

2.5 ENERGY IN POWER PLANT SYSTEMS - OPTIONAL

Lesson Summary

Students will be able to understand how electricity is produced in a power plant and act out a power plant using systems language. They will work together to act out the process of producing electricity in a power plant. After practicing their play, they will engage in a class discussion about the system as a whole.

(Approx. total time: 1 hour)



Standards

NGSS Cross Cutting Concepts

Energy and Matter

Energy can be transferred in various ways and between objects.

Systems and System Models

A system can be described in terms of its components and their interactions.

NGSS Disciplinary Core Ideas

PS3.B Conservation of Energy and Energy Transfer

Energy is present whenever there are moving objects, sound, light, or heat.

Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)

PS3.D Energy in Chemical Processes and Everyday Life

The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.

NGSS Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3-5 builds on K-2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.

Obtain and combine information from books and other reliable media to explain phenomena.

This lesson is part of a Connect Science unit. For information about other Connect Science lessons and professional development opportunities, visit connectscience.org

Objectives

By the end of the lesson, students will

Know (facts/information):

- The names and functions of the basic components of a power plant.
- Electricity is just a special form of energy that we use in our everyday lives.
- Energy in coal can be converted to electricity by a power plant.
- A power plant is a system designed to transfer the energy from coal to electricity.

Understand (concepts, big ideas):

- Energy is present in different forms as it moves through natural and human-made systems.
- Systems thinking can be useful in understanding interactions in the world and designing solutions to challenging problems.

Be able to do (skills/behaviors/scientific and engineering practices):

- Work as a group to act out the process of energy transfer from coal to electricity.

Vocabulary

- **boiler:** a place in the power plant where water is heated
- **electricity:** a special form of energy that we use in our daily lives
- **electrons:** small particles that create electricity when moving fast
- **energy source:** a material that can be used to produce electricity or heat for human needs
- **generator:** a machine in a power plant that changes spinning movement into electricity
- **non-renewable resource:** a resource that cannot be easily made or replaced naturally in our lifetime
- **power plant:** a system that can transfer the energy in a source to make electricity
- **renewable resource:** a resource that can be replaced or restored naturally in a lifetime
- **turbine:** a machine in a power plant that turns due to steam pressure and causes a generator to spin

Materials

- Student Materials (per group):
 - 1 ping pong ball
 - 5 sets of instructions (1 per team or 1 per student - Decide what your class will need)
 - 1 set of role cards (coal, water, turbine, generator, and electricity)

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- The role cards should be cut apart separately so that each member has a different role.

Instructional Strategies

Link to Prior Knowledge (5 minutes)

Review prior knowledge from Lesson 2.3: Renewable Energy Systems.

Does anyone remember what energy source we used to make electricity? That's right! We used sunlight and we talked about how wind can also make electricity. We said that those energy sources were renewable, what does that mean?

Allow students to answer the questions and recap the systems from lesson 2.3.

Today we are going to talk about another system that makes electricity. This system uses a non-renewable energy source. What do you think non-renewable means? We are going to learn about the system of a coal power plant.

Instruction (45 minutes)

Describe the labeled diagram of the power plant.

Project the diagram on the board.

Here is a simple diagram of a power plant with the major components of the system labeled. Here you can see the boiler, the turbine, the generator, and the wires. The output of this power plant is electricity. Many people say that power plants produce energy, but energy exists in all parts of the system. What they really mean is that a power plant takes an energy source and converts that into a type of energy (electricity) that we can use in our daily lives.

Can anyone remember a component from the solar energy system or the wind energy system? That's right! A solar panel, a wind turbine, a generator. This system has some similarities to the wind energy system, but it is very different from the solar energy system. Unlike the wind and solar energy systems, a power plant like this one can use a few different energy sources, but today we are going to talk about coal as an energy source for this power plant. Coal is going to be our input for this system.

Explain how students will act out what happens in a power plant.

Now you know the input, the output, and the components, but you do not know the function of each component in the system or how energy is transferred from coal to electricity. In groups of five, you are going to act out what happens in the power plant. You will each read one part of the system, then you will write what you plan to say and do when you act out your part. The parts of the system interact or act together, so you will have to work with your group mates to figure out what you need to say and do when.

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Once all members have written out their parts you will act out what happens in each part of the system as components interact. This (hold up the 'energy'- a ping pong ball or anything the children can pass along) is the energy, make sure to act out transferring this 'energy' from one part of the system to another.

Once your group has practiced the power plant process once, let me see it so I can give some feedback.

Hand out the directions and roles to each group and review instructions.

Facilitate group role play activity.

After the children read the instructions, go around the room helping them with enacting their power plant play. Suggest places to use important vocabulary words they have learned in this and the past science lessons. Make sure they are transferring the energy, and encourage them to be as creative as possible. If some groups are ahead, have group members trade roles and try acting out different parts.

Closing (10 minutes)

Discuss role-play activity and review vocabulary.

Have at least one group share their power plant play. After sharing, display the power plant diagram and discuss the function of each component and input and output, how energy is transferred in the system, and what evidence of energy there is at different points in the system.

- Function of each component

The boiler heats water to steam when coal is added. The turbine spins due to pressure from steam. The generator spins due to the turbine. The generator makes electricity. The wires allow electricity to travel from the power plant to homes, schools, and businesses.

- Energy Transfer

The coal holds energy that is released in the boiler. That energy goes to the water and changes it to steam. Steam gives energy to the turbine and the turbine spins. The turbine gives energy to the generator, and the generator gives that energy to the electrons to make electricity.

- Evidence of Energy

- Heat: the coal makes the fire hotter
- Heat: the water is heated to steam
- Movement: the steam makes the turbine spin
- Movement: the turbine causes the generator to spin
- Movement: the spinning generator causes electrons to move (electricity)

Assessment

Listen for accurate explanations and use of vocabulary in the spoken and written portion of the role-play activity.

References

All about coal (2017). National Energy Education Development Project. Retrieved from <https://the-need-project.myshopify.com/collections/coal/products/all-about-coal>

*Good resource for extra lessons and teacher information about coal.

Crissman, S., Lacy, S., Nordine, J., & Tobin, R. (2015). Looking through the energy lens. *Science and Children*, 52(6), 26 - 31.

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National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Schweingruber, H., Keller, T., & Quinn, H. (Eds.) Washington, D.C.: National Academies Press.

The American Coal Foundation (2012). *Energy and You*. Retrieved from <http://teachcoal.org/energy-and-you/>

Planning Page

Students will be able to understand how energy is produced in a power plant and act out a power plant using systems language.

Link to Prior Knowledge (5 minutes)

Review prior knowledge from Lesson 2.3: Renewable Energy Systems.

Instruction (45 minutes)

Describe the labeled diagram of the power plant.

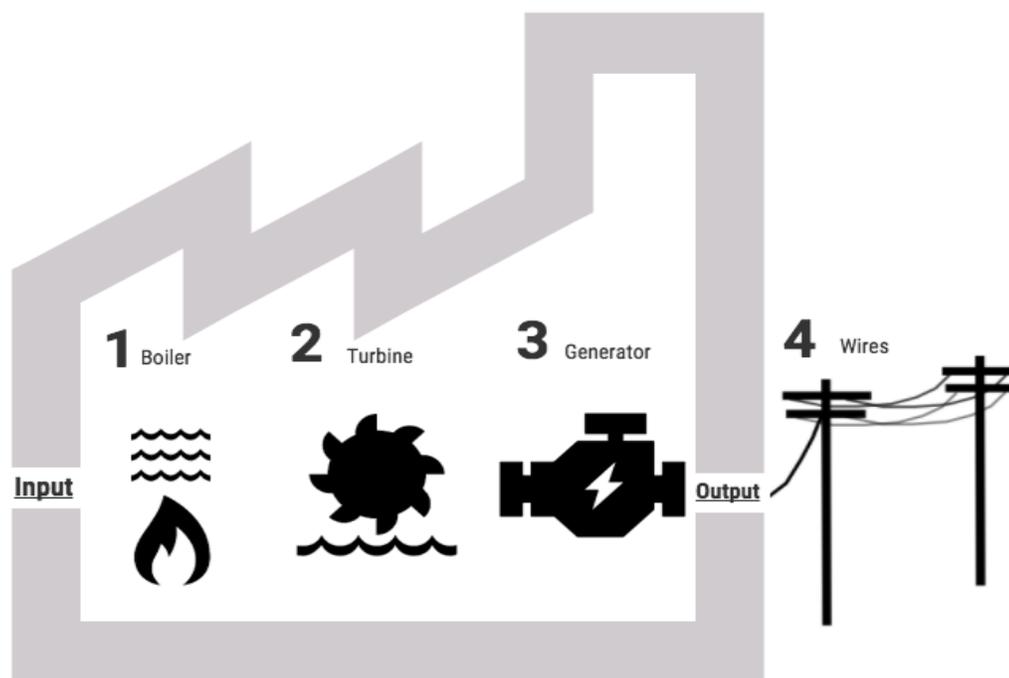
Explain how students will act out what happens in a power plant.

Facilitate group role play activity.

Closing (10 minutes)

Discuss role-play activity and review vocabulary.

POWER PLANT PLAY



Power plants take the energy in coal and turn it into electricity. The power plant is a system designed to produce electricity. Electricity is a form of energy that we can use in our lives. The components of the power plant are the boiler, the turbine, and the generator. Coal is the input, water is a component of the boiler, steam is a component of the boiler and the turbine, and electricity is the output. The wire grid connected to the power plant allows electricity to travel away from the power plant to places like your house and school.

Your group is going to act out what happens in a power plant. Your group has a ball that represents energy, and each person has a different role card. The number(s) on your role card tell you what part of the power plant you are acting in. Some roles have one number, and some have two. The number(s) will let you know what order and who in your group you have to interact with. Once you figure out your order, write down what you will do and say on the space under your role description. Make sure to work with your group as you plan your role.

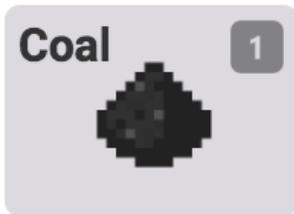
Practice your power plant play. While one person is acting their role, the other group members not involved in the scene should be actively listening so they can make suggestions later. Some things to listen for are:

1. Is the actor speaking like a scientist and using the vocabulary words you have learned?
2. Is the actor explaining what is happening clearly and correctly?
3. Is the actor using movements and gestures that help others understand and add to the fun of the play?

Once everyone has performed their part, ask questions and discuss changes that may need to be made. Provide suggestions to each member of the group. Make any changes, then practice your play again. Once the group agrees that the play is ready, have your teacher watch it.

ROLES IN PRODUCING ENERGY

Role 1: Coal

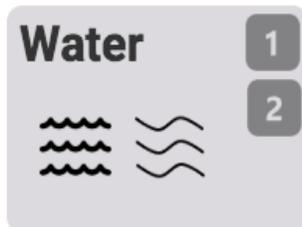


You have the energy to start with because you are the energy source. You go into the boiler where you are heated up. When you get hot you make the entire boiler even hotter than the fire. Then you release energy as heat to water. After you release your energy, you are no longer coal. You turn to ash.

Write down what you will say...	Write down what you will do...

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Role 2: Water



First you are water sitting in the boiler. You are warm, but you are very calm with little energy. Coal heats up and gives the energy to you. When you take that energy, you get very excited and become steam. This causes you to travel to the turbine and push it to get it started. When you push the turbine, you release your heat energy as movement to the turbine. After you interact with the turbine, you turn back into less energetic water and go back to the boiler.

Write down what you will say...	Write down what you will do...



2.5 ROLES IN PRODUCING ENERGY

Role 3: Turbine

Turbine



2

3

You are sitting very still until steam comes over and gives you the energy. Then you start to spin. Your spinning causes you to touch the generator and give the generator energy. Your movement causes the generator to spin, too. Once you get the generator moving, you lose energy and stop moving.

Write down what you will say...	Write down what you will do...

2.5 ROLES IN PRODUCING ENERGY

Role 4: Generator

Generator 3



You are sitting very still until the turbine touches you and gives you energy. Then you start to spin. Your spinning causes electrons to vibrate and then shoot off into the wires becoming electricity. Once electricity is formed you lose energy and you stop spinning.

Write down what you will say...	Write down what you will do...

2.5 ROLES IN PRODUCING ENERGY

Role 5: Electricity

Electricity



3

4

You are electrons sitting very still in (by) the generator. When the generator spins it gives you the energy that allows you to move. Once you start moving your name is electricity. You zip away from the generator and down the wires to houses and businesses.

Write down what you will say...

Write down what you will do...

2.5 POWER PLANT DIAGRAM

Producing Electricity in a Power Plant

