**Generating Solutions to Electrical Energy Production**

**Curriculum Connections**:

The topics addressed in this workshop are relevant for **9 science** (E: electricity), **10 science** (D: climate change, E: light), **11U physics** (F: Electricity and Magnetism, D: Energy and Society) and **12C physics** (D: Electricity and Magnetism, E: Energy Transformations).

**The Problem: Climate Change**

* **Climate change is a fact.** <http://bgr.com/2014/01/29/global-warming-gif-video/>
* **Climate change by human activity is a fact.** <http://climate.nasa.gov/scientific-consensus/>
* **The solution will come from ...**

1. **‘Alternative’ Energy Sources:** What do you see?
2. Noise, bird deaths, ugliness, loss of farmland
3. Elegance, hope, progress
4. Hippy pipe dreams, not economically feasible

**2) Things are changing fast!** <http://energyeducation.ca/encyclopedia/Electricity> (bottom of page)

1. Select bar graph. This shows world **electrical energy production** in 2013. Which regions have increased their output significantly since 1985? Push play.
2. Asia Pacific B) Europe and Eurasia C) North America D) all three
3. Select **Wind Power**. When did wind power become viable?

A) 1970 B) 1980 C) 1990 D) 2000

1. Select **Solar Power**. Europe is leading the way. When did solar power become viable?

A) 1970 B) 1980 C) 1990 D) 2000

**3) Where are things changing most?** <http://energyeducation.ca/encyclopedia/Electrical_generation>

a) What percentage of the world’s electrical energy comes from solar/wind/other?

A) 20% B) 45% C) 70% D) 85%

1. What percentage of the world’s electrical energy causes carbon dioxide emissions?

A) 20% B) 45% C) 70% D) 85%

1. What percentage of Canada’s electrical energy causes carbon dioxide emissions?

A) 20% B) 45% C) 70% D) 85%

1. Which country has the largest percentage of each carbon-free source?

hydro ( ) thermal ( ) wind ( )

solar ( ) biofuel/waste ( ) nuclear ( )

1. How did Denmark achieve their recent turnaround?

**4) Wind and Solar Energy Need Storage** <https://en.wikipedia.org/wiki/Solar_power_in_Germany>

1. How would a graph from Denmark look different?
2. Why does nuclear change so little?
3. Which has a greater need for storage – wind or solar? Consider the effects of the facts below.

Solar installations are more expensive

Solar power is more variable

Solar power occurs in the daytime, when demand is highest.

Large arrays of wind turbines linked together are less variable.

**5) Storing Electrical Energy** <http://www.awea.org/Issues/Content.aspx?ItemNumber=5452>

What are the advantages and drawbacks of these different storage technologies?

a) Pumped Hydro:

1. Compressed Air Storage:
2. Capacitors:
3. Flywheels:
4. Batteries:
5. **Exploring EM Generation and Storage**
6. **Generating Electricity:** Attach the generator to a voltmeter and then a variety of loads. What happens when you turn very slowly and moderately fast? What happens when you stop?
7. **Storing Generated Electricity:** Use the generators to charge the capacitors. What happens when you stop turning? After the capacitor is charged, see how well it can handle each of the loads.
8. **Small Consumer Product:** Does the flashlight use storage? How can you tell?
9. **Exploring Solar Cells:**
10. **Generating Solar Power**: Get the highest voltage with the solar cells. What did you have to do? Attach the cells to various loads. Which can they power?
11. **Storing Solar Power**: Attach the solar cells to a capacitor and a voltmeter. How was this different from the EM generation?
12. **Small Consumer Product:** Does the garden light use storage? How can you tell?