VIRTUAL LABS

BRIEFING document Future Power

Intro

Your local power company, LightBright Electric, produces elec tricity for a small city. They need help deciding what kind of fuel to use to make the electricity. Currently, they use natural gas. Coal is cheaper but it produces carbon dioxide, which con- tributes to global warming. Natural gas produces less carbon dioxide, but its price is going up.

What fuel should LightBright use to keep costs low and produce less carbon dioxide?

Mission

The Problem: The Problem: Your local power company wants to produce low-cost electricity and control its carbon dioxide (CO_2) emissions.

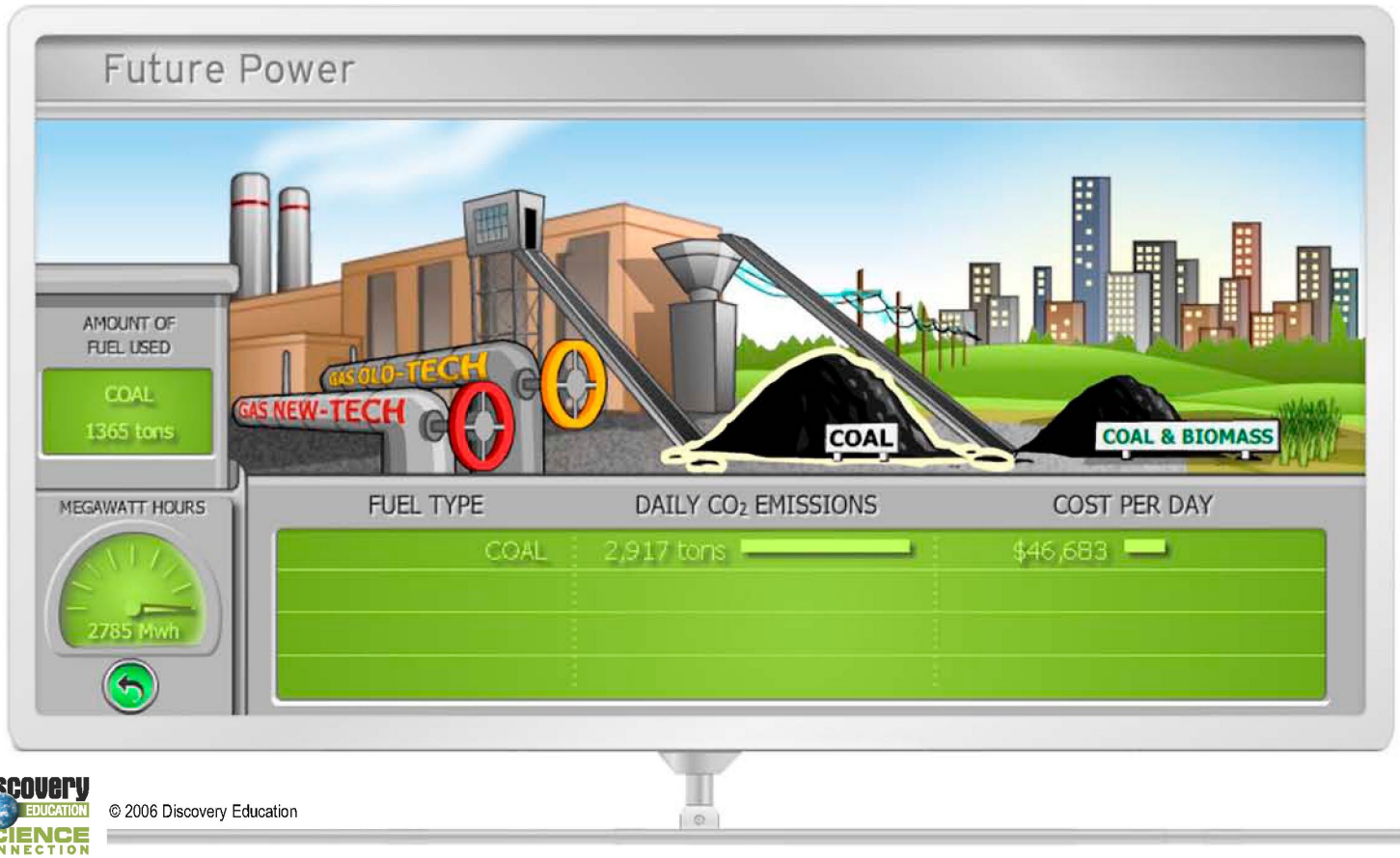
Your Mission: Figure out which of four fuel options will be best for LightBright Electric: coal alone, a mixture of coal and plant material, natural gas using the company's old technology, or natural gas using a new technology.

Explore

First go to the Explore Lab. Here you will find an image of the power plant along with the four fuel options. When you try out the different fuels, you can see how much it costs to light up the city and how much carbon dioxide is produced each day.

Here's how to use the Lab:

- **Gas New-Tech** Click on the valve to use this fuel.
- **Gas Old-Tech** Click on the valve to use this fuel.
- **Coal** Click on the pile of coal to use this fuel.
- **Coal & Biomass** To use this fuel, click on the pile of coal that has the plants growing next to it.
- **Small green window** Displays selected fuel and amount you have burned.
- **Green dial** Displays amount of electricity generated by the type and amount of fuel you have selected.
- **Large green window** Displays CO_2 emissions and cost per day for each fuel you use to produce electricity.
- **Reset** The arrow button erases the data in the window.
- **City** The buildings light up when enough fuel has been burned to power the city.



Suggested Explorations

First, figure out how to light up the city with each of the four fuel options. Then ask a testable question about the different fuels that you can explore in the Explore Lab.

Here's a sample question:

How does changing the fuel option affect the cost of powering the city for one day?

Here's a procedure you could use to explore that question:

1. Click on Gas New-Tech until you have powered the city.
2. Click on Gas Old-Tech until you have powered the city.
3. Click on Coal until you have powered the city.
4. Click on Coal & Biomass until you have powered the city.
5. Print or record your results.
6. Compare the daily cost for the four fuel options.

Now ask another question about the different fuels to explore. For example, you might explore the question, "How does adding biomass to coal affect the amount of carbon dioxide produced?" Or, "How does changing the technology affect the amount of natural gas used each day?" You may assume that the new technology is more efficient than the old technology.

As you investigate the different fuels, costs, and emissions, start to think about how the cost of producing electricity might be affected if (1) gas prices go up or if (2) LightBright Electric is required to pay a tax on its CO_2 emissions. Both a price increase and an emissions tax could increase the company's fuel costs — and that might affect the company's fuel choice. You will have to take these factors into account when you make your recommendation to LightBright.

Do you have any bright ideas? If you do your explorations systematically and record your results carefully, you should be well on your way to making a good recommendation.

Plan

Now it is time to plan an experiment that will help you recommend the best fuel choice for LightBright Electric. In the Experiment Lab, you will have the same four fuel options as before, but now you will be able to investigate increasing gas prices and different levels of emissions taxes, too. You will be able to look at current gas prices, prices predicted for 10 years from now, and prices predicted for 20 years from now. You will also be able to look at different tax rates: $25 per ton of emissions, $50 per ton, and $100 per ton. These variables can help you decide the best fuel choice.

But how do you know whether gas prices will *actually* rise and whether an emissions tax will *actually* be imposed? You don't! You will have to make some assumptions and explain them in your plan. And how will you know which fuel choice is "best"? Is the cheapest option always the best choice? You will have to make that decision, too, and explain it in your plan.

If you need help writing the plan, consult the *Virtual Labs Student Guide*. Remember, you can use everything you learned in the Explore Lab, along with information in this Briefing Document. You can also use the Plan Resources, which you will find in the Virtual Lab under "Plan."

Be sure to look at the "Carbon Dioxide Emissions Graph," which shows CO_2 emissions over 20 years for each of the four fuel options you are investigating. Use this graph to help you think through the long-term costs and environmental effects of each fuel option. You can find this graph on the last page of this Briefing Document, as well as in the articles section of the Virtual Lab's Plan Resources.

Write your plan in your notebook. Have your teacher approve it before you go to the Experiment Lab.

Experiment

Go to the Experiment Lab and conduct your experiment. Record everything that happens at each step. You may need to make a chart to keep track of all the data. When you are finished, write a short summary of your experiment, including your results and your recommendations to LightBright Electric.

Did any of your results surprise you? If so, describe them in your summary. Scientists often learn more from unexpected results than from experiments that go exactly "according to plan."

When you have finished your summary, share your plan and your results with your classmates. Did you all start with the same assumptions? Do you come to the same "best choice"?

Whatever the outcome of your individual efforts, together you will have learned some things about the costs and environmental impacts of different fuels that are used to generate electricity. And that is exactly how science gets done: by exploring, asking questions, planning, experimenting, and sharing information with other curious people — like you!

Some Helpful Information

Carbon Dioxide (CO_2): Carbon dioxide is a gas that occurs naturally in Earth's atmosphere. You exhale CO_2 every time you breathe out. It is also released by volcanoes and by plants and animals when they decompose.

CO_2 is also produced whenever fossil fuels — coal, oil, and natural gas — are burned. When fossil fuels are burned, they release large quantities of CO_2 into the atmosphere. In fact, in the United States, the burning of fossil fuels to generate electricity is responsible for about 40% of the country's total CO_2 emissions.

If CO_2 occurs naturally, why worry about it? Many scientists worry that by burning fossil fuels, humans have been releasing too much CO_2 into Earth's atmosphere. They worry because CO_2 is a greenhouse gas, a gas that traps heat in the atmosphere. On the one hand, this heat-trapping property enables Earth to support life. On the other hand, the steady increase in greenhouse gases due to human activities is believed by many scientists to be causing Earth's temperatures to rise. This temperature rise is called *global warming,* and it may lead to unwanted global changes in Earth's sea levels, weather patterns, landscapes, and ecosystems.

Carbon Dioxide Emissions Tax: Concerned about global warming, some governments have decided to impose taxes on CO_2 emissions. These taxes charge companies like LightBright a certain amount of money for every ton of carbon dioxide they release into the atmosphere. These taxes make it more costly for the companies to run their businesses, giving them a good reason to develop and use fuels, materials, and processes that emit less CO_2.

Biomass: *Biomass* is living or recently harvested plant material that can be used for fuel in industrial production. Examples of biomass include grass, corn, and sugarcane. When biomass is burned with coal in power plants, the power plant's overall CO_2 emissions are reduced. This is because the carbon from biomass cycles to the atmosphere whether it decomposes naturally or is burned for fuel, so it does not contribute to the build-up of greenhouse gases in the atmosphere.