Youth Education & Interpretation It's in Our Nature

Energy Efficiency

Usually the debate about **energy** focuses on which sources of energy are the "best", the most abundant, the cheapest, or the least impactful on the environment. All of these discussions focus on increasing or modifying the supply of energy. Often overlooked is the demand for energy. Decreasing the demand for energy can be achieved in two main ways. The activities which use energy can be decreased (very difficult and unlikely as populations grow and standards of living increase) or the efficiency of energy use can be improved. Improving **energy efficiency** means decreasing the amount of energy needed to continue the same amount of an activity. Increasing energy efficiency can be as simple as purchasing certain lightbulbs and unplugging appliances to as significant as installing solar panels and geothermal heat systems and even upgrading the **electric grid** as a whole.

Because of the ubiquity of energy consumption, small changes in consumption can have widespread and significant effects on energy use. So much so that many energy experts refer to it as the "fifth fuel" for **electricity** after **coal**, **natural gas**, nuclear, and renewables. As conventional sources of power decrease in supply and continue to pose threats to our natural resources and **renewable energy sources** remain years away from financial and baseload viability, energy efficiency is an immediate energy source which can lessen the strain on our energy resources and infrastructure.

Compact fluorescent lamps (CFLs) are one of only a few options to improve the energy efficiency of your home.

Sources and Impacts of Energy Efficiency

Buildings

We spend so much time in our homes, schools, offices, and businesses using lights, heating and cooling the air, heating water, using electronics and appliances and more that there is a large potential to increase efficiency. Considered together, the residential and commercial energy sectors account for more than 39 percent of energy consumption nationally and more than 50 percent of energy consumption in Missouri. The average American utility customer uses 10,932 kilowatt-hours of electricity each year, three times higher than average world household electricity consumption. Further, 60 percent of Missouri homes were built prior to 1980, with a significant portion being built even before 1950. Homes built before 1980 are 14 percent less energy efficient and homes built before 1950 are 44 percent less energy efficient than buildings built after 2000.

Identifying sources of energy inefficiency in a home can save families a lot of energy and money.

Increased energy efficiency in homes and businesses can be accomplished with small or large improvements, all having significant impacts. At a smaller and easier to implement scale, making energy consumption choices more efficient is the simplest place to start (see "Quick Tips for Saving Energy" at the end of this article). There are also energy efficient choices to make when purchasing appliances, electronics, and other goods for buildings. According to the U.S. Department of Energy, during the next decade LED light bulbs by themselves have the potential to save as much energy as 44 large power plants and $30 billion.

At a larger scale, major energy efficiency improvements may take a more committed investment in time, money, and planning, but ultimately have the greatest eventual effects on energy consumption. Installing **distributed energy generation** resources such as **solar photovoltaics**, **wind power systems**, and **geothermal energy systems** during new building construction or remodeling decrease energy consumption and in some cases can even move buildings closer to zero net energy consumption—when the energy consumed by a building is completely offset by the energy it

The Lewis and Clark State Office Building in Jefferson City utilizes passive solar design like these light shelves, among other methods, to increase energy efficiency.

generates. There are dozens of zero net energy buildings currently in the U.S. with close to 200 total projects considered close and moving towards zero net energy, a number that has more than tripled from 60 to 191 since 2012. Energy efficiency often relies on building design, as well. **Passive solar design** utilizes windows, walls, awnings, landscaping, and other features specifically placed to capture and retain the Sun's heat in the winter to reduce heating needs and to block the Sun's heat in the summer to reduce cooling needs. Utilizing sunlight during the day also reduces the needs for electric lights. Tests conducted by the National Renewable Energy Laboratory indicate that passive solar design buildings use up to 50 percent less energy to heat than conventional buildings and often do not cost much more than regularly designed buildings.

The Federal government is the largest owner of buildings in the U.S., and state governments are often the largest owner of buildings in their respective states. Both have taken the lead in recent years in efforts to increase energy efficiency. The Lewis and Clark State Office Building is an example of a building designed using energy efficiency principles. Certified LEED Platinum (considered the highest rating of environmental building design from the U.S. Green Building Council), the Lewis and Clark State Office Building utilizes passive and active solar energy, energy and water efficient lighting and plumbing, sustainable construction materials, and even more features in creating a building which uses half as much energy as other Missouri state office buildings.

Transportation

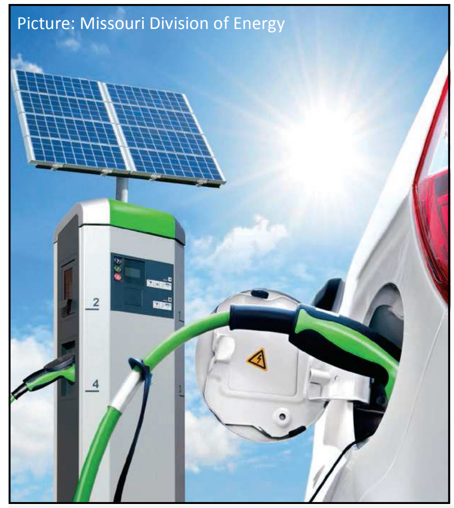
Increasing energy efficiency with regards to transportation generally refers to decreasing the demand for petroleum. The U.S. consumes 19.4 million barrels of oil a day, with 9.4 million of those barrels being imported (just under 50%). In Missouri the transportation sector is close to the largest energy consumption sector, consuming 330 thousand barrels of oil a day, the equivalent of each individual citizen consuming 20 barrels of oil a year. This level of consumption cost a total of $17 billion in 2014 and released over 52 million metric tons of CO_2.

Just like electricity consumption behavior in homes and businesses, changes in transportation habits can increase energy efficiency. Simple changes such as carpooling, taking public transportation, walking and biking more, combining trips, avoiding congested traffic, and utilizing mass transit for longer trips are easy for almost anyone to make and can decrease the 70.6 billion miles Missourians drive a year. At a larger scale, some measures that would take more coordination and investment might include purchasing vehicles with higher fuel efficiency or even electric, natural gas, **biofuel**, or hybrid vehicles. Aggressive efforts by the Federal Government have established the goal of doubling the fuel efficiency of cars driving on American roads by 2025. According to the White House, an increase of transportation efficiency of this magnitude would reduce oil consumption by 12 billion barrels and save around $1.7 trillion in gasoline purchases.

Flexible-fuel cars can use E85 fuel which is made partially from corn.

Industry and Agriculture

The industrial sector is responsible for the greatest amount of energy consumption in the U.S. which hit 31.6 quadrillion BTU in 2014. Petroleum refining and chemical production make up more than half of industrial energy consumption. International Energy Agency estimates place potential industrial energy savings at 26 joules/year (the amount of energy in over 850 million tons of coal or the combined energy consumption of China AND the U.S.). Increasing industrial energy efficiency primarily means making individual components and materials of a manufacturing process slightly more efficient. These small changes translate to major reductions in industrial processes which tend to be very energy intensive.



The availability of alternative fuel stations is a limiting factor when driving an alternative fuel vehicle.

Another potentially major source of energy efficiency in the industrial sector is the **combined heat and power** (CHP) **system**. CHP systems use the large amount of waste heat produced by distributed electricity generation at factories, power plants, and similar sites to power heating, cooling, and even additional industrial processes making the entire system sometimes 30 percent more efficient than separate heat and electricity generation. A U.S. DOE report identified 2,500 MW of potential CHP power in Missouri primarily in commercial buildings, food processing, chemical manufacturing, and colleges and universities.

Agriculture can also be energy intensive. In 2012 the agricultural industry consumed 800 trillion BTU primarily for operating heavy machinery, pumping water, and drying crops, with an additional 350 trillion BTU for fertilizer production. Significant savings, estimated above $1 billion, can be achieved by pursuing energy efficiency on farms—of which Missouri has quite a few. This can be done by using more fuel efficient or alternative fuel heavy machinery for planting, harvesting, tilling, and spraying, more efficient irrigation methods, limiting fertilizer use by using cover crops, natural fertilizers like manure and compost, pest preventing plants, and crop rotations, and by increasing renewable energy production on farms through solar, wind, and **biomass** and biofuels. There are close to 100,000 farms in Missouri operating 28 million acres of land which presents a major opportunity to increase energy efficiency.

Grid Modernization and Net Metering

Electrical grid modernization is an emerging and rapidly advancing concept in energy referring to the process of investing in, improving, and updating the infrastructure which provides our electricity. Modernizing the grid has the potential to make the entire process from generation to consumption more efficient. The primary method of grid modernization consists of building up the "smart grid". The smart grid utilizes technologies like advanced meters on people's homes and in individual products (like appliances) which can track, communicate, and even alter energy use for consumers, as well as installing networking features on electricity generation, transmission, and distribution infrastructure. These smart technologies are able to communicate with each other to provide better real time data to the energy industry, regulators, and consumers and to find ways to automatically decrease energy consumption, increase the reliability of the grid, better integrate renewable energy sources, and protect the grid from potentially threatening conditions such as adverse weather or even terrorism. One benefit of advanced metering technology is the ability to more easily expand net metering capabilities. Net metering occurs when energy consumers install their own energy generation systems (often solar panels or **wind turbines**) and produce power which can be sent back to the larger electrical grid when not needed by the individual. The "net" part of net metering refers to the process of crediting consumers for the energy they provide back to the grid, thus establishing a powerful incentive for consumers to harness more of the small-scale generation potential at individual sites and reducing the demand on centralized generation systems.

Due to rural locations and ample space, farms have a great potential to use energy more efficiently and generate more of their own with renewable technologies, such as this barn with a rooftop solar array.

Difficulties of Achieving Energy Efficiency

Besides requiring an extra level of thought and planning to institute energy efficiency measures, there are sometimes larger barriers which make accessing increased energy efficiency difficult. Often, the simplest reason is that energy efficiency initially costs more. Rooftop solar arrays and geothermal pumps often take five to ten years to yield net savings, and for many consumers this is not an option. Not only do larger technologies cost more, but even comparing energy efficient light bulbs and appliances next to more conventional models can cause cost conscious consumers to opt for the less-efficient products.

The standard electric meter tracks consumption for building owners and utility companies.

When considering many alternative fuel vehicles, aside from higher initial cost, the availability of refueling stations can pose a challenge that many consumers deem not worth it, especially as gasoline prices remain relatively low. There are about 168,000 conventional gas stations in the U.S. while there are only about 900 public compressed natural gas stations, 14,000 electric charging stations, 185 biodiesel stations, and 2,800 ethanol stations. All public alternative fuel stations added together only equal about 13 percent of conventional stations. Drivers can be certain that they will find a gasoline station almost anywhere they travel, but they would have to be much more careful with an alternative fuel vehicle. Considering the long term investment that a vehicle poses and the number of conventional options, it is not surprising that an alternative fuel vehicle would be ruled out very quickly based upon this criteria.

The other major barriers to improving energy efficiency deal with the political and regulatory aspects of energy policy. Government subsidies, tax rebates, and research initiatives are often one of the most effective ways to more quickly bring energy efficient products to the competitive market. Critics of these programs assert that political agendas are driving artificial price management of energy efficient technology and suggest that allowing supply and demand to sort out which products are financially viable is the more efficient way to manage the energy market. This debate often leads to polarizing political arguments.

The regulatory difficulty with energy efficiency is that a majority of **electric utilities** are compensated based on the amount of electricity they deliver to consumers. Increased energy efficiency means that utilities will not be providing the same amount of energy to consumers and will likely lose money, so they have little incentive to pursue efficiency. One method of fixing this problem is referred to as "decoupling" where the amount the utilities are paid is no longer determined by how much electricity they provide and instead is based on other measures. A common form of decoupling is known as performance based ratemaking, where utility companies are compensated based upon conditions such as better customer service, more reliable energy supply, and increased energy generation through alternative renewable sources. Ultimately, consumer choices, political will, and technological advances will determine which methods of energy efficiency become more widespread and how effective they actually are moving forward.

The Future of Energy Efficiency in Missouri

Missouri has taken steps in the past to increase energy efficiency. In 2009 the Legislature passed the Missouri Energy Efficiency Investment Act which created utility efficiency programs that were renewed last year. Also in 2009, Governor Nixon signed an executive order mandating that state agencies reduce energy use by two percent every year for ten years. As of 2015 that initiative has exceeded goals and reduced Missouri government energy consumption by over 22 percent. However, in a 2015 report by the American Council for an Energy Efficient Economy Missouri was ranked 44th in the U.S. for energy efficiency and it was suggested that there was a potential to enact more stringent transportation, appliance, and building efficiency standards and to create a better structure for utility-scale efficiency programs.

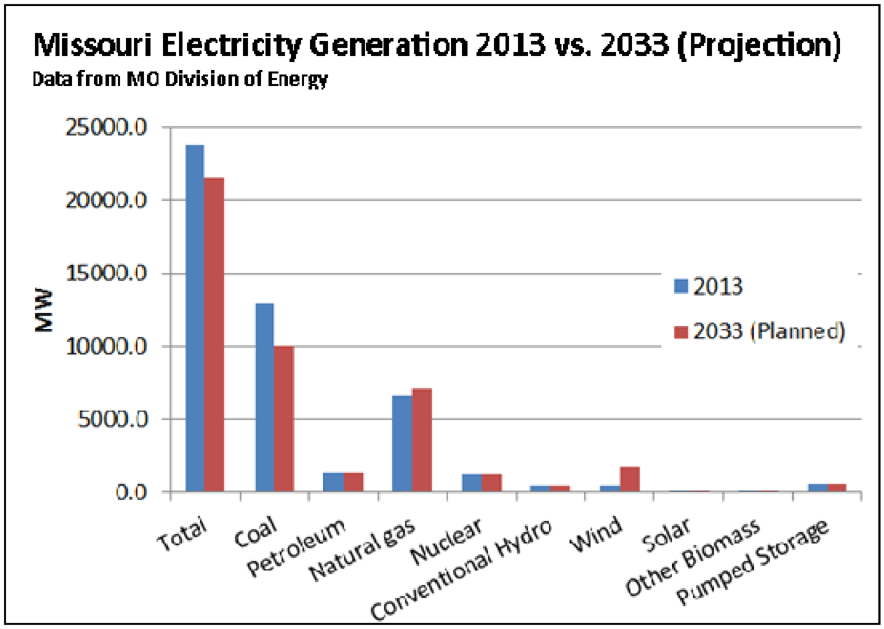
Energy efficiency has been identified as the most cost effective way of providing more energy to Missouri. By 2033, electrical generation in Missouri is expected to decrease overall by about ten percent (see chart). Five percent of this decrease will be from energy efficiency. The greatest potential for energy efficiency improvements come from buildings and homes. While large-scale changes can and will likely be made, it will also be necessary for Missouri citizens to increase the efficiency of their individual energy consumption through some of the suggestions listed in this article and the attached tip sheet (see final page), to decrease energy consumption and help protect our natural resources.

Glossary of Terms

Biofuel: Liquid fuels such as biodiesel and ethanol derived from plant sources

Biomass: Any plant or animal matter; can be used as fuel especially as crop waste, wood, grasses, paper waste, and other plant material

Coal: A solid fossil fuel mined from the Earth's surface and underground which is often used to produce electricity through combustion. There are several different qualities of coal including anthracite, bituminous, and lignite



Combined heat and power system: The capture and subsequent utilization of the large amount of waste heat produced by distributed electricity generation at factories, power plants, and similar sites to power heating, cooling, and even additional industrial processes making the entire process more efficient

Distributed energy generation: The use of small localized power production systems to generate electrical power usually for a specific on-site application and sometimes to the larger electric grid. Solar photovoltaic systems and wind power systems are common distributed energy generation methods

Electric grid: The network of power plants, transmission and distribution lines, transformers, substations, and control centers that deliver and monitor electrical power from generation to consumption

Electricity: The flow of electrical power or charge. A commonly used secondary energy source

Electric utility: An organization that is responsible for reliably providing electricity to consumers in a certain area. Electric utilities might be investor owned utilities (IOUs), electric cooperatives, or municipal public utilities

Energy: The ability to do work

Energy efficiency: The ability to do an equal amount of work with a lower input of energy or the ability to do a greater amount of work with an equal input of energy

Geothermal energy systems: The utilization of the constant temperature of the Earth's crust to heat water and air as well as warmer temperatures deeper underground which can be used to heat water to steam to operate turbines and general electrical power. Can be used in the form of hydrothermal, direct use, or heat pump systems

Natural gas: A fossil fuel gas which can be recovered from underground and combusted as a fuel source. Increasingly used to generate electricity

Passive solar design: Architecture, landscaping, and other design methods which capture and utilize solar thermal and radiant energy to naturally heat and light homes

Renewable energy source/fuel: Primary energy source that can be replenished at an equal or greater rate to its consumption; sustainable energy source

Solar photovoltaic systems: Solar energy system in which solar light energy in the form of photons passes through glass and hits a semiconductor which then excites and displaces electrons which are conducted into an electrical current to generate electrical power

Wind power systems: Technology which utilize the kinetic energy of moving wind to power turbines to generate electrical power

Wind turbine: Wind energy conversion device that produces electricity; typically three blades rotating about a horizontal axis and positioned up-wind of the supporting tower

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