Investigating Missouri’s SO2 and NO emissions from energy plants.

**Missouri Learning Standards**

**9-12.PS3.A.3** – Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

**9-12.ETS1.B.1** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

**9-12.ETS1.B.2** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Learning Outcomes**

- I can identify and describe how energy/temperature flows within a system and transfers between systems.
- I can create a model that demonstrates how energy is conserved within a system and calculate the change in energy of that system.

**Map URL:** http://arcg.is/15bnfq

**Ask**

What is being consumed and emitted in Missouri’s energy plants?

- Students click on the URL above to access the map.
- What do you think the larger circle mean on the map? *(The larger the circle, the larger the water consumption is. Students will not come to this conclusion on their own, unless they are shown the map key.)*
- What regions do you think will have the highest SO2 and NOx emissions? *(Answers will vary. At this point no correct answer is necessary; just get a feel for what the students are thinking.)*

**Acquire**

What types of energy are being used in your region of Missouri?

- Student groups will be assigned one of the following regions of Missouri (*Northwest, Northeast, St. Louis, Central, Kansas City, Southwest, and Ozark*).

**Explore**

Which types of energy plants are emitting the most SO2 and NOx?

- On the content tab, find the US POWER PLANTS WITH EMISSIONS. Underneath click on the 3-shape icon (circle, square, and triangle). Change the second drop down menu and select EIA Model Estimates of NOx emission.
- What type of energy plant emits the most NOx? *(Coal)*
- Where are those plants located and how many are within that region? *(STL-3, SE-3, NE-1, KC-1)*
- What type of energy plant emits the most SO2? *(Coal)*
- Where are those plants located and how many are within that region? *(NE/NW-1, STL-2, SE-2)*
Analyze

Is there a correlation between types of energy and population density?

? Does it make sense for wind turbines to be located in less densely populated areas? (Answers may vary; however, hopefully they realize that wind turbines take up some amount of ground space. This would be a good time to pull up pictures of some wind turbines to show the students who may have never seen them before).

? Are the hydro plants located in the areas found? (Answers may vary, however they should make the connection that there is a vast lake and many rivers located in that region of Missouri. If not, perhaps zoom in on the map and show them the water features found in those areas).

? Are the plants that emitted more SO₂ and NOₓ located in highly populated areas? (NOₓ: Just in the STL and KC regions; SO₂: just the STL region)

Act

How can Missouri be greener?

? What can Missouri do to have fewer emissions? (Answers may vary)

Change the Data Style | Identify a Map Feature

- Using the Details pane, click the button, Show Contents Of Map.
- Hover over the layer name.
- Under the layer name, select the button, Change Style.
- For Choose an Attribute to Show, select an attribute to map.
- For Select A Drawing Style, select the best symbology for the data.
- Click any feature on the map, and a pop-up window will open with information.
- Links and images in the window are often clickable.
- An arrow icon in the upper-right of the window indicates that multiple features have been selected. Click the arrow button to scroll through the features

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to U.S. public, private, and home schools as a part of the White House ConnectED Initiative. A school subscription provides additional security, privacy, and content features. Learn more about

WWW.ESRI.COM/GEOINQUIRIES

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