What You Do Matters:
Your Behavior and Energy

Mark D. Martin
© May 2013

I. What You Do Matters

Each of us has choices about using energy. By wise choices and not wasting energy we can help protect the environment and insure the supply of energy now and for future generations. While we all have a right to use energy resources, we also have the responsibility to use them wisely. Read on to learn why we need to save energy and how you can make wise choices.

II. Why It Matters

Energy conservation, or using less energy, matters. Fossil fuel use is increasing carbon dioxide in the atmosphere and is causing global temperature changes. While the changes seem slight, they may have major environmental and economic impacts. (See generally "Climate Change: Basic Information," United States Environmental Protection Agency, http://www.epa.gov/climatechange/basics/.) While the exact impacts are unclear and may largely be felt decades in the future, do we not have a moral obligation today to take steps to lessen these impacts? Is it not prudent to take reasonable and measured steps to lessen our use of fossil fuels? Many forms of energy generation also have other environmental impacts including causing air and water pollution and generation of hazardous wastes.

Besides the environmental impacts, there are limited supplies of many energy resources. For example, some believe we are near the time of "peak oil" after which production of oil will diminish. (See Paul Roberts, "World Oil," *National Geographic Magazine*, http://ngm.nationalgeographic.com/2008/06/world-oil/roberts-text/1 (June 2008.) While hydraulic fracturing, or fracking, offers new opportunities for domestic oil and natural gas, it comes with its own uncertainties and environmental problems. (Edwin Dobbs, "The New Oil Landscape," *National Geographic Magazine*, http://ngm.nationalgeographic.com/2013/03/bakken-shale-oil/dobb-text (March 2013).) Getting other forms of liquid fuel can be difficult and expensive. While we have promising new forms of energy such as solar and wind, these new forms are only a partial solution and will never provide all the energy we need. Saving energy now will give us time to develop these and other new sources of energy such as advanced nuclear power designs. This will help prevent major economic disruption.

III. What You Can Do To Save Energy

A. Let's Get Going!

"We already know the fastest, least expensive way to slow climate change: Use less energy. With a little effort, and not much money, most of us could reduce our energy diets by 25 percent or more- doing the Earth a favor while also helping our pocketbooks. So what's holding us back?" (Peter Miller, "Saving Energy: It Starts at Home," *National Geographic Magazine*, March 2009, page 60.) There are two main ways to use energy wisely. First, you can use less energy by shutting it off when you are not using it or choosing not to use it in the first place. Second, you can adopt technologies that help you save energy. We will examine these methods in lighting, electronics and appliances, water heating, space heating, air conditioning, transportation, and the products we buy. Don't worry – it may hurt a little at first but in the long run it will help you, the environment, and your fellow humans.

B. Lighting

About 17% of the electricity used by residences and commercial businesses in the United States is for lighting. (U.S. Energy Information Administration, "How Much Electricity is Used For Lighting in the United States, http://www.eia.gov/tools/faqs/faq.cfm?id=99&t=3.) We, of course, need to light our houses and businesses. We can save substantial energy and money if we do this wisely, however.

Shut the lights off. You need light to see when it is dark. You don't need the lights on when you are not in the room, however. Shut the lights off! Let's say you usually leave your bedroom light on when you are elsewhere in the house. If you have a 26 watt bulb and leave it on for two hours each day that adds up to about 19 kilowatt hours per year. To get that number I multiplied 26 watts by two hours by 365 days. To save 19 kilowatt hours per year just shut off the light! To find the money you save you can multiply the kilowatt hours by the cost per kilowatt hour for electricity where you live. In the San Diego area that cost is about $.14 to $.28 per kilowatt hour. More important than the cost savings is that you prevent about 40 pounds of carbon dioxide from entering the environment assuming your electricity is generated by burning coal. (See U.S. Energy Information Administration, "CO_2 Produced Per KWhr," http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11.)

Compact Fluorescents. The type of light you use also makes a big difference. You can replace a 60 watt incandescent light with a 13 watt compact fluorescent bulb that produces about the same amount of light. Modern compact fluorescent bulbs are also reported as having better light quality. (Emily Masamitsu, "The Best Compact Fluorescent Light Bulbs: PM Lab Test," *Popular Mechanics*, http://www.popularmechanics.com/home/reviews/news/4215199.) Going from 60 watts to 13 watts is a 78% savings! Fluorescent bulbs cost more but last about 8 to 15 times longer. ("Compact Fluorescent Lamp," *Wikipedia*,

http://en.wikipedia.org/wiki/Compact_fluorescent_lamp.) LED lights may provide even more efficiency than fluorescent bulbs although they are more costly. (See "LED Lamp," *Wikipedia*, http://en.wikipedia.org/wiki/LED_lamp.)

T-8 fluorescent lights with electronic ballasts. The type of fluorescent bulb may also make a difference. For example, Keystone Academy in Solana Beach, California, replaced their old fluorescent tube lights with T-8 fluorescent lights with electronic ballasts. Each old tube used at least 32 watts. Each new tube uses only 25 watts although it produces more and better quality light. (See generally "Today's Fluorescent Lighting: Better Quality and Efficiency," Eugene Water and Electric Board, http://www.eweb.org/newsletter/fluorescentlight.) That's a 26% savings. The lights in the entire school were replaced in about two hours. The cost was free under a government program. Additionally, the ballasts on the old lights had been failing and hence the old lights needed replacing anyway. In this small school with 26 light fixtures with four bulbs each the projected energy savings is 1872 kwhr per year. (It was assumed the lights were on ten hours per day for five days a week and 40 weeks during the year.) That savings prevents about 2,000 to 4,000 pounds of carbon dioxide from entering the atmosphere in a year. (See U.S. Energy Information Administration, "CO_2 Produced Per KWhr," http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11.)

C. Electronics and Appliances

Example: Computers. Of course, we don't just use electricity for lights. In our homes, schools and businesses we use a variety of other appliances and electronics. The lessons we learned from lighting can be applied to these other appliances and electronics. For example, when using your computer, put it to sleep when won't be using it for more than a few minutes. In sleep mode a desk top computer (excluding monitor) uses about 4.5 watts. They wake up almost instantly. Running in idle a desktop computer uses about 75 watts. Sleep mode therefore saves over 70 watts. ("Power Consumption of a Computer in Sleep Mode," Server Fault, http://serverfault.com/questions/34574/power-consumption-of-a-computer-in-sleep-mode.) At night simply shut the computer off. You can also unplug it (or turn off the power strip) since often electronic equipment uses some energy when plugged in even when not on. (Id.) Instead of using a desktop computer you can use a laptop computer. Laptop computers can use less than half of the power of a desktop computer. (See M. Williams, "Do Laptops Save on Electricity Bills," National Geographic, http://greenliving.nationalgeographic.com/laptops-save-electricity-bills-2998.html.)

EnergyGuide Label. Computers are just one example. Whatever electronic device or appliance you use shut if off if you aren't using it. Also, when you buy an electronic device or appliance look to see how much power it uses. The United States government requires yellow "EnergyGuide" labels on many appliances stating how much power they use and how it compares to similar models. This makes it easy to choose a model with low energy use model. Some appliances are also "Energy Star" certified which means that they use less energy than standard models. (Federal Trade Commission, "Shopping for Home Appliances? Use the EnergyGuide Label,"

http://www.consumer.ftc.gov/articles/0072-shopping-home-appliances-use-energyguide-label.)

Refrigerator. One appliance that almost every home has and that has to be turned on all the time is a refrigerator. Refrigerators are one of the largest electricity users in your house using about one-sixth of all electricity in your house. A ten year old refrigerator can use more than twice as much electricity as a new Energy Star refrigerator. ("Replace Your Old Refrigerator and Slash Your Utility Bill," http://www.human.cornell.edu/dea/outreach/upload/Refrigerator_Replace.pdf. See also "Refrigerator Power Consumption," Home Energy Check List, http://www.thegeoexchange.org/fridge-power-consumption/index.html.) When you replace your refrigerator avoid the temptation to get a larger and fancier model. Your typical 21 cubic foot top freezer model is big enough for most families and uses much less energy than a larger side by side model. It is also much less expensive to purchase. For example, as I write this on May 16, 2013, you can buy an Energy Star rated Sears Kenmore 21.0 cubic foot top freezer model 62152 for $675. The EnergyGuide label states it uses 410 kilowatt hours per year. A 22.9 cubic foot Energy Star rated Sears Kenmore 22.9 cubic foot side by side model 51313 costs $1,425 and uses 549 kilowatt hours per year. (http://www.sears.com/kenmore-22.9-cu-ft-side-by-side-refrigerator/p-04651313000P?prdNo=2&blockNo=2&blockType=G2) For 9% greater volume you pay 111%. You also use 34% more electricity per year. From either an economic or environmental standpoint buying the slightly larger and perhaps more "stylish" model makes no sense. Instead use the $750 you save to help you put solar panels on your house. Finally, don't have a spare old refrigerator running in your garage. It is waste of money and energy!

D. Water Heating

Water Heaters. According to the California Energy Commission, 25% of your energy dollar goes to heating water. (California Energy Commission, "Water Heaters," http://www.consumerenergycenter.org/home/appliances/waterheaters.html.) Use a natural gas water heater if natural gas is available for your home. It costs about three times more to heat your water using an electric water heater compared to gas. (Id.) You can also consider a tankless water heater or a solar water heater. Also, don't get a water heater bigger than you need. The California Energy Commission's article has advice on selecting the right size.

Turn Down the Water Heater. The United States Department of Energy has some good advice. "Lower the temperature on your water heater to 120°F; for every 10ºF reduction in temperature, you can save from 3%–5% on your water heating costs." (Allison Casey, "15 Ways to Save on Your Water Heating Bill," http://energy.gov/energysaver/articles/15-ways-save-your-water-heating-bill.) It also helps to prevent you or your family from getting serious burns from hot water. (See "Scalding from Hot Water," PSG&E, http://www.pseg.com/home/education_safety/safety/scalding.jsp (water at 110º is

unlikely to cause any injury to an adult while water at 160º can cause second and third degree burns in less than one second.)

Take Short Showers. If you shorten your time in the shower from 10 minutes to 5 minutes you can save between $35 and $100 per year depending on your type of water heater and power source. (Tom Nutt-Powell & Sergio Siani, Massachusetts Interfaith Power and Light, "Shower Length," http://www.mipandl.org/MIPL_resources/MIPL_ShowerCostCalculatorTemplate.xls.) Not only do you save energy, you save water and the energy it takes to clean that water and transport it to you. You may like a ten minute shower, but isn't it better to save money, help protect the environment, conserve natural resources and help future generations?

Laundry. The key to saving energy while doing the laundry is to use a high efficiency front loading washer and cold (or at most warm) water. Front loading washers use much less water and extract more water in the spin cycle reducing drying times. (See generally, American Council for an Energy Efficient Environment, "Laundry," http://aceee.org/consumer/laundry.) When buying a washer check the yellow EnergyGuide label and choose an Energy Star rated model. Use a gas dryer and take your clothes out as soon as they are dry. (An electric clothes dryer accounts for 5.8% of the electricity used in a house. "End Use Consumption of Electricity 2001," http://www.eia.gov/emeu/recs/recs2001/enduse2001/enduse2001.html.) Better yet use a high tech solar clothes dryer, formerly called a clothesline! (See generally, "Energy Tip: Get Yourself a Clothesline," http://www.terrapass.com/conservation-tips/how-to-finance-2/.) You can get a high rated portable one for $36.29 from amazon.com, http://www.amazon.com/Household-Essentials-Portable-Umbrella-Style-Clothes/dp/B001H1GUXW/ref=reg_hu-rd_add_1_dp.

Swimming Pools. While a swimming pool at home can be great fun, a pool is costly to operate and not environmentally friendly. Pools use energy in two main ways – heating and running the filter pump. Heating a pool even in a relatively warm environment like Southern California can cost thousands of dollars a year. ("Gas Swimming Pool Heaters," http://energy.gov/energysaver/articles/gas-swimming-pool-heaters.) Adding a cover can reduce that cost by over 80%, however. Better yet have a cover and add solar water heating to your pool. While a solar pool heating system can cost between $3,000 and $4,000 to buy, the payback is period is only 1.5 to 7 years. ("Solar Swimming Pool Systems," http://energy.gov/energysaver/articles/solar-swimming-pool-heaters.) Besides heating a pool you need to run the filter pump. A pool pump can use 3,000 kilowatt hours per year. Through a combination of downsizing your pump, selecting an efficient pump, and decreasing the time you run it, you can reduce the amount of electricity used and associated costs by up to 75%, however. ("Installing and Operating an Efficient Swimming Pool Pump," http://energy.gov/energysaver/articles/installing-and-operating-efficient-swimming-pool-pump.)

Whatever you do, however, pools use a lot of water, energy and chemicals. If you don't already have a pool, think about how much you will really use one. Also, think about the high energy used and carbon emissions that will result. Finally, think about how much money it costs to install and operate a pool. You may find that it is much better not to install a pool and instead use a community or municipal pool.

E. Space Heating

According to the American Council for an Energy Efficient Environment (ACEEE): "Heating is the largest energy expense in most homes, accounting for 35-50% of annual energy bills in colder parts of the country. Reducing your heating energy use is the single most effective way to save money and reduce your home's contribution to global environmental problems." ("Heating," ACEEE, http://aceee.org/consumer/heating.) The energy used for space heating primarily depends on where you live (a cold or mild climate), how big your house is (bigger house means more heat needed), how well insulated your ceiling, walls and ducts are, the energy efficiency of your furnace (old furnaces might be 60% efficient while you can get new furnaces up to 97.5% efficient), and how warm you need your house to be. Some of these things you can change easily and some you can't.

If you haven't purchased a house yet, consider the size of your house. A bigger house means you spend more money buying it, more money keeping it up and substantially more money (and energy) heating and cooling it. A smaller home will have a substantially lower carbon footprint. The average square footage of a new home has gone from 983 square feet in 1950 to 2,349 square feet in 2004. (Margot Adler, "Behind the Ever-Expanding American Dream House," http://www.npr.org/templates/story/story.php?storyId=5525283 (July 4, 2006). See also http://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf.) During the same period the average number of people per household went from 3.37 in 1950 to 2.63 in in 2009. (Haya El Nasser and Paul Overberg, "After 50 Years of Decline, Household Size is Growing," *USA Today*, http://usatoday30.usatoday.com/news/nation/census/2011-05-04-Census-Households-Demographics_n.htm (May 5, 2011).) Therefore, in less than 60 years the square footage of new houses has risen 139% while the number of people per household has declined by 22% all of this during a time of rapidly increasing population, carbon emissions and environmental stress.

If you are building a new house make sure the walls and attic space are well insulated. If you have an existing home, at least make sure the attic space is well insulated. Be sure to caulk around doors and windows. Also, if possible have energy efficient dual glazed windows. If your furnace is over 20 years old it may be wise to invest in a new energy efficient model. (See generally, American Council for an Energy Efficient Environment, "Heating," http://aceee.org/consumer/heating.) Finally, turn the thermostat down. Set the thermostat to no more than 68°F in the winter while you are awake. ("Thermostats and Control Systems, http://energy.gov/energysaver/articles/thermostats-and-control-systems.) In cold climates turn it down at night and when you are away. In mild climates like Southern California

turn the heat off at night and when you are away. I live in the San Diego area and usually turn the heat on two or three months out of the year and then only occasionally in the evenings and sometimes in the early morning. If you live in a cold climate you might want to consider getting a programmable thermostat.

F. Air Conditioning

Do without? Air conditioning is not as necessary as home heating. While we take air conditioning for granted today, in 1965 only 10% of homes in the United States had air conditioning. By 2007 that number was 87%. (Will Oremus, "A History of Air Conditioning," *Slate*, http://www.slate.com/articles/arts/culturebox/2011/07/a_history_of_air_conditioning.html, July 22, 2011.) Somehow people use to survive without air conditioning. I was born in 1957 and grew up in La Mesa, California just east of San Diego. The San Diego area is fortunate to have both mild winters and summers although temperatures in the 90s, and occasionally over 100, are not uncommon in summer in inland communities. My family did not have air conditioning until the early 1970s. I have also lived in La Mesa the past 26 years, most of those years without air conditioning. From elementary school through high school none of my schools had air conditioning. They instead had windows on both sides of the room that opened providing for efficient cross ventilation. While there were a few uncomfortable days each year, I don't remember any substantial hardship. Using air conditioning can raise your daily electric bill several fold sometimes without much increase in comfort. (See Tom Murphy, "Rocking the AC," Do the Math, http://physics.ucsd.edu/do-the-math/2012/09/rocking-the-ac/.) In recent years the three schools I attended growing up, as well as my local church, installed air conditioning. With diminishing energy resources and concerns about climate change, a wiser investment would have been to install solar voltaic cells instead of air conditioning.

Use less. Okay, I have to admit air conditioning is sometimes nice. Many parts of the country have really hot and/or humid summers. It's hard to be productive in a hot, humid and stuffy building. Some buildings are just two big to be well ventilated. Nevertheless, there are many things you can do to avoid using air conditioning most of the time. Set your thermostat at 78°F or above. ("Summertime Energy Tips," California Energy Commission, http://www.consumerenergycenter.org/tips/summer.html.) Open windows and let the breeze blow during the evenings and nights when it may be cooler outside. Install a whole house fan. These fans draw cool outside air to the inside of your house during the evenings and at night and push the hot indoor air outside. You can often cool your house down several degrees in half an hour. ("Whole House Fan," National Renewable Energy Laboratory, U.S. Dept. of Energy, http://www.nrel.gov/docs/fy99osti/26291.pdf.) Also, install ceiling fans. Ceiling fans do not really lower the temperature but make it feel substantially cooler primarily by removing the hot air surrounding your skin. They cool people, not buildings. The key is to turn them only when you are in the room and use them in place of the air conditioning. (See James, et. al., "Are Energy Savings Due to Ceiling Fans Just Hot Air?" Florida Solar Energy Center, http://www.fsec.ucf.edu/en/publications/html/FSEC-PF-306-96/.) In my home we have Energy Star rated ceiling fans in each bedroom. With a fan on it is

comfortable sleeping even if the room temperature is in the 80s. Fans use much less energy than air conditioners. Also, use awnings or shades to shield your house from the sun. Plant trees that will shade your house. If you are installing a new roof choose a light colored or white roof that will reflect solar radiation and keep your house cooler especially in southern climates. (See generally, "Reflective Surfaces (Geoengineering)," Wikipedia, http://en.wikipedia.org/wiki/Reflective_surfaces_(geoengineering); Arthur H. Rosenfeld, "White Roofs Cool the World Efficiently," International Energy Agency, http://www.iea.org/newsroomandevents/news/2013/april/name,36700,en.html (4/13/13 2013), "Roof Products," Energy Star, http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=RO. *But see* Samir Ibrahim, "White Roofs, Green Myth," Huffington Post, http://www.huffingtonpost.com/samir-ibrahim/white-roofs-green-myth_b_2901288.html (3/18/13) (may be counter-productive in cold climates).)

Things to do if you use air-conditioning. If you decide to use air conditioning, you may want to consider a window or wall room air conditioner to cool just one room. For example, you may just want it for the bedroom to help you sleep comfortably. Cooling one room will use a lot less energy than cooling an entire house. (See Brian Palmer, "Global Cooling: Is Central Air Conditioning More Efficient Than Window Units," *Slate*, http://www.slate.com/articles/health_and_science/the_green_lantern/2011/05/global_cooling.2.html (May 3, 2011). Also, if you live in a hot but dry climate you can use an evaporative cooler instead of an air conditioner. Evaporative coolers use much less energy than an air conditioner. ("Evaporative Cooling," California Energy Commission, http://www.consumerenergycenter.org/home/heating_cooling/evaporative.html.)

If you choose to have central air conditioning the same factors as with heating apply. The smaller your house the less electricity you will use for air conditioning. You want to make sure your house is well insulated, especially the ceiling. You will also want to make sure windows and doors are well caulked. Have energy efficient dual glazed windows if possible. If you use the air conditioner much, you may want to consider installing a new high efficiency air conditioner. ("Air Conditioning," ACEE, http://aceee.org/consumer/cooling.) Close blinds to keep the sun out. Be sure all doors and windows are closed. Set the temperature no lower than 78°. Shut the air conditioning off if you are gone. If it cools down in the evening, shut the air conditioning off, open up and turn on the whole house fan if you have one.

G. Transportation

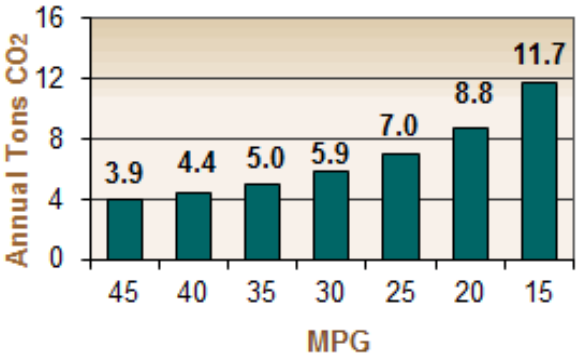
Don't Buy Into the Advertising. There are currently over 1 billion cars in the world. This number will double to over 2 billion in twenty years. (Sperling and Gordon, *Two Billion Cars: Driving Towards Sustainability* (Oxford University Press 2009). "The entire transport sector is not only the second largest consumer of energy, but it also has recently become the largest contributor to U.S. greenhouse gas emissions of carbon dioxide, topping industrial emissions in 1999, primarily due to transport's heavy reliance on petroleum products, such as motor gasoline." ("Household Vehicles Energy Use:

Latest Data & Trends," U.S. Energy Information Administration, http://www.eia.gov/emeu/rtecs/nhts_survey/2001/ (2005).) "The vehicles desired by consumers over the past 15 or 20 years have led to heavier, more powerful, and faster vehicles, equipped with increasing powerful engines, generally exhibiting unexceptional improvements in energy performance." (Id.) People buy into the television ads that lead consumers to believe they can be more sophisticated, racy, successful, sexy, rugged, powerful, or the envy of their neighbors if they just get that new, bigger, more powerful, more luxurious, faster car or truck. (*See generally* Vance Packard, *The Hidden Persuader* (Random House 1957) and Vance Packard, *The Waste Makers* (D. MaKay Co. 1960) two classic books on the effects of advertising and planned obsolescence.)

Choose Smaller and Still Meet Your Needs. Cars have given us wonderful mobility and have transformed society in the past 100 years. Pretending that they somehow define who we are is not responsible or sustainable, however. We already know how to make cars efficient and we can continue to improve efficiency. A key problem however is convincing people to buy efficient cars. We must move beyond using cars to create an image. We can have cars with all the room, comfort and power we need. We can't afford as a society to have unreasonably large, luxurious or powerful cars, however.

As I am writing this my neighbor has Ford Expedition, Explorer and Focus vehicles parked outside that represent a range of the cars available by most car manufacturers today. According to information at www.fueleconomy.gov the base models of these vehicles with two wheel drive have the following base prices and combined fuel economy ratings in miles per gallon: Expedition $40,605, 16 mpg; Explorer $32,680, 20 mpg; Focus $16,020, 31 mpg. The Focus has almost twice (100 %) the fuel economy as a Expedition at much less than half the purchase price. The Focus has 55% better fuel economy compared to the Explorer at half the price. While the Explorer and Expedition hold seven passengers while the Focus holds only five, the vast majority of families would do fine with a five passenger car. Even if you have a large family, it would be hard to justify an Expedition over the more fuel efficient Explorer. There is also a 2013 Explorer model with front wheel drive and a 2.0 L engine with 23 mpg combined fuel economy rating. As described below in the discussion of hybrid vehicles, Toyota has a seven passenger Prius car in Japan with likely a 44 mpg combined fuel economy rating.

Carefully choosing the most fuel efficient vehicle that meets your needs can have a big impact on carbon emissions that cause climate change. Fueleconomy.gov, http://www.fueleconomy.gov/feg/climate.shtml, indicates 51% of carbon dioxide emissions in a typical household are from vehicles. The better your fuel mileage, the less carbon dioxide your car emits as indicated by this chart from http://www.fueleconomy.gov/feg/climate.shtml.



Choose Smarter Vehicles – Hybrids and Diesels. Smaller cars and smaller engines generally use less fuel. You can substantially increase fuel mileage by choosing new higher tech vehicles such as hybrids. A hybrid combines a regular gasoline engine with an electric motor. You don't plug in a regular hybrid. Rather, the battery for the electric motor charges when the car is coasting or braking. The battery and electric motor then assist the gasoline engine. A smart computer controls it all. It is just like driving a regular gasoline engine car except you get remarkably better fuel economy. For example, the Ford Fusion Hybrid SE is a comfortable family car that has combined fuel economy of 42 mpg and a base price of $27,200. Another popular hybrid that has been around for over ten years is the Toyota Prius. The standard Prius gets 50 mpg combined gas mileage. My 2005 Prius has not had a single problem in almost 9 years. The hybrid batteries on Prius cars are holding up well. For example, in 2011 a Consumer Reports tested a Prius with over 200,000 miles and found no substantial degradation of the hybrid batteries. ("The 200,000 Mile Question: How Does the Toyota Prius Hold Up?" Consumer Reports, http://news.consumerreports.org/cars/2011/02/200000-mile-toyota-prius-still-performs.html (February 16, 2011). In Japan there is even a seven seat Prius Alpha similar to the recent Prius V in the United States but with a third row set. Its combined mpg would likely be around 44 – a lot better than the 16 mpg Ford Expedition discussed earlier. ("Review – Seven Seat Toyota Prius," Cellomom on Cars, http://www.cellomomcars.com/2012/06/review-seven-seat-toyota-prius.html (June 22, 2012).) Another choice is a high mileage diesel car such as the Volkswagen TDI wagon with combined mileage 34 mpg with 30 city and 42 highway.

Electric Cars. Another choice today is to choose all electric vehicles. For example, the Ford Focus comes in an all electric version. While costly at a sticker price of $39,200 (although a $7,500 tax credit is available), the Focus Electric has a mileage rating 105 mpg equivalent. (Since it uses no gasoline, the mpgE rating coverts the electricity used into what the miles per gallon of gasoline would be. One gallon of gasoline is used as the equivalent of 33.7 kW-hr of electricity.) That's remarkable. Electric cars dramatically reduce our use of petroleum. Further, to the extent the electricity to charge the batteries come from non-carbon sources such as wind, solar, nuclear or hydroelectric, driving an electric car does not contribute substantially to climate change. Electric cars currently have some problems, however, besides their high initial cost. First, the car can only go 76 miles between charges. ("2013 Ford Focus Electric," U.S. News, http://usnews.rankingsandreviews.com/cars-trucks/Ford_Focus-Electric/.) Charging takes about 3 to 4 hours with a 240 volt charger or between 18 and

20 hours with 120 volt current. A 240 volt charger is an additional $1,500. (Car and Driver, http://www.caranddriver.com/news/2012-ford-focus-electric-revealed-ford-focus-news.) Second, the longevity of the batteries is an issue. Cars like the Ford Focus Electric use a Lithium Ion battery like those used in laptop batteries. Some question the longevity of these batteries and they have not been used long enough to affirmatively answer how long they last. Nickel Metal Hydride NiMH batteries used in the Prius Hybrid have been shown to have a long life as indicated in the previous section on hybrid cars. (See "Electric Vehicle Battery," Wikipedia, http://en.wikipedia.org/wiki/Electric_vehicle_battery#Lifespan. See also Muller, *Energy for Future Presidents: The Science Behind the Headlines* (W.W. Norton & Co. 2012) (Argues for hybrids like the Prius but against Electric cars saying the Lithium Ion batteries will not last long enough.)) Third, electric vehicles still result in carbon emissions to the extent the electricity used to charge them is generated by fossil fuels. Therefore, the jury is still out on hybrids but they might be the future of cars. While I focused here on the Ford Focus, there are several electric cars on the market today. A list can be found at "Electric Car," Wikipedia, http://en.wikipedia.org/wiki/Electric_car.

Maintain Your Car and Drive Efficiently. Whatever kind of car you drive you can increase fuel economy by properly maintaining your car. For example, change your oil and oil filter on schedule. Use the recommended grade of oil. Change your air filter on schedule. Keep your tires properly inflated. Also, drive efficiently. Avoid fast starts and stops. Obey the speed limit. Avoid excessive idling. ("Gas Mileage Tips," http://www.fueleconomy.gov/feg/drive.shtml.) All of these things help your car last longer which itself can save energy and other natural resources as described next.

H. Products

A final way to conserve energy is to be careful not to buy things you don't really need. It often takes a lot of energy and natural resources to make the products we use everyday. For example, besides using gasoline or another energy source, between about 10 to 20% of the lifetime energy costs of a car are from its manufacture. (See "Life Cycle Costs for Your Car," Cellomom on Cars, http://www.cellomomcars.com/2011/10/lifecycle-energy-analysis-for-your-car.html (October 29, 2011.) Any product takes energy to get the raw products and manufacture the item. Therefore, it makes sense to buy only what you need and take care of what you have so you don't have to buy new things as often.

IV. Generate Your Own Energy – Go Solar

The choices and actions above were designed to save energy you would have otherwise used. Generally, it is hard for individuals to generate their own energy. You can't run your own coal mine and coal power plant. You can't build and run your own nuclear power plant. You can't drill an oil well in your backyard and refine it in your garage. These are expensive and complex things big companies do and governments regulate. One thing individual homeowners and small businesses can do today, however, is to install solar voltaic cells on their roofs or yards and generate their own electricity. It

is remarkably easy to do with virtually no maintenance costs. Described below are my personal experiences with adding solar cells to my home in late 2006. Most of the material here originally appeared on my Web site, Mr. Martin's Web Site, http://www.mrmartinweb.com/solar.html.

My solar voltaic system converts the sun's energy into electricity which is used at home and transferred to the electrical grid of San Diego Gas & Electric. Even with government incentives, the payback time on solar voltaic systems is still long. The prices keep coming down and the price of electricity keeps going up, however. (Alan Chen, "The Installed Price of Solar Photovoltaic Systems in the U.S. Continues to Decline at a Rapid Pace," Lawrence Berkeley National Laboratory, http://newscenter.lbl.gov/news-releases/2012/11/27/the-installed-price-of-solar-photovoltaic-systems-in-the-u-s-continues-to-decline-at-a-rapid-pace/ (November 27, 2012).) My small 12 panel, 2kW system supplies about 75% percent of our electricity over the course of a year. I'm also not putting about 6,000 pounds of carbon dioxide into the atmosphere each year that I would without the solar voltaic system.

I purchased the system in June 2006 from Costco. The price of the equipment including twelve British Petroleum (BP) Solar SX170B 170 Watt PV Modules (made in Maryland) and a PV Powered PVP 2000 Inverter (made in Bend, Oregon) was $13,710, less a $4,710 state incentive, for a total equipment cost of $9,000. Sales tax was $697.50. Installation was $2,800. I received a $2,000 federal income tax credit. The total cost to me was $10,497.50. There were no added costs. I did not deal directly with the governmental agencies except to sign some papers. The contractor dealt with the state agencies, the City of La Mesa, and San Diego Gas & Electric. It was therefore all very easy from my perspective. The installation was very neat and professional. It did take some time with all the permitting, approval of the state incentives, and scheduling with Solar Systems International, LLC, http://solarsystemsintl.com/, in Orange, CA, and the contractor, ACS Construction, LP, in Brea, CA. The system was fully installed and operational on November 10, 2006. The costs would be substantially less in 2013, but the government incentives are also lower. Therefore, I don't think the net cost would necessarily be much less in 2013. I occasionally wash off the cells off with a hose. Other than that there is no maintenance. We further do not have severe storms that could damage the solar panels. Where I live in southern California is about ten miles from the coast and gets a good amount of sun each year. I have a single story house with a large expanse of roof along the driveway that faces the southwest. Installation of the panels was therefore relatively easy.

In the year prior to the installation we used about 4,500 kilowatt hours of electricity. In the year since the installation we have used about 1000 kilowatt hours of electricity from San Diego Gas & Electricity. The system in that year will have generated about 3050 kilowatt hours. (I originally wrote as of October 25, 2007, shortly before the one year anniversary of the system going into operation. These figures therefore include some projections, but are reasonably accurate.) Our total electricity use this past year was therefore about 4,050 kilowatt hours of which the system provided about 3,050 kilowatt hours or about 75%. Our electricity bills averaged less than $10 per month. In addition to

the solar system, we did conserve more electricity than the prior year (about 4,050 kilowatt hours now vs. 4,500 kilowatt hours the prior year). I attribute this to purchasing a new energy efficient refrigerator in the summer of 2006 as well as my older son living in an apartment while at college for part of the year.

Was it worth it? Absolutely! It's an easy question. I could afford it and it was the best thing I could do to help the environment. On a personal economic level it's a closer call. We took efforts to conserve electricity in the first place. Our use of 4,500 kilowatt hours a year before the solar voltaic system compares with an average U.S. household use of 11,280 kWh per year in 2011. (U.S. Energy Information Administration, http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3.) Our monthly electricity bill was therefore was only about $50 per month. We are only saving perhaps $500 dollars per year. I would not generally invest $10,000 to make $500 per year. At that rate it would take 20 years to get my principal back. Solar panels should generally last at least 30 years. ("How Long Do Solar Electric PV Panels Last?," CAT Information Service, http://info.cat.org.uk/questions/pv/life-expectancy-solar-PV-panels.) If we had used more electricity a greater percentage of our payment would have been above the lower baseline rates offered by San Diego Gas & Electric. The marginal savings would hence be greater. Additionally, I suspect electricity costs will rise faster than the general rate of inflation and in the long run the solar system will result in an economic benefit to me. Indeed, residential electricity costs in San Diego have risen to about $.14 per kWh in 2013. I think they were more like $.10 per kWh in 2006. Finally, it does make economic sense for everyone if we were to include the costs associated with global warming, political tensions associated with petroleum use, conventional pollutants associated with fossil fuel use, the dangers inherent with nuclear energy, and the environmental problems associated with hydroelectric power generation. Most of these external costs are not reflected in current electricity rates.

The figures above do point out that the most economical line of defense is to save electricity in the first place. As indicated above, we used 40% of the average United States household use before the solar voltaic system. Part of this may reflect living in the mild climate of southern California. On the other hand, the average French household uses 6,400 kWh per year and the average UK household uses 4,600 kWh. (Lindsay Wilson, "Average Household Electricity Use Around the World," Shrink That Footprint, http://shrinkthatfootprint.com/average-household-electricity-consumption.) With effort households in the United States could achieve similar levels.

What's the future? Solar energy will never be a total solution since the sun doesn't always shine. It can be a significant part of power generation, however. While the Bell Labs discovered photovoltaic cells over 50 years ago, wide scale deployment of it is just beginning. With greater economies of scale costs continue to come down. Further, electricity prices will likely rise. It's time to get aboard. Do something for the environment. Do something for your children and grandchildren. Go solar!

V. Conclusion – What You Do Really Does Matter!

By taking reasonable steps to save energy the average American could reduce their electricity use by half. Significant reductions could be made in natural gas use for water and space heating. By choosing more efficient cars we could also significantly reduce petroleum use. All of this will significantly increase energy security and reduce carbon emissions. These are reasonable and prudent measures to take. Additionally, by installing solar panels on homes especially in the Sun Belt many households could economically use no net electricity.

A cynical view would be that what an individual does is simply a drop in the bucket and doesn't matter. That's true. How much energy I save or how much energy I generate doesn't have a significant effect on climate change, energy security or conventional pollutants. If most people operate on that belief it will be business as usual and the security of future generations will be threatened. Equally true, however, is that if most individuals act prudently to save energy and if many even generate their own electricity, then there will be change. Each of us owes it each other and future generations to take reasonable and prudent measures to save energy.

Individual actions alone will not be sufficient, although they are necessary and are the quickest and cheapest to implement. In addition to individual actions, society including industry and governments, need to generate power. Individuals can be part of that by being educated and pushing their leaders to make wise choices for energy generation that are environmentally sustainably and emit less carbon. Individuals should also accept paying for the true costs of energy including the costs imposed on society as a whole and on future generations. It is time for each of us to act responsibly.