OHIO STATE UNIVERSITY EXTENSION

PROJECT IDEA STARTER

Shale Gas Extraction

by Jane Keyser, Extension Educator, 4-H Youth Development; Mike Lloyd, Extension Educator, Community Development; Steve Schumacher, Extension Educator, Agriculture and Natural Resources; and Nancy Snook, Extension Educator, 4-H Youth Development. Reviewed by Andrea Davis, Extension Educator, 4-H Youth Development; and Eric Romich, Field Specialist, Energy Development.

Americans use a lot of energy. In fact, the United States is the second largest consumer of energy in the world, and the seventh largest per capita. Most energy in the U.S. comes from fossil fuels.

Oil and Gas as Energy

Fossil fuels were formed from prehistoric plants and animals whose remains were gradually buried by layers of sediment, water, sand and rock. The chemicals they contain — hydrogen and carbon — form petroleum, coal or natural gas. These are typically burned to provide energy.[1]

Most of the nation's natural gas comes from what has been called conventional sources. Conventional gas often comes from underground sandstone formations in the Gulf of Mexico and the western and southwestern U.S. However, in recent years more gas comes from unconventional sources, including shale gas.[2]

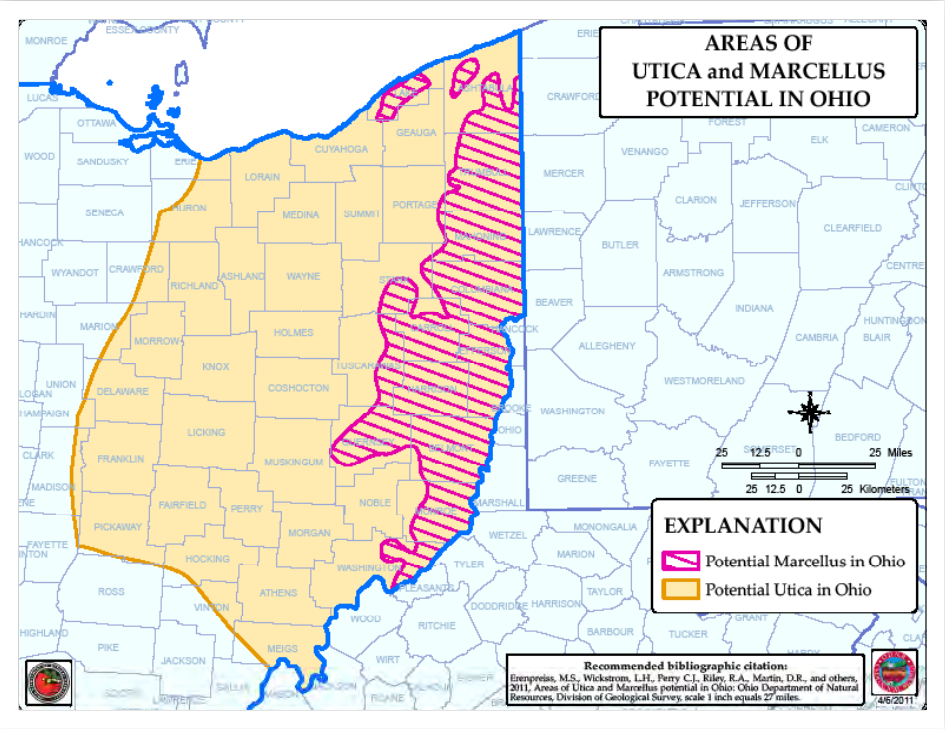
Shale is a very fine-grained sedimentary rock that breaks easily into thin, parallel layers. It is a very soft rock, but it does not fall apart when it becomes wet. Shale can contain natural gas, usually when two thick, black shale deposits "sandwich" a thinner area of shale. Getting, or extracting, the natural gas from shale formations is more difficult and perhaps more expensive than getting it from conventional natural gas sources.[3] Ohio has two such shale deposits: the Marcellus and Utica shales. The Utica shale formed during the Ordovician period (480–442 million years ago) and the Marcellus shale formed during the Devonian period (417–354 million years ago).

Drilling and Production

Exploring for oil and natural gas was once a matter of good luck and guesswork. Today, the guesswork is replaced by science and technology. Geologists

PLAN YOUR PROJECT

Use this idea starter AND publication 4-H 365 *Self-Determined Project Guide* as the starting place for your 4-H self-determined project. The *Self-Determined Project Guide* is available from your county OSU Extension office or on the Web at **ohio4h.org/selfdetermined**. You may choose to do a little or a lot depending on your level of interest. Be sure to register your project with your county OSU Extension office.



Source: Ohio Department of Natural Resources

and geophysicists use many high-tech tools to search for oil- and gas-filled rock layers. One exploration method involves sending sound waves into the earth and interpreting the signals that return to the surface.

Geologists then interpret the seismic data. If there is a possibility of gas, exploration wells are the next step. A drilling rig drills a hole about the size of a soccer ball several thousand feet to determine if oil and gas are actually there. Historically, these wells were drilled vertically (straight down), but the technology available today allows for wells to be drilled horizontally (parallel with the ground) too. Modern wells drilled into Ohio and other shale deposits are large and may be drilled down over a mile vertically and then out a mile horizontally.

After a well is drilled, the shale is hydraulically fractured in a process commonly called fracking. Fracking involves pressurizing the wells up to 15,000 pounds per square inch and injecting water, sand, and a variety of other chemicals to break the shale and create channels that allow the gas and oil to escape. Fracking a horizontal well can use five million gallons of water or more, 20 percent of which is returned to the surface. The water, sand and chemical mixture that returns is called flow back. Some of the flow back is recycled while some must be disposed of. Typically, in Ohio the portion that is disposed of is injected into deep underground wells called injection wells.

Pressure in the newly drilled wells may be high enough that oil and gas flow to the surface without any assistance, but most wells are expected to eventually require a pump jack or other system to help remove the deposits.

Usually, a system of pipeline is installed to move the oil and gas to refineries. There are two types of natural gas. “Dry” gas is primarily methane and “wet” gas contains oil and natural gas liquids such as ethane, pentane, propane and butane, in addition to methane.

Much of the Ohio shale gas is expected to be wet gas. As such, it needs to be sent to a refinery, such as a fractionator or cracker, where the different components are separated and sent to the various industries that use them.

Products

The crude oil that results is used as fuel and lubrication for cars and other transportation. It is also used to make over 6,000 different products we use every day, including medicines, paint, cosmetics, fabric and plastics. As with other nonrenewable resources, greater emphasis is being placed on “reduce and reuse” with the many products made from oil and gas.

Impact

The gas and oil industry in Ohio is likely to create a wide variety of new jobs in Ohio. People trained for highly technical jobs such as petroleum engineers and geophysicists are needed, and

so are people to work as truck drivers, welders and rig workers.

Regulation of the industry is a work in progress. Many people are enthusiastic about the potential benefits of growth in Ohio's oil and gas industry. Many others are concerned about impacts on the environment. One of the primary concerns is the effect on air and water quality. Also, an increase in truck traffic during drilling creates road maintenance and road safety concerns. Finally, if new jobs do result, local leaders must think about all the new people who will need schools, health care and housing.[4]

AREAS OF INTEREST AND THINGS TO DO

Every self-determined 4-H project can be broken down into areas of interest. These are the specific things members want to address during their project adventures. Using 4-H 365 *Self-Determined Project Guide*, identify at least three areas of interest with at least three activities per area to explore. Take your ideas from the list below or make up your own.

Shale Formations

☐ Find five differences and five similarities between Marcellus shale and Utica shale.

☐ Learn how fossil fuels are formed in shale with the Fossil Bread Experiment.[5] Follow these easy steps:

1. You will need three slices of different kinds of bread, gummy animals (gummy worms or fish), paper towels and a stack of heavy books.
2. On a paper towel, layer three pieces of bread on top of each other like a pancake stack. The bread slices represent sediment layers that form over millions of years.
3. Next, insert a few gummy animals in a middle layer. (The gummy animals represent animals that died, became trapped in sediments and later fossilized.)
4. Wrap the entire bread fossil in a paper towel.
5. Stack a layer of heavy books on top of the bread fossil. For best results, apply more pressure. Let it sit overnight. Do not disturb or peek!
6. The next day, predict how you think the bread fossil will look. Uncover the bread fossil and observe very closely.
7. Has the bread fossil changed? How? What eventually happened to the animal material when it was trapped in the porous bread layers? Try to pull the layers apart. What do you see in the pores of the bread?

☐ Learn how natural gas is formed with the Magic Balloon Experiment.[6] Follow these easy steps:

1. You will need tuna, lettuce leaves, a 1-liter clear plastic bottle, one balloon, a graduated cylinder, sand, pond water and masking tape.
2. Layer the following in order in a 1-liter clear plastic bottle: 1 tablespoon of tuna, two torn lettuce leaves and 3 tablespoons of sand. Slowly add 10 ml, or about 2 teaspoons, of water without shaking or disturbing the layers.
3. Stretch the opening of the balloon over the opening of the bottle. Seal with masking tape. Carefully move the bottle to a hot, sunny place outside.
4. Observe and predict the bottle's changes for several days. Record your observations in a chart that includes dates and comments.
5. What do you think caused the changes in the balloon? What happened to the materials in the bottle as time passes? Can you explain what happened in the bottle?

☐ Explain how different rocks (limestone, sandstone, granite) absorb oil differently.

- Which rock might hold the most oil, and why?
- Where are the best geologic conditions of oil deposits?
- How can scientists use geology to help find oil deposits?

Exploration

☐ Research how geologists locate oil and gas deposits.

☐ Explore how seismic data is used to find oil and gas deposits below the surface of the earth.

- ☐ Describe what information is found when a drilling site is "logged" during exploration for oil and/or gas.
- ☐ Explain the difference between vertical (straight down) and horizontal (parallel with ground) drilling as it relates to oil and gas exploration.

Drilling and Production

- ☐ Go to the Ohio Department of Natural Resources Division of Oil and Gas Resources website (**oilandgas.ohiodnr.gov**) and use the Oil and Gas Well Locator. Are there wells or refineries in your county?
- ☐ Make a flow chart describing what happens to oil and gas at a "cracker" plant. Explain how it works to your project helper.
- ☐ Explore how natural gas is separated from oil by conducting the Soda Separation Experiment.
  1. You will need a glass container, colored vegetable oil and an unopened can of clear, carbonated beverage.
  2. Pour ½ can of vegetable oil into the glass container.
  3. Predict what might happen when the carbonated drink is poured into the oil.
  4. Open the can of carbonated beverage and pour a small amount into the glass container. Observe closely and record results. Discuss your findings.
  5. What did you observe? Why do you think some bubbles are "trapped" in the oil? How can you compare this experiment to the function of an oil field?
  6. Assemble a collection of online or print articles about shale gas extraction. Analyze whether they offer a negative, positive or neutral stance, and write your own comments for each one.

Byproducts

- ☐ Research byproducts of oil and gas. Does anything surprise you? Share what you find with your project helper.
- ☐ List 10 products from oil and 10 products from natural gas. Discuss your list with someone who might not know how many products there are.
- ☐ Make a petroleum collage to share with your club.
  - Cut out pictures of as many products as you can find that are made from petroleum.
  - Glue or tape them to a poster board to make a collage.
  - On the collage, label if the product is a byproduct of oil or gas.

Impact

- ☐ Explore higher education opportunities available for training in the oil and gas industry.
- ☐ List 20 career opportunities related to the oil and gas industry.
- ☐ Make a list of ways to conserve energy around your house.
- ☐ Identify and explore at least one of the environmental concerns about shale gas. Are there good reasons to be concerned? Summarize your findings and share them with your project helper.
- ☐ Create a survey about the benefits and potential risks of shale gas extraction and use it to interview friends and family members. What did you discover?

RELATED RESOURCES

Ohio Department of Natural Resources Division of Oil and Gas Resources, **oilandgas.ohiodnr.gov**

Subsurface Energy Resource Center, **serc.osu.edu/resources**

Ohio Oil and Gas Energy Education Program (OOGEEP), **oogeep.org/teachers-students**

SOURCES

[1] "Fossil." United States Department of Energy, Energy Sources, **energy.gov/science-innovation/energy-sources/fossil**, accessed December 31, 2013.

[2] "National Assessment of Oil and Gas Fact Sheet: Natural Gas Production in the United States." U.S. Geological Survey. **pubs.usgs.gov/fs/fs-0113-01/fs-0113-01textonly.pdf**, accessed December 31, 2013.

[3] "Unconventional Natural Gas Resources." **naturalgas.org/overview/unconventional-ng-resources**, 23 February 2012.

[4] Romich, R., and Schumacher, S. *Summary of Hydraulic Fracturing in Ohio*. 2012. The Ohio State University.

[5] "Science Fair Project #1: Fossil Bread." Oklahoma's Oil & Natural Gas Producers & Royalty Owners, **oerb.com**, accessed December 31, 2013.

[6] "Science Fair Project #2: Magic Balloon." Oklahoma's Oil & Natural Gas Producers & Royalty Owners, **oerb.com**, accessed December 31, 2013.

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES