Where does our Energy Come From?

Objectives: Students will explore data around energy use to make inferences about the connection between energy use, resources and climate change.

Time: 2-3 class periods

Teacher background:
This lesson uses a set of charts put out by the Lawrence Livermore National Laboratory that present data on energy and resource use over time: https://flowcharts.llnl.gov/

While the data in this charts is compelling and accessible, the creators of these charts use energy units that most people are not familiar with. To make matters more complicated, different data sets use different units. Here are some notes which help show the conversion between the energy units used in the LBL data sets.

There are five types of data that can be accessed:

1. **Energy consumtion data for the United States** (https://flowcharts.llnl.gov/commodities/energy). This data has compiled energy use using a unit called a "Quad", which is a quadrillion BTUs (British Thermal Unit). A BTU is 1055 Joules, so a Quad is 1.055×10^{18} Joules. "Energy Services" is energy that goes to actual useful purposes, whereas "Rejected Energy" is energy that is wasted as heat, sound, etc.

2. **Energy consumption data for individual states** (https://flowcharts.llnl.gov/commodities/energy). This data uses a different unit, Trillion BTU. 1 Trillion BTU is 1.055×10^{15} Joules (or one thousandth of a Quad).

3. **Energy consumption data for other countries** (https://flowcharts.llnl.gov/commodities/energy). This data uses, unfortunately, a third unit called a "PetaJoule" (PJ). A PJ is 1 quadrillion Joules, or 1×10^{15} Joules. This is quite close to a Trillion BTU, so for the purpose of this activity you can assume 1 PJ = 1 Trillion BTU.

4. **Carbon emissions data for the United States** (https://flowcharts.llnl.gov/commodities/carbon).

5. **Water usage data for individual states** (https://flowcharts.llnl.gov/commodities/water).

Lesson:

1. (10-15 min.) Show students the most recent Energy Use Flowchart from https://flowcharts.llnl.gov/commodities/energy. You could project it on a screen or print it out for students.

   Have students list questions as they are studying this chart. At first, the chart will likely be confusing to them, but consider that they may learn better by wrestling with this complex set of data and working with each other to figure it out - rather than walking them through it yourself. (There are some good online tools, like padlet.com, that could be used to have students generate questions and help each other answer them, as they work through trying to understand this chart.)

3. (10-15 min.) Have a class discussion about their thinking on this graph. Answer any clarifying questions they may have, especially about units and what the different sources of energy mean.

4. (5-10 min.) Split the class into groups. Show the class all the data sets at https://flowcharts.llnl.gov/ and give the groups 5-10 minutes to explore the data. Each group generates questions that they have from exploring the data.

5. (30-50 min.) Each group chooses a question that they would like to explore. Groups will be given 30 minutes to gather data from the LBL data sets (or other sources) in order to try to come up with information to help answer their question.

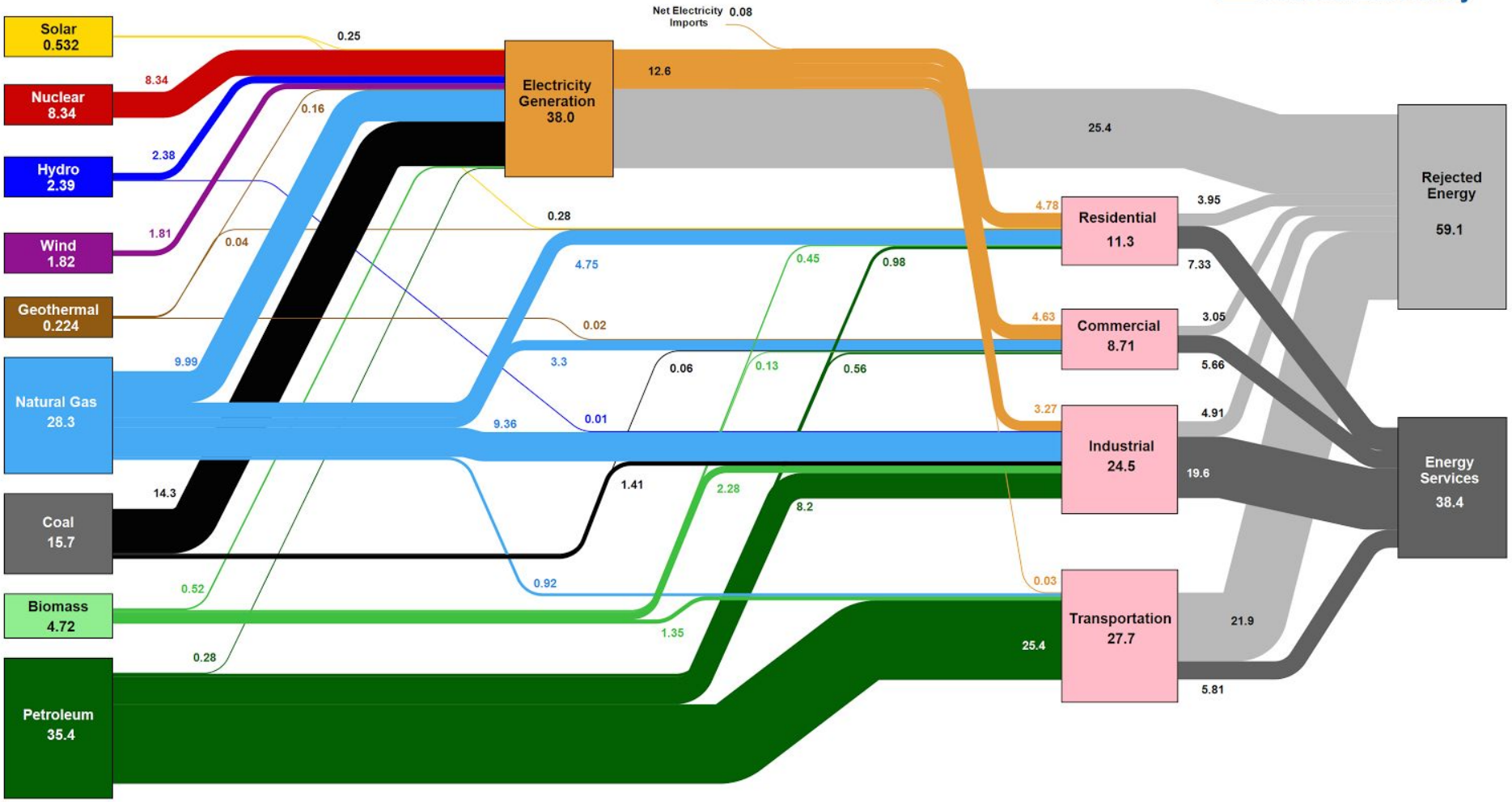
Encourage students to compare data and make their own graphs to visualize differences they observe in the data. You can make this more or less in-depth depending on time and the level of your students.

6. (20 min.) Groups come up with a short presentation to share what they learned. Here are some links to some presentations from Mark Goldner's 8th graders: https://drive.google.com/folderview?id=0B6x4wqEibb4TY0ZjcVljN1BGX28&usp=sharing

7. Groups present to the rest of the class and generate further questions and discussion. One useful way for groups to present to each other is to record themselves (using QuickTime screencast, for example) and share through a class blog or other website.

Estimated U.S. Energy Consumption in 2015: 97.5 Quads

Lawrence Livermore National Laboratory



Source: LLNL March, 2016. Data is based on DOE/EIA MER (2015). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.8% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527