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SMART-GRID: TECHNOLOGY AND THE PSYCHOLOGY OF ENVIRONMENTAL BEHAVIOR CHANGE

STEPHANIE M. STERN*

INTRODUCTION

There is a growing debate about the capacity of psychological forces, including social norms, personal values, and information provision, to reduce individual emissions and pollution. One group of scholars has argued that values, personal norms, social pressure, and information campaigns can activate and maintain individual pro-environmental behaviors.¹ This line of research has focused on interventions to activate personal norms and increase the visibility of household environmental behaviors.² Other researchers are more pessimistic and contend that cognitive, motivational, and social forces sharply limit behavioral change, at least for certain subtypes of environmental behaviors that involve large numbers of players and minimal personal payoffs.³ They advocate greater use of financial incentives and structural changes that increase the convenience of environmentally-friendly behaviors.⁴

Both camps of legal scholarship have neglected the less intellectually enticing, but in some cases more potent, domain of technology. Indeed, for

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1. See, e.g., Hope M. Babcock, *Assuming Personal Responsibility for Improving the Environment: Moving Toward a New Environmental Norm*, 33 HARV. ENVTL. L. REV. 117, 174 (2009) (concluding that despite its costs and fallibilities, norm change is more effective than other means of producing individual behavior change); Michael P. Vandenbergh & Anne C. Steinemann, *The Carbon Neutral Individual*, 82 N.Y.U. L. REV. 1673, 1713–1717 (2007) (discussing how the norms of personal responsibility and carbon neutrality can affect individual and household greenhouse gas emissions); see also Jed S. Ela, Comment, *Law and Norms in Collective Action: Maximizing Social Influence to Minimize Carbon Emissions*, 27 UCLA J. ENVTL. L. & POL'Y 93, 93–94 (2009) (discussing the importance of social visibility in environmental behavior change).

2. See *id.*

3. See, e.g., Ann E. Carlson, *Recycling Norms*, 89 CALIF. L. REV. 1231, 1236 (2001) (“Though social norms can, and sometimes do, play a role in encouraging cooperative behavior to resolve large-number, small-payoff problems, if recycling is any indication, their force is fairly limited.”).

4. See *id.* at 1292–95.

many environmental behaviors, the scholarly debate may soon be moot. Technology and automation are poised to reduce both the need for and the costs of individual behavior modification in many contexts, including residential energy usage. Psychology research has long established that consumer adoption of energy-efficient and pollution-reducing technology has much greater impact on consumption behavior than psychological and informational interventions.⁵ The comparative neglect of technology in the environmental law scholarship is worrisome: lawyers, policymakers, and scholars will need to be technology's legal architects and to balance environmental gains against autonomy, property rights, and privacy.

This Essay questions the efficacy of traditional norm change and information provision interventions to reduce pollution from residential electricity consumption. The example of electricity "smart grids" illustrates how technology engineered to override cognitive and behavioral limitations can substantially reduce energy consumption and emissions.⁶ By bringing into sharper analytical focus what is likely to be effective in households, smart grid enhances our understanding of the psychology of individual environmental behavior change and underscores the importance of technology to human behavior. It also increases the common ground between the optimist and pessimist accounts in the legal scholarship: It is not despite cognitive and behavioral limitations but because of them—and because of technology specifically adapted to human limitations—that we are likely to see major reductions in individual emissions.

In the near future, we may dispense with information pamphlets, slogans to encourage households to turn off lights, energy audits, and the like in favor of sophisticated default- and preference-setting and integrated external control of residential electricity. Smart grid is a high-efficiency infrastructure for electricity transmission and distribution that employs automated and semi-automated consumption management, integrated communications, real-time information sharing, and advanced sensor and measurement technology.⁷ Smart grid technology automates residential electricity delivery and appliance cycling based on consumer preferences,

5. See Paul C. Stern & Gerald T. Gardner, *Psychological Research & Energy Policy*, 36 AM. PSYCHOLOGIST 329, 331–34 (1981) (noting the importance of encouraging active conservation behavior but concluding that the largest gains frequently derive from adoption of efficiency-enhancing technology).

6. See Scott Blake Harris, *The SmartGrid Stakeholder Roundtable Group: Perspectives for Utilities and Others Implementing Smart Grids*, in GREEN TECH. LAW & BUS. 2010: LEGIS., FIN., CARBON TRADING & SUSTAINABILITY, 139, 147 (PLI Corp. Law & Prac., Course Handbook Ser. No 227371785, PLI/CORP 139, 147 (2010)).

7. See *id.*

grid emergencies, or imminent shortages.⁸ The technology is capable of suggesting preferences or setting default preferences for households and even individual appliances based on profiles of past energy use patterns.⁹ By reducing the behavioral demand and information load on consumers, smart grid significantly decreases consumption, particularly peak load energy use. When smart grid employs less than full technology override, it is capable of “layering” multiple behavior change mechanisms including real-time information and immediate feedback, social norm dissemination through data about others’ usage, and incentives from off-peak rate structures (often immediately visible on meters).¹⁰

A comprehensive smart grid should be available in another decade or two; even if a national grid fails to emerge, discrete smart grids and smart grid technology will be prevalent. Individual elements of the smart grid, such as smart meters, are already in use in some areas.¹¹ In anticipation of smart grid implementation, there has been an enormous uptick of research and development and significant lawmaking to fund smart grid planning. The Energy Independence and Security Act of 2007 created a research, development, and demonstration program for smart grid technologies and the American Recovery and Reinvestment Act provides more than \$11 billion for research and pilot projects.¹²

For households and individual polluters, smart grid illustrates technology’s key role in collective action problems where comprehensive pollution-reduction is “high behavioral demand” and requires frequent (often daily) action and ongoing vigilance across multiple contexts. In the legal scholarship, Ann Carlson has questioned the efficacy of social norm and other psychological manipulations in “large-number, small-payoff” collective action problems such as recycling.¹³ This Essay contributes to this analysis the concept of high behavioral demand and contends that the barriers described by Carlson intensify when behavior change requires repeated actions across multiple contexts and ongoing cognitive vigilance.

8. See *infra* Part II.B.

9. See *id.*

10. Researchers have found that layering multiple interventions substantially increases behavior change. See Paul C. Stern, *Toward a Coherent Theory of Environmentally Significant Behavior*, 56 J. SOC. ISSUES 407, 419 (2000) (“By far, the most effective behavior change programs involve combinations of intervention types.”).

11. See U.S. DEP’T OF ENERGY, *The Smart Grid: An Introduction*, at 2.

12. Energy Independence and Security Act of 2007, 42 U.S.C. §§ 17381-17382 (Supp. I 2007). In addition, at the state level, the National Association of Regulatory Utility Commissions (NARUC) is studying and pursuing aspects of smart grid implementation. See U.S. Dep’t of Energy, *The Smart Grid: An Introduction*, at 26.

13. See Carlson, *supra* note 3, at 1241–44.

Further amplifying the barriers to change, psychologists have found that behavior perceived as ongoing deprivation or “constant curtailment” is the most resistant to modification.¹⁴

In the context of residential electricity, not only is usage widespread (rather than emerging in a tight-knit community) and the payoff from reduction modest or moderate, the frequency and intensity of behavioral demand is often steep. To reduce electricity usage comprehensively, individuals must complete high-frequency behaviors (e.g., turning off or cycling down) across multiple household appliances, process complex information, and continuously monitor usage. Of course, not every household conservation behavior is high cost. For example, switching to high-efficiency light bulbs and resetting hot-water heaters are comparatively simple and infrequent behaviors. However, even in these instances the low rate of action suggests barriers to behavior change.

Automation and semi-automation are critically useful for household environmental behaviors subject to multiple barriers to behavior change: high numbers, modest payoffs, low visibility, and, in particular, high behavioral demand. Automated technology may be especially useful for private behaviors, such as electricity use within the home, where there is low visibility and a strong sense of personal prerogative.¹⁵ Greater reliance on automation, even at some expense to individual autonomy, takes previous calls in the environmental law literature for restructuring behavioral “architecture” several steps further.¹⁶ Technological automation and semi-automation move convenience to the (controversial) level of control. And there is no more comprehensive example of architectural overhaul than a fully integrated, national smart grid.

This Essay employs the example of smart grid to assess the merits of technology and automation as compared to traditional norm activation and information campaigns. Part I of the Essay provides an overview of the envisioned smart grid as well as smart technologies already in use. Part II argues that in light of the specific characteristics of residential energy

14. See generally Stern & Gardner, *supra* note 5.

15. See generally Stephanie M. Stern, *Residential Protectionism and the Legal Mythology of Home*, 107 MICH. L. REV. 1093 (2009) (describing the cultural importance attributed to control over the home and the impact on laws regulating dispossession); Jed S. Elia, Comment, *Law and Norms in Collective Action: Maximizing Social Influence to Minimize Carbon Emissions*, 27 UCLA J. ENVTL. L. & POL'Y 93, 117–18 (2009) (describing the importance of behavioral visibility and concluding that resources should be directed to more visible environmental behaviors and to raising the visibility of private actions).

16. See Lawrence Lessig, *The New Chicago School*, 27 J. OF LEGAL STUD. 661, 662–63 (1998); Carlson, *supra* note 3, at 1253–54 (expanding Lessig's description of architecture and applying it to personal recycling).

usage, automation and technological innovation warrant greater attention by scholars. Specifically, I contend that automation and technology are better suited than single-process behavioral interventions to address residential electricity collective action problems entailing high-frequency, costly, and varied behavioral demands. Part III considers the potential of smart grid to circumvent traditional barriers to reducing household electricity. In this part, I raise—though do not resolve—some of the complex legal issues at stake in balancing personal autonomy and pollution-reducing automation.

I. SMART GRID AND THE RESIDENTIAL HOUSEHOLD

Smart grid is an integrative technology that seeks to optimize electricity transmission and distribution, increase efficiency, and expand the use of information technology and two-way communication between the consumer and utility.¹⁷ This electrical “super-highway” of the near future envisions electricity delivery across extra high voltage transmission lines that increase efficiency and dramatically reduce the power line footprint.¹⁸ Smart grid incorporates technologies such as consumer “smart meters” (which are already in use in some areas), sophisticated consumer preference-setting, and master control of electricity distribution.¹⁹

A. *Smart Grid’s Environmental and Efficiency Gains*

Because electricity must be consumed when generated, producing the right supply of electricity based on comprehensive, real-time demand information is critical to energy efficiency.²⁰ Electricity generation is responsible for forty percent of all carbon dioxide emissions, making this sector a major contributor to global warming and its associated environmental harms.²¹ High-polluting, coal-burning power plants are the source of over one-half of all electricity generated in the United States.²² Smart grid reduces pollution by decreasing both the amount of electricity consumed and the amount lost in transmission.²³ To put the potential carbon savings in

17. See Harris, *supra* note 6, at 147.

18. See Joseph P. Tomain, “Steel in the Ground:” *Greening the Grid with the iUtility*, 39 ENVTL. L. 931, 934 (2009).

19. See Harris, *supra* note 6, at 149–150.

20. See *id.* at 13–14.

21. See *id.* at 20. One study found that in 2000, each person in the United States on average was responsible for 1,922 pounds of carbon dioxide emissions. See Michael P. Vandenberg & Anne C. Steinemann, *The Carbon Neutral Individual*, 82 N.Y.U. L. REV. 101, 119 (2007).

22. See Tomain, *supra* note 18, at 931.

23. See U.S. DEP’T OF ENERGY, *supra* note 11, at 20.

context, a five percent increase in electricity grid efficiency is equivalent to eliminating greenhouse gas emissions from 53 million cars.²⁴

Smart grid enables utilities to increase energy efficiency through enhanced load control capabilities and reduced losses across the transmission and distribution grids.²⁵ In particular, more sophisticated deployment of electricity reduces peak load provision (typically during the morning and then late afternoon to evening) and thus the use of high-polluting “peaker plants” which come online during these demand windows.²⁶ A fully-functioning smart grid also reduces integration costs for renewable technologies (e.g., solar sources), powers plug-in hybrid and electric vehicles on a national scale, and enables “net metering” where customers can sell excess electricity back to the utility.²⁷ Other mechanisms for increasing energy efficiency include intelligent substations that improve supply-demand matching by providing utilities more real-time information, energy storage devices that enable electricity deployment during peak demand, and more widely distributed generation controls that allow customer-owned distribution or mini-grids.²⁸ Smart grid also increases reliability and reduces outages through better control of distribution, phasor measurement units that sample voltage and current many times per second, and the capacity to “self-heal” the grid.²⁹

Notably, the transition to smart grid will not be costless. Smart grid is likely to increase electricity bills for consumers, at least in the short-term, to recoup infrastructure costs.³⁰ However, absent a move to smart grid, our aging and inefficient electricity infrastructure, created before the age of microprocessors, will soon require major upgrading or overhaul.³¹ As a result of population growth, larger houses, and more power-intensive electronics and appliances, transmission growth has lagged behind electricity

24. See U.S. DEP’T OF ENERGY, *supra* note 11, at 7.

25. See *id.* at 11–12, 29, 33.

26. See *id.* at 13.

27. See Steven Ferrey, *Restructuring a Green Grid: Legal Challenges to Accommodate New Renewable Energy Infrastructure*, 39 ENVTL. L. 977, 993–94 (2009) (discussing issues integrating unpredictable renewable power flow into traditional grids).

28. See Harris, *supra* note 6, at 151–53, 155.

29. See U.S. DEP’T OF ENERGY, *supra* note 11, at 12 (discussing phasor measurement units).

30. For example, for a city of one million people a complete smart grid system is forecast to cost one billion dollars. See OFFICE OF THE OHIO CONSUMERS’ COUNSEL, CONSUMERS FACT SHEET, AN INTRODUCTION TO SMART GRID 4 (2010) [hereinafter OFFICE OF THE OHIO]. Even with more limited implementation, such as smart metering only, consumer costs may increase. One smart metering program in Bakersfield, California resulted in bill increases and a subsequent lawsuit. See MacKinnon Lawrence, *Bringing the Smart Grid Home: Will Consumers Opt-in?*, CLEAN TECHIES BLOG (June 8, 2010, 8:00 AM), <http://blog.cleantechies.com/2010/06/22/bringing-the-smart-grid-home-will-consumers-opt-in>.

31. See U.S. DEP’T OF ENERGY, *supra* note 11, at 2, 6, 18.

demand every year since 1982.³² Moreover, the U.S. Energy Information Administration predicts that electricity demand will increase thirty percent over 2008 levels by 2035.³³ The deployment of a national smart grid could reduce electricity demand by as much as thirty-eight to forty-eight percent.³⁴ In the long-term, smart grid will save consumers money by avoiding ineffective and expensive piecemeal repair of an antiquated infrastructure. Smart grid will also reduce residential electricity consumption substantially so long as households don't "take back" efficiency gains by increasing usage or purchasing more energy-intensive electronics. If consumer take-back occurs, smart grid is more adept than traditional infrastructure at mitigation through pricing, external grid control, more sophisticated appliance cycling, and lower default consumption settings.³⁵

B. Residential Electricity: Bringing Smart Grid Home

A major focus of the current discussion and debate regarding smart grid is its application to residential consumers.³⁶ Residential smart grid technology utilizes advanced metering infrastructure (AMI), which encompasses smart meters and smart appliances.³⁷ Advanced metering infrastructure communicates real-time price signals to residential smart home controllers or appliances.³⁸ These devices then power according to the technology's "learned" preferences (i.e., a profile based on past use), default settings, or settings selected by the consumer.³⁹ As the U.S. Department of Energy notes, "[b]ecause this interaction occurs largely 'in the background' with minimal human intervention, there's a dramatic savings on energy that would otherwise be consumed."⁴⁰

Smart meters provide consumers with real-time or near real-time information about energy usage.⁴¹ They can also be utilized to allow consumers to "pre-commit" to operating appliances or consuming higher levels

32. *See id.* at 6.

33. *See* OFFICE OF THE OHIO, *supra* note 30, at 2.

34. *See* Marc W. Chupka et al., *Transforming America's Power Industry: The Investment Challenge 2010–2030*, THE BRATTLE GROUP 19 (Nov. 2008), http://www.brattle.com/_documents/UploadLibrary/Upload725.pdf. *See* Marc W. Chupka et al., *Transforming America's Power Industry: The Investment Challenge 2010–2030*, at 19 (2008), available at http://www.brattle.com/_documents/UploadLibrary/Upload725.pdf.

35. *See id.* at 6, 37.

36. *See id.* at 10–11.

37. *Id.* at 11.

38. *See id.*

39. *Id.*

40. *Id.*

41. *Id.* at 14, 41.

of electricity during times when energy demand and cost are lower.⁴² One Department of Energy Demonstration project on the Olympic Peninsula found that delivering electricity based on the consumer's preset preference profile saved consumers ten percent on their bills and reduced peak load by fifteen percent.⁴³ Several cities have made or are making major investments in smart meters, including Miami's recent 200 million dollar investment in smart meters, Cincinnati's installation of 30,000 smart meters, and plans in California to install a total of 9.8 million smart meters in the northern and central parts of the state.⁴⁴

Smart appliances communicate directly with the grid and enable utilities to cycle individual household appliances on and off. Smart appliances are also able to receive price signals about peak rates and remain on but automatically shift into a reduced electricity usage or conservation mode (e.g., clothes dryer will take longer to dry but the appliance is not cycled off entirely and the consumer receives discounted pricing).⁴⁵ Currently, early prototypes of smart appliances are beginning to become available on the market, with General Electric recently launching consumer energy communication devices.⁴⁶ External control of smart appliances may occur, in theory, with or without consumer permission or may utilize a middle-ground approach where consumers complete preference-settings that subsequently control their appliances. The differential in rate structures for peak/off-peak, coupled with initial consumer costs from smart grid infrastructure, may mean that many consumers opt for large amounts of automated cycling—a good result from the standpoint of consumer behavior change and environmental protection.⁴⁷

Instead of relying solely on automation, residential smart grid technologies can also utilize semi-automation and layered behavior change interventions to encourage households to voluntarily reduce consumption. For example, smart technologies can provide real-time cost feedback, environmental impact information, and even peer usage benchmarks. The smart grid can send customers price signals in order to address short-term power supply imbalances or potential grid emergencies and enable consumers to

42. See Harris, *supra* note 6, at 159.

43. See U.S. DEP'T OF ENERGY, *supra* note 11, at 30.

44. See Ariel Schwartz, *One Million Smart Meters for Energy-Smart Miami Program*, April 20, 2009, available at <http://www.fastcompany.com/blog/ariel-schwartz/sustainability/1-million-smart-meters-energy-smart-miami-program>; OFFICE OF THE OHIO *supra* note 30, at 1, 45.

45. See Martin LaMonica, *Are Consumers Ready for the Smart Grid?*, CNET News (July 15, 2009) 2, http://news.cnet.com/8301-11128_3-10287240-54.html.

46. See *id.* at 1.

47. See Harris, *supra* note 6, at 156.

sell energy back to the grid.⁴⁸ Price information is most helpful when utilities amplify the price signal to the consumer by “decoupling” the infrastructure and fixed costs from the volume of electricity sales.⁴⁹ While some degree of automation or a combination of automation and pricing appear most effective, information about energy usage and environmental impacts as well as non-monetary incentives also have a role (especially when automation is unavailing or normatively undesirable).

II. PSYCHOLOGY OF INDIVIDUAL ENVIRONMENTAL BEHAVIOR CHANGE: MOVING TOWARD AUTOMATION “NORMS”

Psychologists and engineers have long recognized the primacy of technology to environmental behavior change. Legal scholarship, on the other hand, has focused disproportionately on altering norms and inculcating civic virtue. There has been an ongoing debate in the legal scholarship about whether—or in what circumstances—norm, value, and awareness-raising initiatives can form the basis of successful environmental reform.⁵⁰ To the extent this debate marches on, it is beginning to sound a little dated. Moreover, this framing of the issue has led to the comparative neglect of automation and technology as behavior change agents.⁵¹

This Essay contends that the sizeable barriers to behavior change require a stronger focus on automation and technology to address residential electricity consumption. This approach prioritizes technological investment and development where possible. It emphasizes technology adoption and consumer usage setting rather than day-to-day environmental behavior modification. Financial incentives and information may be part of this approach, but not its sum total.⁵²

48. See Amy Westervelt, *The Smart Grid is Dumb Without Smart Consumers*, SOLVE CLIMATE NEWS (March 23, 2010) 1–2 <http://solveclimate.com/blog/20100323/smart-grid-dumb-without-smart-consumers> (citing internal IBM study).

49. See Tomain, *supra* note 18, at 960–61.

50. See generally *supra* notes 1–4.

51. Many accounts of individual energy use do not consider at all (or consider only peripherally) technology and automation. See, e.g., W. Kip Viscusi, *Using Economics to Fuel Responsible Energy Consumption Decisions*, 38 ENVTL. L. REP. 10842, 10842 (2008) (noting that policymakers should take advantage of regulatory standards, taxes, incentives, and informational remedies to address individual energy consumption).

52. Financial incentives entail ongoing costs and must be set at high levels to provoke substantial behavior change. See Richard A. Winett & Michael T. Nietzel, *Behavioral Ecology: Contingency Management of Consumer Energy Use*, 3 AM. J. CMTY. PSYCHOL. 123, 129 (1975) (significant economic incentives reduced household electricity consumption by fifteen percent); cf. Steven C. Hayes & John D. Cone, *Reduction of Residential Consumption of Electricity Through Simple Monthly Feedback*, 14 J. APPLIED BEHAV. ANALYSIS 81, 85–88 (1981) (thirty percent reduction in electricity use in response to cash rebates).

A. Cognitive and Behavioral Constraints

Changing environmental behavior with information provision or norm-change interventions is a difficult and resource-intensive process.⁵³ Research findings illustrate the challenges of behavior change, particularly absent face-to-face interaction and social visibility. As one researcher observes, “marketing a behavior is . . . very different than marketing a product. Traditional marketing approaches, which tend to target attitudes, have had some success in raising levels of awareness and concern, but have a poor track record when it comes to promoting behavior change.”⁵⁴ For behavior change to occur, consumers must have the right information, possess or adopt consonant norms and values (or receive financial incentives), translate those motivations into action, and maintain behavior change over time.⁵⁵ These are steep barriers and even scholars who are optimistic about behavior change and “environmental republicanism” have found that theoretical aspirations often break down in implementation.⁵⁶

Residential energy use is a paradigm of the barriers to behavior change. Much has been written about the deleterious effects of large numbers, minimal payoffs, loose or non-existent social ties, and lack of public visibility on cooperation.⁵⁷ Scholars such as Elinor Ostrom have devoted decades to studying cooperation to resolve environmental and natural resource commons problems.⁵⁸ Ann Carlson has written persuasively about the inability of social norms to resolve collective actions problems such as recycling that involve large numbers of players and small payoffs.⁵⁹ Electricity conservation is vulnerable to similar obstacles. Electricity usage is widespread, dispersed, and private, occurring in virtually all households in the United States. The payoffs from conservation are modest because elec-

53. The high-cost nature is evident in initiatives focused on both personal contact and financial incentives. Face-to-face contact to change behavior is inherently expensive. The research on financial incentives, at least in the household energy sector, has shown that incentives typically need to be substantial to provoke significant behavior change. See Paul C. Stern, *Blind Spots in Policy Analysis: What Economics Doesn't Say About Energy Use*, 5 J. POLICY ANALYSIS & MGMT. 200, 210–11 (1986).

54. See Amanda R. Carrico et al., *Energy and Climate Change: Key Lessons for Implementing the Behavioral Wedge*, 2 J. ENERGY AND ENVTL. L. (forthcoming Dec. 2010).

55. See *id.*

56. See Hope M. Babcock, *Responsible Environmental Behavior, Energy Conservation, and Compact Fluorescent Bulbs: You can Lead a Horse to Water, But Can You Make It Drink?*, 37 HOFSTRA L. REV. 943, 946 (2009) (“Somewhat to my surprise, and perhaps to the surprise of anyone who has read my previous work in this area, this Article reaches the conclusion that the perceived problems with CFLs (compact fluorescent light bulbs) are sufficiently severe that no amount of persuasion will induce individuals to acquire them, despite their individual and social benefits.”).

57. See generally *supra* notes 1–3.

58. See generally ELINOR OSTROM, *GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION* (1990).

59. See Carlson, *supra* note 3, at 1241–44.

tricity has historically been underpriced relative to its environmental costs.⁶⁰ In addition to these structural impediments, there are behavioral, cognitive, and cultural stumbling blocks to changing household energy consumption.

First, motivational deficits arise from faulty risk assessment.⁶¹ There is significant evidence that people apply inaccurate discount rates and fail to recognize the long-term savings and value from conserving energy or investing in energy-efficient technology.⁶² Experts estimate the discount rate of greenhouse gas emissions between three and seven percent; individual consumers display “temporal myopia” and on average employ a discount of over thirty percent when they consider future energy cost savings (both social and private).⁶³ Diminished risk perception is due to knowledge deficits and uncertainty about global warming outcomes as well as a lack of personal experience with climate change impacts.⁶⁴ People experience climate change risk as distant and hypothetical and process that risk analytically.⁶⁵ In contrast, direct, personal experience with outcomes activates emotional and affective processing which is automatic, fast, and robust (sometimes too much so).⁶⁶ Compared to affective processing, analytic processing significantly decreases perceptions of risk.⁶⁷

Second, information costs are high for households. Most people have limited knowledge of the amount of electricity they consume in daily life, its environmental impact, or how to reduce usage. In general, research shows that individuals have difficulty gathering, understanding, attending to, and retaining information, particularly material that is technical, com-

60. See David P. Spence, *Coal-Fired Power in a Restructured Electricity Market*, 15 *DUKE ENVTL. L. & POL'Y F.* 187, 191-192 (2005) (describing how the “remarkably stable and low” price of coal-fired electricity does not reflect the social and environmental costs of its generation).

61. See generally Christine Jolls *et al.*, *A Behavioral Approach to Law and Economics*, 50 *STAN. L. REV.* 1472 (1998).

62. See Viscusi, *supra* note 51, at 10843.

63. *Id.*

64. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *Psychology and Global Climate Change: Addressing a Multi-Faceted Phenomenon and Set of Challenges* 34, 125 (2009), available at <http://www.apa.org/science/about/publications/climate-change.pdf>.

65. See *id.* at 34.

66. See generally SHELLY CHAIKEN & YAAKOV TROPE, *DUAL PROCESS THEORIES IN SOCIAL PSYCHOLOGY* (1999) (describing affective and cognitive modes of decision making and problem-solving).

67. See George F. Loewenstein *et al.*, *Risk as a Feeling*, 127 *PSYCHOL. BULL.* 267, 274 (2001) (“Behavioral evidence suggests that, to the extent that emotional reactions to, and cognitive evaluations of, risky choice options are dissociated, risk preference is often determined by the former.”).

plex, or low-interest.⁶⁸ In studies of household energy, researchers have found that most individuals don't understand which actions to take to effectively reduce consumption.⁶⁹ Compounding these deficits, residential electricity consumption takes multiple forms in households, many of which are not salient (e.g., leaving appliances plugged in when not in use).

Third, knowledge, motivation, and even specific intentions do not translate readily or reliably into behavior change. Even if motivation is properly inculcated, there is evidence that (even minute) behavioral change often fails to occur in the face of supportive attitudes.⁷⁰ For example, studies evaluating the effects of awareness-raising provision of energy conservation information (as opposed to personalized feedback) have found that these initiatives increase knowledge but have "minimal effects on behavior."⁷¹ Time, money, infrastructure, household needs, and other contextual factors constrain household energy consumption and dampen the influence of values, beliefs, and norms.⁷² Culture also constrains behavior change: American consumerism encourages large houses and myriad electronics and appliances without equivalent value placed on thrift and conservation.⁷³ Over time, socially-ingrained consumption behaviors take root as personal habits.⁷⁴

In the absence of incentives or strong intrinsic motivation, behavioral costs must be low to ensure pro-environmental action. One need only look at the amount of litter on streets with garbage cans on every block to realize that even low levels of behavioral cost often prevent socially beneficial actions.⁷⁵ Even if a behavior is established, it is difficult to maintain over time. If a behavior does not become a habit or automatic response, then

68. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *supra* note 64, at 123 (describing how individuals lack knowledge both about climate change and about which personal actions to take to reduce emissions).

69. See Willett Kempton *et al.*, *Do Consumers Know "What Works" in Energy Conservations*, 9 MARRIAGE FAM. REV. 115, 131 (1985).

70. See, e.g. Tanya Domina & Kathryn Koch, *Convenience and Frequency of Recycling: Implications for Including Textiles in Curbside Recycling Programs*, 34 ENV. & BEHAV. 216, 234 (2002) (finding the convenience is a key predictor of recycling behavior and mixed results for whether environmental concern mediates recycling behavior).

71. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *supra* note 64, at 146.

72. See J. Stanley Black *et al.*, *Personal and Contextual Influences on Household Energy Adaptation*, 70 J. OF APPLIED PSYCHOL. 3, 3 (1985) (finding that norms and personal values have a much smaller effect on constrained activities).

73. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *supra* note 64, at 72-73 (discussing interaction between consumerism and climate change).

74. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *supra* note 64, at 129-130.

75. See Carlson, *supra* note 3.

people must direct continual attention and energy to maintaining the behavior. In the absence of habit development or high motivation, pro-environmental behaviors such as energy thrift often do not develop or, if they do, fade over time.⁷⁶

Last, behavior change may be particularly difficult within the residential home. Because domestic behavior is largely private, it is less susceptible to social norm activation and maintenance.⁷⁷ People do not receive the same social approval and psychological reinforcement for electricity conservation as they do from more public behaviors, such as brandishing reusable canvas bags at the grocery store.⁷⁸ For example, there is evidence that homeownership increases recycling, presumably in part because homeownership results in longer tenure and thus greater likelihood that neighbors and community members will recognize the homeowner bringing recycling to the curb or local drop-off.⁷⁹ However, it does not follow that pro-environmental actions occurring within the home interior or other private residential spaces will be similarly forthcoming. To the contrary, the cultural and legal construction of the American home has emphasized dominion, individualism, and private prerogative rather than social responsibility.⁸⁰ It may be the case that people feel particularly at liberty to satisfy their individual desires and convenience, rather than their environmental responsibilities, within the four walls of the home.

B. *High Behavioral Demand Environmental Action*

This Essay seeks to add another dimension to the legal scholarship discussing the efficacy of environmental behavior change: high behavioral demand. As I employ this term, high-demand behavior refers to behavior

76. Moreover, habit currently works to the detriment of environmental protection in most households. Many individuals habitually waste energy, over-consume, idle cars, etc. See A Report by the American Psychology Association's Task Force on the Interface Between Psychology and Global Climate Change, *supra* note 64, at 129-30.

77. Homes and similarly exclusive private spaces limit both the social reinforcement of pro-environmental behavior and derision and shaming responses to anti-environmental actions. For a discussion of this dynamic in the context of residential land conservation incentives, see Stephanie Stern, *Encouraging Conservation on Private Lands: A Behavioral Analysis of Financial Incentives*, 48 ARIZ. L. REV. 541, 556 (2006).

78. A recent paper argues that public visibility, and thus social influence, are the key predictive factors in norm change and discusses the difficulty of personal behavior change in low-visibility contexts such as residential energy use. See Jed S. Elia, Law and Norms in Collective Action: Maximizing Social Influence to Minimize Carbon Emissions, 27 UCLA J. ENVTL. L. & POLIC'Y 93, 133 (2009).

79. See Domina & Koch, *supra* note 70, at 218-19 (reviewing research literature finding that income and homeownership, as well as age, are predictors of recycling behavior).

80. See, e.g., Stephanie M. Stern, *The Inviolable Home: Housing Exceptionalism in the Fourth Amendment*, 95 CORNELL L. REV. 905101, 913-915114-115 (2010).

that is frequent (often involving many small acts), ongoing, periodic or constant, and requires action or attention in multiple household contexts. The concept of high behavioral demand partially intersects with the discussions of convenience in Ann Carlson's work, as well as with the psychological research on the difficulty of "constant curtailment" (i.e., ongoing restriction or deprivation).⁸¹ However, high behavioral demand is broader, encompassing not only the effects of convenience and perceived deprivation over time, but also the challenges of high-frequency, multi-context behavior and the cognitive burdens of ongoing vigilance and multi-tasking. The conceptual focus is on these characteristics as proxies for behavioral intensity: how costly is pro-environmental behavior to the individual consumer in the currencies of time, energy, and effort.

High-demand behaviors entail frequent, often daily, actions. A unifying characteristic of high-demand behaviors is that they are not "one-shot" (e.g., setting the water heater temperature), but rather involve repeated action (e.g., turning off or unplugging electronics not in use or reducing consumption during peak load times).⁸² Repeated action is costly and typically requires ongoing behavioral reinforcement, whether social, personal, or monetary.⁸³ Of course, not all electricity conservation is behaviorally demanding: reducing pollution through energy star appliances, for example, requires only a single purchase decision which is often spurred by incentives or information and labeling. However, many other aspects of residential electricity conservation are not so readily elicited due to their higher frequency and costs of action.

Typically, high-demand conservation behavior is ongoing and requires constant, episodic, or periodic action. Behavioral costs are highest when action is not amenable to habit formation and calls for ongoing cognitive vigilance due to variable timing or dependence on external factors or cues, such as changes in pricing. In some instances, such as reducing electricity consumption from lights and appliances, conservation requires daily behaviors. In other cases, conservation is semi-automated but still necessitates periodic action (e.g., optimally resetting complicated heating/cooling thermostat models for seasonal changes).

81. See Carlson, *supra* note 3, at 1265–66. (discussing convenience and "architectural change"); Willett Kempton *et al.*, *Psychological Research for the New Energy Problems: Strategies and Opportunities*, 47 AM. PSYCHOLOGIST 1213, 1216–17 (1992) (defining constant curtailment as long-term changes in behavior that involve giving something up).

82. Smart electrical power strips have come on the market to automatically stop power drain from electronics not in use. However, these strips still require further work to refine their reliability and to ensure ease of use and thus widespread adoption.

83. See Kempton, *supra* note 81, at 1216–17.

The varying household contexts for electricity conservation also increase behavioral costs. People must not only act frequently and over time but also act across multiple household domains. Absent a public smart grid or private computerized smart house system, there is no master control for consumption. Instead, people must remember to conserve across multiple appliances, myriad electronics, and different lighting contexts such as indoor and outdoor. Moreover, using electricity-draining appliances less frequently, decreasing usage during peak load times, and other consumption-reducing behaviors compete with each other and with other personal and household demands. As a result, individuals often must perform different tasks simultaneously or switch rapidly between tasks. The psychology research illustrates that we are poor multi-taskers: information processing suffers, rates of error increase, and task completion decreases when we multi-task.⁸⁴

In sum, many aspects of household electricity conservation impose steep behavioral demands by requiring frequent, ongoing, and multi-context behavior change. Because of these high costs, comprehensively reducing electricity consumption requires more targeted, sophisticated, and effective interventions than traditional information and social norm approaches offer.

C. Automation Norms

As a result of the barriers to behavior change, it seems unlikely that social and psychological interventions can adequately address pollution problems characterized by loose-knit ties, widespread players, limited financial reward, and as explored in this Essay, high behavioral demand. Thus, I argue here for a greater emphasis on automation and technology for residential electricity (and other household pollution problems). This proposal aligns with research showing that at appropriate price points people greatly prefer to invest in energy-efficient technology rather than change their daily behaviors and habits.⁸⁵ Once an individual adopts higher-efficiency technologies environmental benefits accrue automatically and less painfully than with curtailment, which consumers typically perceive as deprivation.⁸⁶

84. See H. Pashler, *Dual-Task Interference in Simple Tasks: Data and Theory*, 116 PSYCHOL. BULL. 220, 220 (1994); W.H. Gladstones *et al.*, *Divisions of Attention: The Single-Channel Hypothesis Revisited*, 41 Q. J. OF EXPERIMENTAL PSYCHOL. 1, 12–16 (1989).

85. See generally RAYMOND S. NICKERSON, PSYCHOLOGY AND ENVIRONMENTAL CHANGE 96 (2003).

86. See Carrico *et al.*, *supra* note 54, at 4 (“Efficiency improvements generally offer greater long-term potential for reducing energy use and emissions. Once upgraded, savings can be achieved without

An emphasis on technology development has permeated the history of environmental law with respect to industrial and corporate polluters. Individuals and households have not been the beneficiaries of a similar technology push, in part because of their large numbers, geographic dispersion, and lack of technical sophistication.⁸⁷ However, smart grid is changing this dynamic: in the foreseeable future we should be able to deliver advanced pollution-mitigating technologies to residential consumers nationwide. Residential smart grid, unlike industrial pollution-control technologies, does not require expert operators. To the contrary, smart grid capitalizes upon “bounded rationality” with technology designed specifically to avoid or mitigate weaknesses in human cognition and behavior.

It is time to reorient household environmental policy (and scholarship) from educational pamphlets and information disclosures toward a greater focus on technology. We need a policymaking “norm” in the residential context, comparable to what exists in the industrial sector, favoring technology as the first-pass solution. Comprehensive pollution reduction in an era of ever-increasing electricity demand requires the deployment of sophisticated automated and semi-automated technology. Enabling one-time preference-setting, computer-generated settings, or even limited external control reduces or eliminates behavioral and cognitive barriers to pro-environmental behavior.

In addition, although a seemingly obvious point, people interact with technologies. Lest my depiction of the social norms scholarship sound too cavalier, I note here that the research on environmental values and norms should prove helpful to automated technology. First, both personal and social norms influence which technologies consumers are likely to accept and adopt. Initiatives to develop and disseminate pro-environmental norms supporting household smart technology will be a critical aspect of smart grid’s “social marketing.” Second, when smart technology requires preference-setting or acquiescence to a computer-generated default, pro-environmental norms encourage consumers to complete (low-cost) preference-setting and increase the likelihood that consumers will input or accept environmentally-beneficial preferences.

relying on consumers to develop and maintain energy-saving habits, and may reduce actual or perceived sacrifices in lifestyle and comfort . . .”).

87. Even the subsidies for hybrid and electric vehicles, one of the major governmental technology initiatives for individual households, were quite limited in both funding and duration (and it appears that a significant portion of the subsidy ended up in the hands of car manufacturers and dealers). See B. Andrew Chupp *et al.*, *The Incidence of Hybrid Automobile Tax Preferences*, 38 PUB. FIN. REV. 120, 122, 130 (2010) (describing recent federal tax credits for hybrid car purchases and finding that nearly half of the subsidy accrues to car sellers because the tax credit is capitalized into higher car prices).

III. PARADIGMS OF AUTOMATION: A BEHAVIORAL ANALYSIS OF SMART GRID

Smart Grid represents a major advance in bringing sophisticated and interactive technological automation to the residential consumer. Comprehensive reduction of household electricity usage typically requires repeated action, on different schedules, aimed at a variety of consumption behaviors and household appliances. Technology is critical to decreasing emissions when pro-environmental behavior is demanding and costly. In this Part, I consider behavioral rationales for funding a full-scale, national smart grid and discuss how psychological research can inform smart grid design to maximize energy savings and consumer acceptance.

A. *The Case for Smart Grid*

Moving to a national smart grid is an expensive and resource-intensive endeavor. To justify such a move on an efficiency basis, the social, private, and environmental savings must be substantial. This Essay focuses on environmental gains from automation and increased behavioral compliance (though lower electricity consumption may translate into consumer savings as well). Specifically, I contend that the psychological barriers to high-behavioral demand electricity conservation argue strongly in favor of a national smart grid.

Decades of information provision and behavior change initiatives have made only limited headway in reducing electricity consumption—and those gains have been virtually obliterated by the proliferation of energy-draining appliances such as computers and flat-screen televisions.⁸⁸ Smart grid dramatically alters the traditional paradigm of energy consumption and household emissions by providing a high-efficiency infrastructure that responds to behavioral deficits with automation and semi-automation. Smart technology reduces both the information load and behavioral demand on consumers by making energy efficient behavior a one-step “set it and forget it” process. Thus, smart grid fills gaps in human motivation, knowledge, the translation of attitudes to actions, and cognitive vigilance. In addition, unlike informational remedies and social norm interventions, smart grid is capable of responding quickly to consumption trends or new, energy-intensive appliances through master control and targeted on/off cycling.

Policymakers and some scholars have advocated focusing on a few household energy uses that generate high carbon emissions, which can be

88. See U.S. DEP'T OF ENERGY, *supra* note 11, at 6.

reduced at comparatively low behavioral cost. For example, one group of researchers has characterized certain household conservation practices, such as the one-time lowering of water heater settings, as “low-hanging fruit” that produce substantial greenhouse gas savings at minimal individual cost.⁸⁹ Certainly, there is traction to be gained from targeting the electricity consumption behaviors that are most cost-effective to address. However, there is potential for much greater energy savings from a comprehensive, smart grid approach that uses advanced technology to prioritize high-yield conservation measures, while simultaneously addressing other types of household consumption and transmission losses.

B. Planning Smart Grid: Prioritizing Automation

The nation is currently in the planning and pilot stage of smart grid technology, presenting a window of opportunity to influence the development of smart grid.⁹⁰ Based on available and emerging technology, the future residential smart grid can emphasize sophisticated information provision through real-time pricing and consumption feedback or favor automation and one-time preference-setting or defaults. Focusing solely on information and pricing would likely decrease consumption more than traditional initiatives but would fall short of the emissions-reducing potential of automated or semi-automated consumption controls. In this Essay, I argue that a strong (though not exclusive or unbounded) emphasis on automated technology is critical to the success of a residential smart grid.

Automation responds directly to human deficits in information-processing and behavior change. In a sense, automation is the ultimate “default” and capitalizes on the research demonstrating the carbon-reducing efficacy of policies that “nudge”—or in this case more than nudge—“consumers towards the economically or socially optimal options.”⁹¹ Smart grid technology can automatically cycle appliances on and off, shift them into conservation mode, or power appliances down during peak load times. Rather than requiring individuals to physically adjust appliances periodically, smart grid can deploy household electronics based on individual consumer profiles or grid needs (presumably subject to consum-

89. See Michael P. Vandenbergh et al., *Individual Carbon Emissions: The Low-Hanging Fruit*, 55 UCLA L. REV. 1701, 1745–50 (2008). The other household energy action characterized as low-hanging fruit, reducing stand-by energy use by turning appliances on and off or using an automated power strip, does not in my view meet the definition of low behavioral cost (particularly since automated power strip technology is still unreliable and difficult to utilize).

90. See Harris, *supra* note 6.

91. See Carrico et al., *supra* note 54, at 7.

er override).⁹² Smart technologies enable individuals to select one-time preference-settings for consumption or to utilize preset consumption defaults. Consumption settings ameliorate cognitive errors by limiting the information the consumer must process (research shows that individuals can only process four to five pieces of information reliably).⁹³

When full automation is impracticable or normatively undesirable, smart technology can employ semi-automation coupled with immediate feedback and pricing incentives. Here, social and perhaps to a greater extent personal norms can fill the gaps left by partial automation and encourage pro-social behavior.⁹⁴ Because discrete psychological and norm initiatives tend to have modest impacts, the most effective strategy for semi-automation is to combine multiple psychological reinforcers. Thomas Dietz and his research team note that, “interventions that combine appeals, information, financial incentives, informal social influences, and efforts to reduce the transaction costs of taking the desired actions have demonstrated synergistic effects beyond the additive effects of single policy tools.”⁹⁵ Similarly, smart grid has much greater potential than traditional initiatives to decrease electricity use by “layering” multiple interventions from technology, information, financial incentives, and interactive feedback.⁹⁶

The move toward technological automation for residential electricity will require resolving a variety of sticky policy and legal issues. What kind of technologies should smart grid employ in homes? At what point does automation impermissibly infringe on individual autonomy and privacy interests? What are the standards of consent, if any, which consumers must give to external control of household energy usage? There are legal and ethical concerns about automating, or semi-automating, areas of traditional consumer choice and private behavior. Smart technologies gather significant information about household daily life by tracking individual appliances and other electricity consumption. And the ability of smart grid to

92. See *supra* Part I.

93. See Viscusi, *supra* note 51, at 10845.

94. For a discussion of personal norm activation in the context of household toxics, see Michael P. Vandenbergh, *Order Without Social Norms: How Personal Norm Activation Can Protect the Environment*, 99 NW. U. L. REV. 1101, 1129–1140 (2005).

95. See Thomas Dietz et al., *Household Actions can Provide a Behavioral Wedge to Rapidly Reduce US Carbon Emissions*, 106 PROCEEDINGS OF THE NAT’LS ACADEMY OF SCIENCES 18452, 18453 (2009).

96. For example, one reason the Toyota Prius hybrid car has been successful in reducing consumption is that it offers real-time fuel utilization information, efficiency feedback, high-visibility design that publicizes the environmental behavior, and financial incentives in the form of gas savings and other benefits. For a general discussion of the importance of layering interventions, see Psychology and Global Climate Change, *supra* note 64, at 148.

automatically reduce electricity provision or downshift appliances in real time may strike consumers as intrusive.⁹⁷

A substantial amount of smart grid technology is nascent and the legal framework undeveloped. Accordingly, this Essay raises, but does not resolve, issues of privacy, autonomy, and control. As a general matter, an effective national smart grid requires households to cede a quantum of their historical control over electricity consumption. Electricity usage has traditionally been an area of individual sovereignty, limited only by price (or urgent shortage). But, there is no constitutional or moral rationale for elevating energy usage to the level of an absolutely protected right, particularly given its third-party generation and provision. Certainly, external restriction of energy is desirable during shortages and emergencies. And, although the details remain to be worked out, a measure of additional external control or on/off cycling should be acceptable during periods of normal operation as well.

There are multiple ways that smart grid can limit perceived incursions on household autonomy and privacy. First, aspects of the technology that result in third-party control or may otherwise feel intrusive to consumers can be phased in incrementally. Autonomy and privacy are constructed socially and interpersonally.⁹⁸ With gradual exposure to automated technology, norms of “eco-privacy” will likely change over time.⁹⁹ Second, smart grid is likely to adopt a model of “soft” control via consumer profiling and default settings subject to consumer override. Presently, most smart grid plans incorporate individual consent through the consumer setting initial preferences, voluntarily installing a smart meter or appliance, or overriding default settings.¹⁰⁰

C. *Consumer Adoption and Acceptance*

Consumer support is crucial to transition smart grid from the planning stages to full implementation. Once smart grid is established, consumer attitudes and willingness to adopt specific technologies will influence the impact of smart grid: A significant swathe of smart grid technologies requires consumer acquiescence, initial preference-setting, or ongoing inter-

97. See LaMonica, *supra* note 45, at 3.

98. For a discussion of privacy as control over interpersonal boundaries, see IRWIN ALTMAN, *THE ENVIRONMENT AND SOCIAL BEHAVIOR* 6 (1975).

99. There is a voluminous literature on the adoption and diffusion of environmental behavior and efficiency-enhancing technology. For an overview, see *Psychology and Global Climate Change*, *supra* note 64, at 142–43.

100. See LaMonica, *supra* note 45, at 2–3.

active energy utilization management. Consumer marketing research has found that over seventy percent of consumers would like more information about their electricity usage and the ability to better control their consumption.¹⁰¹ Yet, consumers are notoriously risk-adverse to change, particularly if they perceive it as imposing inconvenience or threatening their financial bottom line.¹⁰²

Six dimensions predict the diffusion and adoption of new technologies: their compatibility with consumer values, the perceived advantage over alternatives (“what’s in it for me”), the perceived risks of adoption, the ability to try out products prior to committing, the complexity of products, and their visibility and observability.¹⁰³ Of these factors, researchers have found that complexity, observability, and perceptions of the relative advantages of smart grid for the consumer account for most of the variance in stated intent to subscribe to smart grid.¹⁰⁴

There are several ways to increase consumer acceptance of smart grid. First, the development of smart grid technologies should focus on the ease and simplicity of the user interface through, for example, clear visuals, intuitive settings, simple steps for inputting preferences, and pre-programmed default settings. Consumers report the strongest willingness to adopt smart grid when the technology requires two hours or less per year to set and maintain.¹⁰⁵ Second, emphasizing the benefits of smart grid, including long-term financial benefits, is critical to its social marketing and political success. Providing consumers with information about dollars saved, as well as quantity of emissions avoided, encourages environmentally-friendly preference-setting and maintenance of preset defaults. Last, the use of pre-implementation pilots, such as recent smart meter installations in several states, increase observability and thus diminish consumer concerns about smart electricity technology.¹⁰⁶

101. See Westervelt, *supra* note 48, at 1.

102. For example, consumers frequently under-estimate the savings from energy-efficient purchasing decisions. See Carrico et al., *supra* note 54, at 6.

103. See Richard Feinberg, *Achieving Consumer Acceptance of the Smart Grid*, THE INTELLIGENT PROJECT, 3 (Apr. 15, 2009), http://theintelligentproject.org/assets/docs/061509_achieving-customer-acceptance.pdf.

104. See *id.* at 7–8.

105. See U.S. DEP’T OF ENERGY, *supra* note 11, at 20.

106. In addition, research on social diffusion shows that new practices and technologies spread as people follow the lead of their friends and neighbors. See Paul C. Stern, *What Psychology Knows About Energy Conservation*, 47 AM. PSYCHOLOGIST 1224, 1229 (1992).

CONCLUSION

The focus on individual behavior change, and the comparative neglect of automated technology, has left gaps in both residential pollution policy and environmental scholarship. The future of environmental psychology and law will inevitably intertwine more tightly with technology to focus on how behavioral research informs technological innovation, consumer preferences, and technology adoption. Residential electricity provision is a paradigm of this trend. Because behavior change is demanding and costly, automation and technology have key roles to play in electricity conservation. The emerging smart grid represents a fundamental and large-scale shift away from educational and social norm change initiatives and toward integrated technology and automation.