Education for Reenergization: Overcoming Behavioral Barriers to Energy Efficiency in the Residential Sector

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Editors' Summary

To face the challenges of energy consumption, the United States requires a policy that aims to bring the country to the highest level of residential energy efficiency possible, while educating the next generation of leaders on energy use and the potential for change through efficiency. Standing in the way of improved energy efficiency are behavioral barriers, including information barriers, transaction cost barriers, and landlord-tenant barriers. Current domestic energy-efficiency programs operate with varying degrees of effectiveness, but more widespread and lasting change could be accomplished by implementing a program that would educate high school students on energy and create incentives for students to improve their homes' efficiency.

The generations living today get to retrofit, reboot, and reenergize a nation. We get to rescue and reinvent the U.S. economy. We may as well do it right the first time.

—Van Jones[1]

We're at the precipice of energy transformation with an essential choice: change the way we produce and use energy now, or wait until we're absolutely forced to. The inexpensive oil, natural gas, and coal we've based our economy on are slated to run out in roughly 40,[2] 60, and 120 years, respectively.[3] America *could* wait and let the market run its course, using up all the cheap fossil fuels to the last drop before we switch gears to something else.

Or we could not. There are some really good reasons why waiting might not be the best idea. First, climate change: if we burned all the black stuff we could get our hands on, we would, to put it bluntly, "destroy the planet we know."[4] "Carbon dioxide (CO_2) would increase to 500 ppm or more. We would set the planet on a course to the ice-free state, with sea level 75 metres higher. Climatic disasters would occur continually."[5] Second, energy security: although we have our own coal reserves, we rely on other countries to supply the lion's share of our oil. And "more than 70 percent of the global oil reserves are controlled by countries with which the United States has tenuous and troubled relations such as Venezuela, Russia, and

Author's Note: The author would like to thank Jody Freeman for her helpful comments and suggestions.

1. Van Jones, The Green-Collar Economy 10 (HarperOne 2008).
2. The predictions for when oil ceases to be cheap and plentiful range from a decade to 150 years. *Compare* Colin J. Campbell & Jean H. Laherrere, *The End of Cheap Oil*, *in* Oil and the Future of Energy 1, 2 (Sci. Am. ed., 2007):
   > From an economic perspective, when the world runs completely out of oil is . . . not directly relevant: what matters is when production begins to taper off. Beyond that point, prices will rise unless demand declines commensurately. Global production of conventional oil will begin to decline sooner than most people think, probably within 10 years.

   with Nathan S. Lewis, *Powering the Planet*, 2 Engineering & Sci. 15 ("[T]he higher the price [for oil] goes, the more reserves you can access economically. . . . The entire resource base [of oil]—the best estimate of what's waiting to be discovered—gives us between 50 and 150 years at 1998 consumption rates.").
3. Roy L. Nersesian, Energy for the 21st Century: A Comprehensive Guide to Conventional and Alternative Sources, 379 (M.E. Sharpe 2010). *But see* Lewis, *supra* note 2, at 14 ("The Stone Age did not end because we ran out of stones, and the fossil-energy age is not going to end any time soon because we've run out of cheap fossil energy.") (arguing that, at higher prices, there are 200-600 years of natural gas, and 2,000 years of coal).
4. James Hanson, *Coal-Fired Power Stations Are Death Factories. Close Them*, The Observer, Feb. 15, 2009. *See also* Victor Anderson, Energy Efficiency Policies 1 (Routledge 1993) ("Carbon, the basis of life, is becoming a threat to life.").
5. *Id.* For a slightly more nuanced view of the threats of climate change, see generally Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report: Climate Change 2007 (2007).

Saudi Arabia."[6] Finally, economic stability: if we continue to rely on dwindling supplies of fossil fuels, we may wind up in deep economic trouble as "the increasing depletion of oil resources, the drastic rise in oil prices and the simultaneous escalation of the global environmental crisis [precipitates] an unprecedented worldwide economic crisis."[7]

Yet, in America at least, we're at a political standstill to do the one major action that might propel us toward our clean energy future—set a price on carbon.[8] And we continue to invest in new fossil fuel-based power plants, laboriously building the coal and natural gas infrastructure to last another 50 years.[9] We're not charging ahead to change how we produce energy, and it may not be politically feasible to do so in the near future.

This Article will argue that, in the absence of political will to change *production* of energy, the Barack Obama Administration should focus even more strongly on changing how we *use* energy[10]—the low-hanging fruit, both from a technical and political standpoint. At the same time, the Administration should also focus on educating the next generation of leaders on the need to solve climate change and reduce our dependence on fossil fuels, so that if this generation indeed fails to transform energy production, political support might be available in the next generation.[11]

This Article proposes a policy that aims to bring the United States to the highest level of residential energy efficiency possible, while educating the next generation of leaders. Part I of the Article will give a brief overview of energy use in America, and discuss the potential for change through efficiency. Part II will examine the behavioral barriers to improving energy efficiency, including information barriers, transaction cost barriers, and landlord-tenant barriers. Part III will examine current domestic energy-efficiency programs and evaluate their effectiveness, arguing that overall, they are ineffective to inspire large-scale adoption of energy efficiency in homes. Finally, Part IV of the Article will propose a program, which will educate high school students on energy and create incentives for students to improve their homes' efficiency, designed to overcome behavioral barriers to energy efficiency and to be both wide and deep in impact: wide in the sense that the program will affect the maximum number of homes in America possible, and deep in the sense that it will encourage homes not just to change a light bulb or two, but to overhaul energy use entirely.

I. Energy Use and the Potential for Improvement

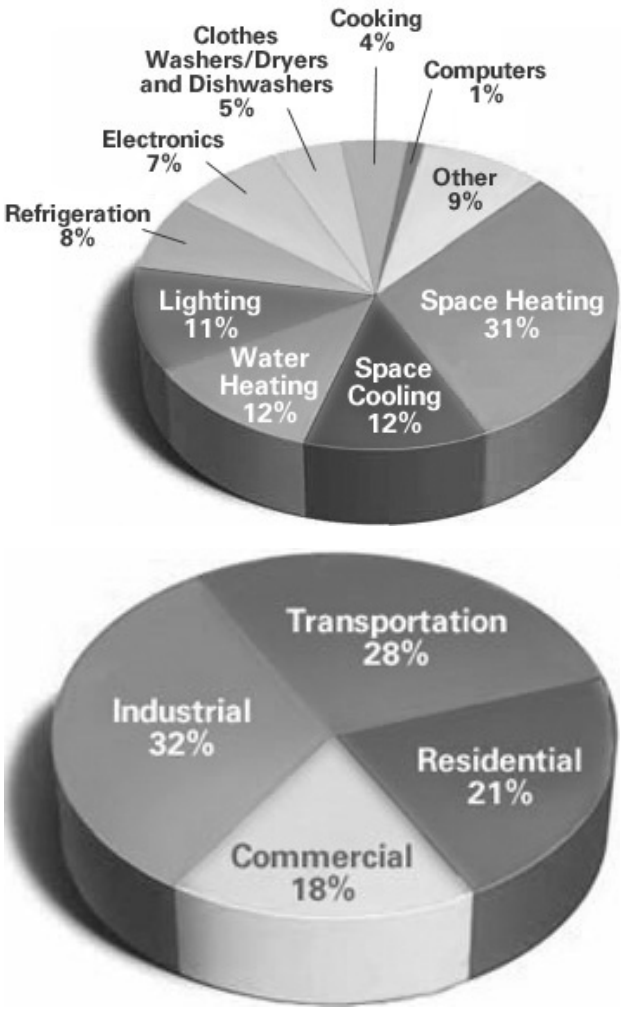
> *The amount of energy waste in the United States . . . far exceeds the inevitable loss.*[12]

A. Energy Use in the Home

Residential buildings account for approximately 21% of energy use in the United States,[13] and with a continuation of existing policy, appliance consumption alone is projected to grow by 25% by 2020.[14] Energy is used in the home for heating, cooling, lighting, and powering appliances.[15]

Much of the electricity generated to power homes is wasted.[16] Both the transmission of power to residential buildings and the use of power by households are highly inefficient. "For every unit of energy delivered to the residential sector in the form of electricity, over two units of energy are lost as waste heat in electric power generation and transmission."[17] And, once energy reaches the home, much of that energy may be lost by inefficient home design, and inefficient appliances. For example, a home may lose up to 30% of its energy through air leakage[18]; older fur-

6. *Foreign Policy and National Security Implications of Oil Dependence: Hearing Before the H. Comm. on Foreign Affairs*, 110th Cong. 1 (2007) (statement of Tom Lantos, Chairman of the Comm. on Foreign Affairs).
7. Hans-Josef Fell, *The Renewable Imperative: Providing Climate Protection and Energy Security*, *in* 100% Renewable: Energy Autonomy in Action 57, 63 (Peter Droege ed., 2009).
8. In July 2010, U.S. Senate Democrats gave up trying to pass a comprehensive energy bill that would have set a price on carbon. *See* Stephen Stromberg, *What Sank the Senate's Climate Bill*, Wash. Post, July 29, 2010.
9. Power plants built today last for about one-half century or more. 151 Cong. Rec. 11503 (2005). Although additional renewable energy capacity is projected to be added to the grid in the next 25 years, coal-fired power plants are slated to provide the largest share of electricity supply in 2035. U.S. Energy Information Administration, Annual Energy Outlook 2010 With Projections to 2035, 66-9 (2010).
10. *Cf.* Barry Barton, *The Law of Energy Efficiency*, *in* Beyond the Carbon Economy 60, 67 (Donald N. Zillman et al. eds., 2008) ("Energy efficiency is often treated dismissively. It is not as exciting as new sources of supply: the great engineering adventures of ultra-deep-water oil exploration, giant pipelines snaking across the globe, colossal new mines, or returning to nuclear.").
11. *Cf.* Richard L. Ottinger et al., *Renewable Energy in National Legislation: Challenges and Opportunities*, *in* Beyond the Carbon Economy 183, 200 (Donald N. Zillman et al. eds., 2008):
    > Education is vital for informing the public, energy decision makers, and the private sector about the external costs of fossil fuels, the need to reduce carbon dioxide emissions, and the available renewable energy options, applications, costs, and benefits. This knowledge is also essential to build the political support necessary to enact laws promoting renewable resource use.
12. Daniel D. Chiras, Environmental Science 310 (Jones & Bartlett 7th ed. 2006).
13. National Academy of Sciences, What You Need to Know About Energy, *available at* http://www.nap.edu/reports/energy/sources.html.
14. International Energy Agency, Cool Appliances: Policy Strategies for Energy-Efficient Homes 12 (2003).
15. *Id.*
16. For a comparison of energy-efficiency opportunities across sectors, see D. Yogi Goswami & Frank Kreith, *Global Energy System*, *in* Handbook of Energy Efficiency and Renewable Energy 1-1, 1-19 to 1-20, tbl 1.9 (Frank Kreith & D. Yogi Goswami eds., 2007).
17. National Science Board, Building a Sustainable Energy Future: U.S. Actions for an Effective Energy Economy Transition 34 (2009).
18. Jean Nayar, Green Living by Design 40 (Filipacchi Pub. 2009).



The figure at top depicts energy usage in the U.S. residential sector in 2006. The bottom figure represents the percentage of energy consumed in the United States by each economic sector in 2006. Source: National Academy of Sciences, *What You Need to Know About Energy* (2008), http://www.nap.edu/reports/energy/sources.html.

naces and boilers operate at about 65% efficiency[19]; and incandescent light bulb uses only 10% of the energy it requires to produce light, the other 90% is lost as heat.[20]

B. Potential for Efficiency Gains

There is a range of predications for what energy-efficiency measures could accomplish. On the conservative side, "cost-effective energy-efficiency measures could cut total energy consumption in U.S. buildings by as much as 30% over the next two decades, despite a 15 to 20% increase in the number of buildings."[21]

From a more ambitious perspective, aggressively pursuing a goal of zero net energy for residential buildings could bring even higher energy savings. For example, California has set a target to reduce energy use in existing homes by 40% by 2020.[22] California is also aiming to bring new residential buildings to zero net energy use.[23] The zero net energy goal couples energy efficiency with onsite renewable power generation (think solar panels or wind turbines on the roof). A zero net energy building is envisioned as being connected to the grid, but producing as much or more energy a year than the home requires.[24]

Focusing on residential energy efficiency can have major effects. First, even under the conservative perspective of what efficiency gains are possible, Stephen Pacala and Robert Socolow predict that pursuing "'known and established approaches' to energy efficient space heating and cooling, water hearting, lighting, and refrigeration in residential and commercial buildings [could] . . . reduce [GHG] emissions from buildings by about one-fourth."[25] This could represent one-seventh of the GHG savings needed in order to solve climate change for the next 50 years.[26] California's more aggressive energy-efficiency goals, in contrast, are expected to represent approximately 30% of California's *total* GHG emissions savings goal in 2050.[27]

Second, increasing energy efficiency has major implications for the need to build additional generating capacity.[28] For example, meeting the National Action Plan for Energy Efficiency's goals would reduce the need to build 100 500-megawatt (MW) power plants over the next 20 years.[29] Moreover, decreasing demand is much less expensive than increasing supply. For example, "[i]t costs about $2.50/watt to build a new coal power plant. But replac-

19. As opposed to new appliances, which may operate at 90% or higher. John Krigger & Chris Dorsi, The Homeowner's Handbook to Energy Efficiency 8 (Greenleaf 2008).
20. Clarke Snell, The Good House Book: A Common-Sense Guide to Alternative Homebuilding 134 (Lark Books 2004). Note that the Energy Independence and Security Act of 2007, Pub. L. No. 110-140, is requiring light bulbs to be 30% more efficient by 2012-2014.
21. Chiras, *supra* note 12, at 315.
22. Marrian C. Fuller et al., *Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power*, Environment 2009. The California Public Utilities Commission (CPUC) adopted California's first long-term energy-efficiency strategic plan on September 18, 2008, setting energy-efficiency goals. *See* CPUC, Energy Efficiency Strategic Plan, http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.
23. *See* Fuller, *supra* note 22.
24. California Energy Efficiency Strategic Plan, §2, 13 (2011).
25. Stephen Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years With Current Technologies*, 305 Sci. 968, 969 (2004). Over one-half of these potential savings are in buildings in developed countries. *Id.*
26. *Id.* Increasing building energy efficiency by 25% could provide one of seven "wedges" of action needed to solve climate change for the next 50 years.
27. Hyrodgen Energy International LLC, Summary: Meeting California's Long-Term Greenhouse Gas Reduction Goals 5-6 (2009), *available at* http://www.ethree.com/documents/2050revisedsummary.pdf. The emissions savings goal is to bring state emissions to 80% below 1990 levels by 2050. *Id.* at 1.
28. Richard W. Asplund, Profiting From Clean Energy 188 (Wiley 2008) ("Rather than building new power plants, the more rational course is to focus on power efficiency as a way to make our existing power base go farther and thus reduce the need for new power plants.").
29. National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change 2-1 (2008). The Action Plan predicts that energy efficiency may be able to meet 50% of the expected load growth. *Id.* This is a relatively modest number; there are about 5,400 power plants in the United States. U.S. Energy Information Administration, Frequently Asked Questions, How Many and What Kind of Power Plants Are There in the United States, http://tonto.eia.doe.gov/tools/faqs/faq.cfm?id=65&t=2.

ing light bulbs can decrease demand for only $.025/watt"[30] This may be why President Obama calls energy efficiency "the cheapest, cleanest, fastest energy source."[31]

C. *Technology Is Available*

Although technology is likely to continue to improve, technology exists today that could drastically improve energy efficiency in existing homes, and even bring existing homes to zero net energy.[32] The easiest and most cost-effective energy-saving opportunities include installing smart meters, which help consumers track and reduce energy use,[33] and making energy retrofits, including weather stripping and replacing older heating, cooling, and lighting systems with more efficient equipment.[34] But even more aggressive efforts to achieve zero net energy—for example installing photovoltaic panels or solar heat collectors—are possible with current technology.[35] By 2015, the cost to retrofit a home with solar panels is projected to fall to $3.10-4.80 per watt, making solar photovoltaics "equivalent with the lifetime cost of an equivalent amount of grid electricity."[36] In some states, such as California, parity has already arrived.[37]

II. Barriers to Improvement

If the consumer gains from energy efficiency are relatively high, and the technology exists today, why isn't every home in America 40% more efficient? Several barriers to widescale energy efficiency in the residential sector exist. These include information barriers, transaction cost barriers, and landlord-tenant barriers.[38]

The "information barrier" is the difficulty of obtaining information relevant to make informed energy decisions. This includes understanding which products save energy and on what payback periods,[39] and which energy retrofits a consumer might need.[40] "Furthermore, obtaining such information and the requisite professional help to make [comparisons of life-cycle costs of alternative energy options] is burdensome and expensive."[41] This highlights why, even when consumers have access to financing needed to cover up-front costs, "people often fail to make efficiency investments that appear to provide a payback in a relatively short time—that are rational at any ordinary discount rate."[42] In other words, consumer energy-efficiency decisions exhibit "bounded rationality."[43]

The transaction cost barriers include lack of access to financing,[44] and the reluctance of homeowners to "pay the higher cost of energy-efficient appliances and products when less efficient products cost less."[45] Although many

30. Thomas R. Blakeslee, *Energy Saving: Much Cheaper Than Building Power Plants!*, Renewable Energy World.com, Nov. 12, 2009, http://www.renewableenergyworld.com/rea/news/article/2009/11/energy-saving-much-cheaper-than-building-power-plants. ("A 13-watt compact florescent bulb replacing a 60-watt incandescent bulb reduces demand by 47 watts for only $1.19. $1.19/47 = $.025/watt.").
31. As cited in Neil Peretz, *Growing the Energy Efficiency Market Through Third-Party Financing*, 30 Energy L.J. 377, 378 (2009).
32. For a comprehensive overview of energy-efficiency technologies available, see generally Frank Kreith et al., *Energy Efficient Technologies*, *in* Handbook of Energy Efficiency and Renewable Energy 12-1 (Frank Kreith & D. Yogi Goswami eds., 2007).
33. Sandra Levine & Katie Kendall, *Energy Efficiency and Conservation: Opportunities, Obstacles, and Experiences*, 8 Vt. J. Envtl. L. 101 (2006).
34. *See* U.S. Department of Energy, Weatherization & Intergovernmental Program, http://www1.eere.energy.gov/wip/weatherization.html (last visited Sept. 19, 2011); John Krigger et al., Residential Energy: Cost Savings and Comfort for Existing Buildings 17 (Saturn Resource Mgmt. 2004). Weatherizing a home can save between 10-30% of home energy use. *Id.*
35. "Many existing homes can also incorporate solar technologies. Photovoltaic panels can be installed on the roofs of 35-40 percent of homes nationwide, and solar heat collectors on 50 percent of residential roofs." Environment Maine, Building a Solar Future 2 (2010) (citing Paul Denholm, National Renewable Energy Laboratory, The Technical Potential of Solar Water Heating to Reduce Fossil Fuel Use and Greenhouse Gas Emissions in the United States, Mar. 2007).
36. Environment Maine, *supra* note 35, at 42. *See also* Posting of James Kanter, First Solar Claims $1-a-Watt "Industry Milestone" to the New York Times' Green blog (Feb. 24, 2009, 16:30 EST) (predicting parity in 2012, and noting that First Solar, a photovoltaic energy company, has brought costs down below $1/watt).
37. *Id.* For a general discussion of solar power in the home, see Bob Everett, *Solar Thermal Energy*, *in* Renewable Energy 18 (Godfrey Boyle ed., 2006).
38. For another way to view the behavioral barriers, see Loren Lutzenhiser, *Marketing Household Energy Conservation: The Message and the Reality*, *in* New Tools for Environmental Protection: Education, Information and Voluntary Measures, 49, 55 (Thomas Dietz & Paul C. Stern eds., 2002):
> [T]he question "Why haven't we had greater success with our efforts to promote energy conservation?" is best addressed by considering a set of system characteristics, including *embeddedness* of energy use, the *constrained* nature of household choice, the *countermarketing* of consumptive lifestyles and behaviors, and the lack of *impetus* for change.
39. "Consumer durable prices are lump sums . . . but taking into account energy costs involves complex calculations, even including prediction of future energy prices." Anderson, *supra* note 4, at 31.
40. Council on Environmental Quality, Recovery Through Retrofit 1 (2009), *available at* http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf (noting consumer barriers generally).
41. Eric Hirst et al., *Improving Energy Efficiency: The Effectiveness of Government Action*, 1982 Energy Pol'y 131, 134.
42. Barry Barton, *supra* note 10, at 74.
> That consumers and firms frequently do not undertake energy-efficiency investments that appear cost-effective on an estimate life-cycle basis was first recognized in the 1970s; specifically, the empirical pattern is of customers appearing to require returns on these investments that exceed—in some cases very substantially—market interest rates for borrowing or saving.

Id. at 64-65 (quoting Alan H. Sanstad et al., *End-Use Energy Efficiency in a "Post-Carbon" California Economy: Policy Issues and Research Frontiers*, *in* Managing Greenhouse Gas Emissions in California 6-9, 6-17 (Berkeley: California Climate Change Center at UC Berkeley, 2006)).
43. *See* Steve Sorrell, *Understanding Barriers to Energy Efficiency*, *in* Steve Sorrell et al., The Economics of Energy Efficiency 25, 44-50, 277 (2004):
> Boundedly rational individuals require time and resources to obtain information and are limited in their ability to make full use of information. As a result, they will substitute routines and rules of thumb for more compressive assessments, and make sub-optimal decisions relative to the predictions of neo-classical theory. Bounded rationality may therefore create an additional barrier to energy efficiency, as well as reinforcing the operation of other barriers.

See also Alan H. Sanstad & Richard B. Howarth, *"Normal" Markets, Market Imperfections and Energy Efficiency*, 22 Energy Pol'y 811 (1994). "Close study of the procedures actually used by consumers in making energy-related decisions has revealed systematic deviations from rational or cost minimizing behavior even when consumers are motivated to make careful decisions." *Id.* at 816.
44. Council on Environmental Quality, *supra* note 40.
45. Edward H. Comer, *Transforming the Role of Energy Efficiency*, 23 Nat. Resources & Env't 34, 35 (2008).

energy-efficiency measures are inexpensive to implement, some energy-efficiency systems can require fairly high up-front costs; a relatively small 2 kilowatt (kW) solar system for an average grid-connected home, for example, runs about $16,000.[46] Homeowners may be concerned that they will be unable to recoup the investment in such a system if they later choose to sell their home.[47]

Finally, landlord-tenant barriers may exist. Thirty-two percent of homes in America are tenant-occupied.[48] For tenant-occupied buildings, "[t]enants may have little motivation to improve the performance of an asset they do not own, particularly if they have a short-term lease."[49] At the same time, "a landlord might be unwilling to retrofit an apartment because the resulting energy savings would be realized by a tenant who paid the utility bills. Nor would the landlord agree to pay for utilities since this would create an incentive for renters to overconsume."[50] This means that even when a tenant has access to information about energy efficiency, and the financing to implement it, they may be unwilling to do so.

III. Current Programs

The main programs at the national level aimed at promoting energy efficiency in the home include: (1) increasing energy-efficiency standards for products from light bulbs to washing machines; (2) providing tax and rebate incentives for energy efficiency; and (3) implanting weatherization programs.[51] Although various governmental programs are aimed at improving energy efficiency, no program effectively overcomes all of the barriers described above. Indeed, most governmental programs are aimed *only* at decreasing costs for consumers and/or improving access to information. Moreover, no government program provides incentives for comprehensive overhaul of home energy use. This section will briefly describe each program, and demonstrate where behavioral barrier gaps remain in each.

In the strongest example of command-and-control regulation for energy efficiency, the Energy Independence and Security Act (EISA) of 2007[52] requires light bulbs to be 30% more efficient by 2012-2014. On its face, by outright mandating improvements for a product that has a life expectancy of only 750 hours,[53] the law would appear to quickly implement wide-scale improvements in lighting efficiency. However, the law has also caused some confused consumers to try to stockpile inefficient bulbs.[54] This represents at least a partial failure to overcome the information and transaction cost barriers: consumers are worried about the higher up-front costs of the bulbs,[55] and are misinformed that buying them does not represent a rational economic choice. The law also makes only a relatively small improvement in total home energy use. Lighting represents only 11% of energy use in the home.[56] Improving lighting by 30% only improves total home energy use by 3.3%.

The Energy Star Program also aims to improve energy efficiency in home products.[57] But rather than requiring a set standard for energy improvement for all products, Energy Star rewards voluntary improvements in energy efficiency with the Energy Star label. Although Energy Star improves the information barrier by increasing access to information about a product's lifetime costs, the program does not adequately address the transaction cost and landlord-tenant barriers; some appliances—especially large appliances, such as refrigerators, washing machines, and water heaters—have high up-front costs, and energy-efficient products may be more expensive than other models.[58] Consumers may therefore be reluctant to replace inefficient but operable appliances, despite the potential for long-term energy savings. Sadly, even when the Energy Star program works effectively to sway consumer choice, that choice may not be the correct one; the U.S. Government Accountability Office (GAO) found in 2010 that the Energy Star Program is vulnerable to fraud and abuse.[59]

Federal tax credits exist to decrease the up-front costs of energy retrofits and home energy generation. For exam-

46. Linda Pinkham, *What's the Average Cost to Install a Solar-Electric System to Power Your Home?*, Mother Earth News, May 21, 2009.
47. Council on Environmental Quality, *supra* note 40.
48. Press Release, U.S. Department of Housing and Urban Development, HUD Releases 2009 American Housing Survey (July 1, 2010), *available at* http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2010/HUDNo.10-138.
49. Sorrell, *supra* note 43, at 76. *But see* Ronald J. Sutherland, *The Economics of Energy Efficiency*, 24 Energy Pol'y 361, 365 (1996) (questioning the "occupancy hypothesis" and arguing that empirical data needed to prove a disparity).
50. Richard B. Howarth & Alan H. Sanstad, *Discount Rates and Energy Efficiency*, 13 Contemp. Econ. Pol'y 101, 107 (1995).
51. Additional federal and state programs exist that indirectly encourage energy efficiency, including promoting smart-grid technology and encouraging state conservation programs. *See, e.g.*, Public Utility Regulatory Program (PURPA), 16 U.S.C. §§1623-1625 (encouraging states to adopt policies to improve conservation). For a more-or-less comprehensive list of programs aimed at energy efficiency and renewable energy, see Lisa Dilling & Barbara Farhar, *Making It Easy: Establishing Energy Efficiency and Renewable Energy as Routine Best Practice*, *in* Creating a Climate for Change 365-68, tbl. 23.1 (Suanne C. Moser & Lisa Dilling eds.). For a sampling of innovative state programs aimed at overcoming behavioral barriers, see Merrian C. Fuller et al., Lawrence Berkeley Nat'l Lab., Driving Demand for Home Energy Improvements: Motivating Residential Customers to Invest in Comprehensive Upgrades That Eliminate Energy Waste, Avoid High Bills, and Spur the Economy 76-128 (2010). That other state programs exist cuts both ways; on the one hand, there are additional efforts to address barriers to energy efficiency, on the other hand, the plethora of programs adds to the daunting complexity for consumers.
52. Pub. L. No. 110-140.
53. Gilbert Held, Introduction to Light Emitting Diode Technology and Applications 89 (CRC Press 2009).
54. Edward Wyatt, *Give Up Familiar Light Bulb? Not Without Fight, Some Say*, N.Y. Times, Mar. 11, 2011.
55. "'I do care about my carbon footprint, not to mention my light bill,' said Dana Carpender, a cookbook author in Bloomington, Ind. 'But unless something dramatic happens to bring down the cost of alternatives, I will be stashing away a pile of incandescents.'" *Id.*
56. See the figure (top) on page 11032.
57. Energy Star, Products, http://www.energystar.gov/index.cfm?c=products.pr_find_es_products (setting voluntary standards for energy-efficient appliances).
58. Hawaii Energy, Energy Solutions, http://www.hawaiienergy.com/21/energystar-appliances (noting that Energy Star appliances "may be more expensive than other models" and offering energy rebates to decrease the higher up-front costs).
59. U.S. GAO, Energy Star Program: Covert Testing Shows the Energy Star Program Certification Process Is Vulnerable to Fraud and Abuse (2010).

ple, tax credits include 10% of the cost (up to $500) of installing energy-efficient biomass stoves, HVAC systems, insulation, roofs, water heaters, and windows and doors; and 30% of the costs of installing geothermal heat pumps, small wind turbines, solar energy systems, and fuel cells.[60] A "cash for appliances" program also offers rebates on purchasing energy-efficient appliances.[61] But while these programs potentially help decrease the transaction cost barriers, they do not effectively overcome the information barriers. The tax program, for example,

> is not widely advertised, and as a result, relatively few eligible people even know which efficiency investments qualify . . . 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.[62]

The Weatherization Assistance Program (WAP) was created under the Energy Conservation and Production Act of 1976,[63] following the 1973 oil crisis. In 2009, the WAP received $5 billion under the Recovery Act to increase the energy efficiency of low-income homeowners and renters.[64] The typical weatherization activities include air sealing and insulation.[65] While this program decreases information and transaction cost barriers by providing consumers with home energy audits and workers to provide the weatherization services, and by giving direct grants to perform the work, respectively, the program still has high information barriers and transaction costs in terms of time spent to join the program. A consumer must know about the program in general, research the specific program for her state, determine her eligibility, fill out an application form, provide proof of income, be put on a waiting list, obtain permission from her landlord (if she rents), and be willing to take the time to meet with the auditor and to allow work crews into her home.[66]

Most importantly, while a consumer could *potentially* utilize all government programs together to overhaul home energy—for example, buying all new Energy Star appliances, using tax incentives to install solar roofs and high-efficiency water heaters, and weatherizing her home with the WAP—this consumer would have to have enough information to understand the complex grant and tax programs, what her home energy current uses and needs are, where to find professional home energy retrofitting services, and be both high-income enough to afford the up-front costs of new appliances *and* be low-income enough to qualify for the WAP.[67] In other words, this *potential* consumer probably does not exist. This highlights the piecemeal quality of government energy-efficiency programs; although there are myriad programs to increase efficiency, there is no one-stop-shop or program to encourage a consumer to completely overhaul his home, let alone his apartment. Finally, "[b]ehavioral science research and practical application confirm that simply providing information and financing is insufficient to incentivize widespread energy improvements,"[68] yet apart from the WAP, no government program attempts to do more than provide information or ex post financing.

IV. Solution

What the federal government needs is a program that educates *all* consumers on the need for energy efficiency and incentivizes them to take *all* energy-efficiency measures possible, while simultaneously overcoming transaction cost and landlord-tenant barriers. This section will endeavor to describe a single program to achieve these goals.

A. *Program Design*

The proposed program would both educate high school students on energy and create incentives for students to improve the energy efficiency of their home, as well as to get their home to "zero net energy." Funded at the federal level, every high school would be encouraged through funding, but not mandated, to offer a course on energy for high school students, or to incorporate energy lessons into other courses such as math and science.[69] The course or lesson would include a project where students conduct an energy audit of their home, and attempt to increase their home's energy efficiency. A yearly prize, funded at the federal level but administered at the state level, would award college scholarships to students in each state who have made the most progress in achieving zero net energy of their home in various categories, e.g., single family home, apartment building, etc. The course would be aimed at encouraging students to do the most basic energy assessments and retrofits, whereas the prize would be aimed at

60. Energy Star, 2011 Federal Tax Credits for Consumer Energy Efficiency, http://www.energystar.gov/index.cfm?c=tax_credits.tx_index.
61. U.S. Department of Energy (DOE), Rebates for Energy Star Appliances, http://www.energysavers.gov/financial/70020.html.
62. Michael P. Vandenbergh et al., *Implementing the Behavioral Wedge: Designing and Adopting Effective Carbon Emissions Reduction Programs*, 40 ELR 10547, 10552 (June 2010).
63. Pub. L. No. 94-385, 12 U.S.C. §1701z-8 (2006).
64. Alliance to Save Energy, Recovery Act Weatherization Assistance Program Funding Opportunity Announcement, http://ase.org/resources/recovery-act-weatherization-assistance-program-wap-funding-opportunity-announcement.
65. *See, e.g.*, Massachusetts Department of Housing and Economic Development, Weatherization Assistance Program, http://www.mass.gov/?pageID ehedterminal&L=3&L0=Home&L1=Community+Development&L2=Housing+Energy+Programs&sid=Ehed&b=terminalcontent&f=dhcd_cd_wap_wap&csid=Ehed.
66. U.S. DOE, Apply for Weatherization Assistance, http://www1.eere.energy.gov/wip/wap_apply.html#eligible. *See also* Fuller, *supra* note 51, at 22-23 (discussing why poorly designed retrofit programs are "too much hassle").
67. "Depending on what state you live in, you are eligible for weatherization if your income falls below the 200% poverty level. . . ." U.S. DOE, Apply for Weatherization Assistance Program, http://www1.eere.energy.gov/wip/wap_apply.html#eligible.
68. Fuller, *supra* note 51, at 5.
69. For an example of a project-based environmental curriculum, see, e.g., Investigating and Evaluating Environmental Issues and Actions (IEEIA), as discussed in John Ramsey & Harold R. Hungerford, *Perspectives on Environmental Education in the United States*, *in* New Tools for Environmental Protection: Education, Information and Voluntary Measures, 147, 149 (Thomas Dietz & Paul C. Stern eds., 2002).

encouraging the most motivated students to tackle the bigger challenge of zero net energy.

This program would be coupled with federal financing, so that parents are not forced to bear high up-front costs for their children's school projects. States have already begun experimenting with these types of financing programs; this project would simply seek to elevate the most effective program to the federal level to ensure consistent access to financing.[70] There are several ways this financing could work, including providing interest-free loans to be paid back over the payback period of the efficiency measure, "on-bill financing," and financing through tax liens.[71]

For example, North Carolina created a low-interest revolving loan program for energy improvements.[72] With the revolving loan, loan repayments are fed back into the fund, allowing the loan program to, in theory, continue indefinitely. To implement a revolving fund on the federal level, the U.S. Congress would need to pass an act authorizing the loan program. Congress passed a similar type of revolving loan as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[73] to fund a revolving loan for brownfields redevelopment.[74]

A utility in New Haven experimented with providing interest-free loans to customers to fund energy-saving improvements. The loans are paid back over time through the customer's electricity bill. Once the loan is repaid, the customer's energy bill reflects the full value of the energy savings.[75] As a corporate-driven program, this may be more difficult to federalize. To do so, the president or Secretary of Energy could partner with major utility companies to encourage adoption and/or perhaps provide financial or regulatory incentives for utility companies to adopt this measure.

Finally, the city of Berkeley created a special tax bond that provides financing for residential energy improvements.[76] To participate, property owners submit an application for energy-efficiency improvements to the city. Once the application is approved, a lien is placed on the property to provide the homeowner with the financing for the improvements.[77] However, the future of this type of program is currently uncertain; In July 2010, the Federal Housing Finance Agency, "effectively derailed the program when it issued guidance to lenders stating that the liens violated the agency's underwriting standards."[78] This type of program could be supported by the federal government working out the program's compatibility with underwriting standards, and "by providing capital or by assisting municipalities in aggregating bonds so that larger bonds can be issued at a lower cost."[79]

Whatever the funding mechanism chosen, the funding needs to provide "strong financial incentives," be marketed effectively, and be simple and convenient to use.[80] It also needs to fit a multitude of circumstances, and be flexible enough to fit many types of homes and income levels. In other words, it needs to be easy enough for a high school student to apply for, and risk-free enough that their parents would give them permission to do so.

Implementation of this program would be in three phases. In Phase I, the president would announce a campaign to focus on energy education in schools,[81] and direct the Secretary of Education and the Secretary of Energy to establish a task force on energy education.[82] The task force would develop the energy education curriculum and prize, create the financing system for energy improvements, and provide recommendations for implementing the program. In Phase II, the U.S. Department of Education, in partnership with the U.S. Department of Energy (DOE), would establish and fund a pilot grant program for a small number of schools to implement the energy curriculum. Based on the success of the pilot program and lessons learned,[83] in

70. A federal program would ensure that access to financing is not determined on where a home is located, and could potentially offer better interest rates due to economies of scale. Moreover, municipal financing programs are much more sensitive to economic downturn than a federal program would be. *See* Merrian C. Fuller et al., *Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power*, Environment Mag., Jan-Feb 2009.
71. For a general discussion of programs aimed at providing financing, see Liam Pleven, *Buy Now, Pay Later*, Wall St. J., Feb. 28, 2011. For a deeper discussion, see Robert P. Taylor et al., Financing Energy Efficiency: Lessons From Brazil, China, India, and Beyond (World Bank 2008).
72. N.C. Gen. Stat. §153A-455.
73. 42 U.S.C. §§9601-9675, ELR Stat. CERCLA §§101-405.
74. CERCLA §10(k)(3); FY 2011 Supplemental Funding for Brownfields Revolving Loan Fund (RLF) Grantees, 76 Fed. Reg. 2905 (Jan. 18, 2011).
    > Revolving Loan Fund (RLF) grants provide funding for a grant recipient to capitalize a revolving loan fund and to provide subgrants to carry out cleanup activities at brownfield sites. Through these grants, EPA seeks to strengthen the marketplace and encourage stakeholders to leverage the resources needed to clean up and redevelop brownfields. When loans are repaid, the loan amount is returned into the fund and re-lent to other borrowers, providing an ongoing source of capital within a community.

    U.S. EPA, Brownfields and Land Revitalization, Revolving Loan Fund Pilot/Grants, http://epa.gov/brownfields/rlflst.htm#fy10funds.
75. Mayor's Training Program Case Study, "On-Bill Financing" for Energy Efficiency (2009), *available at* http://energy.sipa.columbia.edu/researchprograms/urbanenergy/documents/On%20bill%20Financing%20FINAL.pdf.
76. Twenty-four states now have some form of Property Assessed Clean Energy (PACE) financing. *See* PACE*NOW*, The Promise of Pace, http://pacenow.org/blog/.
77. Fuller et al., *supra* note 70.
78. Posting of Todd Woody, Homeowners Must Pay Off Energy Improvement Loans, to the New York Times' Green blog (Aug. 31, 2010, 17:30 EST).
79. *Id.*
80. Vandenbergh et al., *supra* note 62, at 10551-52 (discussing design principles for government programs aimed at changing consumer behavior). *See also* Fuller et al., *supra* note 70. ("[T]he financing itself needs to be easy to access. . . . Turnaround time for getting approved for financing must be fast and painless for property owners. And payment must get to the contractor or installer quickly so that they do not have to carry project costs.").
81. This announcement might be similar to President Obama's announcement of his campaign "Educate to Innovate" to promote science, technology, engineering, and math in middle and high schools. *See* Kenneth Chang, *White House Pushes Science and Math Education*, N.Y. Times, Nov. 22, 2009.
82. For examples of recent analogous presidential-directed task forces, see the White House Task Force on Middle-Class Working Families and the Task Force on Childhood Obesity. Memorandum From the President on White House Task Force on Middle-Class Working Families to the Heads of Executive Departments and Agencies (Jan. 30, 2009); Memorandum From the President on White Establishing a Task Force on Childhood Obesity to the Heads of Executive Departments and Agencies (Feb. 09, 2010).
83. "Programs designed to change energy consumption need to be evaluated carefully and objectively. As shown by experience, even the best-intended programs can be less than effective, and it is important to evaluate, learn, and re-tool so that programs can innovate." Dilling & Farhar, *supra* note 51, at 379.

Phase III, the president would include funding in the budget to cover implementation of the energy curriculum in all high schools, financing for energy improvement loans, and a prize for student achievement toward zero net energy.

B. Overcoming Barriers

1. Political Barriers

Although energy issues are almost always politically controversial, and given the traditionally local and state focus on education, there may be political pushback for a federal-driven curriculum,[84] this program is likely less politically infeasible than other current energy reform efforts. First, changing efficiency is easier than changing production. We're at a political impasse to pass aggressive and comprehensive legislation to change how energy is produced; efforts to tax carbon in order to bring the price of carbon on par with the price of renewable energy are at a political standstill.[85] And even building new large-scale renewable projects have often been a political nightmare because of land impacts,[86] NIMBYism,[87] transmission siting,[88] and jurisdiction quagmires.[89] In contrast, addressing energy efficiency in individual homes doesn't face the same political battles and decades of delay. If a family wants to change their light bulbs, they can go to a store and change them. If DOE wants to site solar energy fields in the desert, it's not quite as simple.[90]

Second, the program proposed here, which aims to improve energy efficiency through voluntary "carrot" or incentive-based means, is also more feasible than programs that aim to improve energy efficiency through "sticks" or disincentives, such as "environmental levies, emissions taxes, or environment-based energy taxes."[91] The incentive-based nature of the program means that, although this program is aimed at the federal level to provide maximum reach of the program, many aspects could be easily implemented by state or local governments, or even a private foundation.[92] If the Gates Foundation wanted to provide funding to schools for energy teachers, or promote a zero net energy prize for students, it could easily do so.[93] This also means that even in a climate where other federal energy-efficiency projects have struggled to obtain funding—for instance, DOE's Home Star program[94]—this program will not live or die based on an appropriation from Congress.[95] Finally, unlike disincentives, which are relatively politically

84. *Cf.* Jennifer Medina, *California May Require Teaching of Gay History*, N.Y. Times, Apr. 16, 2011 (noting pushback on a California bill proposing to mandate gay history in schools due to the controversial nature of the subject and the argument that "school curriculum should be left to local schools").
85. Stromberg, *supra* note 8.
86. For example, impacts to the endangered California desert tortoise and other wildlife have stalled desert solar projects in the Pacific Southwest and have pitted environmental interests against each other. *See, e.g.*, Michael R. Blood, *Solar Showdown in Calif. Tortoises' Desert Home*, U.S. News, Jan. 3, 2010. Even projects with smaller footprints have seen opposition because some view solar panels as eyesores. *See* Mireya Navarro, *Solar Panels Rise Pole by Pole, Followed by Gasps of "Eyesore,"* Apr. 28, 2011 (discussing pushback to a New Jersey project to mount small solar panels on utility poles).
87. "NIMBY" or "not in my backyard" refers to people who oppose projects, including wind farms, that may damage the aesthetic value of their property. *See generally* Susan Lorde Martin, *Wind Farms and NIMBYS: Generating Conflict, Reducing Litigation*, 20 Fordham Envtl. L. Rev. 427 (2010). A notable example is the Cape Wind Project off the coast of Massachusetts, which, proposed over a decade ago, is still mired in litigation from "property owners concerned about scenery." *Id*. at 450-51.
88. Transmission siting is key to the growth of the renewable energy market, yet building the grid to get renewables to market is proving challenging. "Currently, almost 300,000 MW of wind project, more than enough to meet 20 percent of our electricity needs, are waiting in line to connect to the grid because there is inadequate transmission capacity to carry the electricity they would produce." American Wind Energy Association & Solar Energy industries Association, Green Power Superhighways: Building a Path to America's Clean Energy Future 6 (2008). For examples of the battles between states, and between states and the federal government in siting transmission, see *In the Matter of the Application of Southern California Edison Company*, Order Denying CEC, No. 130, 2-3 (Ariz. Corp. Comm. June 6, 2007) (denying citing approval for a transmission line sited in Arizona that would provide power to California, and noting that the line would force Arizona to "become host to new power plants designed purely for use by California consumers . . . [representing] an unnecessary usurpation of Arizona's land, water and air shed"); Piedmont Envtl. Council v. Fed. Energy Reg. Comm'n, 558 F.3d 304 (4th Cir. 2009), *cert. denied*, 130 S. Ct. 1138 (2010) (limiting the Federal Energy Regulatory Commission's ability to approve permit applications for transmission lines when a state has denied the application).
89. *See, e.g.*, John Noor, *Herding Cats: What to Do When States Get in the Way of National Energy Policy*, 11 N.C. J. L. & Tech. 145 (2009) (discussing jurisdiction battles between states and the federal government over transmission citing); John Perkins, *Overcoming Jurisdictional Obstacles to Feed-in Tariffs in the United States*, 40 Golden Gate U. L. Rev. 97, 106-07 (2009) (discussing jurisdiction battles between states and the federal government over feed-in tariffs); Mark Sherman, *Wave New World: Promoting Ocean Wave Energy Development Through Federal-State Coordination and Streamlined Licensing*, 39 Envtl. L. 1161 (discussing jurisdictional conflict over outer continental shelf wave-energy projects).
90. Nor would it be as effective. If every home in America changed one bulb, it would save enough energy to power 3 million homes. EnergyStar.gov, Frequently Asked Questions: Information on Compact Fluorescent Light Bulbs (CFLs) and Mercury (2010), *available at* http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf. In contrast, the president's "revolutionary solar plant" in the California desert would power a meager 140,000 homes. The White House Blog, Weekly Address: Solar Power & a Clean Energy Economy (Oct. 2, 2010, 6:00 EST).
91. Barry Barton, *The Law of Energy Efficiency*, *in* Beyond the Carbon Economy 60, 64-5 (Donald N. Zillman et al. eds., 2008) (quoting Alan H. Sanstad et al., *End-Use Energy Efficiency in a "Post-Carbon" California Economy: Policy Issues and Research Frontiers*, *in* Managing Greenhouse Gas Emissions in California 6-9 (Berkeley: California Climate Change Center at UC Berkeley, 2006)).
92. Indeed, a few energy-efficiency prizes already exist, funded at various levels. *See, e.g.*, Flex Your Power Awards (a California-State award with a prize for energy efficiency), http://www.fypower.org/feature/awards/ (last visited Sept. 21, 2011); Nicor Energy by Design Contest (a utility company award for student posters discussing energy efficiency), http://www.nicor.com/en_us/news_and_media/latest_releases/release_041811_ebd.htm (last visited Sept. 21, 2011); Homer Electric Association, Inc., Energy Efficiency & Conservation Student Contest (a utility company award for student poems, essays, news articles, and commercials on energy efficiency), http://www.homerelectric.com/LinkClick.aspx?fileticket=x7z4yIPv%2FpI%3D&tabid=286 (last visited Sept. 21, 2011).
93. The Gates Foundation already provides some funding for education. *See* the Bill and Melinda Gates Foundation, Early Learning, http://www.gatesfoundation.org/topics/Pages/early-learning.aspx (last visited Sept. 20, 2011).
94. The Home Star Act of 2010, which would provide "direct consumer incentives for residential efficiency retrofits," is still pending in the Senate. Efficiency First, the Home Star Program, *available at* http://www.efficiencyfirst.org/home-star/ (last visited Sept. 20, 2011).
95. For example, the curriculum could be developed by a joint task force without appropriation by Congress. The agencies might be able to partner with universities or foundations to provide the zero net energy prize. And states or a private foundation might be able to provide funding to implement the curriculum.

infeasible, "[p]olicies such as . . . efficiency-promoting public programs and measures enjoy the singular distinction of having been, and remaining, feasible to implement."[96]

Finally, a program housed in the Department of Education and DOE, designed to primarily utilize existing authority and to be directed by the president, is more feasible than a program primarily dependent on Congress (although certain aspects of the program may require congressional action, including financing). Since the president

> is a unitary actor, he can act without the indecision and inefficiency that so often characterize the behavior of collective entities. And because his "jurisdiction" extends throughout the administrative state (or at least, the executive branch), he can synchronize and apply general principles to agency action in a way that congressional committees, special interest groups, and bureaucratic experts cannot.[97]

In other words, it is relatively quick and easy for the president to establish an interagency task force on energy efficiency through a directive to executive branch agencies. This task force may be able to get quite far, even without funding or other support from Congress.

2. Behavioral Barriers

Each piece of the proposed program—the energy curriculum, the federal financing, and the prize for achieving energy efficiency—is designed to overcome the traditional barriers to adopting energy efficiency. The program would overcome traditional behavioral barriers by educating a member of each household about how to implement energy efficiency, and by aligning the household incentive to increase energy efficiency with the household incentive for children to do well in school. The program recognizes that "[s]ingle policy tools have been notably ineffective in reducing household energy consumption,"[98] and therefore seeks to combine multiple policy tools, including education, prizes, and financial incentives.

a. The Energy Curriculum

The energy curriculum directly addresses the information barrier to obtaining energy-efficiency information. "Social actors are competent masters of their routines and habits. But as such, there is no reason to expect them to have much energy 'literacy,' to know how their homes are built or equipped, or to know how to think and act responsibly about efficiency choices."[99] To the extent that people do not make energy-efficiency improvements because of the difficulty of obtaining information, understanding what improvements are right for their home, and having the impetus to change, this program would provide every home in America with a high school-aged child with their own personal live-in energy expert.

Beyond simply providing residents with information about energy, there is evidence that school educational programs are effective at directly influencing behavior patterns of parents. For example, an empirical study found that after a school program on recycling, "[t]here were . . . marked differences in numbers of *parents* who recycled waste materials before and after the school environmental education programme."[100] Parents reacted to information, and perhaps pressure, from their children and changed their individual behavior.

b. The Energy-Efficiency Project and Prize

The energy-efficiency project and zero net energy prize have the potential to overcome the transaction cost barrier, as well as the landlord-tenant barrier. Indeed, the prize especially capitalizes on the ways figuring out home energy improvements, and especially getting a home to zero net energy, is difficult. It directly acknowledges the challenge, and the need for creativity and specialized knowledge about energy, and rewards enterprising teenagers who can figure out, for example, how to work with their landlord to install solar panels.

Many of the improvements needed in homes could be done by teens themselves. After the school course in energy efficiency, students should be able to complete a rough home energy audit. And many of the commonly recommended energy conservation measures, including addition of thermal insulation, weather stripping, and changing light bulbs, all could be done by teens without hiring pro-

96. *Id.*

97. Elena Kagan, Presidential Administration, 114 Harv. L. Rev. 2245, 2339 (2001).

98. Thomas Dietz et al., *Household Actions Can Provide a Behavioral Wedge to Rapidly Reduce US Carbon Emissions*, 106 Proc. Nat'l Acad. Sci. 18452, 18453 (2009):

> Mass media appeals and informational programs can change attitudes and increase knowledge, but they normally fail to change behavior because they do not make the desired actions any easier or more financially attractive. Financial incentives alone typically fall far short of producing cost minimizing behavior—a phenomenon commonly known as the energy efficiency gap. However, 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.

99. Lutzenhiser, *supra* note 38, at 56.

100. Stewart M. Evans et al., *Schoolchildren as Educators: The Indirect Influence of Environmental Education in Schools on Parents' Attitudes Towards the Environment*, 30 J. Biological Educ. 246-47 (1996) (emphasis added).

> Numbers [of parents] who claimed to recycle paper increased from 24 per cent in the pre-education questionnaire to 52 per cent in the post-education questionnaire, those who recycled aluminum (tin) cans from 18 to 38 per cent, and those who recycled plastics from 6 to 31 per cent. These differences are significant ($p < 0.05$, < 0.05, and < 0.01 respectively Chi-square Test).

Id. Other examples of education aimed at changing behavior of parents can be found in Ann E. Carlson, *Recycling Norms*, 89 Cal. L. Rev. 1231, 1256 (2001). For example, Ann Carlson recounts the story of Colonel Waring, who, in 1896 created a "Junior Street Cleaning League" of 5,000 children to increase street sanitation. She notes that "Waring was engaged in norm shaping on an impressive scale. He believed that if he inculcated children with a belief in his policies they, in turn, would influence their parents." *Id.* at 1256.

fessionals.[101] But even some of the more difficult tasks—for example, hiring professionals to install a photovoltaic roof or change out an inefficient water heater—could be researched and initiated by students, especially if the financing system is easy to use. The project would encourage students to do basic home energy improvements, while the prize would encourage students to go as far as possible in bringing their homes to zero net energy.

The project and the prize help overcome the barrier of bounded rationality. Even when the need for energy-efficiency improvement should be made based on a favorable payback period, and even when households have information about energy-efficiency matters, households may not implement them because of the time it takes to make the changes. There are just too many other priorities in the home for residents to focus on energy efficiency. As one recipient of energy-efficiency information noted: "I've had some information passed on to me . . . but I just can't use it. I don't have the time. If I had somebody else to actually do it, yes, I'd have no problem."[102] The prize solves this problem by giving families "somebody else to actually do it": a self-interested teenager, motivated either by the requirements of their energy course, or by prize money.

Besides simply getting teens to do energy improvement work, a prize likely would induce parents to participate as well. Parents can be notorious for spending inordinate amounts of time helping their children on school projects.[103] For example, one study of science fairs found that parents spent an average of 10.88 hours (with a standard deviation of 14.60 hours) helping with their child's project.[104] The zero net energy prize helps align a parent's interest in his or her child's success and future, with an interest in home energy retrofitting. This may even help overcome the landlord-tenant barrier by removing some of the reluctance to undertake projects where the benefits are shared or speculative, because the prize creates additional value accruing to the energy-efficiency implementor.

Finally, prizes are praised relative to other instruments of public policy for their ability to produce more investment in a problem than the size of the prize award.[105]

> At their best, prizes inspire people . . . to push their efforts beyond conventional limits. Freed from an overreliance on narrowly commercial incentives, competitors can turn their efforts to addressing issues that the market may overlook. Prizes also add additional layers of motivation beyond money, such as prestige and intellectual curiosity."[106]

And although prizes are sometimes criticized for producing waste (since not everyone who works toward achieving the prize will win it, leading to wasted work),[107] this prize doesn't have that problem; the energy improvement work of the students who lose is still beneficial to society. Prizes, unlike grants or other inducements to do the same work, also have the benefit of low barriers to entry because they reduce "the costs, bureaucratic and regulatory obstacles, and compliance burdens typically associated with other instruments of public policy in science and technology."[108]

c. Federal Financing

The federal financing prong directly addresses the transaction cost barrier by ensuring that any energy improvements made have zero up-front costs. This also ensures that a student's eligibility for the zero net energy prize is not dependent on that student's family having the resources to bear the sometimes high up-front costs of energy retrofitting.

In Berkeley, California, an area of the country where information barriers preventing energy efficiency are arguably uncommonly low,[109] once financing was available, homeowners jumped at the opportunity to install home energy systems. "The City of Berkeley started accepting applications through its Web site on 5 November 2008, and applications to claim the $1.5 million available for the pilot were submitted within 10 minutes."[110] This suggests that the financing feature of the program could, even in the absence of the energy curriculum and prize, spur homeowners to invest in energy retrofits.

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101. Moncef Krarti, *Energy Audits for Buildings*, *in* Handbook of Energy Efficiency and Renewable Energy 16-1, 16-8 to 16-14 (Frank Kreith & D. Yogi Goswami eds., 2007).
102. Steve Sorrell, *Barrier Busting: Overcoming Barriers to Energy Efficiency*, *in* Steve Sorrell et al., The Economics of Energy Efficiency 287, 295 (Edward Elgar 2004). This quote was taken from a study of energy managers at companies. That company energy managers find it hard to find time for energy efficiency suggests homeowners may find it even harder.
103. *See, e.g.*, Nancy Gibbs, *The Growing Backlash Against Overparenting*, Time, Nov. 20, 2009 (noting the phenomenon of "helicopter" parenting).
104. Tammy V. Abernathy & Richard N. Vineyard, *Academic Competitions in Science: What Are the Rewards for Students*, 75 Clearing House 269, 272 (2001).
105. *Cf.* Jonathan H. Adler, *Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 Harv. Envtl. L. Rev. 1, 16 (2011):
> Prizes have the capacity to stimulate increased investment in a given technological problem from a wide range of sources. Because the prize is a competition, multiple innovators may invest in trying to obtain the prize, accelerating the process of innovation. As a consequence, prizes "can stimulate philanthropic and private sector investment that is greater than the value of the prize.

(quoting Thomas Kalil, *Prizes for Technological Innovation, Hamilton Discussion Paper* 2006-2008, Brookings Inst. 7 (Dec. 2006)).
106. Mckinsey & Company, "And the Winner Is . . .": Capturing the Promise of Philanthropic Prizes 19 (2009), *available at* http://www.mckinsey.com/App_Media/Reports/SSO/And_the_winner_is.pdf.
107. Clayton Stallbaumer, *From Longitude to Altitude: Inducement Prize Contests as Instruments of Public Policy in Science and Technology*, 2006 U. Ill. J.L. Tech. & Pol'y 117, 129, n.100.
108. *Id.* at 128.
109. The city of Berkeley has often been at the forefront of environmental policies, suggesting that residents' knowledge about and interest in environmental issues is higher than elsewhere in the nation. This indicates that while financing was one of the main barriers to home energy improvements in Berkeley, other areas of the country would require consumer information and outreach in addition to financing. Kristin Bender, *Berkeley Considers Banning Plastic Grocery Bags*, Oakland Trib., Apr. 18, 2007 (noting that the city was the first in the state to ban Styrofoam takeout containers, and the first in the nation to convert its fleet of diesel vehicles to biodiesel). For middle America, selling the program as a way to reduce dependence on foreign oil may be more effective than marketing it as an environmental program.
110. *See* Fuller et al., *supra* note 70.

C. Additional Benefits

The program proposed here is aimed primarily at overcoming political and behavioral barriers to energy efficiency. But the program has additional potential benefits worth discussing, including: (1) effecting social change beyond individual homes; (2) creating and training a generation of Americans to design and build our clean energy future; and (3) moving quickly to address climate change.

1. Potential for Social Change Through Education

The proposed program not only has the ability to temporarily change behavior and environmental awareness of the students in the program, but has the potential to effect social change by creating a new generation of Americans committed to (or at least knowledgeable about) a sustainable energy future. Research on environmental behavior has found that environmental education can have long-lasting effects in "responsible environmental behavior."[111] For example, one study found that eighth graders involved in environmental education had higher levels of responsible environmental behavior when tested three years later, "despite the absence of subsequent instructional reinforcement during the ensuing three-year period."[112] And the type of program proposed here, giving students ownership over the problem of energy transformation in their own home, has been shown to be especially effective at instilling long-term behavior change. "For learners to become actively involved in issue investigation and escalation as well as citizenship behavior outside school, it is rather clear that they must own the issues on which they focus and be empowered to do something about them."[113] Teaching students about energy now, in other words, may affect their long-term outlook on energy, potentially causing them to be more informed voters,[114] if not better environmental citizens.

The program would also likely have effects outside of each student's home. As neighbors and friends see the progress and cost savings a high school student has been able to achieve, they may decide to adopt similar measures.

> For most individuals, what is required to actually implement [actions to combat climate change] is empowerment through a sense of self-efficacy, social support or peer pressure, or modeling by others. In groups people help each other learn, offer assistance, but also produce accountability—all of which can overcome resistance and barriers.[115]

In the same way that seeing a Prius parked down the street has been shown to encourage someone to buy a Prius,[116] seeing your neighbor's child put solar panels on their roof may encourage others to do so as well.

This effect led the authors of the recycling study discussed above to posit that "[e]nvironmental education offers the long-term solution to environmental problems."[117] Indeed, the energy curriculum would provide the first serious social marketing of energy conservation in the United States. "Comprehensive social marketing of the sort used for AIDS prevention or antismoking campaigns never has been tried in the case of energy in the United States, with the range of policy instruments used (efficiency appeals, advertisements, incentive payments, labeling) generally being quite restricted and applied only in selected settings."[118] A social marketing program on the scale proposed in this Article could have far-reaching effects on attitudes and behaviors of Americans in general toward energy efficiency.

2. Training America's Energy Retrofitters and Energy Leaders

> *In this kind of economy, countries who out-educate us today will out-compete us tomorrow."*
>
> President Barack Obama[119]

Van Jones, the leader of the "green-collar jobs movement" notes that

> [i]f we are going to beat global warming, we are going to have to weatherize millions of buildings, install millions of solar panels, manufacture millions of wind-turbine parts, plant and care for millions of trees, build millions of plug-in hybrid vehicles, and construct thousands of solar farms, wind farms, and wave farms.[120]

In other words, we are going to need a lot of new workers trained in how to do these things. Jones argues that the government's approach should be to offer job training programs to train "middle-skill"[121] "Joe Sixpack with a hard hat and a lunch bucket"[122] workers in energy retrofitting.[123] This Article agrees with Jones' basic premise, that it would be beneficial to train additional workers in energy retrofitting, but simply carries it one step further: let's provide the basic education to an entire generation.[124]

111. Ramsey & Hungerford, *supra* note 69, at 153.
112. *Id.* at 154.
113. *Id.* at 158.
114. *See* Ottinger, *supra* note 11.
115. Susanne C. Moser & Lisa Dilling, *Toward the Social Tipping Point: Creating a Climate for Change*, *in* Creating a Climate for Change 505 (Suanne C. Moser & Lisa Dilling eds.).
116. Mathhew E. Kahn & Ryan K. Vaughn, *Green Market Geography: The Spatial Clustering of Hybrid Vehicle and LEED Registered Buildings*, 9 B.E. J. Econ. Analyses & Pol'y 1, 20 (2009) ("In 'green' communities such as Berkeley, buying a Prius could cause an increase in the likelihood that your neighbor buys one.").
117. *Id.* at 243.
118. Lutzenhiser, *supra* note 38, at 51.
119. 2007 New Hampshire speech as quoted by Anna Weinstein, Obama on Math, Science, and Tech Education, Education.com; *see also* Remarks of President Obama to Congress (Feb. 24, 2009) ("[W]e know the countries that out-teach us today will out-compete us tomorrow.").
120. Jones, *supra* note 1, at 10.
121. *Id.* at 12.
122. *Id.* at 10.
123. *Id.* at 150-56.
124. Although specialized skills—for example, installing wind turbines—would require additional vocational training, students under the proposed program should be able to complete a basic energy audit and energy retrofits.

Energy education isn't just important for the "Joe Six-packs"; educating tomorrow's leaders, policymakers, scientists, and engineers in the complex science, engineering, and math challenges of energy reform is important for our shift to renewable energy, and for our international competitiveness. Currently, American students rank 21st out of 30 in science and 25th out of 30 in math, compared with students in other countries.[125] This program would support the president's "Educate to Innovate Campaign" to increase the math and science ability of American students.[126] The president has already promised funding for additional math and science teachers;[127] this program would add additional federal support specifically for math and science education related to energy.

More than just providing additional support for science education, there is evidence that a problem-based curriculum proposed here (also known as experiential or problem-based education) has pedagogical benefits over traditional classroom education. "At the completion of each problem, students reflect on the abstract knowledge gained . . . Because students are self-directed, managing their learning goals and strategies to solve [problem-based learning's] ill-structured problems (those without a single correct solution), they also acquire the skills needed for lifelong learning."[128] Problem-based education has been shown overall to have a "robust positive effect" on students' acquisition and application of knowledge,[129] and in some cases, has led to dramatic gains in academic achievement in schools.[130] For instance, a study of 10 schools that implemented Expeditionary Learning[131] (a form of project-based learning) found that nine of the schools "demonstrated significant improvement in students' test scores on standardized tests of academic achievement."[132]

Finally, educating students in energy will help us stay competitive internationally. Andrew Liveris, the CEO of Dow Chemical, argues that, by not embracing the shift to renewable energy more quickly, the United States is losing competitiveness with other nations more aggressively pursuing renewable energy policies.

> While the United States cedes the industries of the future to other nations, most policymakers seem not to notice. If America doesn't shift gears quickly and take advantage of the energy opportunity, we are almost certain to trade a present where we import oil from Saudi Arabia and Kuwait for a future where we import solar panels from China and wind turbines from Europe.[133]

Liveris links this failing in competitiveness to a lack of policy measures aimed at promoting the development of renewable energy, but also to the decreasing quality of the American workforce—especially engineers and scientists—that has come as a result of the American education "recession."[134] To the extent that competitiveness in the renewable energy market will depend on training a new workforce of Americans, the program proposed here will help fill this gap by providing initial training, and inspiring the next generation to pursue further education and careers in energy.

3. Addressing Climate Change Quickly

> *One can hope that the national policy will be bold, recalling the turtle that only makes progress when it sticks its neck out. Only time will tell.*[135]

Climate change is the most important and urgent problem facing the 21st century.[136] It is also a "super wicked problem," in part because the "longer it takes to address

125. The White House, Educate to Innovate, http://www.whitehouse.gov/issues/education/educate-innovate (last visited Sept. 14, 2011).
126. *Id.*
127. *Id.*
128. Cindy E. Hmelo-Silver, *Problem-Based Learning: What and How Do Students Learn?*, 16 Educ. Psychol. Rev. 235, 237 (2004). Problem-based learning has several goals, including "(1) construct an extensive and flexible knowledge base; (2) develop effective problem-solving skills; (3) develop self-directed, lifelong learning skills; (4) become effective collaborators; and (5) become intrinsically motivated to learn." *Id.* at 240. *See also* Robert Delisle, How to Use Problem-Based Learning in the Classroom 5 (Ass'n for Super. & Curr. Dev. 1997) (noting that project-based learning can "motivate bored students," as well as "build critical thinking and reasoning skills, further students' creativity and independence, and help students earn a sense of ownership over their work").
129. Filip Dochy et al., *Effects of Problem-Based Learning: A Meta-Analysis*, 13 Learning & Instruction 533, 548 (2003) (conducting meta-analysis of project-based learning studies).
130. For a summary of research on project-based learning programs, see John W. Thomas, A Review of Research on Project-Based Learning 8-28 (Mar. 2000) (unpublished Ph.D. dissertation), *available at* http://www.ri.net/middletown/mef/linksresources/documents/researchreviewPBL_070226.pdf. *But cf.* John R. Mergendoller et al., *Comparing Problem-Based Learning and Traditional Instruction in High School Economics*, 93 J. Educ. Res. 374 (2000) (finding no difference between problem-based learning and traditional instruction in high school economics).
131. For more on the approach of Expeditionary Learning schools, see Expeditionary Learning, What We Do, http://elschools.org/our-approach/what-we-do.
132. Thomas, *supra* note 131, at 9:
> The gains exhibited in academic achievement on the part of Expeditionary Learning schools are quite dramatic. In Dubuque, Iowa, three elementary schools implemented the EL program. After two years, two of these schools showed gains on the Iowa Test of Basic Skills from "well below average" to the district average; the third school showed a gain equivalent from "well below average" to "well above the district average."

Id.
133. Andrew Liveris, Make It in America: The Case for Re-Inventing the Economy 102 (Wiley 2011).
134. *Id.* at 105-24; *see also* Peter Lietz & Dieter Kotte, *Science and Education*, *in* Energy and Culture: Perspectives on the Power to Work 113 (Brendan Dooley ed., 2006) (finding that "[q]ualified scientists are vital for the further development of renewable energy sources" and noting that the current educational systems are not inspiring students to pursue careers in science).
135. John D. Leshy, *The Future of Mineral Development on Federal Lands*, *in* The Evolution of Natural Resources Law and Policy 346, 348 (Lawrence J. MacDonnell & Sarah F. Bates eds., 2010) (discussing his hopes for a national energy policy).
136. *See, e.g.*, John P. Holdren, *The Energy Innovation Imperative: Addressing Oil Dependence, Climate Change, and Other 21st Century Energy Challenges*, 2006 Innovations 3; Lewis, *supra* note 2, at 13; Hanson, *supra* note 4.

the problem, the harder it will be to do so."[137] And unlike other problems, if we don't act now, we might not get another chance. If we don't cure cancer, alleviate poverty, or develop the next great iPhone App, the world will at worst be the same.[138] If we don't solve climate change now, the world may be drastically different in 100 years.

At the same time, "[t]he most prominent policy approaches to the climate commons dilemma—national and international cap-and-trade regimes—face issues of implementation feasibility that could delay achievement of carbon emissions reduction objectives for years."[139] With the problems of delay in mind, Thomas Dietz and others have suggested that individual and household behavior change can provide the meaningful opportunity for short-term emissions reduction.[140] "Because [behavior change] can ramp up in 10 years . . . it provides both a short-term bridge to gain time for slower-acting climate mitigating measures and an important component of a long-term comprehensive domestic and global climate strategy."[141]

There are almost four million high school seniors in America.[142] This means, under the most optimistic projections, if every student went through the program, four times the number of homes would see energy-efficiency improvement in one year than under the goals of the current WAP.[143] If the program ran for 10 years, roughly 28% of American homes would see energy-efficiency improvements.[144] In a generation, the majority of homes could be improved. In other words, aggressively pursued, this program could have massive results in a relatively short amount of time.

The program proposed by this Article might be criticized for being too massive in scope, requiring too great an overhaul of the American educational system, and investing in every student regardless of their interest in energy. But unfortunately, *massive* is exactly the scale needed if America is going to make a dent in climate change.[145] And aggressively pursuing energy efficiency now buys us the time we need to pursue *even more massive* comprehensive climate change strategies,[146] including passing a cap-and-trade bill and developing new technologies that could further reduce emissions (such as improved solar technology,[147] and carbon capture and sequestration[148]). Although not a panacea, in light of political standstill and slow technological development, energy efficiency stands out as a viable policy goal. Currently, energy-efficiency policy is being pursued at the pace of a child dipping a toe into cold water. This Article simply argues we need to be diving in.

V. Conclusion

This is not a particularly unique idea. Educational campaigns aimed at students have been used to achieve social goals from tolerance[149] to abstinence,[150] and to prevent everything from bullying[151] to terrorism.[152] Nor is this a particularly ambitious idea. An ambitious idea is to pump CO_2 underground,[153] to build massive transmission projects,[154] and to force consumers to pay an artificially high price for their electricity.[155]

No, this is an ordinary idea with humble goals: teach a few classes, award some prizes. It's an idea with crossed fingers: that motivating and educating the next generation will be enough to transform our future. It's a solution that

137. Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 Cornell L. Rev. 1153, 1160 (2009).
138. Lewis, *supra* note 2, at 13.
139. Dietz et al., *supra* note 98, at 18452.
140. *Id.*
141. *Id.* at 18455.
142. U.S. Census Bureau, S0902. Characteristics of Teenagers 15 to 19 Years Old, 2005-20009 American Community Survey, http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2009_5YR_G00_S0902&-ds_name=ACS_2009_5YR_G00_&-redoLog=false. There are 18,646,121 15-19-year-olds enrolled in school, which equates to roughly 3.7 million per grade level.
143. The WAP goal, post stimulus package, was originally to weatherize one million homes a year, but that goal has fallen short. The Obameter, Weatherize 1 Million Homes Per Year Politifact.com, http://www.politifact.com/truth-o-meter/promises/obameter/promise/452/weatherize-1-million-homes-per-year/ (last visited Sept. 14, 2011). Before the stimulus funding, the WAP only weatherized roughly 100,000 homes per year. U.S. DOE, Weatherization & Intergovernmental Program—About, http://www1.eere.energy.gov/wip/m/wap_goals.html (last visited Sept. 14, 2011).
144. There are roughly 130 million units of housing in the United States (as of 2009). U.S. Census Bureau, Quickfacts, http://quickfacts.census.gov/qfd/states/00000.html. 3.7 million students per year x 10 years = 37 million students. 37/130 = 28%. This assumes each home has only one high school-aged student in a 10-year period, which likely overestimates the number of homes reached in a 10-year period.
145. As Prof. Michael P. Vandenbergh and his co-authors note:
> The use of aggressive assumptions is fueled by the magnitude of the task. For example, even to achieve a global GHG target of roughly 650 ppm CO_2eq [carbon dioxide equivalent] (a target far above the 450 ppm CO_2eq target associated with the 2° C goal) by using nuclear power alone would require the addition of a new, standard-sized (1000 megawatt) nuclear power plant every day for the next fifty years, in addition to substantial increases in efficiency and conservation. To achieve a 650 ppm CO_2eq target with solar power would require installing twenty-seven square kilometers of solar cells every day over that period.

Michael P. Vandenbergh et al., *Micro-Offsets and Macro-Transformation: An Inconvenient View of Climate Change Justice*, 33 Harv. Envt. L. Rev. 303, 306 (2009).
146. *Cf.* Michael P. Vandenbergh et al., *Time to Try Carbon Labeling*, 1 Nature Climate Change 4 (2011) (proposing carbon labeling) ("At this point, with the theoretically ideal measures (such as a carbon tax or cap-and-trade system) not under active consideration globally, it is appropriate to seek a portfolio of measures in the hope that a combination will enable us to avoid crossing important thresholds.").
147. *See* Lewis, *supra* note 2, at 22-23 (discussing the current state of energy technology development).
148. Report of the Interagency Task Force on Carbon Capture and Storage (2010), *available at* http://fossil.energy.gov/programs/sequestration/ccstf/CCSTaskForceReport2010.pdf (noting barriers to carbon capture and storage).
149. *See, e.g.*, Southern Poverty Law Center, Teaching Tolerance, http://www.tolerance.org/ (last visited Sept. 19, 2011).
150. *See, e.g.*, National Abstinence Education Association, http://www.abstinenceassociation.org/ (last visited Sept. 19, 2011).
151. Medina, *supra* note 84 ("Advocates say that teaching about gay, lesbian, bisexual and transgender people in schools would prevent bullying and shatter stereotypes that some students may harbor.").
152. *See generally, e.g.*, Greg Mortenson & David Oliver Relin, Three Cups of Tea: One Man's Mission to Fight Terrorism and Build Nations . . . One School at a Time (Viking Penguin 2006).
153. *See supra* note 149.
154. *See supra* note 88.
155. *See supra* note 8.

recognizes that the federal government needs to steer the boat, but that we can only move forward if we all want to go the same direction. It's a solution that recognizes we won't solve climate change without political will, and that political will must be sown.

At the same time, this solution aims to be massive in reach and scale. It aims to be comprehensive, to educate not just some, but *everyone*. It aims to overcome *all* behavior barriers to energy efficiency. It aims to encourage households not just to change a light bulb or to buy a better washing machine, but to overhaul their homes. This solution aims to stabilize and decrease our growing need for energy today, at a time when we're living off the "black bones of the ancients,"[156] so that tomorrow we can begin to reenergize our nation.

156. Jones, *supra* note 1, at 4.