



Drexel-SDP GK-12 LESSON

Lesson: Alt. Energy & Green Homes

Subject Area(s) Science and Technology

Associated Unit Environments, module 4

Lesson Title Lesson: Green Homes

Grade Level 6 (4-8)

Lesson # 3 of 5

Lesson Dependency None.

Time Required 40 minutes

Heading



Image 1

ADA Description: Picture shows a surveyor on a wind farm

Caption: A surveyor on a wind farm

Image file name: windfarm3.jpg

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Summary

World statistics paint a frightening picture. 1992 World Energy consumption, as measured by USEIA, is as follows: Oil 38 %, Coal 26 %, Gas 22 %, Hydro 7 %, Nuclear 6 %. It is immediately noteworthy that almost 90 % of the consumed energy of the world came from non-renewable, fossil fuels.

Students and all community members can engage in small, everyday activities that can have a meaningful impact on improving energy efficiency in a household, and reduce energy usage nationwide. This lesson reviews some sources of renewable and non-renewable energy, and concludes with a discussion of ways to improve energy efficiency in the home.

Engineering Connection

Electrical engineering and power engineering address the generation, storage, and distribution of electrical power to our homes and businesses. The many choices for the source of electrical power generation are ultimately selected by consumer demand. If the customer makes demand for cleaner sources of energy, and energy generated from renewable resources, then the supply will increase and the costs of such energy will decrease. Electrical and power engineers are continuously working toward ways to make electrical power generation, independent of its source, more efficient, that is, to generate more electricity for the same amount of resource.

Keywords

Alternative energy, energy efficiency, fossil fuels, renewable resources

Educational Standards (PA)

- Environments and Ecology: Renewable and nonrenewable resources 4.2.A. Uses, 4.2.B. Availability, 4.2.C. Management, 4.2.D. Influential factors
Environmental Health 4.3.A. Environmental health issues, 4.3.B. Human actions, 4.3.C. Biological diversity
Humans and the Environment 4.8.A. Societal needs, 4.8.B. Sustainability, 4.8.C. Human impacts, 4.8.D. Supply and demand
- Science: Technology Education – Science, Technology and Human Endeavors – Meeting Human Needs 3.8.B, Science, Technology and Human Endeavors – Consequences and Impacts 3.8.C
- Math: Computation and Estimation 2.2

Pre-Requisite Knowledge

None.

Learning Objectives

After this lesson, students should be able to:

- **Give three examples of renewable energy sources**
- **Describe what a non-renewable energy source is**
- **Name three ways that households can improve their energy efficiency**

Introduction / Motivation

Right now, we are used to plugging in our electronic devices (computers, cell phones, games) into the wall and forgetting about how they get their charge. Do you think our current sources of

energy could ever run out? Guess what, they can! Also, do you think energy could ever become so expensive that only movie stars and very rich people could afford it in big quantities? Guess what, it can! In this activity, we will learn a little bit about where our energy comes from, before it is sent to our homes to come out of the wall sockets. We will challenge you to think like an engineer and identify other sources of getting energy to power our homes and favorite electronics so that we never run out.

(World statistics paint a frightening picture. 1992 World Energy consumption, as measured by USEIA, is as follows: Oil 38 %, Coal 26 %, Gas 22 %, Hydro 7 %, Nuclear 6 %. It is immediately noteworthy that almost 90 % of the consumed energy of the world came from non-renewable, fossil fuels.)

Lesson Background & Concepts for Teachers

Ask the students to take notes on the types of alternative energy and their pros and cons.

Hydroelectric power:

Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. In this case the energy extracted from water depends on the volume and on the difference in height between the source and the water's outflow. The amount of potential energy in water is proportional to this height difference.

Pumped storage hydroelectricity produces electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir. When there is higher demand, water is released back into the lower reservoir through a turbine. Pumped storage schemes currently provide the only commercially important means of grid energy storage.

Pros:

- Provide a means to store energy
- Renewable resource/ non-fossil fuel
- Low emissions/ carbon dioxide production
- Long life of the plant
- Low operating costs
- Recreational benefits and possible flood control

Cons:

- Disruption to habitat

Loss of downstream silt, added erosion

Exiting water has low oxygen

Exiting water is colder

Disrupt salmon spawning, disrupts the path of migratory birds

Some carbon dioxide emission from decaying submerged material

Population relocation

Dam failures

Wave power:

Wave power refers to the energy of ocean surface waves and the capture of that energy to do useful work - including electricity generation, desalination, and the pumping of water (into reservoirs). An object bobbing up and down in the waves will generally follow an elliptical path, which can be harnessed as mechanical energy and turned into electrical energy.

The potential energy of a set of waves is proportional to wave height squared times wave period (the time between wave crests). Longer period waves have relatively longer wavelengths and move faster. The potential energy is equal to the kinetic energy (that can be expended). Wave power is expressed in kilowatts per meter (at a location such as a shoreline).

Formula: Power (in kW/m) = $k H^2 T \sim 0.5 H^2 T$,

where k = constant, H = wave height (crest to trough) in meters, and T = wave period (crest to crest) in seconds.

Pros:

Renewable resource

Available to any country with a coastline

Zero emissions

Cons:

Low velocity, high force from all directions (most converters want high velocity, low force)

Salt water is corrosive

High startup/maintenance costs

Lots of potential for storm damage

Wind power:

Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In windmills (a much older technology), wind energy is used to turn mechanical machinery to do physical work, such as crushing grain or pumping water.

An estimated 1% to 3% of energy from the Sun that hits the earth is converted into wind energy. This is about 50 to 100 times more energy than is converted into biomass by all the plants on Earth through photosynthesis. Most of this wind energy can be found at high altitudes where continuous wind speeds of over 100 mph occur.

The origin of wind is complex. The Earth is unevenly heated by the sun resulting in the poles receiving less energy from the sun than the equator does. Also, the dry land heats up (and cools down) more quickly than the seas do. The differential heating powers a global atmospheric convection system reaching from the Earth's surface to the stratosphere which acts as a virtual ceiling.

Since wind speed is not constant, a wind generator's annual energy production is never as much as its nameplate rating multiplied by the total hours in a year. The ratio of actual productivity in a year to this theoretical maximum is called the capacity factor. A well-sited wind generator will have a capacity factor of about 35%. This compares to typical capacity factors of 90% for nuclear plants, 70% for coal plants, and 30% for oil plants.

Pros:

- Renewable resource/ non-fossil fuel
- Low emissions/ carbon dioxide production
- Low operating costs

Cons:

- High capital investment
- Noise made by turbines
- Vibrations made by turbines may disturb marine life
- Inconsistent output
- Relatively low productivity (35%)

Solar power:

Solar power is the technology of obtaining usable energy from the light of the sun. Solar energy has been used in many traditional technologies for centuries, and has come into widespread use where other power supplies are absent, such as in remote locations and in space.

A recent concern is global dimming, an effect of pollution that is allowing less sunlight to reach the Earth's surface. It is intricately linked with pollution particles and global warming, and it is mostly of concern for issues of global climate change, but is also of concern to proponents of solar power because of the existing and potential future decreases in available solar energy. The order of magnitude is about 4% less solar energy available at sea level over the timeframe of 1961-90, mostly from increased reflection from clouds back into outer space.

Pros:

- Renewable resource/ non-fossil fuel
- Pollution free
- Low operating costs

Cons:

- High capital investment
- Noise made by turbines
- End-of-life recycling issues for photovoltaic cells
- Inconsistent output
- Low power density (7-19%)
- Must be converted to A/C energy for most uses

Geothermal power:

Geothermal power is the use of heat from the Earth to generate electricity. Geothermal comes from the Greek words geo, meaning earth, and therme, meaning heat. Iceland get over 50% of its energy from geothermal power sources.

Three types of power plants are used to generate power from geothermal energy: dry steam, flash, and binary. Dry steam plants take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator. Flash plants take hot water, usually

at temperatures over 200 C, out of the ground, and allows it to boil as it rises to the surface then separates the steam phase in steam/water separators and then runs the steam through a turbine. In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine. The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat. This is why geothermal energy is viewed as sustainable. It is the second fastest growing power industry. The Earth's heat is so vast that it is possible to take only a small fraction of it, and still sustain the world, even assuming only geothermal energy is used as a source of energy.

Pros:

- Low capital cost
- Low operating cost
- Low emissions

Cons:

- Can exhaust the hot water source at certain sites (plant too big capacity)
- Not strictly non-renewable
- Not all locations viable

Nuclear power:

Nuclear power is the controlled use of nuclear reactions to release energy for work including propulsion, heat, and the generation of electricity. Nuclear energy is produced by a controlled nuclear chain reaction and creates heat-which is used to boil water, produce steam, and drive a steam turbine. The turbine can be used for mechanical work and also to generate electricity. As of 2004, nuclear power provides 6.5% of the world's energy and 15.7% of the world's electricity.

The term "nuclear power" is generally used to mean fission reactors (striking and splitting enriched substance to make a new, less dense substance and free neutrons as energy), which are the type of reactors that are currently used to generate electricity and power naval vessels. Fusion reactors are also a type of nuclear power, however the term "fusion power" or "fusion reactor" is used instead.

Pros:

- Low emissions
- Uranium is as plentiful as zinc and aluminum
- High productivity (attack, using waste for weaponry)

Cons:

- Safely disposing of radioactive waste
- Plant failures
- High capital cost
- Vulnerability to attack

Vocabulary / Definitions

Word	Definition
Renewable resource	Renewable energy resources are those that will be available to us forever.
Non-renewable Resource	Resources that once they are used, they are permanently depleted.
Fossil fuels	Oil, coal and natural gas that originates from decayed plants and animals.

Lesson Extension Activities

<http://www.eia.doe.gov/kids/energyfacts/saving/efficiency/moresavings.html>

Evaluation of Retrofitting in Home and School

1. Are windows single or double pane?

In winter season, heat conducts through windows and is lost into the cold air outside. A double pane window provides an extra space of air acting as insulation between the two glasses.

2. Is caulk and weatherstrip around openings and cracks still intact?

Cold air that leaks into a building from cracks around windows and doors lowers room temperatures. This makes the building's furnace operate longer, using up needless energy and adding extra cost to heating bills.

3. Are hot water pipes insulated?

As hot water travels from the boiler to the point of use, heat loss through convection with the metal pipes can be significant. This lowers the temperature of the resulting water at the point of use. If it is a classroom radiator, for example, the device will not be as hot as it is capable of being.

4. Are window draperies open-ended at the bottom?

Any cold air that is between the window and the drapes is sucked downwards by convection. Thus, drapes that are open-ended at the bottom will actually contribute to heat loss! Drapes that hang down far enough to touch the floor or a counter top will trap cold air in the space between the window and the drapes themselves. \

5. When winter winds blow, can a breeze be felt through wall sockets?

Wall sockets are an excellent way of assessing how well a wall is insulated inside. Poorly insulated walls allow cold air to infiltrate a room through wall sockets, lowering room temperatures. Holding a feather or strand of tissue paper against a socket may show infiltration that cannot be detected by actually feeling a cool breeze against the skin.

6. When was the last time the furnace and water heaters were tuned-up?

For proper efficiency, this should be done on an annual basis. In schools, many of these devices will have a tag attached to them displaying the last date of service.

7. Do any outside doors face north?

Doors facing north are completely exposed to cold winter winds each time they are opened. Any one of these doors should have an L-shaped vestibule outside of them.

8. Are shower heads water-saving types?

Inexpensive and easy to change (shower heads simply unscrew - no tools are required), water-saving shower heads mean less hot water is being used, and thus less electric energy is required at the boiler.

9. Are shrubs or other foliage growing outside windows?

This is especially important on north facing windows that receive direct winter wind. The addition of shrubs can cut cold air infiltration down significantly, as well as improve the aesthetic look of the building's exterior.

10. Are fluorescent lights used instead of incandescent lights?

With classrooms, this is never a problem. Virtually all classrooms are equipped with fluorescent lighting. In the home however, fluorescent lights are seldom used. However, they provide the same lighting as a 75-W bulb, use 75 % less energy and last up to 9 times longer. The payback comes in less than one year for average use.

11. Are gym lights shut off when not in use?

Gymnasium lights are a notorious waste of electric energy. When the gym is not in use, there are an average of 80-200 lights (depending on your gym's size) burning needlessly. Let's assume for a moment that the gym lights in your school are left on a total of four needless hours per day. At current Ontario Hydro rates, one fluorescent light would cost

approximately \$0.20 per month to operate for the four wasted daily hours. If you are not shocked, go into your school gym and count the number of fluorescent lights. Multiply \$0.20 times this number, then multiply the result by 10 months to cover the entire school year.

12. Are interior walls painted with light colors?

In schools, most classrooms are already painted with white walls. At home however, dark colored walls can lower room temperature significantly. The energy from sunlight and other forms of heat is actually absorbed by the dark colors, effectively sucking a room's heat into the walls.

13. Do fireplaces have glass doors?

Most people do not think of a fireplace being a problem for heat loss in winter.

However, when a fire is not burning, cold winter air has an easy path into the home - straight down the chimney. Glass doors are very effective in stopping this infiltration.

Lesson Closure

Follow with the Activity: Visit the EIA children's interactive website

Assessment

Lesson Summary Assessment

Ask to see the students' notebooks to ensure they have recorded the lesson notes – design a short quiz of 5-6 questions to see if the students were listening. In addition, you may use the rubric below for your evaluation of students' note-taking.

Students will be evaluated on a scale from 0 to 4 on:

_____	_____	_____
Attentiveness	Participation	Comprehension

Contributors

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