Future Energy Trends

Distributed Generation

Distributed energy generation or "micropower" systems refer to 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**. The United States currently relies on large centralized power stations and an extensive electric grid that relays electrical power over long distances to millions of end users. The rapidly decreasing cost of more developed **energy** technology like **solar photovoltaics** and small-scale **wind turbines** along with developing technologies such as **fuel cells** make distributed generation increasingly economical. These systems can reliably generate power at levels as low as one kilowatt. Most commercial applications require no more than 1-10 kilowatts and "micro-power" systems offer better scale of application than large centralized power systems. Continued technological advances in micro-power systems are likely to accelerate the trend of downsizing power generating systems.

Characteristics of Distributed Generation

- Micro-power systems are modular allowing units to be added or removed to match the energy demand.
- The systems can offer a high quality constant voltage which is critical for our increasingly electronically-driven society.
- Micro-power systems can be less susceptible to interruptions in supply that can sometimes arise from centralized power systems (California brownouts in 2001).
- These systems promote a more diverse, renewable energy-based mix that can readily take advantage of resources specific to a region such as wind power in the Central U.S. and solar power in the Southwest.
- Micro-power systems facilitate **combined heat and power systems** where "waste" heat from the electrical power production system (such as a gas micro-turbine) is used to provide space heating needs, heat water or to provide heat for a manufacturing processes. Such cogeneration strategies can result in significant energy savings and help conserve resources by producing only the amount of power required directly at its point of application.
- The trend towards distributed generation also reduces the need to expand or upgrade current power distribution lines and can be configured to meet local needs more precisely.
- Fuel cells and micro-turbine systems can be highly technical, are often computer controlled and make home maintenance impractical.
- Electrical power is still often least expensive when purchased from a large utility power plant.
- Environmental emissions from multiple small on-site power systems can present regulatory challenges.

Hydrogen

Hydrogen is the most abundant element in the universe. The heat from **combustion** of hydrogen is two to three times greater than other fuels and the byproduct of burning hydrogen is simply water. Hydrogen can be produced from petroleum products, natural gas or can be generated using an electric current to "split" water. Hydrogen can be used in most applications where natural gas is used and the same infrastructure could be adapted to carry hydrogen. Hydrogen can be used to generate electrical power using fuel cell technology to provide residential and commercial electrical needs. Hydrogen driven fuel cells can also be used in motor vehicles replacing fossil fuels for transportation needs. Almost every automobile manufacturer has conducted fuel cell research program s and several test fleets are currently out with a few commercial options. Expectations for a hydrogen future are lower than previously thought, but research and development is still occurring. A sustainable energy cycle could be implemented using hydrogen produced from renewable energy sources. A similar distribution system was developed for gasoline and natural gas in the 1930's and much of this system could be adapted to deliver hydrogen. Hydrogen is an ideal candidate to replace fossil fuels promising to be a clean burning, convenient source of power dependent upon technological advancements.

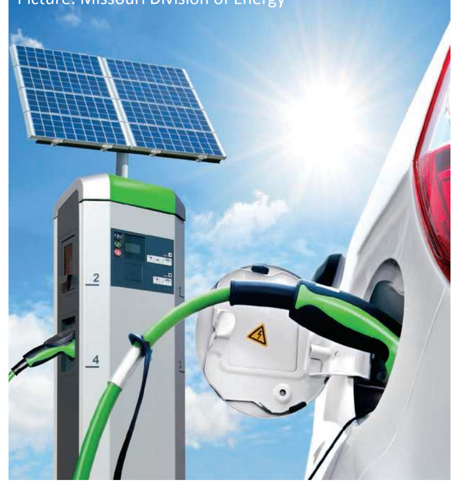
Fuel Cells

A fuel cell is an electro-chemical device that converts **chemical energy** of fuels such as hydrogen, methane, gasoline, methanol or propane to **electrical energy**. Fuel cells are designed to extract electrons from the fuel source and provide a continuous electrical current. Essentially a fuel cell is a battery that is constantly refueled. Because no combustion takes place, fuel cells do not produce the pollution associated with a traditional power systems and are significantly more efficient. Fuel cells can be sized for any given application from a handheld radio to a system large enough to provide on-site electrical power for a homeowner or business. Fuel cells often run on gases such as hydrogen or methane or they can be designed to strip hydrogen from more complex fuel sources such as methanol or gasoline.

Nuclear Fusion

The heat of our Sun is basically the result of a massive set of on-going **nuclear fusion reactions**. The process is so intense that you can step outside on a sunny day and feel the heat from these nuclear reactions even though the Sun is more than 80 million miles away. The Sun's gravitational forces and immense heat are so intense that the nuclei (center) of millions of hydrogen atoms are continuously being combined.

Currently, scientific teams are working on ways to create fusion-type reactions for our own power needs. This would be an attractive source of power because many of the radioactive byproducts and disposal problems associated with more conventional **nuclear fission reactions** would be eliminated. Scientists have been able to create and briefly sustain fusion reactions, but the amount of energy required to create even a small reaction in the laboratory is greater than the energy gained from the event. Estimates put the achievement of commercially-viable reactors at sometime in the 2040s with commercial use of fusion following soon after. If scientists can determine a practical way to maintain and harness fusion this may be a very attractive energy source indeed.


Picture: Missouri Division of Energy

Alternative Fuel Vehicles

Unlike electric cars that run on batteries, **hybrid electric vehicles** (HEVs) do not need to be plugged in for a recharge. Car batteries are recharged using inertia and the force generated during braking. A small traditional gasoline engine is used during higher speeds and the battery driven electric motor is used at lower speeds (usually below 25 mph). As a result these cars get their best gas mileage in city driving where drivers brake more and speeds are lower. The Toyota hybrid (four passenger Prius) gets an average of 50 miles per gallon and the Honda hybrid (two passenger Insight) gets an average of 65 miles per gallon. Many other car companies have developed similar technologies and are increasing market share.

Greater development has been made in recent years with other alternative fuel vehicles such as biofuel and biodiesel, liquid and compressed natural gas, and completely electric vehicles. Ethanol production has increased by 739 percent since 2000 and more than 90 percent of U.S. gasoline is now blended with ethanol. Biodiesel is produced in much smaller total quantities, but has still increased by over 1000 percent from nine million gallons in 2001 to 967 million gallons in 2012. There are now 900 public compressed national gas stations and 14,000 electric vehicle charging stations along U.S. roadways.

Glossary of Terms

Chemical energy: The potential energy released by breaking the bonds in molecules

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

Combustion: A high-temperature chemical reaction resulting from the combination of a fuel with oxygen which releases carbon dioxide and water mixed with other substances (smoke) as well as thermal and light energy

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

Electrical energy: Kinetic energy as a result of moving electrons

Electrical power: Electrical energy used to conduct work; the measure of the rate of electrical energy used by a circuit. This is usually measured using a unit called a Watt (W)

Energy: The ability to do work

Fuel cell: An electro-chemical device that converts chemical energy of fuels such as hydrogen, methane, gasoline, methanol or propane to electrical energy by extracting electrons from the fuel. Essentially a fuel cell is a battery that is constantly refueled.

Hybrid electric vehicles: Vehicles which are powered by conventional combustion engines at higher speeds and use electric batteries recharged by inertia and braking force at lower speeds to increase fuel efficiency.

Nuclear fission reactions: The process of breaking apart the nuclei of atoms through chain reactions to release potential energy

Nuclear fusion reactions: The process of combining the nuclei of atoms to release immense amounts of energy

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

For more information:
DNR Youth Education and Interpretation
P.O. Box 176
Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 522-2656 office
e-mail: naturalresources.ed@dnr.mo.gov
http://dnr.mo.gov/education

MISSOURI DEPARTMENT OF NATURAL RESOURCES