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Research Paper

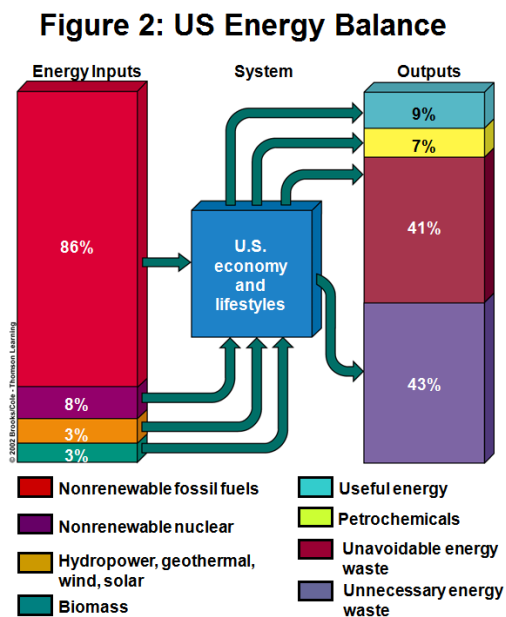
Residential Energy: Habits and Solutions

Residential energy encompasses many aspects, and is something that I think is extremely overlooked in the effect that its abundance has had on our lives. Waste of resources and negligence about the importance of energy has become customary because the amount of electricity a home can use is limitless; it is restrained only by the marginal economic cost of electricity production from fossil fuels. One problem is that cost of these resources does not encompass the effect that their utilization has on the environment, and therefore does not inform consumers of the impact that they personally are having on their surroundings. The average American household has many unrealized opportunities for energy savings, including simple efficiency upgrades and habit changes, and their implementation will result in both increased awareness of energy issues and less energy waste.

Specifically, the three main sources of residential energy are natural gas used for heating and cooking, gasoline used to power automobiles, and electricity that is used in large amounts for refrigeration, cooling, and heating. This is an important assumption, as I am leaving out the analysis of energy use in the manufacturing of the houses themselves, the manufacturing and shipping of the automobiles, the transport and disposal of waste, and the production and distribution of the countless other products used in the home. These “indirect” uses of energy are still very important to recognize and are significant sources of energy, but are beyond the direct control of consumers for our purposes. There are 119,117,000 homes in the United States,

so clearly their construction is also important on such a large scale because that also does consume energy, and because there are so many homes if every home can make even a small efficiency and habit changes, that can have tremendous impacts on the US's energy as a whole (US Census Bureau). However, in a nation dedicated to growth, by producing more products and using as much energy as is available to maximize profits that contributes directly to increased energy use over the past few decades despite the fact that our energy intensity, the amount of energy used to generate one dollar of GDP, has decreased. So efficiency has actually increased over that same time period, but both of these gains have been greatly outweighed by increased use. For example, although heating and cooling of homes now takes significantly less energy than it did 30 years ago per square foot, the square footage per person in the US has increased dramatically over that time period.

The understanding of units is necessary to understand the quantitative effects of energy



efficiency and savings. Energy is defined as power times time, and is in science-related applications quantified as the capacity to do meaningful work. An example would be pushing a large block for an hour. Pushing on it with a certain amount of power, let's call it one push, allowed the block to experience one push-hour of energy input. There is also the very important and relevant concept of "qualities of energy," defined by the second law of thermodynamics. This is a law of

nature so we can't get around it and it says that energy is always trending toward lower-quality, more dispersed energy. Take the example of room-pressure air, which is roughly one

atmosphere, atm., of pressure. This is low quality energy because we can extract from it little work, whereas with air at a pressure of 10 atm. we could use that pressure to spin a turbine to generate electricity. As can be seen in Figure 2 from David Dillard's presentation, about 40% of all US energy usage is "lost" to this low-quality energy which we cannot use, as a result of the second law of thermodynamics. The other 40% that is "unnecessarily wasted" is where we can focus efforts on efficiency and conservation. It may be also true that we cannot supply current demand for energy with renewable technology, but in that case current usage is clearly the problem, not technology. If we are wasting 40% of our energy, it makes sense to first focus on reducing our unnecessary demand before trying to meet that with renewable technologies. All of the energy unnecessarily wasted in the United States does actually go somewhere, and in Figure 2 the 40% that is being unnecessarily wasted specifically includes driving inefficient vehicles, lighting unused parking lots all night, and other blatant wastes of energy (Dillard).

The good news is about our ability to reduce wasteful energy use. Specifically, knowledge is plentiful about ways to reduce use and energy is far from just a modern concern. In the 1972 book *Cutting Energy Costs*, by Dick-Larkham, wind and solar energy is discussed in the chapter titled "Future Energy Sources." Thirty-seven years ago those were renewable sources of energy that had just begun undergoing research and looked very promising, and today they are available for purchase by anyone. This research has also allowed us to create appliances and homes that are much more efficient. Homes are more efficient with better insulation, tighter thermal barrier, more efficient windows, and programmable temperature control. The efficient appliances are also becoming available to more consumers everywhere, but that means that even though they are more efficient, there are many more people using them. For example, refrigerators today consume only a fraction of the electricity they used to, but this makes less of

difference because they so common that a family can easily own more than one, whereas they used to be a luxury. For the ease of consumers and to promote appliances that save energy, the most efficient that are in stores are labeled as Energy-Star. The attraction of these Energy-Star appliances is most often not that they save the environment but rather that they save the consumer money. This is true, because cutting energy costs is the way in which energy efficiency “pays off.” Specifically, the money savings by cutting energy costs outweigh initial investment, and energy efficiency makes sense for everyone (Dick-Larkham 25).

Green building standards are evolving and are a good way to measure how the construction and operation of a house will affect the environment (Walcott). The points awarded within the Energy-Star and LEED certification checklist for energy efficiency are by nature general, but all of them include certain parts that mandatory to achieving certification; refrigeration efficiency is a universally mandatory criterion (Walcott). So, by buying efficient appliances that are using the latest energy-saving technology, which is easy to do when they most efficient appliances are clearly labeled, people can save substantial amounts of energy. Green building standards also include requirements for efficiency technology that makes homes have less heat transfer to require less energy to heat and cool. This is very important that homes are heated and cooled efficiently because that is the chief source of residential energy use; space heating consumes 3.32QBtu of Natural Gas and 0.39QBtu of Electricity annually, much greater than other sources (Ristinen 213). All of this energy is a result of some level of inefficiency, as Ristinen says: “If we could build an ideal house that had perfect thermal insulation in the walls windows, roof and floors and had no leakage of air into or out of the house...no energy source would be needed to keep the insides of the house at a constant temperature” (213). There have been various innovations over the years that have allowed houses to become better sealed, like

GE's Tyvex plastic coating that is now standard practice on new homes. Double-paned windows and other more efficient technology also significantly seals homes, and awards points within green building standards.

Some would, however, argue that we do not yet have the available technology needed to reduce our energy use and that there are economic barriers to changing our current patterns. They point out that with the current efficiency of solar panels and locations for wind turbines it would be unreasonable to supply the US's current and future needs from these sources. But, if we are able to use energy more efficiently there will be less demand. Over the same time period that our use of energy has continued to rise exponentially, the intensity of that energy, defined as the amount of energy required to produce one dollar of gross domestic product, has actually decreased so we are becoming more efficient even now. The current efficiency gap is a measure of comparison of the efficiency that is currently in use with the energy efficiencies that are available, yielding a "gap" in efficiency that is not being utilized. There are economic obstacles within our market system that are preventing the implementation of technology and the major ones are risk, imperfect information, hidden costs, access to capital, split incentives, and bounded rationality (Sorrell 55). Each of these factors, however, has a solution that will allow for the market to make energy efficient technology, some of them which I will discuss. Risk is one of the largest obstacles, and it means that people are afraid of putting out money up front with a long payback period, and is a serious problem when business or circumstances encourage short-term return on investment. The government does offer rebates for wind turbines and solar panels to make the more affordable, but when demand increases so that the rebates are becoming too burdensome on the government, they will have to repeal them like they did with hybrid vehicles, specifically the Toyota Prius. Split incentives are built into the way we purchase energy today,

taking electricity for example, if a household is able to reduce its electricity demand they have the incentive of saving themselves money, but that is only part of the incentive because the other split part represents the incentive gain by the electricity utility now needing to produce less electricity and burn less coal (Sorrell 77). If government subsidies for utilities are reduced, so that the consumer sees the true cost of electricity production, then they would also receive the full incentive to reduce use. Hidden costs include the costs that are associated with the overhead costs of energy management, the costs which are specific to an individual investment in energy efficiency, and the potential loss of utility associated with energy efficient choices (Sorrell 65). The understanding of each of these issues is what allows officials to address them to correct the market failures and make barriers less ominous.

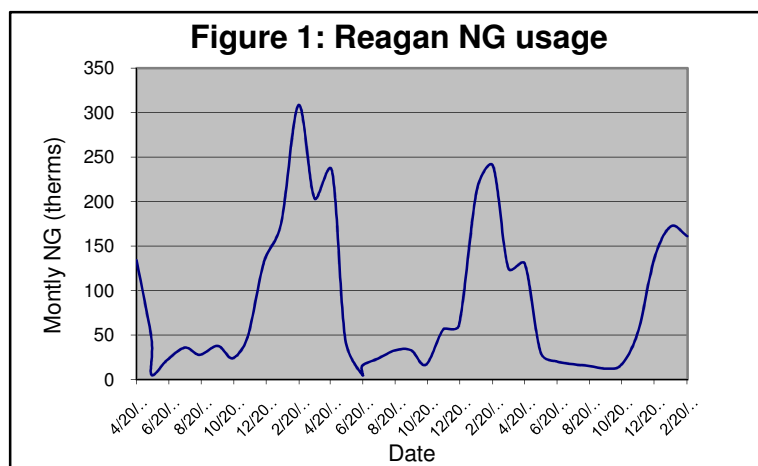
More good news is that the other major problem also has a simple fix. That is, standing right beside technology use as something that can be corrected are our habits and poor awareness of energy use as a whole. The reasons that people have lost sight of the amount of energy they use on a daily basis is not a fault of theirs entirely; it is easy to lose sight of how much we use of something when it is so abundant. In *The 11th Hour*, Leonardo DiCaprio points out many of the problems that are direct and indirect results of this excessive energy use, namely global warming. Movies like this are meant to inform, and at points do scare, the public about the consequences of our actions that we do not normally think about. Al Gore's well-known "An Inconvenient Truth" may not be perfect as many like to point out, but the fact that it creates controversy is bringing the terms "global warming" and "climate change" to the television sets of Americans everywhere and in some way making the nation more aware. In the similar but less widely known informative movie "Killowattt Ours," energy is the main topic and the movie itself is intended to educate Americans and show that it is possible to reduce energy use to the level

where it can be fueled by renewable resources. All of these media sources and the “green revolution” that is making environmentalism popular help to raise awareness and change the habits of Americans every day.

Some people are more stubborn than others, and it is sometimes difficult to “teach an old dog new tricks.” So, it is also arguable that habits are very difficult to change. In some cases, this is definitely true, like changing the habit of smoking cigarettes is so difficult for some people that they cannot do it. But, just because habits are so ingrained that they are difficult to change does not mean that they can’t be changed. When the time comes, people may not even be confronted with a choice of habits but rather be mandated to change, for example when water runs low in dry areas of the country its use is restricted. With education, people’s attitudes toward the environment can be changed and their actions toward it will follow their renewed attitude, which I have witnessed in many friends and in myself as we are becoming more aware of environmental issues through the Earth Sustainability class that we are taking. This type of education through the media and of the generation in college right now will relate to the nation’s awareness of energy as a whole, and therefore on a broader scale have an effect on the amount of it we use every day and the repercussions that has on the environment.

The analysis up to this point has been general and dealing with the “average” American, so to back up my assertion that these changes can make a significant difference, the energy use and changes that have been made over that time at my own home are examined as a case study. Indeed, looking at my own home, changes that we have made have had noticeable impacts on the amount of energy we use. These changes were mostly habitual and included sealing the house with caulk, not heating rooms that we do not use, and changing our thermostat to heat only when people are home and to only 68°F. Figure 1 depicts the changes in natural gas usage from those

changes over a three year period, which can be seen decreasing during the peak winter usage for heating in New York State (Reagan). It is important to note that the reason my Dad was so motivated to make these changes was to save money on energy, not to save the environment. But the outcome is still the same, using less energy which is beneficial to the environment. We researched into purchasing a wind turbine or solar panels to provide electricity, but the economic disincentive of risking a large upfront cost was too much. But there are many smaller upfront costs that we were able to stomach, for example purchasing only CFL lights. To prevent ghost loading, the use of electricity by appliances that are turned off but still plugged in, we tried putting our electronics onto power strips that could turn off completely. This was difficult to remember to do each time, and was really a pain in the back reaching behind the TV to turn on and off, but we manage to do it because we are aware of how much electricity we are saving by doing it and the implications that has. If we had



known about ghost loading before buying our TV, or that information was made more available to consumers, we may not have bought the TV that we did because it has unusually high ghost loading. By looking into energy use issues, my parents and I both gained increased awareness of energy and used less energy.

So with changed habits and the use of new and old technology, homes in the US can consume much less energy without major changes. Investment in efficient technology pays off over time, so that with the understanding of economic barriers and through efficiency

investments people can become aware of energy issues. Living in a nation that is aware of energy and does not waste it would be living in a more environmentally sustainable nation, and that better place is possible today.

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