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Barriers to Reducing Energy Consumption at Home and on the Road

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Prepared by:
Bruce E. Tonn
Jean H. Peretz

INSTITUTE FOR A SECURE AND SUSTAINABLE ENVIRONMENT

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Institute for a Secure and Sustainable Environment
311 Conference Center Bldg.
Knoxville, TN 37996-4134
Phone: (865) 974-4251
Fax: (865) 974-1838
E-mail: isse@utk.edu
URL: isse.utk.edu

THE UNIVERSITY of TENNESSEE

EXECUTIVE SUMMARY

Energy Information Administration data show that about 50% of the energy consumed in the United States is by the residential and transportation sectors. EIA is projecting a 20% increase in residential and a 17% increase in transportation consumption between 2006 and 2030. There are energy and non-energy benefits from reductions in this consumption. These include reductions in greenhouse gas emissions and mitigation of global climate change. Security benefits may occur because of reduction in imported oil from politically unstable countries. Households can reduce their costs, and health benefits may result. The literature suggests three barriers to greater energy conservation at the household level: economic, technology adoption, and social/psychological. Many of these barriers can be overcome however—some with relative ease of adoption, some with more pronounced financial commitment.

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1. INTRODUCTION

According to the U.S. Energy Information Administration, the combined consumption of energy in our homes and cars represents almost one-half of the energy consumed in the United States,[1] but there are numerous actions Americans can take to reduce their consumption of energy. Generally, these actions include more effective use of existing technology, behavioral changes, and investment in more energy-efficient technologies. Unfortunately, many barriers seem to prevent households from adopting these technologies and practices.

Reduced energy use in our homes and on the road provides several benefits. Decreased energy consumption can help lead our country toward energy independence and increase our energy security. Because most energy consumed is in the form of fossil fuels, decreased energy consumption can also lead to reductions in greenhouse gas emissions and help to mitigate global climate change.[2] Reduced energy consumption is also relatively noncontroversial, at least when compared with strategies to increase our energy supply. Indeed, reduced energy use helps avert some of the environmental drawbacks associated with increased use of coal; the security, safety, and long-term waste disposal issues associated with increased use of nuclear power; or the potential negative impacts on food prices resulting from increased use of biofuels. Certainly, the United States cannot function without these energy sources, but reduced energy demand can help limit the liabilities associated with their use.

Households can benefit enormously from reduced energy consumption. Most directly, they can see home energy bills and costs at the gas pump reduced. Households can also realize numerous non-energy benefits. For example, weatherizing homes can lead to better health and improved comfort and safety through, for instance, inspection and maintenance of home heating systems.[3] If a significant number of people changed their driving habits, all drivers would benefit from reduced traffic congestion and all citizens would benefit from improved air quality.

This paper has four additional sections. The next section presents a brief but comprehensive review of energy use in the United States, with an emphasis on the residential and personal vehicle transportation sectors. This section shows where most energy is used in these two sectors. Section 3 presents a compilation of actions that households can take to reduce energy consumed at home and on the road. Section 4 presents a review of the literature on barriers to reducing energy consumption and suggestions on how to overcome these barriers. The last section describes three energy conservation success stories, starting with *Flex Your Power*, a media campaign that has been successful in reducing energy consumption in the state of California.

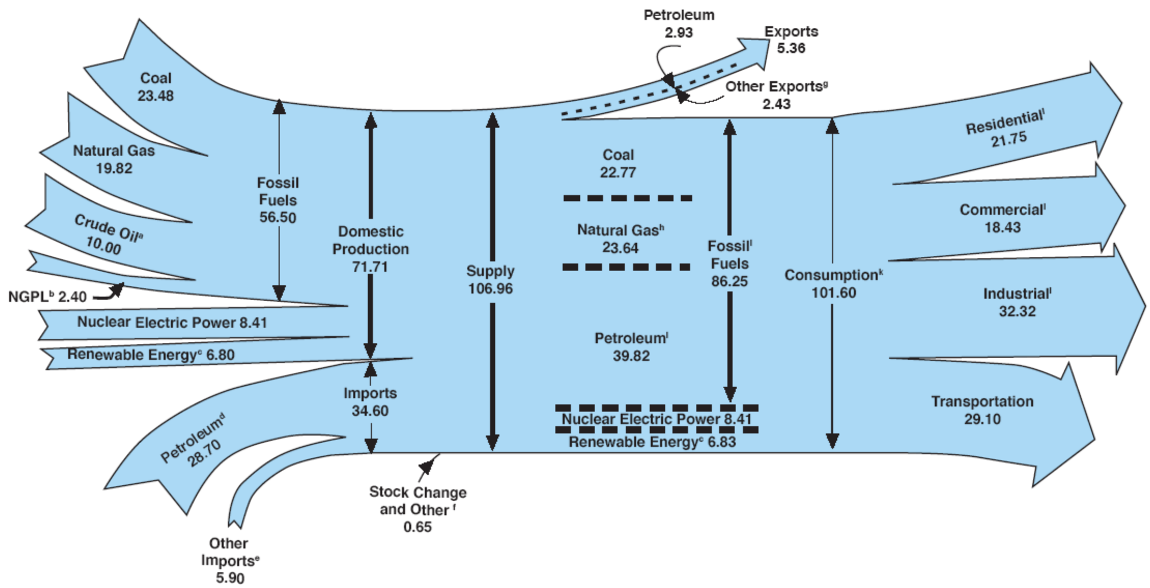
[1] All information attributed to the U.S. Energy Information Administration can be found at http://www.eia.doe.gov
[2] Intergovernmental Panel on Climate Change, http://www.ipcc.ch
[3] See Schweitzer and Tonn 2001.

2. ENERGY USE IN THE UNITED STATES

The United States consumes a prodigious amount of energy every year. According to the Energy Information Administration (EIA), in the year 2006, the U.S. consumed almost 100 quadrillion British thermal units (Btus) of energy. To provide some context for this number, one Btu is the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit. The average American household consumes a couple hundred million Btus per year.

The EIA developed Figure 1 to illustrate where energy comes from and how it is used in the United States. Our main sources of energy are coal, natural gas, crude oil/petroleum, nuclear energy, and renewable energy. The U.S. imports about 34% of its energy, mostly in the form of petroleum. The industrial sector consumes the most energy in the U.S., closely followed by the transportation, residential, and commercial sectors. Notice that the combined residential and transportation sectors comprise about half of the energy consumed in the United States.

FIGURE 1. ENERGY PROFILE UNITED STATES – 2006 (Quadrillion Btus)



These four sectors consume energy in different manners. The transportation sector, which is dominated by private vehicles, is almost wholly dependent on liquid fossil fuels (e.g., gasoline, diesel, and jet fuel, all distilled from crude oil). About 60% of the liquid fossil fuels consumed in the United States are imported. Thus, recent skyrocketing oil prices mostly impact transportation costs. Calls for energy independence are largely focused on reducing oil imports that support the transportation sector.

It can be argued that sprawl has significantly worsened our transportation sector energy woes. As shown in Table 1, growth in personal trips and vehicle miles traveled in the United States from 1990 to 2001 (the last year for which data are available) far outpaced population growth during this time period. The effects of sprawl are clearly seen in the growth of the length of the average trip from approximately nine miles to ten miles.

TABLE 1. U.S. PERSONAL TRANSPORTATION STATISTICS

	1990	2001[4]	% Change
Vehicle Trips	194 Billion	235 Billion	21
Household Vehicle Miles Traveled	1.7 Trillion	2.3 Trillion	35
Person Trips	304 Billion	411 Billion	35
Person Miles of Travel	2.8 Trillion	4.0 Trillion	42
Average Personal Vehicle Trip Length	8.85 Miles	9.82 Miles	11
U.S. Population	249 Million	285 Million	14

When one considers energy consumption for personal trips, it is important to understand that work trips represent only a portion of the miles driven on the average automobile (see Table 2). In fact, households drive more miles per week for combined family/personal trips and social/recreational trips than for work trips. Table 2 also shows that, by far, most trips are made in private vehicles, a percentage that has been steadily increasing over decades. It should be noted, however, that during the summer of 2008, the number of vehicle miles traveled decreased at least 1% due to gasoline price increases and there are reports of increasing transit use.

TABLE 2. U.S. TRIP STATISTICS (2001)

	All Trips	Work	Family - Personal	School - Church	Social - Recreational	Other
Person Trips Per Week	27.8	4.9	12.4	2.7	7.5	0.2
Mode (% Private, Public, Other)	84/1/12	93/3/4	93/1/6	76/2/22	80/1/19	73/2/24
Trip Length per Vehicle (Miles)	10.7	14.9	8.0	7.4	12.0	18.9
Vehicle miles traveled (billions)	2,282	813	809	85	548	16

[4] These data are derived from the national household travel survey with 2001 as the latest data available. A new survey is being conducted in late 2008 and early 2009.

Energy use in the residential sector is relatively complicated. As shown in Table 3, most energy used in this sector is for space heating and cooling. The dominant fuels for home heating, according to EIA's Annual Energy Outlook, are electricity (43% in 2006), natural gas (42%), and fuel oil (12%). Almost all natural gas and electricity consumed in the U.S. is produced domestically. However, many homes in the Northeastern United States use fuel oil to heat their homes. Most of this oil is imported, making the budgets of these households extremely vulnerable to swings in world oil prices. Natural gas also fuels many home water heaters and stoves. Electricity runs the rest of the home, from lights and fans to refrigerators and dishwashers to televisions and computers. Coal, natural gas, nuclear power and dams (hydro power) produce most of the electricity consumed in the United States.

TABLE 3. RESIDENTIAL ENERGY END USES (Quadrillion Btus)

Home Energy End Uses	2006	2020	2030	% Annual Growth
Space Heating	5.31	6.21	6.18	0.6
Space Cooling	2.39	2.83	3.19	1.2
Water Heating	2.44	2.59	2.52	0.1
Refrigeration	1.24	1.14	1.20	-0.1
Cooking	0.58	0.67	0.72	0.9
Clothes Dryers	0.88	0.92	0.99	0.5
Freezers	0.26	0.29	0.34	1.1
Lighting	2.35	1.58	1.49	-1.9
Clothes Washers	0.11	0.08	0.08	-1.2
Dishwashers	0.30	0.30	0.33	0.3
Color Televisions and Set-top Boxes	1.05	1.33	1.69	2.0
Personal Computers	0.21	0.38	0.48	3.5
Furnace Fans	0.17	0.23	0.24	1.5
Other Uses	3.50	4.84	5.55	1.9
Total	20.82	23.39	25.01	0.8

The commercial sector (e.g., office buildings, stores, schools, and hospitals) is much like the residential sector; its main uses for energy are for space heating and cooling and lighting. Energy used in the industrial sector drives the extraction of raw materials from the earth, the processing of these materials into usable forms (e.g., the production of aluminum from bauxite), and manufacturing plants. Motors and machines that heat, cool, bend, and shape are the major end uses in this sector.

U.S. energy consumption has steadily increased over the years and is forecasted to continue to increase. As shown in Table 3, the EIA forecasts that energy use will increase for almost every end use in the home at least up through the year 2030. More broadly, the EIA forecasts that energy use will increase in all four sectors and that electricity demand will also increase significantly, likely resulting in increases in the demand for coal, natural gas, nuclear, and non-hydro renewables (e.g., photovoltaics, wind).

In addition, energy consumption is forecast to increase worldwide in the coming decades (see Figure 2). As shown, energy use in the developed world may only increase a small amount. The largest increases are likely to take place in developing countries like China and India, which are "catching up" to the developed countries in their market penetration of energy consuming technologies (e.g., automobiles, clothes washers and dryers). Worldwide increases in energy consumption primarily impact the United States through world oil markets and thus primarily impact energy prices in the transportation sector. There is concern that world oil production will not keep pace with rising demands and that world oil production may soon peak, if it hasn't already. This viewpoint, known as Hubbert's Peak, is driven by the observation that new oil field discoveries have been few in recent decades (see Figure 3) and that existing fields are being tapped out (U.S. oil production peaked around 1970). Thus, we believe it is likely that oil prices will remain high for many years into the future.

FIGURE 2. FORECAST WORLD ENERGY CONSUMPTION (Quadrillion Btus)

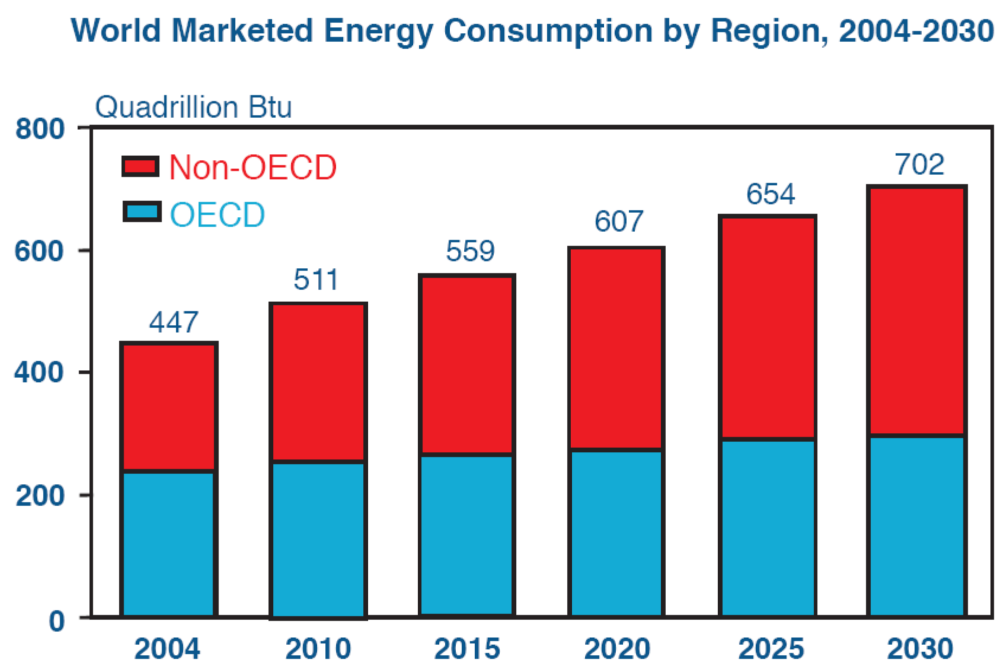
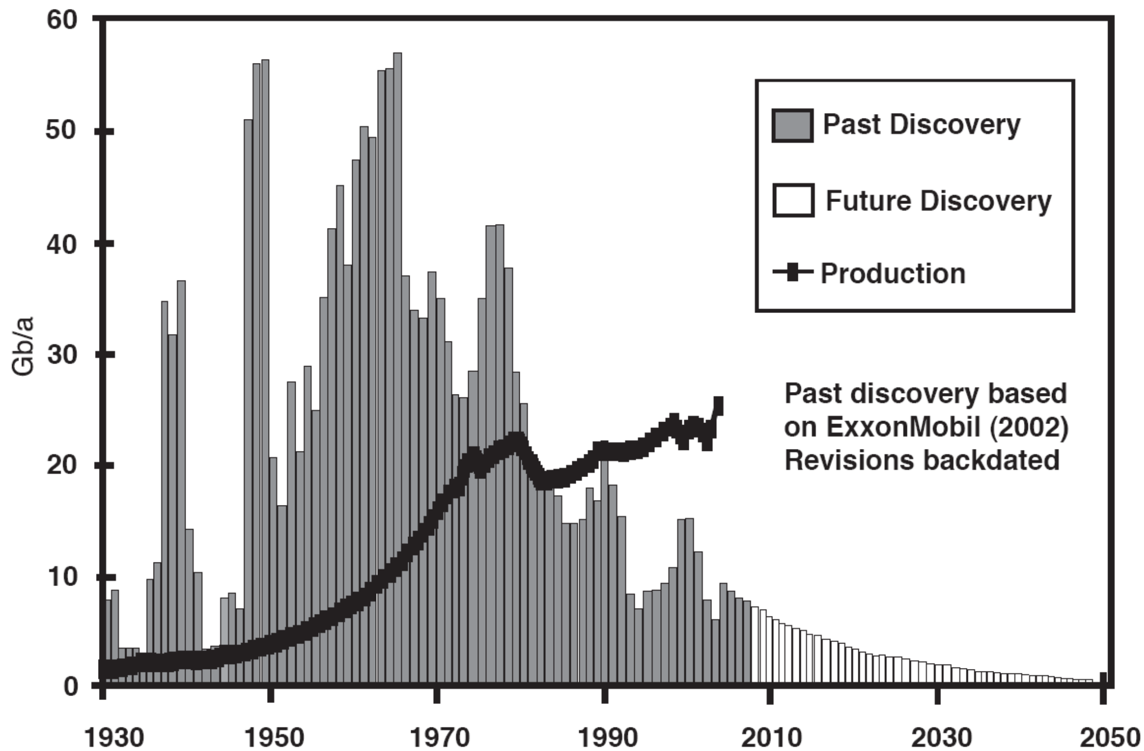


FIGURE 3. HISTORY OF WORLD OIL DISCOVERIES AND PRODUCTION
(Billion barrels per year)



It should also be pointed out that prices for domestically produced natural gas and electricity have also been increasing and are also forecast to continue to increase. For example, residential natural gas prices increased in real terms over 50% between the years 2000 and 2006 and electricity prices rose just over 12% during this same period. Anything that U.S. citizens can do to decrease their energy use in any way, from turning lights off and driving less, will save them money.

3. WAYS TO REDUCE ENERGY CONSUMPTION AT HOME AND ON THE ROAD

Exhibit 1 (found at the end of this document) presents a comprehensive list of actions that households can take to reduce their energy use at home and on the road. The actions are grouped into three categories: changing how existing technology is used, changing behavior, and investing in new, more energy-efficient technologies. All of these actions can directly reduce energy consumption. Actions that can indirectly reduce energy consumption, such as buying locally grown produce and recycling household waste, are not included in this list. Actions that increase the use of renewable energy, such as installing roof top photovoltaics, are also not included in this list. We have organized the actions by what we consider ease of personal adoption.

Changing how households use technology they already possess is generally simple and involves no cost or only minimal cost. For example, it costs nothing to close off rooms and turn off lights. It also costs nothing to run your dishwasher in the early morning hours during low peak demand (rather than high peak demand periods of late afternoon and early evening), empty your car of junk, and typically only a few cents to inflate your tires. These kinds of actions generally do not involve major changes in behavior and are not typically related to perceptions of reductions in quality of life.

More dramatic changes in behavior, on the other hand, may be associated with impacts on quality of life, and, therefore, may be harder to implement. For example, some people may be reluctant to take shorter showers or take mass transit to work instead of riding in their cars. Some may be unwilling to downsize a home or move closer to their employment. On the other hand, some changes in behavior may eventually be embraced, such as doing a better job of combining trips, which can save both time and energy, and telecommuting more frequently (for those whose jobs allow this possibility). Most of the actions listed in this category in Exhibit 1 are also no and low cost.

There are numerous investments Americans can make to reduce their energy consumption. Many are low cost, such as buying energy-efficient lights and weather stripping. Some are moderate cost, such as replacing windows and buying energy-efficient appliances. Some can entail major investments, such as buying a newer, more energy-efficient car or moving closer to work and shopping, which may potentially substantially increase housing costs. Generally, the much discussed gap between how much energy households use and how much less they could be using is conceptualized in terms of this question: Why do households not buy more energy efficient end use technologies?

4. BARRIERS TO REDUCING ENERGY CONSUMPTION

This section addresses barriers to reducing energy consumption by households. Research on barriers actually began in the late 1970s and early 1980s with path-breaking work done by psychologists and economists. Based on our review of this literature, we label typical barriers as economic, technology adoption, and social/psychological.[5]

4.1 Economic

As noted in the previous section, economic costs are significant barriers to reducing energy consumption, especially with respect to investments in new technologies. Economic costs are usually identified as being first (e.g., capital) costs and then operation and maintenance (O&M) costs. For many energy-efficient products, their first costs are higher than for conventional products, but their O&M costs are lower. Total costs for the energy-efficient products are often much lower than conventional products over the lifetime of the products. Consumer education is helpful in explaining the concept of total lifetime costs.

[5] Wilson and Dowlatabadi (2007) provide a thorough review of this literature using this general framework.

Unfortunately, for many people, first costs dominate their decision making for products such as energy-efficient appliances and fuel-efficient cars.[6] Costs are borne today or in the near term and benefits are enjoyed tomorrow or in the near future. Economists believe that different households and people have different and varying "discount rates" that they use to weigh costs and benefits that accrue over time. A higher discount rate suggests that costs today far outweigh benefits enjoyable tomorrow. Research shows that low-income households exhibit very high discount rates and therefore, out of necessity, opt for products with lower first costs. Programs that offer rebates on purchases or loan subsidies are successful at overcoming first cost barriers.

A third cost that may impact decision makers is referred to by economists as transaction costs. This cost describes how hard it might be to buy or sell a product or enter into some sort of economic agreement. These are also sometimes referred to as hassle costs. Trying to reduce one's driving may entail much hassle in order to merge trips, coordinate schedules with others in the household, and take other modes of transportation (see below). There may also be a psychological barrier to giving up the freedom of driving. Going to your local home products store to buy compact fluorescent light bulbs does not entail much hassle. Trying to choose among a wide range of dishwashers, all with different manufacturers, prices, features, and energy efficiencies, could prove more daunting and off-putting. Prospective consumers may decide that they do not have the time and patience to make the best informed decision. Trying to apply to a government program for an energy-efficiency loan or weatherization services could be fraught with so much uncertainty and anxiety that few people eligible for the program may apply. In these types of situations, transaction costs, even if only perceived, are judged to outweigh any level of benefits from the activity. Buyer's guides and simple, user-friendly government programs can help reduce transaction costs.

A fourth point related to costs is who bears what costs and who receives what benefits. Oftentimes, the distribution of costs and benefits among actors become split or skewed in such manners that reducing energy consumption is discouraged. A classic example is the split incentives of the rental housing market. In most rental situations, unit owners provide heating and cooling units and major appliances as part of the rental package and let units that may be more or less weatherized. Unit renters pay the energy bills. Unit owners generally have incentives to keep first costs as low as possible since they do not pay operating expenses for less efficient technology and units. Renters suffer by having to pay more for energy but do not have incentives to invest in improving the energy efficiency of units that they do not own. Programs to provide incentives to unit owners to make their units more energy efficient can help to overcome this split-incentive problem.

Economists also believe that some decision makers are naturally risk takers and others are risk avoiders. There is always some uncertainty about any decision. With respect to energy-efficiency investments, there are uncertainties about the benefits (e.g., energy cost savings), product reliability, product service availability, and product performance. A risk

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[6] Oak Ridge National Laboty 2000. Is There a Green Car in Your Future? http://222.ornl.gov/info/ornlreviw/v33_3_00/green.htm

taker is willing to accept more uncertainty than one who is risk averse. Trustworthy product information can often overcome the reticence shown by the risk averse. (For another viewpoint on technology adoption, see Section 4.2.)

More generally, psychological research has shown that human decision making is frequently governed by heuristics and biases that defy "rational" economic models.[7] In a famous set of psychological experiments conducted in the 1970s and 1980s, researchers showed that individuals prefer certain but lower gains over uncertain but higher expected gains, and they hate any type of losses.[8] Their decisions, therefore, can be influenced by how the problems are posed to them – i.e., in terms of gains or in terms of losses.[9] Thus, over the years, many in the energy field prefer to characterize actions in terms of *gaining energy efficiency* instead of *conserving* (or otherwise not losing as much) energy.

Nobel Prize winner Herbert Simon coined the term *bounded rationality* to describe people's propensity to find "satisfactory" decisions rather than optimal decisions.[10] It is rare that people have the time, energy, or even the interest to become perfectly informed about a potential investment, to exhaustively evaluate all possible decision alternatives and compare all possible decision alternatives rationally using well-ordered preferences. Instead, people will use only the most available information (e.g., what they read in the paper that day, what they heard from their neighbors), rely on clues to reduce the decision space (e.g., favor one trusted product brand over another), and construct their decisions in an ad hoc manner in real-time. Government programs can provide better information in a timely manner and help with trustworthy product clues (e.g., the Energy Star labeling program is a notable success in this regard). Frequent publicity of these programs can also assist citizens.

4.2 Technology Adoption

Closely related to economic barriers are barriers associated with adopting new technologies. Generally, adopting new technologies is a multi-step process with these components:

- Awareness;
- Interest/Information;
- Evaluation;
- Trial; and
- Adoption.[11]

The first two components are straightforward. Potential new technology adopters need to be aware of new technology options. By now, most people have probably heard of compact fluorescent bulbs, but probably few have heard of solid-state or light-emitting

[7] See Kahneman, Slovic, and Tverskey (Eds) 1982.
[8] See Kahneman and Tverskey 1979.
[9] See Tversky and Kahneman 1981.
[10] See Simon 1979.
[11] See Roger 1962.

diode lights. They may be aware that some heating systems are more efficient than others, but they may not have heard of residential geothermal heat pumps. Educational and informational campaigns can help to increase awareness of new products.

After awareness of a new product is established, information needs to be available that describes its costs and benefits. Then, decision makers may need assistance in evaluating new products versus conventional products or even versus keeping what one already has. People are not averse to trial, but are averse to error. So, most people would rather take a wait-and-see attitude and let others suffer the errors (as might currently be the case with new hybrid automobiles). Research has shown that new technologies are adopted following an s-curve over time. For many years or even decades, a new product may only be used by a small set of early adopters or risk takers. After some period of time, when the product has proven itself to the early adopters, the product will take off and its market share will increase appreciably quite quickly. Then market penetration of the product will level off, as only "laggards," the highly risk averse, refuse to adopt the new technology. Only by getting new technologies into the field sooner and generating good responses more quickly can lead times from early adoption to mass market penetration or adoption of new energy-efficient products be shortened.

4.3 Social/Psychological

Dealing with people in most any situation can become complicated very quickly. Trying to discern all the social and psychological factors that may influence energy consumption behavior and decision making is no exception. One of the first insights made by psychologists about energy consumption behavior is that there is typically no feedback to energy users.[12] Households may receive bills from their utility company every month, but those bills usually do not provide details on how much energy was used for space heating, water heating, lights, kitchen appliances, etc. If households implemented more than one change in how they use technology and/or in their energy-relevant behavior, their bills cannot tell them how much energy each change saved. Without direct, even real-time feedback, it is hard for households to reduce their energy consumption. New devices, such as smart meters, could begin to provide the necessary feedback.

Without feedback, positive or negative, people can develop misperceptions about the world. In most situations, people strive to be scientists of a sort, always trying to explain reality as they perceive it. Without good data, even the best intentioned people could be led astray. Indeed, energy researchers and program evaluators have documented numerous myths that people have about energy and buildings. Myths related to household energy use include: [13]

- Cleaning the refrigerator coils improves refrigerator efficiency;
- Installing foam gaskets in electrical outlets will significantly reduce air infiltration;

[12] See Kempton and Montgomery 1982.
[13] See Diamond and Moezzi 2000.

- Leaving on lights, computers, televisions, printers, copiers, etc., uses less energy than shutting them off and turning them on again; and
- Fluorescent lighting is bad (for your health, bad quality light, noisy, not natural, etc.) and can cause problems with your electrical appliances.

Energy use is also associated with social status, good health, comfort, cleanliness, and convenience. People consume energy as part of their entertainment and recreational activities. Energy use is intimately interwoven with lifestyles and quality of life. As Exhibit 2 (at the end of this document) illustrates, all of these factors and more can act as barriers to using mass transit, car pooling, and bicycling and walking. For example, barriers to mass transit include loss of freedom, fear of crime (threats to good health), stigma associated with using mass transit (threat to social status), and crowded conditions (threats to comfort and cleanliness). Carpoolers may fear being left at work and be irritated with not being able to do errands on the way home from work (threats to convenience). Safety concerns are barriers to the purchase of smaller, but more fuel efficient, automobiles. These are legitimate concerns that proponents of alternative travel modes need to address.

It could also be the case that many people know deep down that they should consume less energy but simply refuse to do so, usually out of pure self-interest. Eminent psychologist Albert Bandura refers to this phenomena as "moral disengagement."[14] There are many ways that people disengage morally. They will justify their actions using other moral arguments (e.g., religion gives man domination over the earth). They will dispute the facts (e.g., it has not been proven that humans are causing global warming) and downplay consequences (e.g., global warming may not be that bad). They will use euphemistic labeling to obfuscate their true intentions or rationalize not changing their behavior (e.g., driving SUVs) because their behavior is a small part of a huge problem. They will often blame others for the problems. The morally disengaged exist in groups (e.g., political, business, or religious groups), which many consider tribes. The tribes strongly re-enforce moral disengagement. Strong, persistent, and well-intentioned grassroots efforts are needed to promote more enlightenment.

From another viewpoint, it could be that individuals simply find it difficult thinking about the future. Since many of the benefits of reducing energy consumption will be enjoyed by future generations, the inability to even imagine potential future worlds to be inherited by future generations could be a significant barrier. Recent research has shown that most people do indeed have difficulty thinking about and imagining the future.[15] For example, on average, when people hear the word "future," they think only ten years into the future. People report being unable to imagine clearly the world ten to fifteen years into the future; everything seems dark after that. Ironically, it was found that worrying about the future tends to prevent people from thinking about and clearly imagining the future. Scenario writing and other exercises centered on energy use could help people improve their ability to deal with this futures-oriented issue.

[14] See Bandura (forthcoming)
[15] See Tonn, Conrad, and Hemrick 2006; Tonn and Conrad 2007.

As a last point, trust is an important factor when dealing with people about their energy consumption. Communications concerning energy are often heated and contradictory, whether well-meaning or not. Because of this, many people cannot help but be cynical in their attitudes toward government, corporations, utilities, advertisers, media, and even non-profit groups about energy or any other topic currently confronting the United States. Breaking through the trust barrier requires careful crafting of messages and integrity of approach. Lessons learned in California, discussed below, could be useful in dealing with this barrier.

4.4 Summary

Household energy consumption behavior is quite complex. In the home, energy use is a consequence of lifestyle, social influence, economics, and technology. How households set their thermostats could be influenced as much by the weather as by who was the last person in the household who had access to the thermostat. On the road, trip-taking behavior is influenced not only by the proximity of home to work, but also by sprawl, access to modes of transportation other than private vehicles, ability to make multiple shopping trips during any one day or week, and attitudes towards mass transit, car pooling, etc.

As shown above, barriers come in all shapes and sizes. Often, the barriers are chained together, so that after one is overcome another takes its place. Economic barriers generally plague the purchase of new technologies. Socio-psychological barriers constrain more efficient uses of existing technologies and changes in behavior. Conventional wisdom has held that policies to change behavior are quite difficult to implement and that any possible achievements are unpredictable and may not be very long-lasting. For example, it has taken the U.S. approximately 40 years to achieve a 33% recycling rate for household municipal waste, which does not rely on significant changes in behavior because many areas have curbside recycling. While changing over technology is more costly and takes more time, these savings are usually seen as more certain. Recent experience in California, in response to its own energy crisis in 2001, calls into question this conventional wisdom.

5. SUCCESS STORIES

This section presents three different success stories related to reducing energy consumption, mainly in the home. The first comes from California and the second is from New York. The last story is about the innovative Hood River Conservation Project, conducted in the 1980s.

5.1 California Success Story[16]

In the first years of this new century, the state of California experienced an energy crisis. More specifically, California experienced an electricity crisis. During the 1990s,

[16] Information presented in this section is drawn from Lutzenhiser et al. 2004, Jennings et al. 2002, and Bender et al. 2002.

California was one of the first states to re-structure its electric power industry, allowing utilities to divest, split-off, or independently invest in power plants. Re-structuring also made the transmission system independent of the regulated utilities. Speculation and market manipulation in the power generation sector created an electric supply crisis of the first order. During 2000 and 2001, Californians were warned of potential cuts in electricity service, brownouts, and even potential blackouts. Severe price shocks were also anticipated.

It turns out that the cuts in electricity service were few, mainly because Californians responded by changing their behavior to reduce their electricity consumption. The average household reduced its energy consumption by 10% during peak summer hours in the summer of 2001. A large-scale survey of households in the fall of 2001 revealed that five behavioral changes represented over 80% of the actions taken to reduce electricity consumption. The most common behavioral changes related to using less lighting. A second behavioral change that was observed in the survey was that almost half of the households reported some action related to heating or cooling, with the latter being most popular. Households also reported (3) turning off equipment when not in use, (4) using compact fluorescent lights, and (5) shifting electricity use to off-peak hours. A follow-up survey in the fall of 2002 showed only a slight regression in the behaviors exhibited the previous year.

It should be noted that these gains were achieved by-and-large without the anticipated price shocks. Observers of the California scene attribute behavioral change to fundamental worries about the reliability of electric services, a feeling of community spirit, and altruism.

An innovative media campaign called *Flex Your Power* has also been cited for its influence on changing behavior. This campaign was funded by the state government. Given the crisis at hand was blamed in part on the state government (eventually Governor Gray Davis was recalled and replaced by Arnold Schwarzenegger), a huge trust barrier had to be overcome. To help overcome this barrier, a non-energy agency, the California State and Consumer Services Agency, was given responsibility for the campaign.

The campaign consisted mostly of targeted television ads about how Californians could save electricity. The messages were targeted to sub-markets and niches; languages other than English (e.g., Spanish, Mandarin) were used as necessary. The messages themselves were very straightforward (e.g., showing an incandescent light being turned off or office equipment running in darkened offices). Few promises were made related to energy savings, money savings, or other direct benefits to electricity users. Mostly the messages focused on community and altruism and were considered quite successful.

5.2 New York Energy $mart^{SM}

New York is another state that has aggressively pursued the restructuring of its electric power industry. However, it was realized early-on that restructuring may put at risk numerous social benefit programs that had been administered by individual utilities throughout the state at the behest of the New York Public Service Commission. In response, it was decided to consolidate the administration of energy-related public benefits programs within the responsibilities of the New York State Energy Research and Development Authority (NYSERDA) and fund the programs through a state-wide Systems Benefits Charge (SBC). The resulting New York Energy $mart^SM Program was initiated in 1998.

New York Energy $mart^SM consists of over 40 programs that fall into four major program areas: business/institutional, residential, low-income, and research and development. Through the end of calendar year 2004, just over $800 million has been committed to New York Energy $mart^SM and the program's annual electricity savings are estimated to be 1,400 GWh.[17] Peak demand has been reduced by 860 MW. Annually, state energy customers are saving $195 million on their energy bills. The benefit-cost ratio for the portfolio of New York Energy $mart^SM programs was calculated under several different assumptions and ranges from between 5.9 to 7.2 and 13.5 to 16.4.

What has the New York Energy $mart^SM Program done specifically to accomplish these results? Here are a few examples of specific program outputs. The ENERGY STAR® Products program has resulted in the sales of more than 800,000 energy efficient appliances and almost 1.4 million efficient lighting products, some subsidized directly to the consumer, others to retailers. Specifically, incentives were offered to retailers to promote Energy Star appliances; consumers were given 2 for 1 fluorescent lights (buy one, get one free). More than 18% of new residential homes are being built to ENERGY STAR® specifications. People from all walks of life report being more aware of energy efficiency technologies and issues, including residents, small business owners, motor vendors, architecture and engineering firms, home construction firms, and commercial construction firms. One important consequence of increased awareness has been a significant increase in energy service company (ESCO) activity during the past five years.

The New York Energy $mart^SM Program also addresses many of the barriers discussed above. In the early years, the Program funded a major, cross-media energy awareness campaign that substantially increased the brand identity of the New York Energy $mart^SM Program. A large number of its 40 programs work to reduce the costs of energy-efficient investments. Several programs, such as the Technical Assistance Program for the commercial and industrial sector, help to overcome capabilities barriers. Finally, the program identified and worked to overcome numerous thorny economic issues (e.g., by guaranteeing markets for some energy-efficient lighting).

5.3 Hood River Conservation Project[18]

In the 1980s, the small town of Hood River, Oregon (pop. 15,000), was chosen as the site for a unique experiment in energy conservation. The goal of the project was to see how

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[17] NYSERDA, 2005.

[18] The information presented in this sub-section is largely drawn from Hirst 1989 and personal experience of one of the authors of this white paper.

much energy could be conserved if cost was removed as a barrier. The $20 million (in 1980s dollars) project was funded by the Bonneville Power Administration and administered by the Pacific Power and Light Company (PP&L). Hood River was chosen because it had a relatively isolated media market and its climate and energy consumption were typical for towns in the Pacific Northwest.

Only households that used electricity as their main source of space heating could participate in the project. All a household needed to do to participate was to make a phone call. In response to a call, PP&L sent someone to perform an energy audit on the home. The audit results included recommended building shell weatherization measures (e.g., ceiling insulation, caulking and weather stripping, electric water heater wraps, wall insulation). Measures that passed a cost-efficiency test (the cost of the measures was compared to the cost of providing electricity from coal-fired plants) were installed in the homes. Less than 1% of all the measures installed in the homes were paid by homeowners; the project paid the rest.

Virtually eliminating the economic barrier proved a great success. About 91% of the 3500 eligible households made the call. About 85% of the homes had one or more major retrofit measures installed. The most popular installed measures were ceiling insulation, storm windows, caulking, door weather stripping, and outlet gaskets. The average savings per house were 2600 kWh (compared to 300 kWh in two control communities). Had this project been able to include the whole house (e.g., lights, appliances), savings could have been much higher.

6. CONCLUSIONS

The United States is faced with two severe challenges, a shock in world oil prices and the need to mitigate global climate change. Reducing energy consumption is one strategy to deal with both of these problems. There is huge potential to reduce energy consumed in our homes and cars.

Barriers to reducing energy consumption are numerous and complex. However, various energy-efficiency and conservation programs have overcome economic, technology adoption, and social-psychological barriers. California used a well-crafted media campaign, among many other levers. The state of New York has implemented a wide-range of inter-connected programs. The Hood River Conservation Project showed that much can be accomplished if the will is there to fully fund programs to overcome economic barriers. It should also be noted that evaluation was an important part of all three efforts. We would not be able to recount these stories had their outcomes not been documented.

7. SUGGESTED READINGS

Ajzen, I. and Fishein, M. 1980. Understanding Attitudes and Predicting Social Behavior. Prentice-Hall, Englewood Cliffs, NJ.

Bandura, A. (forthcoming). "Impeding Ecological Sustainability Through Selective Moral Disengagement," International Journal of Innovation and Sustainable Development.

Barata, S. and Anderson, C. 2007. "Making the Intangible Tangible: How to Evaluate a Social Marketing Campaign," International Energy Program Evaluation Conference, Chicago, 862-869.

Bender, S., Kandel, A., and Goldstone, S. 2004. "Behavioral Economics: The Link Between Human Dimensions and Market Transformation," ACEEE Summer Study, Asilomar, CA, 7-16-7-27.

Bender, S., Moezzi, M., Gossard, M., and Lutzenhiser, L. 2002. "Using Mass Media to Influence Energy Consumption Behavior: California's 2001 Flex Your Power Campaign as a Case Study," ACEEE Summer Study, Asilomar, CA, 8.15-8.28.

Dennis, M., Soderstron, E., Koncinski, W., and Cavanaugh, B. 1990. "Effective Dissemination of Energy-Related Information: Applying Social Psychology and Evaluation Research," American Psychologist, Vol. 45 (10), 1109-1117.

Energy Information Administration. Annual Energy Outlook. Available online at eia.doe.gov.

Diamond, R. and Moezzi, M. 2000. "Revealing Myths about People, Energy and Buildings," ACEEE Summer Study, Asilomar, CA, 8.65-8.76

Goldberg, M. 2003. "Does Talking About Barriers Just Get in the Way?" International Energy Program Evaluation Conference, Seattle, WA. 145-156.

Hardin, J., Tucker, L., and Callegas, L. 2001. Assessment of Operational Barriers and Impediments to Transit Use: Transit Information and Scheduling for Major Activity Centers. National Center for Transit Research, University of South Florida, see http://ntl.bts.gov/lib/12000/12000/12049/392-11.pdf

Hirst, E. 1989. "The Hood River Conservation Project: A Unique Research and Demonstration Effort," Energy and Buildings, Vol. 13), 3-9.

Issacson, M., Kotewa, L., and Star, A. 2006. "Changing How People Think About Energy," ACEEE Summer Study, Asilomar, CA, 7-127 – 7-140.

Jennings, C., McNicoll, S., Lawrence, P., Larson, D. and Stone, N. 2002.. "Conservation Motivations and Behavior During California's Energy Crisis," ACEEE Summer Study, Asilomar, CA, 8.129 – 8.140.

Kahneman, D. and Tversky, A. 1979. "Prospect Theory: An Analysis of Decision Under Risk," Econometrica, Vol. 47, 263-292.

Kahneman, D., Slovic, P, and Tversky, A. (Eds.)1982. Judgment Under Uncertainty: Heuristics and Bias. Cambridge University Press, Cambridge, England.

Kempton, W. and Montgomery, L. 1982. "Folk Quantification of Energy," Energy – The International Journal, Vol. 7, 817-827.

Kempton, W., Darley, J., and Stern, P. 1992. "Psychological Research for the New Energy Problems: Strategies and Opportunities," American Psychologist, Vol. 47 (10), 1213-1223.

Loughran, D. and Kulick, J. 2004. "Demand-side Management and Energy Efficiency in the United States," The Energy Journal, Vol. 25 (1), 19-43.

Lutzenhiser, L. 1991. "A Cultural Model of Household Energy Consumption," Energy, Vol. 17 (1), 47-60.

Lutzenhiser, L, Kunkel, R., Woods, J., Lutzenhiser, S., and Bender, S. 2004. "Lasting Impressions: Conservation and the 2001 California Energy Crisis," ACEEE Summer Study, Asilomar, CA, 7-229 – 7-240.

Lutzenhiser, L. and Gossard, M. 2000. "Lifestyle, Status, and Energy Consumption," ACEEE Summer Study, Asilomar, CA, 8.207-8.222

McKenzie-Mohr, D. 1994. "Social Marketing for Sustainability: The Case of Residential Energy Conservation," Futures, Vol. 26 (2), 224-233.

Mitchell-Jackson, J., Barata, S., Hall, N., and Lai, P. 2007. "Measuring the Effects of Marketing Campaigns: Lessons and Innovative Methods from California," International Energy Program Evaluation Conference, Chicago, 870-879.

New York State Energy Research and Development Authority. Generally http://www.nyserda.org/ and on economic and environmental benefits http://www.nyserda.org/ny_energy_smart.asp

Rogers, E. 1962. Diffusions of Innovations. The Free Press, New York.

Schweitzer, M. and Tonn, B. 2001. Non-energy Benefits from the Weatherization Assistance Program: A Summary of Findings from the Recent Literature. ORNL/CON-484, Oak Ridge National Laboratory, Oak Ridge, TN, April.

Simon, H. 1979. "Rational Decision-Making in Business Organizations," American Economic Review, Vol. 69 (4), 493-513.

Skumatz, L. 2007. "Using NEBS (Non-Energy Benefits) to Attract "Ordinary" Homeowners to Energy Efficiency: The New Zealand Case," International Energy Program Evaluation Conference, Chicago, 728-738.

Stern, P. 1992. "What Psychology Knows About Energy Conservation," American Psychologist, Vol. 47 (10), 1224-1232.

Ternes, M., Schweitzer, M., Tonn, B., Schmoyer, R., and Eisenberg, J. 2007. "National Evaluation of the Department of Energy's Weatherization Assistance Program (WAP): Program Year 2006 Experimental Plan," ORNL/CON-498, Oak Ridge National Laboratory, Oak Ridge, TN, February.

Tonn, B., Conrad, F., and Hemrick, A. 2006. "Cognitive Representations of the Future: Survey Results," Futures Vol. 38, 810-829.

Tonn, B. and Conrad, F. 2007. "Thinking about the Future: A Psychological Analysis," Social Behavior and Personality, Vol. 35, No. 9, 889-902.

Tversky, A. and Kahneman, D. 1981. "The Framing of Decisions and the Psychology of Choice," Science, Vol. 211, 453-458.

Ueno, T. and Nakano, Y. 2006. "Effectiveness of Displaying Energy Consumption Data in Residential Buildings: To Know Is To Change," ACEEE Summer Study, Asilomar, CA, 7-264 – 277.

Wilson, C., and Dowlatabadi, H. 2007. "Models of Decision Making and Residential Energy Use. Annual Review of Environment and Resources," Vol. 32, 169-203.

EXHIBIT 1. WAYS THAT HOUSEHOLDS CAN REDUCE THEIR ENERGY CONSUMPTION AT HOME AND ON THE ROAD

Change Technology Use	***Change Behavior***	***Invest in New Technologies***
Close off rooms not in use Close drapes and blinds in summer and open them in winter Turn lights off -- indoors and outdoors Run full loads of laundry and dishes Use ceiling fans more often Regularly change/clean air filters on heating and cooling equipment Turn-off or unplug appliances when not in use Set refrigerators to 38°F and freezers to 5°F ------------------ Remove unnecessary items from car Reduce car idling in morning to no more than 30 seconds Keep tires inflated Keep car tuned-up Replace clogged air filters	Take quick showers instead of baths Raise home thermostat settings in summer and lower them in winter Use major appliances during non-peak times Lower water heater settings Air dry laundry Use cold water for laundry --------------------- Combine trips Do not speed and accelerate and slow down gradually Reduce use of car air conditioner Join a car pool Telecommute Take advantage of distance education and telemedicine Walk or bicycle more often Use public transit more often	Buy low watt, compact fluorescent bulbs and solid state lights Buy low-flow shower heads Buy a programmable thermostat Insulate water heater Plant deciduous trees on south side of home Weatherize your home – plug leaks, fix ducts Install energy-efficient windows Add insulation to home – attic, walls Buy energy-efficient appliances – clothes washers and dryers, water heaters, air conditioners Buy energy-efficient heating and cooling systems --------------------- Buy a more fuel efficient car Live closer to work and shopping Live in a smaller home

* The actions presented in this Exhibit are drawn from these sources: http://www.context.org/ICLIB/IC22/Guide.htm, http://www.epa.gov, http://www.doe.gov, and Ternes et al. 2007.

EXHIBIT 2. BARRIERS TO MASS TRANSIT, CAR POOLING, BICYCLING AND WALKING

Barriers to Mass Transit	***Barriers to Car Pooling***	***Barriers to Bicycling and Walking***
Impinges upon freedom	Irregular work schedule	Safety
Lack of service, especially in suburbs and outlying areas	Need to do errands	Time
Inconvenient stops and service times	Fear of getting stuck at work	Effort
No parking near outlying transit stops	Flextime makes coordinating schedules harder	Cannot carry much
Cannot carry much on buses or trains	Impinges upon freedom	Limits trip making options
Does not go where want to go	Prefer solitude	Physical disabilities
Too many transfers required	Cannot find compatible carpoolers	Rain, snow, heat, and cold
Do not know prices or how to pay	Fear of unknown carpoolers	
Do not know about routes		
Crowding on buses and subways		
Fear of crime		
Obnoxious passengers		
Seats too small		
Only low social status people use mass transit		