Gas?*, N.Y. TIMES, Jan. 15, 2007, http://pipeline.blogs.nytimes.com/2007/01/15/who-cares-about-the-price-of-gas (registration required) (concluding that "we have demonstrated that we can't or won't respond rationally to high prices, so taxes will not push conservation"). Important structural limitations also exist for household energy use. Many home buyers have little choice of appliances when they buy houses, and renters typically have little control over the heating and cooling systems used in their apartments. NRC, ENERGY, *supra* note 156, at 117–20.

199 NRC, ENERGY, *supra* note 156, at 51–52.

objections from the right and the left. The question is whether the law can disrupt this gridlock. One way to do so is to link the personal responsibility norm to carbon neutrality by using information that resonates with individuals across the political spectrum. Changes in beliefs about threats to biodiversity may motivate those who already hold the abstract environmental protection norm. Similarly, information about the disparate impact of climate change on the poor may motivate those who hold abstract norms about distributive justice. But if many of those who hold the personal responsibility norm are less motivated by environmental protection and distributive justice norms, then policies may need to change beliefs about the economic and human health harms that individual carbon emissions will cause.[200] These belief changes have the prospect of demonstrating to individuals across the political spectrum that carbon-emitting behaviors conflict with the personal responsibility norm.

2. *The Concrete Norm of Carbon Neutrality*

a. The Rising Popularity of Carbon Neutrality

The norm of carbon neutrality involves a perceived obligation to achieve zero net carbon emissions through a combination of reductions in carbon emissions and purchases of carbon offsets. The carbon-neutrality norm reflects the idiosyncrasies of the carbon emissions problem. Unlike many behaviors that contribute to environmental harms, individuals can achieve carbon neutrality not just by eliminating emissions but also by a combination of emissions reductions and offset purchases.[201] Carbon neutrality has spread rapidly in the last several years,[202] although largely among those who were already likely to adhere to environmental protection norms.[203] Surveys on the adoption of the carbon-neutrality norm are not yet available, but a variety of sources provide anecdotal indications that

[200] At least one recent article in the popular press explicitly linked the purchasing of offsets to a sense of personal responsibility and quoted one individual as saying, "I like the idea that I pollute this much, so I pay this much." Christine Larson, *A New Way to Ask, "How Green is My Conscience?,"* N.Y. TIMES, June 25, 2006, § 3, at 6. The growing awareness of climate change in America is reflected in public-opinion polls, although climate change continues to rank well below Iraq, the economy, and health care in terms of political importance. John J. Fialka, *Global Warming Pushes Politicians to Mark Positions*, WALL ST. J., Sept. 19, 2006, at B2.

[201] *See supra* notes 2–3 and accompanying text.

[202] *See, e.g.*, Matthew L. Wald, *What's Kind to Nature Can Be Kind to Profits*, N.Y. TIMES, May 17, 2006, at G1 (discussing widespread corporate interest in carbon neutrality).

[203] Anthony DePalma, *Gas Guzzlers Find the Price of Forgiveness*, N.Y. TIMES, Apr. 22, 2006, at A1 (noting that beliefs about air emissions appear to be influencing personal carbon-offset market).

the norm is becoming widespread. "Carbon neutrality" was Oxford Dictionary's "word of the year" for 2006.[204] More than half a dozen companies, ranging from the predictable (Ben & Jerry's) to the surprising (Rupert Murdoch's News Corporation), have adopted carbon neutrality as an overall corporate goal.[205] Many more firms have adopted programs that rely on customers to pay more at the time of purchase to help customers move in the direction of carbon neutrality by offsetting the carbon footprint of particular goods or services.[206] Sports organizations, including the Australian Football League, FIFA

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[204] *See supra* note 13.

[205] The companies that have declared a firm-wide carbon-neutrality goal include: (1) Ben & Jerry's, DePalma, *supra* note 203; (2) HSBC, Braden Phillips, *Paying the Freight for Polluting the Air: Europe Takes the Lead*, N.Y. TIMES, Sept. 18, 2006, at F8; (3) News Corporation, Louise Story, *The Hidden Life of Paper and Its Impact on the Environment*, N.Y. TIMES, Oct. 25, 2006, at C3; (4) Marks and Spencer (a UK grocer and department store), John Willman, *M&S Chief Wins "Eco-Plan" Praise*, FIN. TIMES (London), July 3, 2007, at 4; (5) Saab Australia, Press Release, Saab Austl., Saab Drivers Go Carbon Neutral (Jan. 12, 2007), *available at* http://www.saab.com.au/main/AU/en/pressreleases/4/index.shtml; (6) Salesforce.com, Gavin Clarke, *Salesforce.com Goes Carbon Neutral*, REGISTER (London), Jan. 18, 2007, http://www.theregister.co.uk/2007/01/18/salesforce_carbon_trading; (7) Silverjet, Andrew C. Revkin, *Carbon-Neutral Is Hip, but Is It Green?*, N.Y. TIMES, Apr. 29, 2007, § 4, at 1; and (8) Timberland, Jad Mouawad, *A Few Companies Take Special Steps to Curb Emissions*, N.Y. TIMES, May 30, 2006, at C1. BP contributes to offset registered customers' travel emissions in the United Kingdom when they purchase BP gas. James Daley, *BP Targets Green Consumers with Carbon-Offset Scheme for Drivers*, INDEPENDENT (London), Aug. 23, 2006, at 37, *available at* http://news.independent.co.uk/business/news/article1221122.ece.

[206] For example, for a 2% premium on its usual shipping charge, DHL offsets all emissions from transport to make its delivery and logistics services carbon neutral. *Morning Edition: Europe's Carbon Trading Market Sees Brisk Business* (NPR radio broadcast June 5, 2007), *available at* http://www.npr.org/templates/story/story.php?storyId=10716772 (follow "listen" hyperlink for audio recording). Similarly, Pacific Electric & Gas allows customers to add a monthly charge to their electric bill that is used to purchase offsets for the greenhouse gas emissions from their electricity use. *See* Rebecca Smith, *California Kindles Green Energy; Ahead of New Standards, Utilities Push Use of Cleaner Resources*, WALL ST. J., Dec. 26, 2006, at A2; *see also* Press Release, Ford Motor Co., Ford and TerraPass Create Program To Help Drivers Reduce Greenhouse Gas (Apr. 28, 2006), *available at* http://media.ford.com/newsroom/feature_display.cfm?release=22971 (describing Ford's pilot program with TerraPass to allow customers to purchase offsets for greenhouse gas emissions from driving); Damon Darlin, *Dell Says Plant a Tree, Help the Environment*, N.Y. TIMES, Jan. 10, 2007, at C6 (noting that Dell donates money from computer sales to funds promoting offsets); Michelle Higgins, *Raising the Ante on Eco-tourism*, N.Y. TIMES, Dec. 10, 2006, § 5, at 12 (describing trend of travel companies, including Expedia and Travelocity, to purchase carbon offsets to allow travelers to compensate for carbon dioxide production from trips); Tom Arnold, Testing TerraPass on the Shelf at Sam's Club, TerraPass Blog, Jan. 22, 2007, http://www.terrapass.com/blog/posts/2007/01/testing-terrapass-on-the-shelf-at-sams-club.html (noting Sam's Club's bundling of TerraPass with pressure washer purchases in order to offset carbon dioxide emissions).

(for the 2006 World Cup), and the National Football League have also begun adopting carbon neutrality for particular events or seasons.[207]

Not-for-profit organizations and governments also are adopting carbon neutrality.[208] California's most recent gubernatorial inauguration was carbon neutral.[209] Several governments attempted to make a recent international summit meeting carbon neutral, although the effort faced political obstacles.[210] New Zealand,[211] the Vatican,[212] the Canadian province of British Columbia,[213] and at least one British town[214] have announced their intention to become carbon neutral. The presidents of more than 150 colleges and universities in the United States have signed a statement committing to take steps toward achieving carbon neutrality.[215]

More than a dozen personal carbon calculators are now available on the Internet.[216] These calculators typically allow individuals to input data on their motor vehicle and household energy use and estimate their total annual carbon emissions. In addition, more than thirty nongovernmental organizations and for-profit corporations now

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207 Stephanie Peatling, *A Worthy Goal: AFL to Ban Greenhouse Gases*, SYDNEY MORNING HERALD, Sept. 19, 2006, at 3, *available at* http://www.smh.com.au/news/national/afl-puts-its-energy-into-greener-goals/2006/09/18/1158431644199.html (Australian Football League); Wald, *supra* note 202 (National Football League and World Cup).

208 For example, the Natural Resources Defense Council has offset the emissions from electricity use at its Washington, D.C., office. Antonio Regalado, *New Lifestyle Option for the Eco-Minded: Carbon-Neutral*, WALL ST. J., May 14, 2004, at B1.

209 Press Release, Pac. Gas & Elec. Co., Pacific Gas and Electric Company Energizes Governor's 2007 Inaugural "Green Dream" Celebration (Jan. 4, 2007), *available at* http://sev.prnewswire.com/oil-energy/20070104/SFTH04404012007-1.html.

210 Matthew Chapman, *Green Government Plan "a Fiasco,"* BBC.COM, Oct. 29, 2006, http://news.bbc.co.uk/2/hi/business/6092460.stm (describing efforts to make 2006 G8 Summit carbon neutral).

211 Eduard Goldberg, *New Zealand Prime Minister Announces Plans To Make Country "Carbon Neutral,"* Int'l Env't Daily (BNA), Feb. 23, 2007.

212 Elisabeth Rosenthal, *Vatican's Tree Penance: Forgive Us Our CO_2*, N.Y. TIMES, Sept. 17, 2007, at A4.

213 *British Columbia To Trim Greenhouse Gases, Go Carbon Neutral*, ENV'T NEWS SERVICE, Feb. 14, 2007, http://www.ens-newswire.com/ens/feb2007/2007-02-14-02.asp.

214 *Village Aims To Be Carbon Neutral*, BBC.COM, Jan. 18, 2007, http://news.bbc.co.uk/2/hi/uk_news/england/merseyside/6275323.stm (reporting village of Ashton Hayes's intention to become carbon neutral).

215 American College & University Presidents Climate Commitment, http://www.presidentsclimatecommitment.org/index.php (last visited Oct. 10, 2007).

216 *See, e.g.*, Personal Emissions Calculator, http://www.epa.gov/climatechange/emissions/ind_calculator.html (last visited Oct. 12, 2007) (enabling users to "estimate [their] household greenhouse gas emissions" and "identify ways to reduce [their] personal greenhouse gases"). *See generally* J. Paul Padgett et al., *A Comparison of Carbon Calculators*, 27 ENVTL. IMPACT ASSESSMENT REV. (forthcoming 2007) (comparing ten U.S.-based individual carbon-emissions calculators).

sell carbon offsets to support the burgeoning demand for them.[217] Although the number of individuals who have committed to carbon neutrality is unknown, one firm that offers carbon offsets claims it has more than 34,000 customers.[218] Moreover, $110 million in voluntary offsets were sold in 2006, an increase from $6 million in 2004.[219]

b. The Characteristics of Carbon Neutrality

Several features of carbon neutrality may explain its rapid adoption. First, the concept is easy to understand and express. Studies suggest that simplicity is essential for many types of socially induced behavior changes because it enables individuals to notice, understand, and remember information.[220] The simplicity comes at a cost, however: It may be possible to achieve the short- and long-term global emissions reduction targets through very large individual reductions rather than actual neutrality. A norm phrased as "no harmful carbon emissions" or "no more than your fair share" might accurately express this concept. Alternatively, some might argue that individuals in developed countries must become *carbon negative* to account for the needs of the developing world. Communicating the precise permissible levels of emissions to hundreds of millions of people in a way that generates desired levels of behavior change, however, would be impossible. Moreover, even if precise optimal emissions levels could be calculated, they would change from year to year.

Carbon neutrality also squares well with the abstract personal-responsibility norm: it enables individuals to be confident that regardless of others' behavior, they are not contributing to the harm. In short, carbon neutrality enables individuals to take personal responsibility for their contributions to climate change without reliance on uncertain or shifting estimates of the necessary reductions or of others' behavior.

Carbon neutrality may have achieved its current level of popularity because compliance is achievable without significant sacrifice for many individuals. Because carbon neutrality can be achieved through a mix of emissions reductions and offsets, it does not require massive behavior changes or financial costs. Many behavior changes

217 TERRAPASS, COMMENTS ON CENTER FOR RESOURCE SOLUTIONS GREEN-E GREENHOUSE GAS PRODUCT STANDARD 1 (2007), *available at* http://www.terrapass.com/images/blogposts/TerraPass%20CRS%20comments.pdf; CLEAN AIR-COOL PLANET, A CONSUMER'S GUIDE TO RETAIL CARBON OFFSET PROVIDERS iii (2006), *available at* http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf.

218 TERRAPASS, *supra* note 217, at 7.

219 James Kanter, *Guilt-Free Pollution. Or Is It?*, N.Y. TIMES, Feb. 20, 2007, at C1.

220 NRC, DECISION MAKING, *supra* note 6, at 74.

can generate substantial emissions reductions at low cost. Furthermore, although the retail price of carbon offsets is likely to rise, it recently has been as low as $4 per ton of carbon.[221] For example, some individuals may not be able to reduce motor vehicle use, but at least one retailer is selling offsets for the annual carbon emissions from a standard car for roughly $50.[222]

Not surprisingly, psychological studies demonstrate that eliminating the barriers and availability of excuses for inaction are critically important steps for behavior change.[223] Studies also demonstrate that once individuals have committed to a particular viewpoint or action, they tend to continue engaging in the behavior long after the original period of commitment has ended.[224] Compliance with the carbon-neutrality norm does not require that individuals adopt other environmental beliefs, norms, or lifestyles that are inconsistent with their own. Moreover, it allows individuals to maintain control over the mix of behavior changes that they will use to achieve compliance. These points are essential. By adopting the carbon-neutrality norm, Ed Begley's wife can reduce her carbon footprint without making fences out of plastic milk jugs. More important, she can no longer assume that those who are unwilling to take the milk-jug route do not have an obligation to reduce their carbon footprint.

Empirical and theoretical studies support this analysis. Concrete norms that require wholesale changes in worldviews or clusters of abstract norms have little prospect for success.[225] Those who do not subscribe to a worldview compatible with environmentalism will be more likely to reject information about climate change if they are forced to change their worldview rather than simply adopt new norms.[226] Similarly, individuals are likely to reject a new norm that appears to divest them of control over daily life activities, as might be

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221 *See* EcoBusinessLinks, *supra* note 2 (surveying prices among carbon-offset providers). Of course, carbon offsets are a viable means of reducing individuals' carbon footprint only if the offsets actually offset other emissions. For a discussion of the criticisms of carbon offsets, see *infra* notes 229–40 and accompanying text.

222 *See, e.g.*, TerraPass, TerraPass Products for Your Car, http://www.terrapass.com/road/products.road.all.php (last visited Oct. 10, 2007) (selling carbon offsets for midsize motor vehicle for $49.99). For a general discussion of carbon offsets, noting that "[c]arbon offsets typically include renewable energy, energy efficiency and reforestation projects," see EcoBusinessLinks, *supra* note 2.

223 GARDNER & STERN, *supra* note 86, at 80, 92.

224 *Id.* at 86–87.

225 *See, e.g.*, Reneé Weber & Jennifer Crocker, *Cognitive Processes in the Revision of Stereotypic Beliefs*, 45 J. PERSONALITY & SOC. PSYCHOL. 961, 967–68 (1983) (concluding that removing stereotype by attempting in piecemeal fashion to disconfirm individual beliefs associated with that stereotype is more effective than attempting to remove stereotypes by altering entire belief system at once).

226 NRC, ENERGY, *supra* note 156, at 47.

required if carbon neutrality could only be achieved through eliminating all carbon emissions.[227] In some cases, individuals not only reject these types of behavior changes but also engage in reactance, acting in opposition to the perceived directive.[228]

c. Criticisms of Carbon Neutrality

Carbon neutrality is not without critics.[229] One concern is that offsets may not always provide genuine emissions reductions. For example, offsets may purport to displace a carbon-emitting activity that would not have occurred without the offset in the first place. Alternatively, the offset-generating activity may have uncertain scientific validity.[230] In a worst-case scenario, offsets may be generated from the destruction of greenhouse gases that were only produced in the first place because of the market value of the offsets.[231] A recent study identified substantial variation in the quality of the offsets available on the retail market,[232] and a private standard is under development for retail carbon offsets.[233] Thus far, personal carbon calculators have received less attention, but a forthcoming study concludes that these calculators lack transparency and vary widely in methodology and outputs.[234]

A second concern is that even if offsets do reduce climate forcing at the levels advertised, the availability of offsets may undermine public support for government regulatory efforts and for individual behavior change that reduces emissions instead of offsetting them.[235]

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227 *Id.*

228 *See id.* at 47–48 (contrasting "psychological reactance" seen with forced energy-saving restrictions to relative lack of resistance seen when people are given "freedom and control" over such restrictions).

229 *See* Ken Caldeira, Op-Ed., *When Being Green Raises the Heat*, N.Y. TIMES, Jan. 16, 2007, at A21 ("We cannot afford to indulge ourselves with well-intentioned activities that do little to solve the underlying problem."); Stephanie Gruner, *Future Forests Trades Trees for Emissions—Critics Say Firm Oversimplifies Issue, Lets Polluters Off Hook*, WALL ST. J., Nov. 15, 2000, at B4B (noting that some environmentalists claim that "the science behind carbon-forestry programs is faulty").

230 For example, a recent study raises questions about the benefits of planting trees outside of tropical latitudes. Seran G. Gibbard et al., *Climate Effects of Global Land Cover Change*, 32 GEOPHYSICAL RES. LETTERS L23705 (2005).

231 Keith Bradsher, *Outsize Profits, and Questions, in Effort to Cut Warming Gases*, N.Y. TIMES, Dec. 21, 2006, at A1.

232 *See* CLEAN AIR-COOL PLANET, *supra* note 217, at iii (noting that carbon-offset providers vary in quality).

233 CTR. FOR RES. SOLUTIONS, DRAFT: GREEN-E GREENHOUSE GAS PRODUCT STANDARD (2006), http://www.resource-solutions.org/mv/docs/DRAFT_Green-e_GHG_Product_Standard_for_Stakeholder_Comment.pdf.

234 Padgett et al., *supra* note 216.

235 The latter concern is sometimes expressed by analogizing offsets to the religious indulgences offered in the Middle Ages. *See* Charles Krauthammer, *Limousine Liberal*

These points are worthy of further empirical study, but it is equally likely that individuals who commit to carbon neutrality through offset purchases will become more supportive of government regulation and more likely to reduce their own emissions. Studies demonstrate that when individuals take affirmative steps to reduce their contributions to social harms, they expect reciprocity from others—in this case, industry, government, agriculture, and others.[236] In addition, as discussed above, when individuals make a personal or public commitment to take an action, they are more likely to follow through on the action.[237] Offsets that involve public commitments by individuals to reduce their carbon footprint thus may induce direct emissions reductions and may build public support for traditional regulatory measures.

A third concern is that as carbon neutrality spreads and more carbon offsets are purchased, the price of offsets is likely to rise. The price increase has at least two implications. First, compliance with the norm may decline if it requires higher costs to purchase offsets or more onerous behavior changes to achieve increased emissions reductions.[238] Although an increase in offset prices is likely to occur, the widespread adoption of carbon neutrality will create incentives for private markets and government to provide alternatives for individuals to achieve emissions reductions. In addition, individuals who have adopted the carbon-neutrality norm may resist acting inconsistently with the norm even after it becomes more expensive to comply.[239]

A second implication of the price increase is that it raises distributive justice concerns. If carbon neutrality can be achieved by offsets,

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Hypocrisy, TIME, Mar. 26, 2007, at 24, 24 (referring to offsets as "ecological indulgences"); Revkin, *supra* note 205 (noting that some environmentalists compare carbon offsets to indulgences). This concern has a moral cast, suggesting that achieving carbon neutrality through anything other than reductions in personal emissions is somehow fraudulent or immoral. The analogy is false, however. Indulgences raised money but did not provide the advertised benefit. Offsets can be genuine, and genuine offsets do provide the benefit advertised. In addition, although in theory the availability of offsets could reduce the moral stigma associated with carbon emissions, no widespread moral stigma currently is associated with these emissions. Given the ubiquity of carbon emissions, the stigma may not emerge unless some standard develops to identify the level at which emissions become harmful. Widespread adoption of the carbon-neutrality norm may begin to establish the standard at zero, even if the norm allows the standard to be achieved through emissions reductions and offsets.

236 *See* Vandenbergh, *supra* note 6, at 1118–19 (describing reciprocity norm).

237 *See supra* note 224 and accompanying text.

238 *See, e.g.*, Regalado, *supra* note 208 (noting that some "think the idea [of carbon neutrality] will take off only when carbon costs are built into a product's price").

239 *See, e.g.*, Vandenbergh, *supra* note 57, at 593–94 (discussing effects of cognitive dissonance and habits on environmentally significant behaviors).

and if offsets increase in price, the wealthy will be able to comply with the norm without facing substantial lifestyle disruptions, but the poor will not. Although this is a genuine concern, the remedy is not to abandon carbon neutrality or carbon offsets but rather to provide public or private subsidies to those who cannot afford offsets. We discuss one possible mechanism in Part V below.[240]

C. *Integration with Traditional Remedies*

The rapid spread of carbon neutrality suggests that information can activate norms and induce individuals to take low-cost actions to reduce their carbon footprints. At the same time, norm activation is not a panacea. Reducing many carbon-emitting behaviors could have negative monetary payoffs for the individual, require changes in deeply rooted habits, or face financial or infrastructure barriers. For these behaviors, studies suggest that norm activation may have limited effects.[241] Instead, a mixture of information provision and traditional regulatory measures may be needed. Traditional measures include taxes or subsidies, cap-and-trade schemes, standards that regulate the efficiency of consumer products made by industrial firms, and support for new technologies and infrastructure.[242] Many of these approaches seek to use price signals to change individuals' incentives, assuming that individuals are rational actors with adequate information. Taxes and subsidies do so directly, and cap-and-trade schemes do so indirectly through increasing the costs of carbon emissions for electric utilities and for the manufacturers of consumer goods. Yet, as the National Research Council has concluded, incentive schemes alone can fall short if appropriate information is not available.[243]

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240 For an analysis of possible approaches to creating "equity offset" programs that address the distributive justice problem, see generally Michael P. Vandenbergh & Brooke Ackerly, *Climate Change and Individual Behavior: The Equity Problem*, 26 VA. ENVTL. L.J. (forthcoming 2007).

241 *See supra* notes 155–56 and accompanying text.

242 Examples of technological innovations that may reduce carbon emissions include advances in solar, hydrogen, nuclear, and carbon-sequestration technology. Experts suggest that two of the most important technological developments, hydrogen vehicles and carbon sequestration, may take many years to develop and deploy. *See, e.g.*, Dawn Reeves, *DOE Admits CO_2 Sequestration Years Away in Coal-to-Fuel Plant Study*, INSIDE EPA, Jan. 19, 2007 (noting that Department of Energy environmental impact statement concluded that carbon-sequestration technology is "years away"); *Surge in Greenhouse Gas Emissions Forecast as World Energy Demands Rise Through 2030*, Daily Env't Rep. (BNA) No. 119, at A-2 (June 21, 2006) (noting comments of EIA Administrator that he does not see important role for hydrogen energy until after 2030).

243 NRC, DECISION MAKING, *supra* note 6, at 76–77 (noting that information can be "instrumental" in changing carbon-emitting behaviors when combined with taxes and other incentives and in some cases can increase effectiveness of incentives by factor of ten).

The need to combine the type of information that is likely to activate norms with traditional measures is perhaps most obvious when examining carbon taxes.[244] Individuals often do not have sufficient information to respond rationally to changes in price signals.[245] They tend to overemphasize the energy-reducing value of behaviors that have perceptible effects, such as turning off lights, and to discount behaviors that are less perceptible but have much greater effects on energy savings, such as improving the efficiency of heating and cooling systems.[246] This problem is particularly acute with home electricity use. One study analogized the information available to individuals when they make home energy use decisions to a grocery store in which no prices are listed on the products and the consumer receives a bill with only a total amount from the cashier.[247] Given this lack of information about how individuals can cut energy use, prices have limited effects on household energy consumption.[248]

Moreover, individuals often are not rational in how they process information about carbon-emitting behaviors.[249] For example, individuals steeply discount long-term savings from energy efficiency, inducing them not to buy vehicles and home heating and cooling sys-

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[244] For an examination of the role of carbon taxes in addressing climate change, see generally Roy Boyd et al., *Taxation as a Policy Instrument to Reduce CO_2 Emissions: A Net Benefit Analysis*, 29 J. ENVTL. ECON. & MGMT. 1 (1995). Taxes may be an efficient way to influence individual behavior and may have effects soon after being imposed. Taxes also create incentives for corporations that further leverage the taxes' influence on individual behavior. For example, taxes that provide incentives for individuals to purchase fuel-efficient cars also provide incentives for manufacturers to market auto fuel efficiency. During the 1979 energy crisis, automakers spent roughly $100 million on fuel-economy advertising. NRC, ENERGY, *supra* note 156, at 82. In addition, the most important function of taxes may be to create incentives for the development of new technologies. POSNER, *supra* note 1, at 258–59. For a discussion of the role of subsidies in encouraging carbon reductions, see *id.* at 159–60, 259, and Green, *supra* note 6, at 424–40.

[245] *See* NRC, ENERGY, *supra* note 156, at 41–42 (discussing problems with information for energy users).

[246] *Id.* at 36–39 (citing studies).

[247] *Id.* at 36.

[248] For example, a 1983 study concluded that a price differential between 2:1 and 8:1 accounted for only 2% of the variation in home electricity use, largely because consumers lacked information about the variable prices. GARDNER & STERN, *supra* note 86, at 109 (noting that perception that reducing peak demand was moral obligation accounted for 11% of variation). Households that received an enhanced information package as compared to the standard utility information package reduced their peak energy use by 16% more than those that received the standard package. *Id.*

[249] *See* Owen D. Jones & Timothy H. Goldsmith, *Law and Behavioral Biology*, 105 COLUM. L. REV. 405, 443–44 (2005) (describing range of common biases and irrational behaviors that affect environmentally significant consumer choices); Jeffrey J. Rachlinski, *The Psychology of Global Climate Change*, 2000 U. ILL. L. REV. 299, 314–16 (discussing several cognitive biases that affect willingness to support government action to address climate change).

tems that have high initial costs but low annual energy costs.[250] Framing information in ways that directly address such cognitive biases may help overcome those biases and induce consumers to purchase more efficient products.

Perhaps most important, information that activates norms may be necessary for more traditional regulatory schemes to be politically viable. Tax changes are a vivid example of an unpopular policy, but many of the other traditional environmental measures also require civic support for public spending (e.g., for technology or infrastructure development) or require public support to overcome industry resistance (e.g., to cap-and-trade schemes or efficiency requirements).[251] Taxes on energy, and gas taxes in particular, are remarkably unpopular in the United States.[252]

The greatest limitation, perhaps, on the prospects for tax measures and many other traditional measures is the assumption that individuals will support measures that are against their short-term interests. The irony is that rational-actor theorists often advocate government policies that appeal to individuals' self-interest without addressing how individuals will be induced to engage in civic behavior (e.g., voting, joining advocacy groups, and contacting policymakers) that in and of itself is not in the individuals' self-interest in the short term. As discussed above, studies suggest that norm activation may be even more successful at inducing civic behavior changes than it is at inducing direct behavior changes.[253] In the absence of the widespread

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250 Jones & Goldsmith, *supra* note 249, at 444.

251 *See generally* MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS (1965) (providing early formulation of public choice theory and description of barriers to collective action toward common interest). Cap-and-trade schemes for industrial pollutants may reduce emissions attributable to individual behavior by reducing the emissions from the utilities from which individuals buy their electricity and from the manufacturing plants that produce consumer goods. Manufacturers, however, are not likely to encourage conservation measures when such measures conflict with their economic interests, which often lie with increased product and energy use. *See* NRC, ENERGY, *supra* note 156, at 42–43 (describing these mixed and conflicting incentives among producers).

252 POSNER, *supra* note 1, at 118 ("[A] politician who wants to raise taxes today to minimize the risk of catastrophes a thousand years hence will be cutting his throat."). Despite widespread support for climate change measures in California, a 2006 ballot measure that would tax oil production—yet not affect gasoline prices at the pump—failed by a vote of 55% to 45%. Aaron S. Edlin, *If Voters Won't Go for Taxing Oil To Conserve Energy, How Do We Do It?*, ECONOMISTS' VOICE, Nov. 2006, http://www.bepress.com/ev/vol3/iss9/art2. Boulder, Colorado, appears to be the only jurisdiction in the United States to have adopted a carbon tax. Katie Kelley, *City Approves "Carbon Tax" In Effort to Reduce Gas Emissions*, N.Y. TIMES, Nov. 18, 2006, at A13.

253 *See supra* note 176 and accompanying text. Scholars unfortunately have given only limited attention to how public support can be generated to put traditional regulatory measures in place. *See* Hersch & Viscusi, *supra* note 172, at 1684–92 (discussing societal bar-

adoption of carbon neutrality or other norms that create a sense of obligation to reduce individual carbon emissions, support for a carbon tax or other traditional measures may not arise at all or may arise too slowly for these measures to contribute meaningfully to the short-term emissions reduction target.

Finally, widespread adoption and activation of norms such as carbon neutrality may be required to prevent consumption patterns from overwhelming the emissions reductions that can be achieved from the promotion of new technologies, industry efficiency standards, and other similar measures.[254] The effects of changing consumption patterns on carbon emissions can be seen in both the household and transportation sectors. For example, a recent study suggests that even though refrigerators are three to four times more efficient than they were in the 1970s, the total demand for electricity from refrigerators has not decreased.[255] Rather than discarding less efficient refrigerators, consumers often have just added additional units. The number of households, the size of refrigerators, and the number of households with more than one refrigerator all have increased.[256] The growth in home air conditioning shows a similar pattern. Thirty years ago, only 36% of single-family homes were built with central air conditioning, compared to 87% today.[257]

Similarly, even though the overall efficiency requirements for motor vehicles have been essentially flat for almost two decades, total carbon emissions have increased dramatically because there are more vehicles on the road, each vehicle is driven more, and customers are purchasing many of the least fuel-efficient vehicles available.[258] Thirty years ago, 61% of automobiles were built with air conditioning, but today that figure is 98%.[259] In addition, driving patterns have

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riers to more sensible climate policies, including irrational assessment of distant future risks).

254 Government efficiency standards typically take the form of mandated efficiency standards for home appliances and efficiency standards or emissions standards for motor vehicles. *See* John C. Dernbach, *Overcoming the Behavioral Impetus for Greater U.S. Energy Consumption*, 20 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 15, 19 (2007) (discussing U.S. efforts to boost energy efficiency of appliances, buildings, and motor vehicles).

255 Jack N. Barkenbus, *Putting Energy Efficiency in a Sustainability Context: The Cold Facts About Refrigerators*, 48 ENVIRONMENT 10, 13–16 (2006) (describing refrigerator efficiency and demand trends and noting that overall electricity used by refrigerators "has remained comparable in absolute terms").

256 *Id.*

257 William Saletan, *Planet of the Indoor People*, WASH. POST, Aug. 6, 2006, at B2.

258 Dernbach, *supra* note 254, at 24–26.

259 Saletan, *supra* note 257. The trends are not limited to the United States. A decade ago, only 25% of new cars in France had air conditioning; today the figure is 75%. Lawrence J. Speer, *Vehicle Air Conditioning in France Worsening Climate Change, Environment Agency Finds*, Int'l Env't Daily (BNA), June 30, 2003.

become less fuel efficient and more carbon-emitting.[260] Thus, unless traditional measures like efficiency standards and taxes are coupled with the kinds of changes in individual behavior that can arise from norm activation, these traditional measures are likely to fall far short of their potential.

V

INSTITUTIONAL DESIGN AND INSTITUTIONAL ACTION

The norm of carbon neutrality has spread remarkably in recent years, but anecdotal information suggests that it has yet to spread beyond those who adhere to proenvironmental abstract norms. Given the timing and magnitude of the short- and long-term emissions reduction targets, the carbon-neutrality norm will need to spread not only among those who ascribe to environmental norms but also to those who do not. This Part examines how policymakers can use the regulatory regime to push the emerging carbon-neutrality norm toward a tipping point without propagandizing.[261] As a general matter, policymakers can do so by requiring that agencies collect and disseminate accurate information about the consequences of individual carbon emissions and the steps that individuals can take to mitigate those consequences.[262] Although many past informational efforts have been ineffective, in prior times of crisis—such as the scrap drives of World War II—government has engaged in successful efforts to persuade individuals to act by providing information about the effects of behavior.[263] The costs and benefits of the measures proposed in this Part will require careful analysis, but many of these measures have the potential to deliver emissions reductions more quickly and at lower costs than many of the traditional measures.

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260 *See* Fuel Economy Labeling of Motor Vehicles: Revisions to Improve Calculation of Fuel Economy Estimates, 71 Fed. Reg. 5426, 5428–30 (proposed Feb. 1, 2006) (to be codified at 40 C.F.R. pts. 86 & 600) (proposing use of new emission tests to account for changes in Americans' driving behavior).

261 Unfortunately, U.S. government agencies, unlike their Canadian counterparts, have been reluctant to promote public policies like conservation through information campaigns. NRC, ENERGY, *supra* note 156, at 74–80.

262 Studies demonstrate that mere hortatory calls to change environmentally significant behavior that do not provide information on the consequences of that behavior are typically ineffective at changing environmental norms. *Id.* at 73 (citing Peter Ester & Richard A. Winett, *Toward More Effective Antecedent Strategies for Environmental Programs*, 11 J. ENVTL. SYSTEMS 201 (1982); Paul C. Stern & Gerald T. Gardner, *Psychological Research and Energy Policy*, 36 AM. PSYCHOLOGIST 329 (1981)).

263 *See generally* CARL A. ZIMRING, CASH FOR YOUR TRASH: SCRAP RECYCLING IN AMERICA 81–101 (2005) (discussing scrap drives and scrap recycling industry during World War II and other periods).

A. Information Disclosure

Government reports inform the public about many of the potential consequences of climate change. The principal gaps in the available information are information that identifies individuals' emissions, the resulting economic and human health harms, and the steps they can take to reduce their emissions.[264] On these issues, the public sector in the United States has been largely silent. In its place, a cacophony of messages from public interest groups, corporations, industry trade associations, and others barrages the public on a daily basis. Although the rapid spread of the carbon-neutrality norm suggests that some information is having an effect, the information is often of the type that appeals only to those with strong environmental norms, addresses only a limited set of behaviors, and sends conflicting messages. In addition, studies suggest that information is more likely to influence behavior if it is provided by a credible source,[265] and that individuals typically view government entities as more credible than private entities.[266]

The discussion below identifies approaches to information disclosure targeted at norm activation for climate change. Although no single approach is likely to lead to universal changes in carbon-emitting behaviors, in combination these approaches may lead to widespread adoption of the carbon-neutrality norm and to behavior change.

1. The Individual Carbon-Release Inventory

One of the most important roles that government can play is to provide individuals and policymakers with accurate information about the aggregate emissions attributable to individual behavior and the emissions of the average individual. The Toxics Release Inventory (TRI), a remarkably successful program focused on toxic emissions,[267] may provide a template for annual government disclosure of indi-

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264 Attempts to use more direct regulatory approaches aimed at individual consumption, such as the creation of personal carbon accounts, have been suggested in the United Kingdom. *See* Rob Edwards, *The New Idea for Tackling Climate Change: Carbon Cards*, SUNDAY HERALD (Glasgow), Jan. 1, 2006, at 16 (describing proposal to create carbon accounts for all adults that would ration "carbon units" corresponding to energy usage).

265 *See, e.g.*, NRC, ENERGY, *supra* note 156, at 96–98 (describing importance of credibility to information campaigns and proposing strategies for bolstering campaign credibility).

266 GARDNER & STERN, *supra* note 86, at 114, 115 fig.5-3 (citing study finding much higher consumer response to marketing strategies showing higher degrees of government support).

267 *See generally* Vandenbergh, *supra* note 6, at 1139–46 (describing Toxics Release Inventory).

vidual and household carbon emissions. Created by the Emergency Planning and Community Right-to-Know Act of 1986,[268] the TRI provisions do not mandate reductions in toxic chemical releases. Instead, they require large industrial firms to quantify and report their toxic chemical releases on an annual basis.[269] The EPA then compiles the data into a publicly available database and issues an annual report on changes in emissions by year, by chemical, and by region.[270] The industrial TRI data release often triggers substantial media attention.[271] The TRI data release also has facilitated NGO, government, corporate, and academic reports on industrial toxic emissions.[272] Despite the absence of mandatory reductions, empirical studies have concluded that TRI reporting requirements have induced firms to reduce their toxic chemical releases.[273]

Policymakers could apply a similar approach to emissions from individuals and households through an Individual Carbon Release Inventory (ICRI).[274] The ICRI could be managed by the EPA or by the EIA.[275] To fill gaps in the data, rather than having hundreds of millions of individuals complete forms to report on their carbon emissions, the EIA could conduct national surveys. The EIA could disclose the ICRI data at the same time and in the same format as the release of the industrial TRI toxic chemical emissions data. Disclosure in this way would enable news about individual carbon emissions to be discussed alongside news accounts about corporate toxic releases. In addition, year-over-year trends and comparisons among

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268 Pub. L. No. 99-499, 100 Stat. 1728 (codified as amended at 42 U.S.C. §§ 11001–11050 (2000)).

269 42 U.S.C. § 11023(a).

270 Emergency Planning and Community Right-to-Know Act of 1986 § 313(j), 42 U.S.C. § 11023(j) (requiring EPA to "establish and maintain in a computer data base a national toxic chemical inventory" and to "make these data accessible by computer telecommunication and other means").

271 *See* Vandenbergh, *supra* note 6, at 1142 & nn.177–80 (describing media coverage).

272 *Id.* at 1142–43.

273 *Id.* at 1144–45 & n.195 (citing James T. Hamilton, *Is the Toxics Release Inventory News to Investors?*, 16 NAT. RESOURCES & ENV'T 292 (2001); James T. Hamilton, *Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data*, 28 J. ENVTL. ECON. & MGMT. 98 (1995); Shameek Konar & Mark A. Cohen, *Does the Market Value Environmental Performance?*, 83 REV. ECON. & STAT. 281, 289 (2001); Shameek Konar & Mark A. Cohen, *Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions*, 32 J. ENVTL. ECON. & MGMT. 109 (1997)).

274 The ICRI is modeled on, and could easily be incorporated into, the proposed Individual Toxics Release Inventory. *Id.* at 1149; *see also* Dernbach, *supra* note 254, at 36 & n.131 (discussing carbon footprint modeled on proposed Individual Toxics Release Inventory).

275 We assume for the purposes of this discussion that Congress would delegate responsibility to the EIA, which already collects and publishes much of the data necessary to assemble an ICRI.

regions and states would make the annual release of the information more newsworthy. The disclosure also would prompt government, NGO, and academic reports analyzing the data and providing additional information.

By disclosing aggregate carbon release data, the ICRI also would demonstrate the importance of individuals as a sector or group.[276] The news accounts about the ICRI also could activate the carbon-neutrality norm by changing beliefs about the harms caused by individual carbon emissions and the means available to ameliorate those consequences. Drawing on our earlier example, a quantification of the mean and aggregate emissions associated with personal motor vehicle idling could be included in the annual ICRI report, and media reports about these emissions might update individuals' outdated beliefs about the personal and social costs of idling.[277]

2. *Information on Specific Behaviors*

In addition to information about carbon emissions, individuals require information about the types of behavior changes that will generate emissions reductions, both to activate norms and to provide knowledge of what steps to take once the individual feels an obligation to act. The ICRI may not generate specific information about emissions reduction efforts, but the media accounts that accompany the release of its data and follow-up reports by NGOs and others may do so. The potential effect of a simple updating of beliefs is substantial. Numerous studies indicate that individuals are unaware of the amount of energy they use and the amount of carbon emissions they produce through their individual behaviors, an "energy invisibility" that is most acute for household energy use.[278]

To address this information deficit, public information campaigns will need to reflect a sophisticated understanding of how information is received, processed, and used by individuals. For example, the National Research Council has suggested that information is more likely to generate behavior change if it is understandable, attracts attention, stays in the memory, is provided at times and places that are close to the point of decisionmaking, and is provided by a trustworthy source.[279] A variety of national, state, and local public information campaigns and labeling programs may be necessary. Programs and technologies currently in development through private sector initia-

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276 *See supra* Part II.A.

277 *See supra* notes 110–21 and accompanying text.

278 *See supra* notes 245–48 and accompanying text.

279 NRC, DECISION MAKING, *supra* note 6, at 74–75.

tives include labels indicating the carbon footprint of foods, a device that records and displays household electricity usage on an ongoing basis, and a simple, color-coded carbon label for consumer products.[280] Another possibility is a digital readout for cars and trucks that displays carbon emissions on an ongoing basis.[281]

More resource-intensive local information campaigns also may be necessary. These programs may need to combine nationwide research with state and local implementation. Ensuring that these efforts rely on the best available social-science research and are implemented rigorously will require a fundamental reexamination of the way government funds research, staffs information offices, designs and evaluates programs, and interacts with state and local governments.[282] Personal motor vehicle idling is the type of activity that may be particularly amenable to change through a sophisticated national, state, and local effort. The effort not only could update individuals' beliefs about the extent to which shorter idling times are often in their personal economic interest, but it also could provide the information necessary to activate norms that influence idling times.

3. *Information on Economic and Human Health Harms*

As discussed above, the personal responsibility norm may be more widely held than the environmental protection norm.[283] Individuals are more likely to be motivated by information that indicates that their behavior will cause economic or physical harm to other people than by information about harms caused to the environment.[284] As a result, government efforts that disclose estimates of the potential human health and economic harms of climate change may activate carbon-neutrality norms among those who feel strongly about per-

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[280] *See* Katherine N. Probst, *Combating Global Warming One Car at a Time: CO_2 Emissions Labels for New Motor Vehicles*, RESOURCES, Spring 2006, at 9, 9–11 (proposing color-coded CO_2 emissions labels for all new cars and discussing similar initiatives outside United States); Elizabeth Rigby, *Tesco to "Carbon Label" Its Products*, FIN. TIMES (London), Jan. 19, 2007, at 1 (noting that UK grocery chain Tesco is providing carbon labels for all products indicating amount of CO_2 emitted during production, delivery, and consumption); *see also* Ian Herbert, *Carbon Footprint of Products To Be Displayed on Label*, INDEPENDENT (London), Mar. 16, 2007, at 22, *available at* http://www.independent.co.uk/environment/climate_change/article2362754.ece (describing initiative to provide labels detailing "carbon footprint" of products).

[281] Although policymakers have taken limited steps to use public information campaigns to reduce personal motor vehicle idling, a sophisticated, far-reaching effort has not been conducted in the United States. For policy proposals to reduce idling, see MMA, BARRIERS, *supra* note 111, at 54–58.

[282] *See infra* Part V.D.

[283] *See supra* Part IV.B.1.

[284] *See, e.g.*, Vandenbergh, *supra* note 131, at 88–99 (noting that human health and environmental norms may have distinct effects on behavior).

sonal responsibility but do not ascribe to the environmental protection norm.

Much remains to be done to compile both human health and economic information. As to human health harms, the Centers for Disease Control is just beginning a comprehensive program to identify the health effects of climate change.[285] As to economic harms, regulatory-impact assessments for recent regulations generally have excluded consideration of climate change. For example, although the corporate average fuel economy (CAFE) standards for personal motor vehicles are among the most important carbon-reducing measures for the transportation sector, the regulatory impact assessment for the 2006 CAFE amendments excludes consideration of the costs and benefits arising from potential climate-change impacts.[286] According to the assessment:

> The agency continues to view the value of reducing emissions of carbon dioxide and other greenhouse gases as too uncertain to support their explicit valuation and inclusion among the savings in environmental externalities from reducing gasoline production and use. . . . As a consequence, the agency has elected to include no economic value for reducing greenhouse gas emissions . . . among the benefits of reducing gasoline use via more stringent fuel economy regulation.[287]

Putting aside whether rational risk regulation by policymakers can occur if one of the most important long-term reasons for adopting a standard is excluded from the regulatory impact analysis, if government is to influence the behavior of those who adhere to the personal responsibility norm but not the environmental protection norm, it will need to express quantitative ranges for the dollar value of the economic and human health harms of climate change.[288] Academics and policymakers have demonstrated that cost-benefit analyses can be conducted by including broad ranges of potential costs and benefits, even if the precise costs and benefits are hard to calculate.[289]

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285 Kim Krisberg, *Climate Change Predicted To Have Dire Effects on Health*, NATION'S HEALTH (Wash., D.C.), Apr. 2007, at 1.

286 OFFICE OF REGULATORY ANALYSIS & EVALUATION, U.S. DEP'T OF TRANSP., FINAL REGULATORY IMPACT ANALYSIS: CORPORATE AVERAGE FUEL ECONOMY AND CAFE REFORM FOR MY 2008–2011 LIGHT TRUCKS 64–65 (2006), *available at* http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/2006_FRIAPublic.pdf.

287 *Id.*

288 *See* V. Kerry Smith et al., *Can Public Information Programs Affect Risk Perceptions?*, 9 J. POL'Y ANALYSIS & MGMT. 41, 57 (1990) (suggesting that quantitative assessments more effectively promote accurate assessments of risk from radon exposure).

289 *See, e.g.*, Jon Gjerde et al., *Optimal Climate Policy Under the Possibility of a Catastrophe*, 21 RESOURCE & ENERGY ECON. 289 (1999) (providing overview of probabilities

The regulatory impact analyses that accompany rulemakings are not widely accessible to the public, but they provide information that others use to disseminate information to the public. In addition, they demonstrate the extent to which agencies have been unwilling to quantify and disclose the effects of climate change, even if only in ranges. Rational risk regulation requires a more thoughtful approach than excluding the most pressing environmental issue of our time because of imprecise information.[290] Although the application of a cost-benefit analysis technique to climate-change regulations faces a number of obstacles, one possible solution is to amend the existing executive order on White House regulatory review of agency rulemakings[291] to require all relevant cost-benefit analyses to account for climate change—perhaps by using high, medium, and low assumptions regarding the costs and benefits of avoiding climate change. Doing so not only will contribute to more rational prioritization of regulatory resources but also may facilitate the linkage between personal responsibility and carbon neutrality among those who do not identify with environmentalism.

4. *The Carbon-Neutral Registry*

One of the fundamental challenges of the climate-change problem is that it poses a classic temporal trap: The costs of emissions reductions will have to be borne now, but they will principally benefit those who will be living fifty or more years from now.[292] The thought that future generations might revere those who act today might provide some solace to those bearing current costs. Yet there is little or no way for individuals today to take comfort from the notion that future generations might know that they achieved carbon neutrality and thus did not contribute to the problem.

We venerate those who are thought to have done great things in the past, including both the leaders and the group members. We also give higher esteem to their offspring, sometimes for many generations. One way to address the temporal trap regarding the costs and benefits of climate change is for government to establish a national Carbon-

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and costs associated with catastrophic climate change and proposing model for determining probabilities of catastrophe).

290 *See* Kenneth J. Arrow, *Global Climate Change: A Challenge to Policy*, ECONOMISTS' VOICE, June 2007, http://www.bepress.com/ev/vol4/iss3/art2 ("[B]oth futurity and uncertainty require significant discounting. However, even with that, . . . we are much better off to act to reduce CO_2 emissions substantially than to suffer and risk the consequences of failing to meet this challenge.").

291 Exec. Order No. 12,866, 3 C.F.R. 638 (1993), *reprinted in* 5 U.S.C. § 601 (2000).

292 *See* Rachlinski, *supra* note 249, at 299–303 (discussing "social traps" that can discourage collective action).

Neutral Registry. The Registry would list in a permanent, public monument the names of those who have pledged to be carbon neutral.[293] Although several aspects of the Registry, such as policing compliance with pledges of carbon neutrality, would pose substantial administrative challenges, research on the influence of public commitments suggests that minimal standards and enforcement may be adequate to generate substantial behavior change.[294]

B. Direct Carbon-Neutral Subsidies

One possibility for addressing the distributive justice issues raised above[295] is to provide public or private subsidies to overcome the lack of financial resources for some individuals. Although public subsidies may be necessary in the long run, they are difficult to fund at meaningful levels and are subject to waste and abuse. An appealing private alternative is to build upon the concept advanced by nonprofit firms such as GlobalGiving,[296] which enables individuals to use the Internet to make financial contributions directly to specific projects. This approach can reduce overhead to less than 10% and provide donors with a substantial amount of control over the use of their funds.[297]

A similar effort could leverage the carbon-neutrality norm by enabling individuals to purchase offsets from a program that directs funds to individuals who are at or near the poverty line. In addition to the benefits of compliance with the carbon-neutrality norm, those who purchase these offsets would gain the normative benefits of helping low-income individuals. Local community groups could serve as intermediaries, as could firms such as retailers of automobiles, appliances, and other equipment.[298]

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293 Efforts that rely on charitable contributions often provide measures of public recognition. An example is the tree-planting movement in Israel, which offers certificates for those who sponsor the planting of trees in the desert. Trees for the Holy Land, http://www.treesfortheholyland.com/index.html (last visited Oct. 22, 2007). Many of these charitable programs, however, do not confront the temporal trap presented by climate change because the donors and donees are currently living.

294 *See supra* note 224 and accompanying text.

295 *See supra* note 240 and accompanying text.

296 GlobalGiving, http://www.globalgiving.com (last visited Aug. 31, 2007).

297 GlobalGiving, How It Works, http://www.globalgiving.com/howitworks.html (last visited Aug. 31, 2007).

298 For a discussion of an "equity offset" scheme along these lines proposing a carbon offset market feature that would enable donors to subsidize the purchase of efficient goods by individuals at or near the poverty line, see generally Vandenbergh & Ackerly, *supra* note 240.

C. Standard Development and Enforcement

Retail carbon offsets and personal carbon calculators are two indispensable tools associated with carbon neutrality, but they require legitimacy among customers and the public in order to function. A recent technical assessment identified several shortcomings that raise concerns about the efficacy of carbon offsets.[299] Similarly, a forthcoming analysis of personal carbon calculators concludes that their methodologies lack transparency and that they vary widely in conversion factors and outputs.[300] In addition, many carbon-calculator providers are associated with retail carbon-offset providers who have incentives to promote higher offset sales.[301]

Given the lack of consumer knowledge, lack of transparency among products, and incentives of providers, standards for retail carbon offsets and carbon calculators are essential to ensure their efficacy and legitimacy. Enforcement of these standards may be equally important. Federal regulatory agencies have shown little interest in setting or enforcing standards, and it is unclear if they have the statutory authority to do so. Nevertheless, government could facilitate the development and enforcement of private standards.[302] Private standard-setting programs with private certifiers have proliferated in the forestry, fishing, and other industry sectors.[303] These standards appear to be influencing firm behavior, although the adequacy of the standards and the extent of their enforcement remain unclear.[304]

Private standard setting for retail carbon offsets is already under way,[305] and a similar effort may be necessary for carbon calculators. In addition, a variety of private certifiers have emerged to begin to fill

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299 *See* CLEAN AIR-COOL PLANET, *supra* note 217, at 21–23 (dividing offset providers into top-tier and non-top-tier based on quality of emissions reductions, and calling for more transparency from all providers). Concerns about carbon offsets have stimulated a congressional request for an inquiry by the Federal Trade Commission. Patricia Ware, *Markey Lauds Trade Commission's Decision to Review Effectiveness of Carbon Offsets*, Daily Env't Rep. (BNA) No. 156, at A-1 (Aug. 14, 2007).

300 *See* Padgett et al., *supra* note 216 (manuscript at 4–5, on file with the *New York University Law Review*) (noting that differences in carbon-calculator outputs may influence amount of effort individuals devote to reducing carbon emissions and types of steps they take).

301 TerraPass is an example of a for-profit firm that offers a carbon calculator and sells offsets. TerraPass, http://www.terrapass.com (last visited Aug. 31, 2007).

302 *See* Ware, *supra* note 299 (reporting that FTC will consider self-regulatory efforts of carbon-offset market as part of its review of environmental marketing claims).

303 Errol Meidinger, *The Administrative Law of Global Private-Public Regulation: The Case of Forestry*, 17 EUR. J. INT'L L. 47, 48–49 (2006).

304 Michael P. Vandenbergh, *The New Wal-Mart Effect: The Role of Private Contracting in Global Governance*, 54 UCLA L. REV. 913, 955–56 (2007).

305 *See* CTR. FOR RES. SOLUTIONS, *supra* note 233, at 2 (proposing private "Green-e standard for Greenhouse Gas Products").

the enforcement niche.[306] At a minimum, policymakers should facilitate the development of private standard-setting and private monitoring while assessing whether they will be sufficient to ensure the efficacy and legitimacy of retail carbon offsets and carbon calculators.

D. Agency Management and Oversight

Efforts to address individual and household carbon emissions also will require fundamental changes in the structure, staffing, and oversight of programs by government agencies. At a structural level, the effort to collect and disseminate information to activate norms may require the sustained attention and staffing that only a program dedicated to this mission can provide. For example, studies identifying the importance of trust in the source of the information, the importance of accounting for the socioeconomic status of the neighborhood, and the social influence of block captains on recycling programs suggest that carefully tailored, personnel-intensive programs will be more successful than many other types of information-dissemination programs.[307] At the same time, these face-to-face programs are expensive and difficult to organize and oversee.

Even if new programs are not initiated, staffing will require attention. Agency staffing reflects path dependency. For decades, legislative directives have required agencies such as the Department of Energy (DOE) and the EPA to focus principally on large industrial sources as the targets of their regulation.[308] Not surprisingly, their staffing reflects this industry focus. For example, the DOE is an outgrowth of the Atomic Energy Commission and thus is staffed largely with the engineers, scientists, and lawyers necessary to regulate large power-generating sources.[309] In the early 1980s, only seventeen of the 19,972 employees at the DOE claimed advanced training in political science, psychology, sociology, anthropology, or geography.[310]

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306 *See, e.g.*, CLEAN AIR-COOL PLANET, *supra* note 217, at 15–20 (private group ranking top carbon-offset providers).

307 *See supra* notes 166–69 and accompanying text. The Agricultural Extension Service of the U.S. Department of Agriculture may be well positioned to play this role in some communities. One institution worth further consideration is the Department of Energy's Residential Conservation Service (RCS). During the last energy crisis, the RCS played a leading role in information campaigns to reduce individual and household energy use, but the service was largely dismantled early in the Reagan Administration. *See* NRC, ENERGY, *supra* note 156, at 53 n.4 (describing general pressure to deregulate in 1981 and its effects on RCS).

308 *E.g.*, Emergency Planning and Community Right-to-Know Act of 1986 § 302, 42 U.S.C. § 11002(b) (2000) (limiting statute's requirements to facilities with substances above established thresholds).

309 NRC, ENERGY, *supra* note 156, at 12 n.4 (citing data from March 1981).

310 *Id.*

Although the requirements of generating cost-benefit analyses have induced the DOE, EPA, and other agencies to hire economists over the last several decades, the agencies have had little incentive to hire other social scientists who are trained to design, implement, and evaluate programs that use information to change individual behavior.

In addition to adding expertise from the social sciences to regulatory staffs, regulators will need to become less reluctant to use principles of effective communication.[311] At the outset, it is important to note that experts are not immune to deficiencies in rational decisionmaking arising from inadequate information and cognitive biases.[312] These deficiencies may have affected both the implementation of information-transmission systems by policymakers and the research supporting these systems by scholars.

Recent work by Robert Cialdini and colleagues demonstrates the depth of resistance by government managers to recommendations from social scientists.[313] Through a series of studies, Cialdini found that the National Park Service could reduce the theft of petrified wood from national parks through a campaign that emphasized both a descriptive norm (that the vast majority of park visitors do not steal fossils) and an injunctive norm (that stealing fossils is wrong).[314] Despite robust, statistically significant results from blind studies, park managers still choose to make decisions based on informal data gathering and their (incorrect) intuitive judgments about visitors' responses to messages.[315]

Perhaps not surprisingly, this type of decisionmaking by regulatory experts regarding individual behavior tracks how nonexperts make decisions. Intuitions about human behavior are often incorrect, and anecdotal information, gathered firsthand from individuals that the decisionmaker knows, may exert strong influences on decisionmaking.[316] The successful use of information by regulatory agencies will require a more sophisticated approach.

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311 *See id.* at 74–75 ("[G]overnment officials have generally been unwilling to build energy information programs on principles of effective communication.").

312 *See* Paul Slovic et al., *Rating the Risks*, 21 ENVIRONMENT 14, 17, 38–39 (1979) (discussing how experts' biases cause them to underestimate risks and develop inadequate safeguards).

313 *See* Robert B. Cialdini, *Basic Social Influence Is Underestimated*, 16 PSYCHOL. INQUIRY 158, 159 (2005) (describing how leaders consistently underestimate persuasive power of others' behavior despite social science research on issue); Robert B. Cialdini et al., *Managing Social Norms for Persuasive Impact*, 1 SOC. INFLUENCE 3, 5 (2006) (detailing government information campaigns ignoring current understandings of social influence).

314 Cialdini et al., *supra* note 313, at 10–11.

315 *Id.* at 12.

316 NRC, ENERGY, *supra* note 156, at 68 (relating example of weighing friend's experience with car over respected consumer magazine's opinion of car).

Finally, policymakers will need to improve the oversight of government public information programs.[317] This need extends to both the performance of the information dissemination efforts themselves (e.g., to what extent did carbon-emissions reductions arise from individual behavior change?) and the management of the programs by federal agencies, state and local governments, and contractors who are likely to carry out many aspects of the information programs (e.g., was money spent wisely?). Without careful design and monitoring, there is a risk that information campaigns will be costly and ineffective.[318] A major emphasis on public information campaigns without such controls may devolve into a wasteful subsidy for state and local governments and social-marketing firms that will only reinforce the skepticism of scholars and policymakers.

CONCLUSION

The model results presented in this paper demonstrate the substantial contributions of individuals and households to carbon dioxide emissions, but much remains to be understood about the contributions from individuals as well as the social, economic, and legal influences on individual carbon-emitting behaviors. Regulatory measures designed to change the behavior of electric utilities or consumer-products manufacturers can assume a high degree of rationality in decisionmaking. In contrast, individuals often lack adequate information, suffer from cognitive biases, are subject to social influences, and act in ways that are not easily understood through the lens of a rational-actor model.

A broad mix of social, economic, scientific, and legal perspectives and remedies will be required to address individuals' contribution to climate change. The growing popularity of carbon neutrality demonstrates the potential influence of norms on individual carbon-emitting behaviors. Private parties are responsible for much of the carbon-neutrality effort to date, but government may be able to push carbon neutrality past a tipping point by collecting and disseminating the information necessary to link carbon neutrality to the widely held abstract norm of personal responsibility. This Article has identified a number of concrete steps available to policymakers.

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317 *See id.* at 74–80 (describing current ineffectiveness of government information programs).

318 Knowing that waste or poor management could eviscerate support for public works programs, President Franklin D. Roosevelt put strong controls in place for the New Deal agencies. *See* Angel Manuel Moreno, *Presidential Coordination of the Independent Regulatory Process*, 8 ADMIN. L.J. AM. U. 461, 484–86 (1994) (describing Roosevelt's aggressive stance towards independent agencies).

Efforts to change individual behavior through norm activation will require the public sector to play a role that it has rarely played on environmental issues in the past, and theoretical and empirical questions remain. Academics can contribute to this effort through research that engages environmental engineers, atmospheric scientists, social and behavioral scientists, and law and policy scholars, among others, in an effort to identify the behaviors that contribute most to carbon emissions, the social and economic influences on those behaviors, and the legal and policy responses necessary to ensure that behavior change measures are cost-effective and minimally intrusive.[319]

Individual behavior change is seen by some as "silly"—not the stuff of rigorous, rational regulatory policy.[320] Perhaps the most difficult change for policymakers and scholars will be to treat the individual sector with the same level of sophistication and rigor as the industrial sector and other sectors. The limited success of energy-efficiency campaigns during the energy crisis of the 1970s, and the failure of campaigns that encouraged mass transit and carpooling over the last several decades, have led to deep skepticism about behavior change. Yet the magnitude and timing of the emissions reductions required to reduce the risk of catastrophic climate change, combined with the large potential reductions that could be achieved from individuals, suggest that individual behavior should not—and perhaps cannot—be left on the sidelines during the development of a comprehensive climate-change regulatory regime.

319 *See* NRC, DECISION MAKING, *supra* note 6, at 69 (advocating federal agency support for "concerted research effort" on environmentally significant individual behavior).

320 Paine, *supra* note 126.

APPENDIX

The model estimates the contribution of individual behavior to U.S. carbon dioxide emissions in 2000.[321] Individual behavior includes only those behaviors that are under the direct, substantial control of the individual and that are not undertaken in the scope of the individual's employment. The model divides individual behavior into two categories: household behaviors and transportation behaviors.

A. Households

The household behaviors present a challenge because most residential energy-consumption data are presented as household numbers. To account for this discrepancy, we convert data given per household into data per individual, using the average American household size as reported by the United States Census Bureau.[322]

To test the reliability of the model, we estimate household emissions by using top-down and bottom-up approaches. For the top-down approach, we calculate household energy consumption using EIA data for residential fuel consumption. The EIA defines the residential sector as "[a]n energy-consuming sector that consists of living quarters for private households."[323] A "household" is "[a] family, an individual, or a group of up to nine unrelated persons occupying the same housing unit."[324] To create a profile of individual greenhouse gas emissions, we convert household energy use into individual energy use. The 2000 U.S. Census reports that the U.S. population was 281,421,906, with an average household size of 2.59 persons per household.[325] We divide the population by the average household size and calculate the number of households in the United States to be 108,657,106.

Following the EIA's practice, we separate household energy use into two categories: primary use and electricity use. Primary use includes household energy consumption apart from an external

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321 To ensure consistency, the data used in the model are from 2000 unless otherwise stated.

322 U.S. Census Bureau, American FactFinder, Occupied Housing Characteristics: 2000, http://factfinder.census.gov (click "Data Sets" on left side of page; then click "Geographic Comparison Tables"; then select geography type of "Nation" and table format of "United States – States; and Puerto Rico"; then click "Show Result") (last visited Aug. 18, 2007). We divide each data set given "per household" by 2.59 persons per household.

323 EIA, 2004 REVIEW, *supra* note 62, at 392 (emphasis removed).

324 *Id.* at 385.

325 U.S. Census Bureau, *supra* note 322.

power-generation source.[326] Examples of primary energy users are water heaters and stoves that utilize coal, natural gas, petroleum, or wood, as opposed to electricity from a power plant.[327] By contrast, the electricity category includes all household energy generated at a power plant, regardless of fuel usage.[328]

For primary use, the EIA's *Annual Energy Review* provides the number of British thermal units (Btus) used annually in the residential sector for coal, natural gas, petroleum, and wood.[329] We convert these values into pounds of carbon dioxide by multiplying by the respective conversion factors (pounds of carbon dioxide per million Btu).[330] Where the EIA further subdivides each primary energy source, giving multiple conversion factors for each, we calculate an average of all the conversion factors for each broad energy source (coal, natural gas, petroleum, and wood). Finally, we divide these values by the number of households and the population size to determine the amount of carbon dioxide emitted per household and per person.[331]

To divide power plant electricity into its corresponding fuels, we calculate the percentage of fuel consumption used by referring to the electricity flow diagram in the *Annual Energy Review*.[332] Using the *Annual Energy Review*, we obtain the total residential electricity use for 2000[333] and multiply it by the percentages of fuel consumption to ascertain the number of Btus attributable to each fuel source. We do not account for inefficiency in electricity generation and line loss. We multiply the thermal energy values by the same conversion factors used in the primary consumption calculations,[334] and then we reduce the figures into pounds per household and pounds per individual.

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326 Email from Robert Adler, Energy Info. Admin., Dep't. of Energy, to Paul Padgett, Graduate Student, Vanderbilt Univ. (June 23, 2006) (on file with the *New York University Law Review*).

327 *See id.* ("Electricity is itself the result of using other fuels to generate it.").

328 *See* EIA, 2004 REVIEW, *supra* note 62, at 382 (defining "electricity retail sales").

329 *Id.* at 39 tbl.2.1b.

330 *See* EIA, LONG FORM, *supra* note 73, at 47–48 (listing conversion factors for energy sources). For example, 5126 trillion Btu of natural gas × 128.129 lbs. CO_2 per million Btu = 657 billion lbs. produced from the primary consumption of natural gas. The 128.129 coefficient for natural gas was determined by averaging the coefficients of the two natural gases (pipeline natural gas and propane) that are used by households.

331 For example, 657 billion lbs. CO_2 produced from primary natural gas consumption ÷ 108,657,106 households ÷ 2.59 persons per household = 2330 lbs. CO_2 per person from primary natural gas consumption.

332 *See* EIA, 2004 REVIEW, *supra* note 62, at 223 (showing 2004 fuel consumption at power plants). We assume that the distribution of fuel use did not change from 2000 to 2004, and we use these figures to calculate the relative 2000 fuel use at power plants.

333 *Id.* at 39.

334 *See* EIA, LONG FORM, *supra* note 73, at 47–48 (listing conversion factors).

We also calculate percentages using dollars spent per fuel source for various household energy uses, such as space heating and lighting, to examine the relative correlation of fuel type and use.[335] We calculate these percentages for each fuel and then propagate the figures through the model to display the amount of carbon dioxide emissions per fuel source per activity.

To validate the top-down approach, we also calculate the household carbon dioxide emissions using a bottom-up approach. We use the EIA's *U.S. Household Electricity Report*, which includes a detailed analysis of end-use electricity consumption for households in 2001.[336] For large numbers of household appliances, it provides the average use per household in kilowatt hours and the number of households utilizing these appliances.[337] From the work discussed above, it is evident that 69.3% of electricity generated at power plants creates carbon dioxide emissions (the remainder is generated by nuclear power, hydropower, etc.).[338] We multiply the EIA's household electricity-consumption numbers by this percentage to yield an estimate of the amount of emission-producing electricity used by each appliance.[339] We then convert the reduced electricity values into Btu.

We also calculate a conversion factor for pounds of carbon dioxide emitted per Btu of electricity by dividing the sum weight of carbon dioxide emitted in pounds for all electricity sources by the sum of Btu consumed. Using this factor, we further convert the reduced electricity values into pounds of carbon dioxide emitted in total and per household. Since these numbers are intrinsically dependent on explicit household usage, they represent an estimate of carbon emissions associated with actual behavior. As discussed above,[340] we identify a per-individual number by dividing the carbon dioxide totals by population size to provide a blended individual average. This approach allocates to every person a share of emissions regardless of behavior.

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335 D&R INT'L, LTD., 2005 BUILDINGS ENERGY DATA BOOK 4-4 (2005), *available at* http://buildingsdatabook.eren.doe.gov/docs/2005bedb-0805.pdf (prepared for Office of Planning, Budget Formulation & Analysis, U.S. Dept. of Energy).

336 EIA, End Use, *supra* note 76.

337 *Id.*

338 EIA, 2004 REVIEW, *supra* note 62, at 223 (showing that fossil fuels account for 28.25 quadrillion Btu out of total of 40.7 quadrillion Btu consumed to generate electricity in United States).

339 For example, 304.5 billion kWh consumed in the kitchen × 69.3% of electricity-producing CO_2 = 211.0185 billion kWh of emission-producing electricity consumption. *See* EIA, End Use, *supra* note 76 (showing 304.5 billion kWh consumed by kitchen appliances in 2001).

340 *See* text accompanying note 77.

B. *Transportation*

According to the EIA, the transportation sector is "[a]n energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another."[341] We divide individual transportation into three categories: automotive, air, and other. We include in automotive transportation all personal vehicle use excluding business travel. We include in air transportation all air travel except business travel and freight. We assign rail and mass transit to an "other" category and are unable to account for personal versus business use.

The EIA provides data on the amounts of motor fuel consumed annually by household uses of passenger cars, vans, SUVs, pickup trucks, and recreational vehicles.[342] We translate these values into pounds of carbon dioxide using the same conversion factors used in the household calculations and then into pounds per person.[343]

We calculate carbon dioxide emissions for domestic passenger air travel from values provided by the Bureau of Transportation Statistics.[344] Using values for the year 2000, we multiply energy intensity per passenger mile (Btu/mile) by the total number of domestic passenger miles, after reducing the total number of miles to account for personal versus business travel.[345] We convert the resulting figure into total pounds of carbon dioxide for all passenger air travel using the conversion factor for jet fuel provided by the EIA,[346] and we divide the total by the total population to yield pounds of carbon dioxide per person.[347]

The North American Transportation Statistics (NATS) database provides values for energy consumed by rail travel.[348] We convert

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341 EIA, 2004 REVIEW, *supra* note 62, at 394 (emphasis removed).

342 ENERGY INFO. ADMIN., *supra* note 103, at 53–56 tbl.A1.

343 For example, for passenger cars, 55 billion gallons of petroleum × 19.564 lbs. CO_2 per gallon petroleum ÷ 281,421,906 people in the United States = 3823.5 lbs. CO_2 per person. See EIA, LONG FORM, *supra* note 73, at 47, for conversion factors.

344 BUREAU OF TRANSP. STATISTICS, U.S. DEP'T OF TRANSP., NATIONAL TRANSPORTATION STATISTICS 2003 at tbl.4-21 (2003), *available at* http://www.bts.gov/publications/national_transportation_statistics/2003/pdf/entire.pdf.

345 Seventy-seven percent of passengers reported that their most recent air travel was for nonbusiness purposes. *See* Bureau of Transp. Statistics, *supra* note 82, at 2.

346 EIA, LONG FORM, supra note 73, at 47.

347 Energy intensity per passenger mile × passenger miles × percentage of nonbusiness travel × lbs. of carbon dioxide per million Btu of jet fuel ÷ the population, or $3883 \times 5.1613 \times 10^{11} \times 0.77 \times 156.258 \div 281{,}421{,}906 = 857$ lbs. of carbon dioxide per person.

348 N. Am. Transp. Statistics Database, Table 4-1: Energy Consumption by Mode of Transportation, http://nats.sct.gob.mx/nats/sys/tables.jsp?i=3&id=14 (last visited Aug. 18, 2007).

these energy amounts, given in joules, to Btu and then to pounds of carbon dioxide using the factors provided by the EIA.[349]

The NATS database also provides values for energy consumed by mass transit.[350] We divide these values into fuel sources used—electricity, gasoline, diesel, and natural gas—and we convert from joules to Btu.[351] We then convert gasoline, diesel, and natural gas into pounds of carbon dioxide per person with the conversion factors cited above.[352] We define a conversion factor for electricity using the same figures used in household calculations: From electricity calculations, we divide total pounds of carbon dioxide emitted by total Btu necessary to emit a pound of carbon dioxide per Btu conversion factor, which converts Btu of electricity used in mass transit into pounds of carbon dioxide per person.

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349 *See* EIA, LONG FORM, supra note 73, at 47.

350 N. Am. Transp. Statistics Database, *supra* note 348.

351 *See* EIA, LONG FORM, supra note 73, at 53 (listing conversion factors for units of measure).

352 *See id.* at 47 (listing emission coefficients for different energy sources).