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Implementing the Behavioral Wedge: Designing and Adopting Effective Carbon Emissions Reduction Programs

by Michael P. Vandenbergh, Paul C. Stern,
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The limited progress of the recent Copenhagen climate negotiations and domestic legislative activity suggests that the time is ripe to identify additional politically viable, low-cost, nonintrusive strategies to reduce carbon emissions. Laws and policies that induce changes in household technology use and adoption are one such strategy. This “behavioral wedge” strategy can be pursued in the near term. The resulting emissions reductions will buy time for a stronger public consensus to emerge on the need for more costly carbon mitigation measures and will complement the additional measures after they are adopted. In short, the case for the behavioral wedge is compelling.

An example of the magnitude of the behavioral wedge opportunity is that President Barack Obama’s recently stated goal of reducing U.S. carbon emissions by 17% from 2005 levels by 2020¹ is achievable without significant sacrifice by energy users if sophisticated household energy programs are part of the policy mix. Our analysis of 17 types of household actions shows that if the most effective programs for inducing household energy efficiency and conservation actions were scaled to national level, carbon emissions in this sec-

tor would be reduced by about 20% in 10 years.² The 20% household reduction is roughly 74% of national emissions, or 44% of the target articulated by President Obama. This estimate is based almost entirely on off-the-shelf technology and the results of programs that did not deploy a full array of policy tools (e.g., we did not consider appliance standards or other regulatory actions). Much larger reductions are possible.

At the federal level, policymakers have debated but not adopted carbon taxes, cap-and-trade schemes, and direct industry carbon regulations. In contrast, federal laws and policies directed at households have demonstrated greater viability in recent years. In fact, laws and policies directed at households, including subsidies for household weatherization, tax incentives for energy-efficient equipment and motor vehicles, labeling programs for energy-efficient appliances, and new appliance efficiency requirements, may have been an important contributor to recent slowing in the growth of U.S. emissions.³ Many state and local governments have been more active than the federal government in adopting climate measures directed at industrial sources,⁴ and they,

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1. President Barack Obama, Remarks by the President at the Morning Plenary Session of the United Nations Climate Change Conference (Dec. 18, 2009) (transcript available at <http://www.whitehouse.gov/the-press-office/remarks-president-morning-plenary-session-united-nations-climate-change-conference>).

2. Thomas Dietz et al., *Household Action Can Provide a Behavioral Wedge to Rapidly Reduce U.S. Carbon Emissions*, 106 PROC. NAT’L ACAD. SCI. 18452 (2009).

3. U.S. DEPARTMENT OF COMMERCE (DOC), U.S. CARBON DIOXIDE EMISSIONS AND INTENSITIES OVER TIME: A DETAILED ACCOUNTING OF INDUSTRIES, GOVERNMENT, AND HOUSEHOLDS 16-18 (2010) (concluding that household efficiency dropped and emissions rose from 1998 to 2006, but improvement in household emissions efficiency is expected for the 2006-2010 period).

4. See Global Warming Solutions Act of 2006, Cal. Health & Safety Code §38500 (2009); Regional Greenhouse Gas Initiative, Memorandum of Un-

too, have adopted a wide range of laws and policies directed at household behavior.⁵

Despite the recent momentum, efforts at the federal, state, and local levels have only begun to explore the full potential of the behavioral wedge. We suggest that the principal barrier is conceptual: widespread misconceptions about the potential emissions reductions from the household sector, not intrinsic shortcomings in the viability of measures designed to reduce emissions from the sector. As a result, overcoming these misconceptions should be easier than overcoming the economic, technological, and political limitations of other measures. Achieving the behavioral wedge opportunity will require policymakers to take a fresh look at the household sector, however, and to develop laws and policies that reflect important, empirically grounded behavioral principles. We identify the conceptual barriers and offer strategies for overcoming them. We also identify principles of effective program design derived from 30-plus years of behavioral and social science research, and we show how the principles can provide a rough-and-ready assessment of the strengths and weaknesses of existing and proposed programs and policies.⁶ They can, in addition, provide process indicators for evaluating and improving efficiency programs and policies. Our focus is on the household sector, but our general conclusions apply to a wide range of additional sectors where behavior matters, e.g., commercial buildings, small businesses, and others.

I. Reasonably Achievable Emissions Reductions (RAER)

Direct energy consumption in the household sector (energy use in homes and for nonbusiness travel) accounts for roughly one-third of U.S. energy consumption and a comparable share of carbon emissions.⁷ Many analyses of the potential to reduce these emissions focus only on what is technically feasible—what would happen if all households made all efficiency improvements achievable with available technology. Our recent analysis estimates the technical potential from 17 types of household actions at 37% of current direct household emissions.⁸ Other analyses estimate the savings that would be achieved if all households took all actions that have positive net present value at a discount rate similar to

what an investment portfolio might provide.⁹ But both of these assumptions are behaviorally unrealistic. No program to date has achieved either the full technical potential or the full economically justifiable potential for efficiency savings. Policies should aim for what is reasonably achievable—what could be achieved by implementing the most effective known inducements to action. For this reason, we estimate Reasonably Available Emissions Reductions (RAER) by combining technical potential with behavioral plasticity.

Substantial energy efficiency gains can be achieved in the household sector if policymakers adopt the key elements of the most successful past programs and scale these programs to national coverage. We emphasize that our behavioral wedge analysis is based on the achievements of actual programs, not on assumptions about behavior. Better program designs could achieve even greater savings. And these calculations in almost all cases assume off-the-shelf technology, so even greater savings are feasible as more efficient technologies are commercialized. These savings can be achieved, however, only if remaining institutional barriers are overcome and if program designs reflect the insights of the behavioral and social sciences. Ample evidence demonstrates that the mere existence of economically attractive technologies or of a moderate price signal is not sufficient to induce widespread behavioral change.

II. Behavioral Wedge Conceptual Barriers

Achieving substantial reductions in carbon emissions from the household sector will require laws and policies that combine financial incentives, information, social incentives, and other types of measures. Despite a remarkable upsurge in public and private activity directed at energy efficiency at the federal, state, and local levels in the last several years, many opportunities for large, low-cost emissions reductions remain unexplored. Achieving the full behavioral wedge potential is not beyond the capability of existing institutions, however, or current knowledge about the influences on behavior.¹⁰

We suggest that the principal remaining barriers to achieving the behavioral wedge arise from misconceptions that impede the high degree of policy attention that house-

derstanding, available at http://rggi.org/docs/mou_final_12_20_05.pdf (last visited Apr. 20, 2010); Regional Greenhouse Gas Initiative: An Initiative of the Northeast and Mid-Atlantic States of the U.S., Regional Greenhouse Gas Initiative Model Rule, available at <http://www.rggi.org/docs/Model%20Rule%20Revised%2012.31.08.pdf>.

5. See, e.g., Michael P. Vandenbergh et al., *Climate Change: The Low-Hanging Fruit*, 55 UCLA L. REV. 1701, 1723-50 (2008) (discussing state and local programs).

6. Our discussion of the principles of effective program design is set forth in more detail in Paul C. Stern et al., *Design Principles for Carbon Emissions Reduction Programs*, 43 ENVTL. SCI. TECH. (forthcoming 2010).

7. Gerald T. Gardner & Paul C. Stern, *The Short List: Most Effective Actions U.S. Households Can Take to Limit Climate Change*, ENV'T, Sept.-Oct. 2008, at 13; U.S. DOC, *supra* note 3, at 7 & fig. 3.

8. Dietz et al., *supra* note 2, at 18453.

9. *Id.*; MCKINSEY & COMPANY, *Unlocking Energy Efficiency in the U.S. Economy*, at http://www.mckinsey.com/clientservice/electricpowernaturalgas/US_energy_efficiency/ (last visited Mar. 19, 2010). For a recent examination of low-cost energy interventions, see Hunt Allcott & Sendhil Mullainathan, *Behavior and Energy Policy*, 327 SCI. 1204 (2010). *But see* Paul Stern et al., *Letter: Energy Efficiency Merits More Than a Nudge*, 328 SCI. 308 (2010).

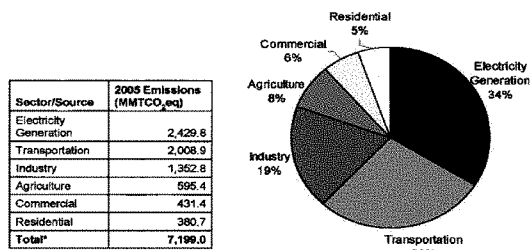
10. For reviews, see Paul C. Stern & Gerald T. Gardner, *Psychological Research and Energy Policy*, 36 AM. PSYCHOLOGIST 329 (1981); Paul C. Stern & Stuart Oskamp, *Managing Scarce Environmental Resources*, in 2 HANDBOOK OF ENVIRONMENTAL PSYCHOLOGY 1043 (Daniel Stokols & Irwin Altman eds., Wiley 1987); GERALD T. GARDNER & PAUL C. STERN, ENVIRONMENTAL PROBLEMS AND HUMAN BEHAVIOR (2d ed., Pearson Custom Publ. 2002); Paul C. Stern, *Environmentally Significant Behavior in the Home*, in THE CAMBRIDGE HANDBOOK OF PSYCHOLOGY AND ECONOMIC BEHAVIOR 363 (Alan Lewis ed., Cambridge Univ. Press 2008); *Psychology and Global Climate Change: Addressing a Multi-Faceted Phenomenon and Set of Challenges*, Report of the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change, at <http://www.apa.org/science/about/publications/climate-change.aspx> (last visited Mar. 19, 2010).

hold sector warrants. We examine five of these misconceptions here and offer suggestions for overcoming each of them.

A. *The Household Sector Is Responsible for Only a Minor Share of U.S. Energy Use and Carbon Emissions*

A first conceptual barrier is the tendency of policymakers to allocate the energy use and carbon emissions from households to other economic sectors when assessing relative sector contributions, and thus to miss the size of the opportunity for behavioral interventions in the household sector. Many analyses of the sources of energy use and carbon emissions do this by segregating personal transportation and household electricity use from the “residential” category. For example, Figure 1 is reproduced from a 2007 U.S. House of Representatives Commerce Committee white paper, and it is based on the annual U.S. Environmental Protection Agency (EPA) greenhouse gas (GHG) inventory.¹¹

Figure 1. Direct U.S. Greenhouse Gas Emissions by Economic Sector (2005)



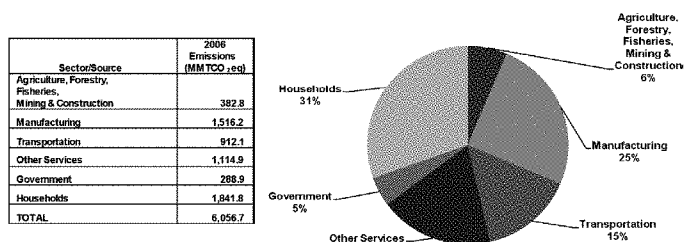
Source: US Environmental Protection Agency, *The US Inventory of Greenhouse Gas Emissions and Sinks (2005)*, April 2007

When personal transportation and household electricity use are separated from the residential share, as they are in Figure 1, the residential share (5%) of the national total makes it the smallest of all sectors. Policymakers viewing the data in this way might reasonably focus their attention on other sources. As a result, this framing encourages the development of laws and policies directed at industrial sources. When policymakers do focus on emissions from personal transportation and households, this framing may lead them to develop measures directed at the manufacturers of cars and trucks and the generators of electricity, and it may discourage them from developing measures directed at household behavior change.

When personal (nonbusiness) transportation and household electricity use are included in a sector defined as “households,” the magnitude of the household contribution becomes clear. The sector now accounts for roughly one-third of U.S.

energy use and carbon emissions.¹² A recent U.S. Department of Commerce (DOC) report reflects this reframing of sectors,¹³ and it identifies households as the largest sector. Figure 2, which is based on the data presented in the DOC report, demonstrates the striking difference when personal transportation and household electricity use are included in the household sector.¹⁴

Figure 2. Total CO₂ Emissions by Economic Sector (2006)



Viewing the household sector in this new way can lead to a focus on developing innovative measures directed at individual technology adoption and use. Policymakers who understand that the household sector accounts for roughly one-third of carbon emissions may be more likely not only to devote substantial attention to this sector, but also to develop new types of laws and policies that would not be contemplated if only the other sectors were considered worthy of regulatory attention.

B. *Household Behavior Should Be a Focus of Private Action and Nongovernmental Organization Initiatives, Not Public Laws and Policies*

A second barrier to adopting the laws and policies necessary to achieve the behavioral wedge is the tendency to interpret recommendations for behavior change as a matter of private or household interest—as lists of small steps individuals can take if they choose to do so—not as a matter of concern for national, state, or local policymakers.¹⁵ Given that energy and

11. STAFF OF H. COMM. ON ENERGY AND COMMERCE, CLIMATE CHANGE LEGISLATION DESIGN WHITE PAPER: SCOPE OF A CAP-AND-TRADE PROGRAM 7 & fig. 2 (2007), available at http://archives.energycommerce.house.gov/Climate_Change/White_Paper.100307.pdf.

12. Estimates of the total share of energy use and GHG emissions attributable to households vary, but are often in the 30 to 40% range. See, e.g., Gardner & Stern, *supra* note 7 (estimating a 38% share); Michael P. Vandenberg & Anne C. Steinemann, *The Carbon-Neutral Individual*, 82 N.Y.U. L. REV. 1673, 1677 (2007) (estimating a 32% share). Our focus in this Article is not on a precise quantification, but on the importance of including in the household sector all aspects of household activity that are relevant to policymakers in terms of the priority given to the sector and the types of law and policy measures that may be deployed.

13. See U.S. DOC, *supra* note 3, at 7 & fig. 3 (concluding that households are the largest sector, with one-third of total U.S. energy-related carbon dioxide emissions).

14. See *id.* The data are presented in the DOC report in bar chart format, and we have presented the data in pie chart format in Figure 2 to facilitate comparison with Figure 1.

15. See Phil Berardelli, Cutting Carbon Emissions, One Household at a Time, SCIENCE NOW, Oct. 26, 2009, at <http://news.sciencemag.org/sciencenow/2009/10/26-01.html>; Elisabeth Rosenthal, How U.S. Households Could Cut Emissions of Greenhouse Gases, N.Y. TIMES DOT EARTH, Oct. 27, 2009, at <http://dotearth.blogs.nytimes.com/2009/10/27/us-households-as-greenhouse-gas-purveyors/>.

environmental policy has focused mainly on large industrial sources for many years,¹⁶ it is perhaps not surprising that the opportunities arising from household behavior change are often thought of as the province of local or national nongovernmental organizations (NGOs), not the subject of serious policy.¹⁷ Barriers to voluntary actions will make it difficult to achieve the behavioral wedge by individuals' voluntary steps alone, however,¹⁸ and public laws and policies are often needed to overcome these barriers. In addition, developments in the behavioral and social sciences now provide a foundation for addressing the household sector with the same level of rigor and focus as other sectors. The carbon reduction opportunities include increases in efficiency arising from the adoption and use of new equipment and curtailment of existing equipment use. It is important not to equate behavioral interventions with curtailment alone, given that much of the behavioral wedge opportunity arises from efficiency rather than curtailment.¹⁹ More than three decades of behavioral research has identified the types of interventions that can serve as the basis for sustained law and policy development at the federal, state, and local levels, not just household behavior campaigns conducted by NGOs.

C. Household Behavior Change Measures Will Crowd Out Other Measures

A third barrier arises from concerns that behavioral measures will crowd out measures directed at other sources. This concern often takes one of two forms. The first is directed at support for climate policy in the general public. This view assumes that behavioral measures will deplete public support for governmental measures because individuals who engage in personal behavior change will conclude that support for public policy measures is not necessary.²⁰ Yet, there is little or no research suggesting that taking energy-saving actions around the house will reduce support for public laws and policies designed to reduce energy use or carbon emissions. The second form of this concern focuses on policymakers and assumes that adoption of laws and policies directed at behavior change will crowd out measures directed at other sectors. Major reductions in energy demand will be needed along with improvements in low-carbon energy supply if any of the widely advocated carbon emissions targets are to be met, and laws and policies directed at household technology

adoption and use need not undermine other demand-side and supply-side efforts.²¹

D. Household Behavior Change Cannot Be Conducted at Large Scale

A fourth barrier arises from concerns that although behavioral measures have been remarkably successful in small studies and field applications, e.g., Bonneville, Progress Energy, national policy requires large-scale applications that are not possible or at least have not been demonstrated. The implication is that federal, state, and local governments are incapable of developing and implementing the measures necessary to achieve widespread behavior change, and as a result, other targets of opportunity are more promising. Government policy has contributed to large-scale behavior change in a wide range of other areas, e.g., smoking, seat belt use, safety helmets, and recycling, however, and the cost savings and convenience of many behavioral-wedge actions may make changes in household energy-related behavior easier to accomplish than behavior change in many other areas. As a result, with sufficient attention to program design, equal or greater levels of change can be expected to occur in energy-related behavior.

E. Household Behavior Change Is Not an Appropriate Role for Government

A fifth and final conceptual barrier arises from concerns about whether government should be in the business of behavior change based on social science insights. In the same breath, critics suggest that behavioral measures are ineffective, and yet are so effective that they raise concerns about mind control.²² Although both cannot be true, these concerns are an important barrier to achieving the behavioral wedge, and policymakers can take a number of steps to alleviate concerns in this area. Even if not rising to the level of mind control, concerns might exist about the level of transparency involved in the use of behavioral instruments. For example, if a report of last month's electricity use combined with a happy-face emoticon induces households that are below the mean electricity use in their neighborhood to keep usage low in the next billing cycle (to engage in socially desirable behavior),²³ is adding the emoticon an appropriate role for government?

This issue deserves more attention than can be devoted to it here, but we suggest several responses. First, open discussion of these issues is appropriate and should accompany the use of behavioral measures. Second, it is important to

16. See 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).

17. See, e.g., DAVID FRUM, *THE RIGHT MAN* 62-63 (2003) (quoting Vice President Richard Cheney for the proposition that although conservation may be a "personal virtue," it alone was not "a sufficient basis for a sound, comprehensive energy policy"). Of course, the issue is not whether energy demand reduction should be the sole approach, but whether it should be accorded an important role alongside policies directed at energy supply.

18. See generally GARDNER & STERN, *supra* note 10 (discussing barriers to individual action).

19. See Stern et al., *supra* note 9, at 308.

20. Michael Tidwell, *To Really Save the Planet, Stop Going Green*, WASH. POST, Dec. 6, 2009, at B1.

21. See, e.g., Nathan S. Lewis, *Powering the Planet*, 2 ENGINEERING & SCI. 12, 19 (2007) (discussing the importance of demand reduction through efficiency and conservation along with the development of low-carbon energy supplies); Dietz et al., *supra* note 2 at 18452; Gardner & Stern, *The Short List*, *supra* note 7, at 22-23.

22. See Emily Badger, *Buy "Climate Change"—Now With Added Warming Power*, MILLER-MCCUNE, at <http://www.miller-mccune.com/science-environment/buy-climate-change-now-with-added-warming-power-3458/>.

23. See, e.g., P. Wesley Schultz et al., *The Constructive, Destructive, and Reconstructive Power of Social Norms*, 18 PSYCHOL. SCI. 429 (2007) (discussing utility bill study).

recognize that many forms of behavior change already exist, whether through obvious or nonobvious marketing, subsidies, default settings, infrastructure investments, lack of information disclosure, or other measures. The issue with behavioral measures is not whether they pose risks, but how the economic and social costs and benefits compare to other viable policy options. In many cases, it may be entirely appropriate—and equally effective—to include a normative intervention in a behavioral effort, e.g., addition of an emoticon to an electric bill, along with a disclosure regarding the goal of the normative intervention. In many other cases, it may be quite effective and entirely appropriate to require that only descriptive information be disclosed, not information designed to convey normative content. In fact, many behavioral-wedge interventions involve financial incentives, convenience features, and other measures that do not raise concerns about inappropriate government efforts to change behavior. Third, it is important to recognize that the United States has been very willing to shape norms regarding energy efficiency and conservation when these goals have been viewed as an urgent national priority. During World War II, for example, the federal government engaged in unambiguous normative message campaigns to encourage energy efficiency and conservation.²⁴

In short, although several conceptual barriers impede development of the laws and policies necessary to achieve the behavioral wedge, these barriers are far from insurmountable and may be less daunting than the barriers facing other carbon mitigation measures.

III. Design Principles for Achieving the Behavioral Wedge

In addition to overcoming conceptual barriers, achieving the behavioral wedge will require laws and policies that reflect behavioral and social science insights. The research on energy and environmental behavior conducted to date yields six basic principles. Some of the principles are widely known and frequently used.²⁵ Other very important ones are less well known. Programs designed to implement all of these principles have a much greater chance of being effective than programs that implement only one or a few.

The design principles for energy efficiency programs are as follows:

A. Prioritize High-Impact Actions

When selecting target actions, look for the ones with the highest achievable carbon and energy impacts. The highest impact depends, not only on *technical potential* (the amount of impact an action has when it is undertaken), but also on

behavioral plasticity (the proportion of households that can be induced to take the action by effective policies).

B. Provide Sufficient Financial Incentives

For some high-impact actions with significant upfront financial costs, strong financial incentives will help elicit action from households. Program success will depend critically, however, on the combination of financial incentives and other design principles, such as marketing, simplicity, and quality assurance, as discussed in the sections below.²⁶

C. Market the Program Effectively

Marketing efforts are needed to get people to notice a program and to convey that it is attractive, but often informal marketing through social networks is as effective as mass marketing.²⁷ To harness local social networks, yet achieve results at a national scale, federal programs will need to include innovative marketing efforts that engage other organizations to reach the numerous target audiences, not just simple advertising.

D. Provide Credible Information at Points of Decision

Information provided at the places and times when people are making the relevant choices, e.g., buying a car or appliance, remodeling a home, moving to a new home, can have substantial effects on individual and household behavior. Programs will need to ensure that a large number and types of organizations have both the necessary information and the incentives to provide that information to the household decisionmaker.

E. Keep It Simple

People economize on cognitive effort, and successful programs (whether in the form of clear, well-designed labels or valid advice from trusted information sources) will need to ensure that the information they provide is easily accessible and actionable, and that inconvenience is kept to a minimum. Although the desire for program managers to assure accountability through paperwork requirements is understandable, overall convenience to the individual, e.g., limited paperwork requirements and one-stop shopping, is critical to success.

24. See Douglas A. Kysar & Michael P. Vandenbergh, *Introduction: Climate Change and Consumption*, 38 ELR 10825, 10830 (Dec. 2008) (noting that during World War II, a federal poster explicitly stated that driving alone in the United States provided support to the German war effort).

25. As noted above, the design principles are presented in more detail in Paul C. Stern et al., *supra* note 6.

26. Programs that have the same financial incentive but differ in other program design features can vary in results by a factor of 10. Paul C. Stern et al., *The Effectiveness of Incentives for Residential Energy Conservation*, 10 EVALUATION REV. 147 (1986).

27. DOUG MCKENZIE-MOHR & WILLIAM SMITH, *FOSTERING SUSTAINABLE BEHAVIOR: AN INTRODUCTION TO COMMUNITY-BASED SOCIAL MARKETING* (New Society Publ. 1999); GERALD T. GARDNER & PAUL C. STERN, *ENVIRONMENTAL PROBLEMS AND HUMAN BEHAVIOR* (2d ed. 2002).

F. Provide Quality Assurance

People must be confident that they will get the promised benefits from adopting new technologies or changing the use of existing technologies. Substantial effort should be directed at adopting and implementing programs that enable people to identify high-quality providers and to ensure that their products and services are sound.

IV. Using the Principles to Assess Programs: Some Examples

These design principles can be used to assess the strengths and weaknesses of existing and proposed programs and policies. The following examples illustrate their use by assigning qualitative ratings ranging from excellent to poor to three energy programs recently in effect in the United States (see Table 1). The rating system is impressionistic. We use qualitative ratings rather than numbers to reflect the imprecision of the current ability to make such assessments. Better measuring instruments could allow more precise evaluation.

A. Cash for Clunkers

This popular but brief 2009 program, formally known as the Car Allowance Rebate System (CARS), could probably have performed better from the standpoint of environmental impact and cost-effectiveness. The new vehicles purchased under the program were only modestly more fuel-efficient than vehicles purchased earlier in the 2009 model year—24.9 miles per gallon (mpg) for the cars purchased under the program, compared with 21.3 mpg for the average vehicle purchased in April 2009.²⁸ However, CARS did extremely well at inducing action. The keys to this behavioral success probably lie in the fact that the program did very well on all the design principles.

We rate the program excellent with regard to impact on carbon emissions and energy use. The target action—acquiring a motor vehicle—has very high technical potential,²⁹ second only to choosing a home, although the modest increases in fuel economy required by the program did not fully exploit the technical potential. CARS probably deserves a rating of good or excellent for incentive. It offered \$3,500 or \$4,500, depending on the fuel economy difference between the old and new vehicles, which amounted to up to 25% of the cost of an \$18,000 vehicle. The incentive was obviously large enough to get consumers' attention. The program certainly deserves "excellent" ratings for marketing and for influence at the point of decision. The automobile industry saturated

the airwaves with ads paid for at no expense to government, to the point that virtually everyone knew about the program. The mass media treated it as a major news story. And the information was front and center in new car showrooms. The program earned at least a "good" rating for accessible information. It was easy to understand how to take advantage of the incentive, and information on the fuel economy and other attributes of new cars is very easy to get, so it was easy to estimate the benefits of the new cars in energy and money savings. Information on the fuel economy of the clunkers is readily available, but you have to know where to look for the official fuel economy ratings, and you need to collect your own data on the old vehicle's actual performance.

The program was also "excellent" with regard to convenience. Although the government imposed a considerable paperwork burden in order to actually collect the rebates, the industry took on the burden. From the consumer's standpoint, all one had to do was drive the clunker to the dealership and make a deal. The rebate was built-in and instantaneous. Quality assurance was not much of an issue for this program, as the consumer could make her own judgment of which make and model would provide the desired fuel efficiency and other quality attributes, from a long list of qualifying models. Quality assurance, as noted below, is a much larger issue with other kinds of efficiency investments, such as in home-weatherization.

B. Energy Efficiency Tax Credits

The federal government now offers a 30% tax credit for qualifying investments in home energy efficiency. The focus of this program is excellent in terms of impact: the suite of qualifying investments has a technical potential and a reasonably achievable emissions-reduction that rivals that of new car purchases. The 30% incentive is similar or larger in size to the one offered in CARS and deserves a similar rating of "good-excellent"—but the program is much less attractive behaviorally than CARS because of its other design features. The program probably deserves to be rated fair for marketing. Compared to CARS, it is not widely advertised, and as a result, relatively few eligible people even know which efficiency investments qualify. Advertising by the home improvement industry does not compare with what the automobile industry did for CARS.

The program deserves a rating of "fair" for providing information at the point of decision. Some home-improvement product retailers advertise the credits in their stores and flyers; home-improvement contractors seem not to advertise the credits prominently.

The program rates "fair" to "poor" in terms of simplicity: fair for actionable information; poor for convenience. It is not very hard to find out what do you have to do operationally to take advantage of the incentive, but it is extremely hard to find out how much energy and money you will save if you make qualifying investments. To get good information, a householder needs to find, arrange, and undertake a good home-energy audit. Actionable information is a seri-

28. Press Release, U.S. Dept of Transp., Cash for Clunkers Wraps Up With Nearly 700,000 Car Sales and Increased Fuel Efficiency, U.S. Transportation Secretary LaHood Declares Program "wildly successful," <http://www.dot.gov/affairs/2009/dot13309.htm> (Aug. 26, 2009); Michael Sivak & Brandon Schoettle, UNIV. OF MICH. TRANSP. RESEARCH INST., *Economic Indicators as Predictors of the Number and Fuel Economy of Purchased New Vehicles* (2009) (UMTRI-2009-27), available at <http://deepblue.lib.umich.edu/bitstream/2027.42/63099/1/102302.pdf>.

29. See Dietz et al., *supra* note 10, at 18453.

ous barrier for home-weatherization because the condition of each existing home is unique. The program deserves a rating of “poor” for convenience. It requires a fairly high level of effort to get the credits. A household needs to make qualified investments, save the receipts, wait up to one year, and do some extra work on its tax returns—much more effort than needed to participate in CARS. Moreover, the program does nothing to make it more convenient to get the qualified investments into place. One must install them oneself or take on the task of finding a contractor to do the installation—and then experience the disruption at home that usually accompanies a remodeling job.

In terms of quality assurance, the program does nothing. It is up to the household to evaluate the quality of work of the available home-remodeling contractors or else to gain the expertise to do the work well itself. It deserves a rating of “poor.” The most effective financial incentive programs for home-weatherization have done much more than this to address the issues of convenience and quality assurance.³⁰

C. Financial Incentives for Residential Photovoltaics

Households in many states can take advantage of at least three incentives for photovoltaic (PV) energy installations: federal and state tax credits; and renewable energy-production credits that can be sold in a complex trading regime that utilities participate in to meet renewable energy portfolio standards. In addition, some jurisdictions offer “feed-in tariffs”—advantageous pricing of electricity that a home feeds into the grid—an additional incentive. The first such tariff in the United States, enacted in Gainesville, Florida, in 2009, offered households 32 cents/kilowatt-hour for this power.³¹ Because the programs are so varied, our ratings are even more impressionistic than for the other programs.

The target actions have a high impact: electricity use accounts for about 72% of in-home carbon emissions in the United States.³² The financial incentive is large (30% from the federal government alone), but the total incentive size depends on the state, and sometimes also on the utility service area. Some jurisdictions have quotas on how much PV can be supplied to the grid or how much is eligible for feed-in tariffs, making the size of some incentives intrinsically difficult to estimate. The variations in the size of the incentive make marketing very difficult, with the result that few households know what the incentives are worth. We are not aware of any systematic efforts to get households to the point of decision on PV, let alone to provide information at that time.

The program structure is the antithesis of simplicity. There are different technical requirements for connecting to the

grid in different states, which are implemented differently by different utilities. Households must follow procedures for two or three different incentive programs. Collecting the incentive provided by renewable portfolio standards requires selling certificates in new markets for the complex credits. Most participants in these markets are large utility companies and professional traders; few households are prepared to participate effectively. The only feasible way for most to do so is to sell their certificates to bundlers, who in turn sell to utilities, taking a fee. To even estimate whether the investment is a good one requires a household to do the kinds of economic analysis for which companies hire accounting firms. PV incentives overall deserve a failing grade for simplicity of design. Quality assurance is a major problem for PV because the industry is new and contractors are few. In most, if not all, states, the program does nothing to address this problem, earning the program another rating of “poor.”

This is not to say that no one participates. In Gainesville, the feed-in tariff program filled its first-year contract quota in three weeks.³³ However, a September 2009 news story in the *Washington Post* makes the difficulties very concrete.³⁴ It told of three upscale neighborhoods in the metropolitan area in which neighbors banded together to help each other take advantage of these incentives. They did this by having knowledgeable group members explain the incentives and how to use them, by sharing the work of finding trustworthy contractors, and by bundling their credits for sale. It is noteworthy that in two of the three exemplary neighborhoods, the individual at the center of the network was an environmental professional—one a career employee at EPA, and the other a staffer at an environmental NGO. The fact that it was newsworthy that anyone was taking advantage of the incentives speaks loudly about the size of the nonfinancial barriers that they leave unaddressed.

D. Emerging Proposals From the Obama Administration

An October 2009 report on “Recovery Through Retrofit” from the Council on Environmental Quality and the Vice President’s office³⁵ proposes a series of new initiatives for residential energy efficiency based on an analysis of “market barriers.” The proposals would address some important barriers to change by making long-term loans more accessible and transferable, developing home-energy rating systems (a good, long-neglected proposal from the 1980s), and training more contractors to do the installations. These proposals demonstrate understanding of some of the design principles, notably the need for sufficient financial incentives, better information, and improved product quality, but they do not address the needs for strong marketing, convenience, and quality assurance systems. They are a good start but would, in our judgment, need to be supplemented by other program

30. See generally GARDNER & STERN, *supra* note 25 (discussing programs); Eric Hirst, *The Hood River Conservation Project: An Evaluator’s Dream*, 12 EVALUATION REV. 310 (1988).

31. Anthony Clark, *Solar Tariff Program Reaches Its Limit in Only 3 Weeks*, GAINESVILLE SUN, Feb. 28, 2009, available at <http://www.gainesville.com/article/20090228/ARTICLES/902270894>.

32. U.S. ENERGY INFORMATION ADMINISTRATION, EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2008 (2009) (DOE/EIA-0573), available at <ftp://ftp.eia.doe.gov/pub/oaia/1605/cdrom/pdf/ggrpt/057308.pdf>.

33. See Clark, *supra* note 31.

34. Elizabeth D. Festa, *To Go Solar, Start Local: Co-ops Can Help You Jump Through Hoops and Start Saving Energy*, WASH. POST, Sept. 19, 2009.

35. COUNCIL ON ENVIRONMENTAL QUALITY, MIDDLE CLASS TASK FORCE, RECOVERY THROUGH RETROFIT (2009), available at http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf.

features if they are to achieve the reduction of 21 million tons of carbon per year that we believe can reasonably be achieved through home-weatherization.

V. Applying the Design Principles

We have used the design principles to make a rough assessment of the practical potential of several recent and proposed policies and programs for the household sector. This analysis shows where and how these policies and programs can be improved, but it does not show how much improvement to expect or at what cost for improved program operation. On the basis of the past performance of home-weatherization programs, we believe that it would be highly cost-effective to supplement financial incentive programs by investing money, effort, and staff in improving their nonfinancial features. However, we cannot quantify the cost or effectiveness for lack of a sufficient database from past program evaluations. Achieving RAER from existing technology in the household sector will require the implementation of programs that apply all six design principles. Because this has been seldom done in the past, it will be essential to evaluate new programs as experiments, using indicators of all the design principles and measures of achieved emissions reductions.

As noted above, much less is known about design principles for energy efficiency programs outside the household sector. It might be assumed that organizations, especially profit-making ones, will be far different from households in that they will behave like economically “rational” profit maximizers. However, this is often not the case. The estimated potential for economically advantageous improvements in energy efficiency in the private sector—the so-called energy efficiency gap—is not much smaller in the private sector than among households.³⁶ Some of the reasons are known. A survey of over 1,000 private-sector managers by the Johnson Controls Corporation shows that, on average, they require a payback on energy efficiency investments of about three years—a rate of return of over 30%.³⁷ A rate of this size is well above the rate that many companies can expect to earn from other investments, and it suggests that nonfinancial factors may be important, not only for household decision-making, but also for firm decisionmaking.

Some of the reasons are known. Many companies do not consider energy efficiency to be a core activity of the firm, so they give it lower priority. Operations and product development have separate budgets, hampering comparisons in terms of return on investment. Some companies prefer to repair outdated furnaces rather than submit to the regulatory reviews required for putting new, energy-efficient ones in place. And so on. The design principles for energy efficiency programs for the private sector are yet to be worked out and will require more empirical investigation. But considering the high potential for economically attractive emissions reductions, we believe that the nonhousehold sectors will be able to carry their share of the burden of achieving near-term emissions reduction goals, if the needed behavioral research is conducted and the resulting design principles applied.

Table I. Recent Programs Rated by Design Principles

Principle	Cash for Clunkers	Efficiency tax credit	Residential PV incentives
Select high-impact actions	Excellent	Excellent	Good
Provide sufficient financial incentives	Good-Excellent	Good-Excellent	Variable
Market effectively	Excellent	Fair	Poor
Intervene at point of decision	Excellent	Fair	Poor
Keep it simple	Good-Excellent	Fair to Poor	Poor
Provide quality assurance	Not an issue	Poor	Poor

36. See MCKINSEY & COMPANY, *supra* note 9.

37. INTERNATIONAL FACILITY MANAGEMENT ASSOCIATION, 2009 ENERGY EFFICIENCY INDICATOR IFMA SUMMARY REPORT (2009), available at <http://www.ifma.org/tools/files/EEIReport.pdf>.