Kilowatt Hours is used as a unit for energy. The energy calculation is the same, except that hours are substituted for seconds and kilowatts (**kW**) are substituted for watts.

Electricity meters measure the energy used in kilowatt hours and then bills you for every kilowatt hour used.

Law of Conservation of Energy

Energy is neither created nor destroyed. It doesn't appear and then disappear, but transformed from one form to another. **No device is able to be 100% efficient in transforming energy**.

Most often, the energy is lost, or dissipated as **heat**. Mechanical systems also dissipate energy to their surroundings, but not as obvious as the heat loss. Much of the dissipated energy is **sound**.

Understanding Efficiency

The **efficiency** of a device is the ratio of the useful energy that comes out of a device to the total energy that went in. The more input energy converted to output energy, the more efficient the device is.

Efficiency = Joules of useful output x 100%
Joules of input energy

Most of the energy transformed in a light bulb is waste heat. (5% is **light** , while 95% is **heat**)
Florescent lights are about 4x more efficient than incandescent lights.
Arc-discharge lights are even more efficient (streetlights)

Comparing Efficiencies

Comparing efficiencies of devices the energy cost and their environmental impact can be determined. **Hybrid gasoline-electric** vehicles are more efficient than gas-powered vehicles.

Reducing Energy Waste

Devices, which have an **energy-efficient design**, are an important consideration for the consumer, because these devices use less electricity.

Limits to Efficiency - Electric heater come very close to being 100% efficient, but devices, which convert electricity to other forms, can never be 100% efficient. Some energy is lost, or dissipated in a form that is not useful output. Friction causes thermal energy to be lost, or dissipated in many devices.

Increasing Efficiency - of a device depends on its purpose. The easiest way to increase efficiency in many devices is to **reduce friction**, as much as possible. **Insulating** a device from heat loss is also another practical way to increase efficiency. Using **capacitors** in electrical circuits is also another way to increase efficiency.

Energy Sources and Alternatives

Burning **fossil fuels** generates 65% of electric power.

Renewable & Nonrenewable Energy

Coal is a **non-renewable** resource (it cannot be replaced, as it is used up). Other **fossil fuels** are non-renewable as well. **Renewable resources** can be replenished over and over again. These types of resources include; **wind energy**, **solar energy**, **tidal energy**, **biomass energy**, **geothermal energy**. **Tree harvesting** can also be renewed, but it takes a much longer period of time to renew this resource.

Using Water to Generate Electricity

Hydro-electric power plants generate 20% of the world's electricity. **Gravitational energy** is transformed into electrical energy.

Coal is mined, crushed into a powder, blown into a combustion chamber and burned to release heat. This heat boils water and superheats the resulting steam to a high temperature and pressure, which then turns a **turbine**. The turbine shaft rotates large electromagnetic coils in the **generator** to produce electricity. In a **nuclear reactor**, atoms of a heavy element, usually uranium, are split (**nuclear fission**) in a chain reaction, which releases an enormous amount of energy. Heat from the Earth's core - **geothermal energy** (hot water and steam) is channeled through pipes to drive turbines - connected to generators, which produce the electricity. **Biomass** is another type of fuel used to generate electricity. The gases produced from the decomposition of garbage in landfills can be used as fuel for stem-driven generators. Waste heat from many industrial processes is used to produce steam generated electrical power. This process is called **cogeneration**.

Alternative Energy Sources

Tides - moving water can power turbines, which then run generators. When the tide comes in, the water is trapped in large reservoirs and then allowed to flow out past turbines.

Wind - this energy is harnessed by large propeller-type blades, which turn a shaft - connected to a generator.

Sunlight - **Solar cells** (made from silicon) enable the energy from the sun to be transformed (**photoelectric effect**) into electricity.

Batteries - from small portable batteries to rechargeable and most recently to the **fuel cells** all provide an electrical source by using chemical reactions within the cells.

Electricity and the Environment

The burning of fossil fuels to generate electricity releases: **Fly ash**, from the burning of coal, is carried up the smokestack and released into the atmosphere.
Sulfur Dioxide (SO_2) - causes acid rain
Nitrogen oxides (NO) - causes air pollution
Carbon dioxide (CO_2) - is the cause of global warming.

Other Environmental Effects

Strip-mining techniques removes all plants and animals from large areas of land - habitat and species destruction.
Oil and Gas wells can often give off poisonous gases.
Steam turbines often release warm water into nearby lakes and rivers – thermal pollution
Mines and refineries produce nuclear fuel and radioactive waste.
Dams, **wind farms** and **solar cell arrays** destroy large areas of ecological habitat.
Tidal power plants disrupt fish habitat and other marine life.

Fossil fuel reserves are decreasing, but with less reliance on these fuels we will be able to see a decrease in pollution. Conserving energy can be accomplished a little at a time.
Sustainability means using resources at a rate that can be maintained indefinitely. If sustainability is not achieved, future generations will suffer. A sustainable approach often means a different way of getting what you want. Personal decisions can affect sustainability, even if it seems like it's only on a small scale. More technology means more resources are needed to manufacture and operate them, making sustainability more difficult to achieve. Electrical signals from computer to computer throughout the world, makes the storage and transmission of information compact, easy and cheap. Concerns include; access, privacy, safety, misleading or false information and the 'information explosion' has created other storage, handling and access problems. Search engines may locate some of the information, but they cannot access everything.

Electrical Technology and Society

Benefits - improved our standard of living. Most improvements have come as a result of a desire to improve speed, efficiency or convenience.
Drawbacks - obsolete devices become waste, adding to our problems of waste disposal. Some technologies are too expensive for some countries to adopt, leading to isolation and exclusion.
Computers and Information - revolutionized the way we accomplish many tasks, including writing, calculations and communications, leading to the digital technology era.
Electricity and Computers - Lasers, photo-detectors, and electrical pulses all enable electronic devices to complete the tasks they are made to do. A computer hard drive - uses electrical pulses to record and transmit information, sent to an arm with read and write heads, which are magnetic coils that magnetize spots on the spinning disk.