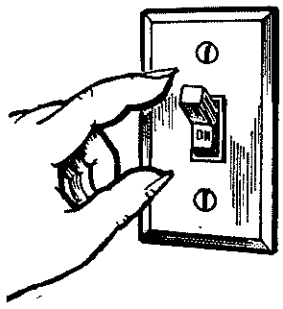
BEHIND THE SWITCH



GENERATION, TRANSMISSION, AND DISTRIBUTION

Leader Guide

4-H 4125L
February 1993

OREGON STATE UNIVERSITY EXTENSION SERVICE

BEHIND THE SWITCH

Generation, Transmission and Distribution

ACKNOWLEDGMENTS

This educational material has been prepared for 4-H use by the National Electric Energy Program Development Committee, composed of representatives of SEA-Extension, U. S. Department of Agriculture and the Cooperative Extension Service of the State Land-Grant Universities. Special appreciation is given to Westinghouse Electric Corporation for technical and financial assistance. The manual is published by National 4-H Council, 150 N. Wacker Drive, Chicago, Illinois 60606.

Special appreciation for technical assistance is given to William T. Cox, Glenda L. Pifer and Kemp L. Swiney, all of SEA-Extension, U.S. Department of Agriculture.

25-2-79

INTRODUCTION

"Behind The Switch" is the first of several second-level topics in the 4-H Electric Energy Program. It deals with how electricity is produced, explains the generation, transmission and distribution of electrical energy and explores the fuels used to power generators.

The subject matter of this unit assumes a basic knowledge of electricity gained through the study of previous units in the 4-H Electric Energy Program. The three Fundamentals of Electricity Units — "Exploring The World of Electricity", "Electricity's Silent Partner - Magnetism" and "Working With Electricity" provide the ground-work for this and following Units. As a leader, you should be familiar with Units 1 through 3. Your county extension staff may supply copies.

Meetings

There are 13 major headings or lessons in Unit 5. Most groups should be able to complete one of these at each meeting, with the possible exception of VII, Nuclear Power, which may require two meetings.

Members should be encouraged to work at home on assigned activities between meetings.

Most meetings should be limited to about one hour of instruction, with a break in between. If you plan an introduction or planning meeting, the program will run a total of 13 or 14 meetings. Schedule the frequency of meetings to fit the interest of your members.

Meeting Place

For many meetings you will need work space to allow for demonstrations and experiments.

Demonstration Equipment

As you review the member's manual, you can easily determine what materials will be needed. Where field trips are indicated, parents should be asked to provide transportation.

Special Aids

Your county extension staff can provide a list of source materials and "do-it-yourself" kits to help maintain a high level of interest among members.

Don't be afraid to ask community leaders, energy specialists and parents to provide information and help. Like you, they have a high degree of interest in youth education programs.

LESSON OUTLINES

Lesson I — Introduction

The first lesson will set the stage for what follows. You need not spend an entire meeting on this section. Simply use it to put the production, transmission and distribution of electrical energy in perspective.

Lesson II "Electricity: The Instant Product"

Teaching Objective To create an appreciation of electricity as a manufactured product and to define the measure of this product as "kilowatt-hours".

Preparation Read Lesson II in the member's

manual. Make sure you understand and can explain the difference between power (*rate* of doing work or expending energy) and energy (total amount of work done).

Questions To Ask

1. Why is electricity a product?
2. What is the product electric utilities sell? (energy, kilowatt-hours)
3. What is power? What is energy?
4. How does time figure in the difference between power and energy?

Things To Do

1. Prepare a list of home appliances along with their wattage. With the club, decide how long each must run to use a kilowatt-hour of energy (fraction of an hour of operation needed to use one KWH divided by the wattage rating).
2. Obtain a list of recommended conservation practices from your local power supplier or federal energy office. Discuss these with the group.

Assignment

Have members read Lesson III.

Ask each member to obtain a rough estimate of the cost of operation for three appliances used at home. (member's manual, Things To Do)

Lesson III "Generating Electricity"

Teaching Objective To review the principle of magnetic induction and how it is used to generate electricity; to give members some feeling for the vast quantities of electricity generated commercially by electric utilities and how it is used by society; to familiarize members with turbine-generator units and their typical size and appearance.

Preparation Read the lesson in the member's manual. This would be a good time for you to visit your local power supplier to gain information on generating electricity. The power supplier may have published information or audio-visual materials which would help make this and future lessons more meaningful to members.

Questions To Ask

1. What three ways can you get more electricity from a generator? (faster operation, more coils, stronger magnets)
2. What is a megawatt? How many 100-watt light bulbs would you need to require one megawatt of power? (10,000 - or a string with one bulb every six inches about one mile long.)
3. What ways is electricity used in the industrial sector? The commercial sector? How is energy related to production of goods and service and to employment?
4. What is a turbine?
5. Is a turbine-generator rated according to its ability to produce energy (power), or according to how much energy it produces in total?

Things To Do

Help members find out the percentage of electricity used by residential, commercial and industrial sectors of your area.

Assignment

Have members read Lesson IV. Ask them to try to find pictures of hydroelectric plants and bring them to the next meeting.

Lesson IV "Hydro Power-Water At Work"

Teaching Objective To acquaint members with water power as a source of mechanical energy for turbines and to allow them to appreciate the limitations on hydroelectric resources.

Preparation Read the member's manual. Determine how much power any local hydroelectric power plant generates and to what segments of the economy the power goes.

Questions To Ask

1. What ways has water power been used in the past, other than producing electricity?
2. Why is a taller dam (deeper reservoir) a better hydroelectric source than a shorter (shallower) one?
3. What hydroelectric power sites have you visited?

Things To Do.

1. Visit a hydroelectric plant, if possible.
2. Help members figure how large a river would be needed to supply electricity for their area. See member's manual for directions.
3. Discuss the advantages and disadvantages of hydroelectric power, and its future.

Assignment

Have members read Lesson V. Ask them to bring in pictures of well-known hydroelectric power facilities, such as Boulder Dam, Grand Coulee Dam and TVA.

Lesson V "The Steam Cycle"

Teaching Objective To acquaint members with how the steam cycle works, the equipment electric utilities must use to take advantage of it, its limitations and the widespread use of it to generate electricity.

Preparation Read the member's manual. Be sure you understand the steam cycle and could diagram it on the blackboard. Find out how the steam cycle is used by your local electric utility.

Questions To Ask

1. What energy conversion steps are involved in the steam cycle?
2. How does the steam cycle lose efficiency?
3. What purpose does the condenser serve?

Things To Do

1. Find out if your local power supplier uses all steam cycle plants.
2. Find out what local bodies of water are used for steam power plant condensers. How much water is needed for top efficiency? Is the production affected by drought?

Assignment

Have the members read Lesson VI. Ask them to bring pictures of mining operations, oil well drilling, dinosaurs and other ancient creatures.

Lesson VI "Fossil Fuels - A Gift From The Past"

Teaching Objective To describe the origin of fossil fuels (coal, oil and gas) and how they are used in a typical large power generating plant; to give members an appreciation of their advantages, limitations and drawbacks; and to acquaint members with areas of research into future uses of fossil fuels.

Preparation Read the member's manual. Make sure you are generally familiar with the layout of a typical fossil-fuel generating plant (fuel handling equipment, boiler, turbine, condenser, generator and control room). Some added reading on the energy issues and availablity of coal, oil and gas in your area might be appropriate.

Questions To Ask

1. What are fossils? Why do we call coal, oil and gas fossil fuels?
2 Why is coal more difficult to handle than oil or gas?

3. What goes on in a power plant control room?
4. What are the advantages and disadvantages of using natural gas? oil? coal?
5. Can electricity be produced from burning refuse alone?
6. What is coal gasification? liquification?
7. What is "MHD" and why is it desirable? What are the problems in its use?

Things To Do

1. Have members follow their local newspapers for a week or two and clip articles dealing with fossil fuels, shortages, environmental effects, etc. Discuss these current events as a group.
2. Make arrangements to visit one of the facilities mentioned in the member's manual.
3. Obtain a sample of coal. Using a metal dish, attempt to light it as a lump. Observe the smoke given off. Now grind some of the coal into a course powder (not too much!). Observe how much easier it is to light.

Assignment

Have members read lesson VII. Ask members to bring in any reference to nuclear power that they can find in the papers between now and the next meeting.

Lesson VII "Nuclear Power-Controlling The Atom

Teaching Objective To acquaint members with the process of nuclear fission and how it is used in different types of reactors to generate electricity; to give an appreciation of the complexity of the nuclear fuel cycle and the difference between naturally-occurring "isotopes" of uranium and their relative usefulness; to summarize measures employed to keep nuclear plants safe, and to review research efforts on the future uses of nuclear power.

Preparation Read the member's manual. Mak sure you understand and can explain how reactors work and how their fuel is produced. Again, some added reading on current events relating to nuclear energy can aid in your group discussions.

Questions To Ask

1. What is an isotope?
2. What is radioactivity?
3. What is fission? How does it differ from fusion? How does it lead to a chain reaction?
4. How is a nuclear reactor like a boiler?
5. How is chain reaction controlled in a nuclear plant?
6. Why is enrichment necessary?
7. What is nuclear waste? What problems are involved in disposing of it?
8. Can a nuclear reactor explode?
9. What is the difference between electricity produced by a fossil fuel plant and that produced in a nuclear plant? (none) What a the differences in how the plants operate?
10. What is a breeder reactor? Why is it desirable and how could it be dangerous?

Things To Do

1. A number of nuclear plants around the country have special visitors centers or other arrangements for accommodating study groups. Contact a nuclear power plant nearest your community and see what visiting arrangements can be made. In some cases, local museums have excellent displays of nuclear power plants.
2. Borrow a Geiger Counter from your local Civil Defense office, university or high school laboratory. Demonstrate the detection of radioactivity, using a sample obtained from the same source or the radium dial of a watch. Note the clicks registered in the absence of the sample due to natural background radiatio Discuss the sources of this natural radiation (cosmic rays, stones, bricks, etc).

3. Inquire at a local hospital in what ways radioactive material is used in medicine.
4. Have members follow their local papers and clip articles relating to nuclear energy. Discuss these current events. You may have a representative of your local power supplier or other groups involved with nuclear energy discuss this topic with the group.

Assignment

Have members read Lesson VIII. Ask them to bring in any material they can find relating to solar energy.

Lesson VIII "Energy From The Sun"

Teaching Objective To explore possibilities for using solar energy as a source of power — its advantages and limitations.

Preparation Read the member's manual. Assemble the material needed to build several hot dog cookers as a group project.

Questions To Ask

1. How is a greenhouse like a solar power plant?
2. Why is solar energy difficult to harness in large quantities? As a constant supply throughout the day and the year?

Things To Do

1. Have each member, or groups of members, build a solar hot dog cooker. You might consider holding a "solar picnic" as a social event.
2. Demonstrate solar heating with the cardboard house as outlined in the member's manual.
3. Review current events relating to solar power as a discussion topic.
4. See if any buildings in your area are partially heated with solar systems. Arrange for a visit, if possible.

Assignment

Have members read Lesson IX. Have the members count the windmills in their area. Ask some of the older citizens where windmills were used and for what purpose. If you live near a coastal area, how much difference, in feet or centimeters, is there between high and low tide?

Lesson IX "Energy From The Earth"

Teaching Objective: To acquaint members with natural forces of the earth (geothermal heat, tides, wind, chemical energy in organic systems) and how they can be harnessed to produce energy.

Preparation Read the member's manual. Check with your local power supplier regarding any local plans for the utilization of geothermal, wind, tidal or "biomass" conversion systems so you can discuss these in general terms with members.

Questions To Ask

1. What is the source of heat deep in the earth?
2. What is the difference between "wet" and "dry" geothermal fields? Which is more plentiful? Which is more difficult to use?
3. Why can't tidal power produce a steady supply of electricity?
4. What are the advantages and disadvantages of large-scale use of wind power?

Things To Do

1. If any geothermal or wind power projects are in use in your area, see if a visit can be arranged or if someone involved with them can visit your group.
2. Have members clip any reference to wind, tidal, geothermal or biomass power systems and discuss these topics in a meeting.

Assignment

Have members read Lesson X.

Lesson X "Planning For Power"

Teaching Objective To acquaint members with the typical daily power supply requirements that must be served by an electric utility and to give them an appreciation for the magnitude and complexity of planning of generating facilities to serve electric power users.

Preparation Read the member's manual. You may wish to obtain from your local power supplier in advance the information suggested in the member's manual regarding local load patterns, growth trends, etc.

Questions To Ask

1. Why isn't an electric utility's load pattern constant?
2. What is the "peak" load and how is it served?
3. Why and how much reserve generating capacity must an electric utility keep?
4. What is the "system" load factor? What would be an ideal load factor from the utility's point of view?
5. What kind of power use contributes to peak loads?
6. What actions by electric utilities are regulated by government agencies?
7. Why are utilities given a monopoly to serve certain areas?

Things To Do

1. Using a blackboard, and with members' help, write down as many things as you can that an electric utility must take into account in planning for the future.
2. Discuss your own community. What would you expect your community's load pattern to look like? Is the area primarily residential? Industrial? Agricultural? What about future needs? Is your community growing?

Assignment

Have members read Lesson XI.

Lesson XI "Transmission-Long Distance Energy"
Teaching Objective To teach members the reasons for and equipment necessary for transmitting power at high voltages, and the rationale and function of regional power pools.

Preparation Read the member's manual. See if your local power supplier can provide a map showing transmission lines in your area.

Questions To Ask

1. Why is alternating current necessary for a transformer function?
2. What happens when a transformer raises the voltage? (current decreases)
3. What causes "line losses"? What happens to them when current is decreased?
4. What precautions should be observed around transmission lines?
5. What is the advantage to a utility and its customers of joining a power pool?

Things To Do

1. Review with the members the transmission line network used in your area.

2. In group discussion, think of some possible emergencies in which a power pool can keep electric service going.

Assignment

Have members read Lesson XII. Have members count the number of transformers within a two block area of their home. If they live in a rural area, have them count the number along the road on which they live.

Lesson XII "Distribution - Special Delivery Energy"

Teaching Objective To acquaint members with the distribution systems and how electricity is delivered to the home; the hazards that face the systems and the measures taken both in terms of equipment and personnel to keep the lines in operation.

Preparation Read the member's manual. If possible, become acquainted with the location of substations and distribution transformers near your meeting place. Try to obtain a utility lineman as a speaker for the club. It would help if he could demonstrate some of his equipment.

Questions To Ask

1. What does the distribution system do?
2. What is the most important part of a substation?
3. What are feeders? Which is the best type of layout of feeders for a reliable electric service in populated areas? (loop)
4. What does the distribution transformer do and how does it do it?
5. What are some of the hazards which can damage distribution lines? What equipment helps protect against them?
6. How does a line crew know where repairs are needed?
7. What are some safety practices to observe around distribution lines?
8. What should you do if a power line falls across your car? If you see someone who has come in contact with a power line?

Things To Do

1. Take a walking, bike or auto tour of the immediate area, noting distribution transformers and substations. Watch for "overload" lights, discuss potential trouble spots (where tree limbs are near), etc. Observe service drops.
2. Arrange for a visit to your local electric utility's maintenance center where line crews and dispatchers are based. Or, arrange for a line crew member to talk to your club members.
3. Obtain some sample distribution protective equipment from your local utility (from the salvage pile?) and examine them at your meeting (arresters, line insulators, fuses, etc.). You may want a lineman or other expert to explain them.
4. Distribution transformers often have a large numeral stenciled on the side — commonly 5, 10, or 15. This number is roughly equal to the number of kilowatts of power the transformer can handle. Have members observe distribution transformers near their homes and report on the capacity of each. If possible, have them find the one to which their home is connected. How many homes are connected to each transformer? How many kilowatts of capacity are allowed for each?
5. Have members watch their local papers for a week and collect articles on accidents or casualties involving electric distribution lines. Discuss the incidents at your meeting. What safety rules did the victims violate?

Assignment

Have members read Lesson XIII.

Lesson XIII "Electricity For Sale"

Teaching Objective To describe how electric meters work and to teach members to read them. To describe utility rate structures and charges for electric energy.

Preparation Read the member's manual. Obtain a sample electric meter (again, from the utility's scrap materials) for examination in the meeting. Be sure that you are comfortable with the technique of reading a meter. Obtain copies of the local rate schedule for distribution in the meeting.

Questions To Ask

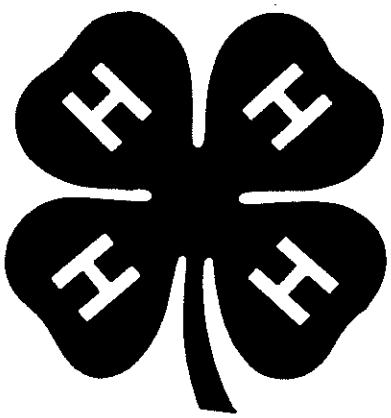
1. What does an electric meter measure? (kilowatt-hours, energy used.)
2. How is an electric meter read?
3. What is a rate schedule? A "block" rate?
4. Why is electric power sold in a "cheaper-by-more-use manner"?
5. What is fuel adjustment?
6. Why do utilities charge extra for high electric power demand ? What is the difference between demand and use?

Thing To Do

1. Show the parts of an electric meter. Examine the disc, drive motor and register gear train. Few realize how delicate an instrument meters are. (Obtain these parts either from your local utility or from an electric supply house. Unless given specific permission, you should not attempt to take a borrowed meter apart).
2. Using your local rate schedule, figure some sample electric bills using fictitious kilowatt-hour usage amounts (or some actual amounts from sample bills brought to club meetings).
3. Does your local utility have fuel adjustment charges? If so, what percentage of each total bill do they represent? If not, how does your utility pass on price increases due to changes in supply? Discuss this in the light of the major fuels used by your utilities. See if your electric utility can tell you how its rates compare with those of other utilities.

NOTES

LITHO IN U. S. A.



Extension Service, Oregon State University, Corvallis, O.E. Smith, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.