



## Natural Gas: An Invisible Fuel

### Teacher's Guide

#### Introduction

*Natural Gas: An Invisible Fuel* explains natural gas science concepts and describes how to safely use natural gas in daily life. This teacher's guide provides the objective for each page of the booklet, background information, and ideas for classroom discussion and follow-up activities. Activity and puzzle answers appear on the back cover. Activities require only the materials listed in the booklet—most require only a pencil and the booklet itself. All other materials are everyday items already on hand in most homes and classrooms.

#### Page 2: Natural Gas Is an Invisible Fuel

Objective: Describe the characteristics of natural gas; list ways natural gas is used as an energy source.

Background: Natural gas is a colorless, odorless gas that is lighter than air. We can use natural gas in appliances (such as clothes dryers, stoves and ovens, furnaces, air conditioners, water heaters, outdoor gas lights, pool or spa heaters, barbecue grills, and fireplaces) and in some motor vehicles.

Discussion: Explain to students that a fuel is a material that can be burned to produce heat or power. Ask: What other kinds of fuels can you think of? (*Wood, gasoline, kerosene, coal.*) What does natural gas look like? (*It's invisible.*) Have students read the Going Further paragraph before completing the missing vowels activity.

Going Further: Supply students with old magazines and catalogs to cut up for their collages, along with scissors, glue or tape, and butcher paper or poster board. Alternatively, students can make their own original drawings of uses for natural gas and create a class collage by pinning their drawings on the classroom bulletin board. Have students label each use they depict in their collages.

#### Page 3: Energy in Your Life

Objective: Define energy; list examples of energy being used to do work.

Background: Energy is the ability to change or move matter. Without energy there would be no motion, no light, and no heat, and life would not exist. Most of the energy on earth comes from the sun. Ask students where they get their energy. (*Food*) Ask them what types of energy run the appliances in their homes. (*Electricity, natural gas, propane, solar power.*)

Discussion: Ask students to list common activities they do that require energy from the food they eat. (*Reading, doing homework, walking, bike riding, etc.*) Then ask them to distinguish between those types of activities and activities that require other sources of energy. (*Taking a shower requires energy to heat the water; running appliances or electronic devices like the TV, computers, and clothes dryers requires energy sources like electricity or natural gas.*)

Activity: Have students create bar graphs illustrating their energy usage. List activities on the *x*-axis and time on the *y*-axis. (*Sample activities: walking, riding a bicycle, playing a game, doing homework, taking a shower, cooking food, drying clothing, watching TV.*)

Going Further: Student stories should indicate that without energy, there could be no motion or growth.

#### **Page 4: Fossil Fire**

Objective: Explain how natural gas and other fossil fuels are formed; demonstrate the decay of organic materials.

Background/Discussion: Explain that natural gas is known as a fossil fuel because it was formed from the fossilized remains of organic materials that were present on earth long ago and buried under lakes and oceans. Fossils are the naturally preserved remains or traces of animals or plants that lived in the geologic past. For natural gas to be formed, fossils further undergo heat, shifting, and pressure that result in gas being formed in the porous pockets within sedimentary rock. Ask students to name the three kinds of fossil fuels. (*Natural gas, crude oil or petroleum, coal*)

Going Further: Ask students to bury organic (*plant food waste*) and nonorganic (*plastic, metal*) materials in soil placed in a large jar or plastic bin, or in an outdoor compost pile. Have students record observations of these materials at two- or three-day intervals over a week or two. They will observe decay of the organic materials.

#### **Page 5: Trapped in Rock**

Objective: Define new vocabulary; explain where natural gas is found in the earth.

Background/Discussion: Methane gas (the main ingredient in traditional natural gas) formed when ancient organisms decomposed and the resultant gas was trapped under layers of solid rock. Today, natural gas is found in the same underground areas where crude oil (*petroleum*) is found. Wells are drilled through the rock to bring natural gas to the earth's surface. The gas is pumped to a processing plant where it is cleaned and then pumped through pipelines to power plants, factories, businesses, and homes.

Today, a newer type of natural gas called renewable natural gas, or RNG, can be made from organic waste materials such as garden and lawn clippings, food scraps, and cow manure. These materials are collected in a "digester" tank where they decompose, creating methane and other gases. Once the methane gas is collected, cleaned, and conditioned, it can be added into the utility natural gas distribution system and used as an energy source for homes, businesses, and factories. It can also be used as a transportation fuel.

Follow-up: Have students make flash cards with a vocabulary term on one side and its definition on the other. Students can use the cards to quiz each other on the new vocabulary on this page.

#### **Page 6: Pump It Up**

Objective: Identify states on a map of the United States and become familiar with those that have traditional natural gas deposits. Calculate the answer to the arithmetic word problem.

Background/Discussion: Map Activity: Thirty-four states are shown on the map to have natural gas activity. Invite students to write the two-letter abbreviations of these states on the board.

Gas Math: Subtract 1821 from the current year. On the board, write other large numbers using words and have students write them using digits.

How Many Digits? On the board, write other large numbers using words and have students write them using digits.

### **Page 7: Natural Gas Can't Be Seen**

Objective: Recognize the hazards of gas leaks; explain how to stay safe around gas in the kitchen, and if a gas pipeline leak is detected.

Background/Discussion: Natural gas is a safe fuel when used properly. To burn, natural gas must mix with the proper amount of oxygen and be ignited by a flame or spark. Burning natural gas without the proper amount of oxygen produces carbon monoxide, a deadly poison. When natural gas leaks, there is a risk of fire and explosion, and there is danger of fire if combustibles are stored or used too close to gas appliances.

There are more than three million miles of pipelines in the United States transporting natural gas to our homes, schools, and businesses. To make sure the gas reaches us safely, these pipelines—made of either steel or high-strength plastic—are thoroughly tested and maintained through a variety of methods. It is everyone's responsibility to be safe around natural gas pipelines, and to learn how to recognize and respond to the rare occurrence of a natural gas pipeline leak.

Ask: Have you ever smelled leaking gas? What did it smell like? (*Responses will vary.*) Explain that a chemical called mercaptan is added to natural gas to make it smell like sulfur or rotten eggs. Why do we want natural gas to smell bad? (*So we know when it's leaking and can protect ourselves.*)

#### Review:

A leak from a natural gas pipeline, although rare, can be a fire hazard. Pipeline markers can provide important information about whom to contact if you detect an outdoor gas leak. Remind students to be alert for any of the following signs, and explain what to do if they notice any of these:

Gas leak warning signs:

- A smell of sulfur or rotten eggs
- A hissing, whistling, or roaring sound
- Dirt spraying or blowing into the air from a hole in the ground
- Continuous bubbling in water
- Grass or plants dead or dying for no apparent reason

What to do:

- Do not use electricity or fire. Even the tiniest spark from a phone, flashlight, electrical device, or match could ignite leaking gas.
- Go far away from the area immediately. Do NOT go back until safety officials say it is safe.
- Ask a trusted adult to report the leak to 911 and the local natural gas utility.

Follow-up: Have students create posters showing safe and unsafe things to do if they smell a gas leak.

### **Page 8: Natural Gas Power**

Objective: List possible uses of natural gas.

Background/Discussion: Natural gas can be used to run appliances and equipment in homes, businesses, and schools, and for transportation. In addition, natural gas can be used to generate electricity. (The gas is burned to heat water and create steam that turns the turbines of generators in electric power plants.)

Going Further: Have students find out what percentage of the electricity supplied by their local electric utility is generated by natural gas. (This information can usually be found on the utility's website.)

### **Page 9: NGVs Get Us There!**

Objective: Calculate answers to arithmetic problems; consider the uses of natural gas in vehicles.

Background/Discussion: Ask students if they know whether their school bus, or a vehicle they ride in, is fueled by natural gas. If they don't, ask them to find out, and report back.

### **Page 10: Home Sweet Home**

Objective: Point out to students the dangers of storing flammable liquids near or around natural gas appliances. Ask them why this can be dangerous. (*The vapors could be ignited by a pilot light or appliance flame.*) Have them brainstorm other potential hazards around natural gas in the home. (*Storing books, papers, or potholders near a gas range flame.*) Gather data on natural gas use in the home.

Background/Discussion: Ask students to speculate about some of the ways their school might be using natural gas. Ask the building custodian or other staff to tell students how natural gas is used in their school.

Going Further: Have students share their findings about natural gas use at home. On the board, compile a list of all the reasons people gave for preferring various fuels.

### **Page 11: Natural Gas Can Heat and Cool**

Objective: Identify uses for natural gas in various workplaces.

Background/Discussion: Discuss safe practices for using a gas range, such as keeping the flame no bigger than the pot, and precautions to take around space heaters. (*Space heaters require proper venting and must be kept away from flammable objects like papers and curtains.*)

### **Page 12: Lighter Than Air**

Objective: Describe the characteristics of solids, liquids, and gases; experiment with the behavior of a gas.

Background/Discussion: Ask: What is matter? (*Anything that takes up space or has a mass of any kind. Everything you can touch is made of matter.*) A solid has a definite shape and volume. A liquid has a definite volume, but takes the shape of its container. A gas can change its shape and volume.

Activities: Use the behavior of the balloon as an analogy for the way gas molecules behave: the balloon moves freely, bouncing off the surfaces of its container (the room). Use several balloons to show how gas molecules bounce off each other.

Going Further: Natural gas can be safer to use than gasoline because if a fuel line breaks, natural gas disperses into the air rather than pooling on the ground the way gasoline does; therefore, it is less likely to catch fire. Natural gas also has a much higher ignition temperature than gasoline.

### **Page 13: Natural Gas Conservation**

Objective: Define conservation; identify ways to conserve energy.

Background/Discussion: Remind students that whenever we burn a fuel, carbon dioxide and other gases are released into the air. Carbon dioxide is a greenhouse gas; some of the other gases released when fuels are burned (e.g., carbon monoxide, nitrogen oxides) are air pollutants. Traditional natural gas is a nonrenewable resource, which means that once we use up the world's traditional natural gas supplies, they will be gone forever. It is important to use natural gas wisely, so that we preserve this important fuel for future generations.

Going Further: Possible energy-saving ideas: Set the flame just high enough to cover the pot bottom. Cover pots when cooking. Use a clothesline instead of the dryer. Wash full loads of dishes and laundry. Clean out the dryer lint filter before each load to improve airflow and reduce fire risk. Set the heating thermostat to 68°F

by day and 55°F by night. Close window coverings at night to retain indoor heat. Close doors quickly when you enter or leave a house where heat is on. Ask an adult to change heating filters at the start of each heating season.

#### **Page 14: Safety First**

Objective: Recognize important gas safety practices in and around the home.

Background/Discussion – Calling 811: Explain to students that natural gas comes to our homes and schools through pipelines that run under streets, sidewalks, yards, and homes. If people dig into these pipelines, they can be damaged and natural gas can leak out. Even a small leak can cause a fire or possibly an explosion. Protecting underground utility lines from damage is everyone’s job, so we all need to take care not to damage underground gas pipes with digging equipment.

Remind students that if someone they know is planning a digging project, they must call the 811 utility locator service by dialing 811 several days ahead of time so underground utilities can be marked for safety. The 811 service arranges for the location of gas pipelines and other buried utilities to be clearly marked so that people can dig a safe distance away from them.

Explain to students that after the 811 service receives a request to have underground utilities marked, a worker comes to the site and uses either colored spray paint or flags to indicate the location of buried utility lines. Natural gas lines are marked in yellow. Remind students that they should never tamper with utility flags or markings, as they are put there to prevent damage to underground utility lines and to keep people safe.

Ask for examples of types of digging projects that would warrant a call to the 811 service. (*Planting a tree or garden; grading a driveway; installing a sprinkler system; or building a home, an addition to a home, or a fence.*)

Background/Discussion – Indoor Gas Safety: Why is it so dangerous to store flammable objects near gas appliances? (*Gas appliances use a flame and some, like an oven or heater, can get hot enough to set fire to something flammable that is close by. Also, the fumes of flammable liquids could be ignited by the flame or pilot light inside a gas appliance.*) What does it mean if your gas range has a large, yellow, or flickering flame? (*It is not working properly and you should call a repairperson.*) Why shouldn’t you let small children play with gas appliances? (*They could turn on the gas by mistake, or damage the pipes and cause a gas leak.*)

#### **Page 15: Smell, Leave, and Tell**

Objective: Know what to do in case of an indoor gas leak; explain how to stay safe.

Background/Discussion: Ask: Why should you tell an adult when you smell gas? (*There is danger of fire or explosion.*) If you smell gas when no adult is home, what should you do? (*Leave and take everyone with you. Don’t use a light switch, TV, remote controller, garage door opener, candle, flashlight, radio, or even a phone, as a spark from any of these could ignite leaking gas. Go to a safe location and ask a trusted adult to report the leak to 911 and the local natural gas utility. Don’t go back home until safety officials say it is safe to do so.*)

Going Further: Any of the above actions could cause a spark or flame that would ignite leaking natural gas.