



A drawing from a Smart Power focus group participant when asked how we will be powering our future. Notice the date 2525, This person clearly thinks that there will be a renewable energy future, they just think it is a long way off. This is a very common perception about renewable energy that may be incorrect.

Energy Notions

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Lesson Zap! - Energy Notions



Background

The goal of this exercise is to explore what your students know about energy sources that create electricity and about emerging technologies that will impact their lives. You might find out that they know nothing. You may find out that they think things will stay the same forever. You may find out that they have no idea what the future may look like.



Objectives:

Students will be introduced to:

- Types of natural resources that are used to generate electricity.
- How we use electricity in the US
- Costs of electrical generation.
- Possibilities for the future electrical generation



Suggested Level

Middle & High School



Time Required

20-40 Minutes



Materials Required

- Paper
- Writing & Drawing Implements
- 5 Two Liter Bottles
- Food Coloring

Doing the Activity

Preparation

Create five 2-liter bottles to represent the fuels used to generate electricity in the US. A full bottle is all of the fuel we use to generate electricity in the US.

Fossil Fuels	70%	1400ml	~ a little less than 3/4 full
Nuclear	20%	400ml	~ a little less than 1/4 full
Hydro	7%	140ml	~ a little less than 1/10 full
Renewables	2.5%	50ml	
Other	.5%	10ml	

In addition to getting some paper and writing implements together, we also recommend making yourself familiar with patterns of US energy generation and consumption related to electricity.

We have provided a short fact sheet at the end of this lesson, but there are a variety of web resources that research this topic for a living and we recommend visiting these sites and doing some research.

This lesson plan is an adapted from recent research about energy perceptions done by **Smart Power**, an energy advocacy group located in Rhode Island. A synopsis of the research is attached to this lesson and more information can be found <http://www.smartpower.org>.

Important Note:

In this lesson we are talking about fuels used to generate electricity, not fuels used for transportation. Almost all of our transportation fuel is petroleum based. Jet fuel, gasoline, diesel fuel are all petroleum based. A small percentage of vehicles use natural gas and biofuels (ethanol and biodiesel) but it less than 5%

Class Time

Part I. - What do they Know?

Begin your discussion by turning on a light or some object in your classroom that requires electricity. Ask your students where the electricity comes from to power this device?

Write down any responses they offer on the blackboard, some of these may be sound silly, but write them down anyway. You may hear things like; *the local power plant, over the wires, from generators*. These are good answers but guide them think about the fuel sources that are used to drive the generators.

(Important note: depending on the age of your students, or what you have been teaching them, they may or may not have an idea about how electricity is generated. If they do not have any background in this area you may need to talk about this. Additional resources to teach about this subject are provided in the support section of this lesson.)

As they provide you with a list of fuels write them on the board. Some may be renewable resources (wind, solar, hydro, biomass) Others may be non-renewable (oil, coal, gas). Do not make any judgments, just write the responses on the board. If you want to break this list down you might ask if there are any differences between these “fuels”, or they can be put into categories.

Pass out sheets of paper and ask them to write at **least** five words that come their mind when thinking about oil, gas or coal (non-renewable energy sources). **DO NOT** try to influence the words they associate with these fuel sources. You are trying to get a real baseline feel for what they know or think about these energy sources.

On the other side of the paper ask the students to draw a picture of a town, city or region might look like once we have utilized all of our non-renewable energy sources (oil, gas, coal). You should ask them to date their pictures as well in an attempt to see how long it will be until we see this future.

While they are drawing inspect their pictures ask them to include things like how we would heat our homes, make electricity, transport ourselves. Do not give them hints let them try to figure it out.

Give students about 10-15 minutes to complete both tasks

PART II. Listening to Student Responses

Remember the goal of this lesson is to get a baseline reading on how your students think about electricity and energy in a very general sense. What are some of their preconceived notions. What do they know? What don't they know?

Once the students look finished have them share the words they used to describe fossil fuel energy sources. Write them all down on the board. Ask them why they use certain terms. Do they describe these fuels positively or negatively? Contrast this with the information found from adults in the Smart Power study (many thought it was evil and dirty but necessary to sustain our lives). Are there any differences in the way the younger generation perceives non-renewable resources?

Now take some time to talk about the pictures. If they have images of cars ask them what fuel they will use to move those cars. How are they going to heat their houses and make electricity or are they going to go without those necessities?

For Advanced Students

If you want to find out how someone feels about something, take it away from them. After students have written their words to describe fossil fuels, ask them to imagine that these fuels on earth have run out. Their task is to write an remembrance of this fuel, including:

- *What was the caused it to run out?*
- *What will it be remembered for?*
- *Who will take its place?*
- *Who will miss it?*

How far into the future did they think these changes would happen. Is it 20 years off or 200 years off?

Part III. What is the Reality?

Pull out your bottles, which are a visual representation of the fuels we use to generate electricity in the US.

Remember what these bottles represent:

Fossil Fuels	70%	1400ml	~ a little less than 3/4 full
Nuclear	20%	400ml	~ a little less than 1/4 full
Hydro	7%	140ml	~ a little less than 1/10 full
Renewables	2.5%	50ml	
Other	.5%	10ml	

Discuss this model with the students some questions to ponder include:

- What do they notice about the fuel mix used to generate electricity?
- Where do they think we get all this fuel (Fossil, Nuclear, Hydro)?
- What they think will happen as the biggest bottle of fuel begins to run out. What do they think will take its place?
- Will it biggest bottle ever run out? If so, when? 50 years, 100 years, 200 years in the future?
- Have they heard of technologies that could replace fossil fuels?
- What are those technologies? Do they have problems? Do all energy sources have problems?
- What are the impacts of this type of fuel mix described above — negative and positive?
- Is there a way that we could use the same amount of fuel to generate more electricity?
- Is there a way we could reduce the amount of electricity we use and still lead normal lives?
- Have you heard about energy efficiency? What is it?
- Is our electricity demand increasing or decreasing?

Once again we are not trying to teach them about all of the details now we are trying to gauge where they are coming from as we start an energy unit.

Once you have a better idea of where they are starting you can start to teach them about how electricity is generated, the variety of sources we use and some possible visions of the future and how far away those futures may be.

Additional Resources

Additional resources for this lesson can be found on the KidWind website.

<http://www.kidwind.org/materials/Lessons/notions/Renewablenotions.html>

<http://www.smartpower.org/> - This lesson was based on research done by **SmartPower**, a research and advocacy group trying to increase the amount of renewable energy that people use in the Northeast and Mid Atlantic States.

<http://www.eia.doe.gov/> - This is the official site of the US Department of Energy. There is a ton of really useful very up to date information here, but it can get bit dense take your time and explore. They also have a kids section which is quite well done.

<http://michaelbluejay.com/electricity/index.html>— Interesting website on electricity, where it comes from and how to save it. Not super reader friendly but interesting and readable information.

<http://science.howstuffworks.com/electricity.htm> - What you expect from *How Stuff Works* a nice background on electricity, generators and other electrical topics, but it can get bit confusing as all the info is surrounded by piles of ads.

<http://www.energyforkeeps.org/> - A great book on electricity from renewable and non-renewable resources. One of the best guides we have ever found for teachers and well worth the price.

<http://www.need.org/guides.htm> - The mission of the **National Energy Education Project** is to create and educated body of citizens who can make knowledgeable energy decisions. They have created a dazzling array of curriculum materials at all levels to do this. Definitely check out this website!

<http://www.ase.org/> - This is a nice site from the **Alliance to Save Energy**. You can learn about energy and electricity consumption and how we can reduce the amount we need to live our lives. Lots of lesson plans here as well!

<http://www.brainpop.com/science/seeall/> - Brain POP is a great site for science shorts. Head to this page and click on the electricity icon. The site costs a little to use but it is great!

<http://www.kelvin.com/> - If you are handy you can find lots of do it yourself stuff on the web about building generators, but if you are busy you can buy some nice hands on kits related to generators and electricity production at Kelvin

SmartPower Consumer Energy Study in a Nutshell

This synopsis is adapted from a presentation made by Brian F. Keane, Executive Director SmartPower in October 2004.

SmartPower research is based on the fact that studies continue to show consumers are willing to switch and pay more for renewable energy, yet there is minimal market activity to date. SmartPower wanted to understand what are the *emotional barriers* which prevent people from purchasing clean energy and what are the most powerful *emotional hooks* that could make clean energy important and desirable to the American public?

SmartPower brought together focus groups to explore how the public perceives current energy choices. Participants were charged to write an obituary. Respondents were asked to imagine fossil fuels on earth have died. Their task is to then to write an obituary including:

- What was the cause of death?
- What will it be remembered for?
- Who will take its place?
- Who will miss it?

They found that many people were far less critical of fossil fuels than you might have imagined. Many felt it was scary to imagine our world without fossil fuels. While many participants clearly recognized the problems of pollution, health and energy independence, they see fossil fuels as a necessary evil because it can be relied on to power our world. They also did not know about reliable alternatives. While they were all comfortable discussing clean energy and know how it's made -- they don't see it as "being up to the job" and is viewed as "eccentric" with "kinks to work out."

Next, they asked respondents to draw what their "clean energy" world would look like and to name their "worlds" and date them. The pictures reinforced the prior findings; fossil fuels are viewed as a necessary evil -- bad for health, bad for the environment, bad for national security. But at the end of the day, it keeps my house warm. Some other findings were that:

- Clean energy is simply not seen as up to the job
- Using clean energy would require sacrifices
- Clean energy is just too far in the future to be useful now

As the obituaries and the drawings tell us we need to convince people that clean energy is *strong* enough to take the place of coal, oil and nuclear. They also found that we need to inform consumers that these sources are *available and happening now*. From this research came an advertising campaign that tries to convince people that clean energy is *viable and available*.

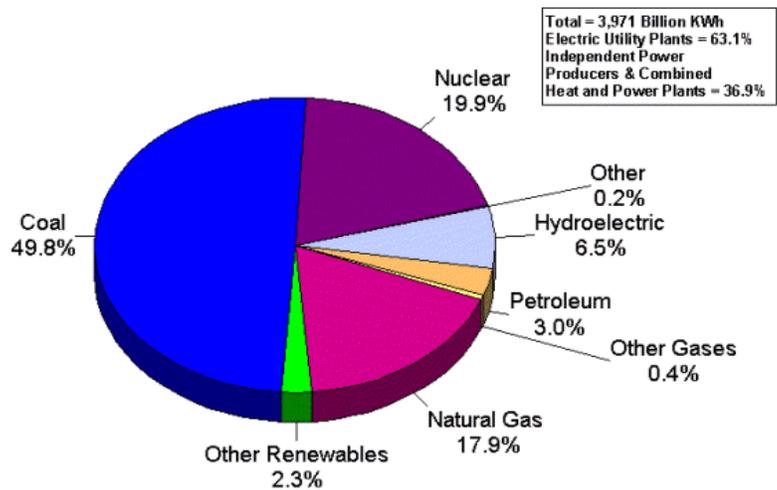
The slogans, ads and radio spots created by this research is called **Clean Energy: Its Real. It's Here. It's Working. Let's Make More.** Now SmartPower is doing research to see if this campaign changes any peoples mind about renewable energy choices.



US Electricity Consumption & Production in a Nutshell

Where does it come from?

This chart shows the fuel sources that are used to generate electricity in the US. These are nationwide totals and there are regional differences in fuel sources used to generate electricity. In the Northeast they use a lot more natural gas and much less coal, in the Midwest they use less natural gas and more coal.

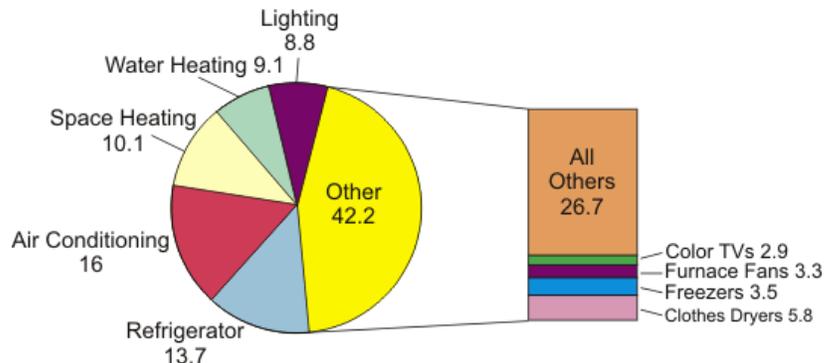


Note: Conventional hydroelectric power and hydroelectric pumped storage facility production minus energy used for pumping.

Source: Energy Information Administration, Form EIA-906, "Power Plant Report."

What do we use electricity for?

These are the common uses for electricity in the US. Air conditioners and refrigerators are big users as is lighting for homes and businesses. If we could build more efficient refrigerators and air conditioners we could save quite a bit of electricity. This is why many people think we need to focus on efficiency and not increasing generation.



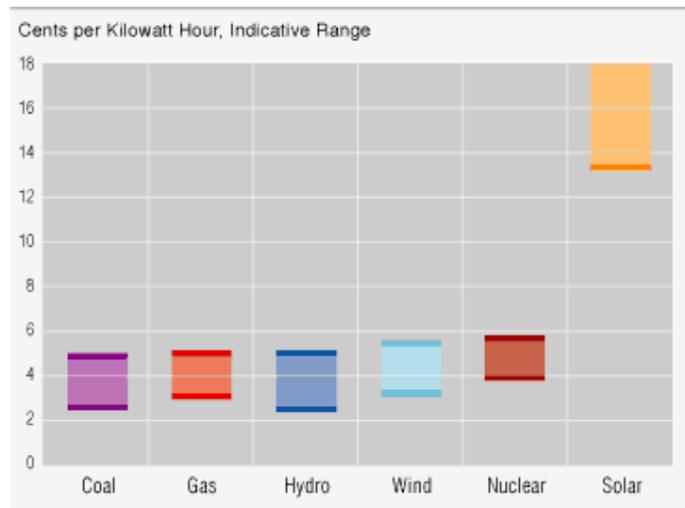
Source: Energy Information Administration, Form EIA-457A, B, C, E, and H of the 2001 Residential Energy Consumption Survey.

What does electricity cost from different fuel sources?

As you can see from this chart the price of electrical generation from coal, natural gas, hydro wind and nuclear are quite close. In recent years natural gas has gotten 20-40% more expensive. Wind energy has recently become very competitive as the technology has improved. Solar is still quite expensive!

Please keep in mind that these are generation costs. You typically pay more for electricity at home due to transmission and other charges.

Costs Converging Though Wind, Nuclear, Solar Remain Higher Cost for Power Generation



Source: <http://www.exxonmobil.com/corporate/Newsroom/Publications/eTrendsSite/chapter5.asp>

Who uses electricity?

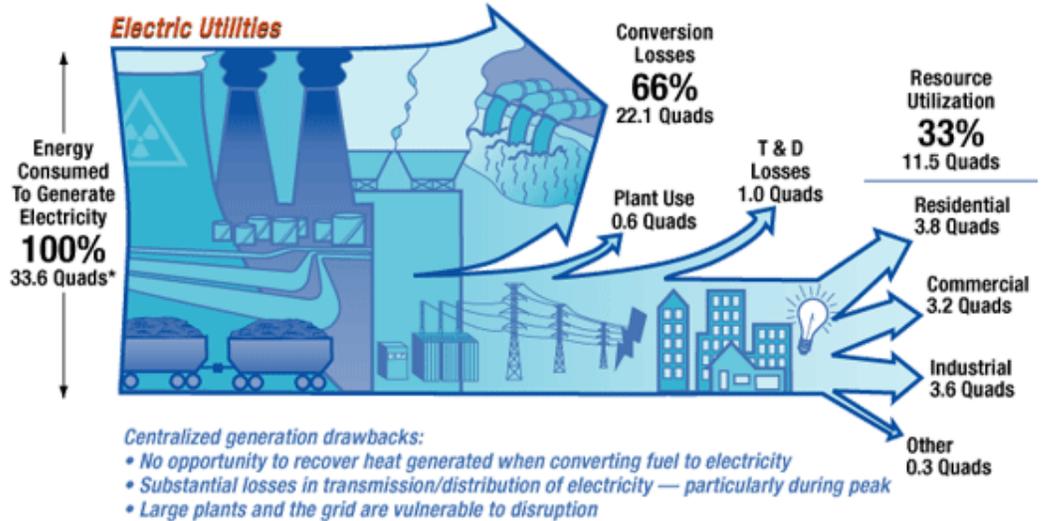
Different sectors of the US economy use different amounts of electricity.

Commercial 30%
 Industrial 34%
 Residential 33%

Notice on this chart that 66% of the electricity we generate is lost during the conversion process!
 Yikes can't we do better?

Current U.S. Electricity Consumption

Opportunity — Useful heat rejected/dumped to the environment



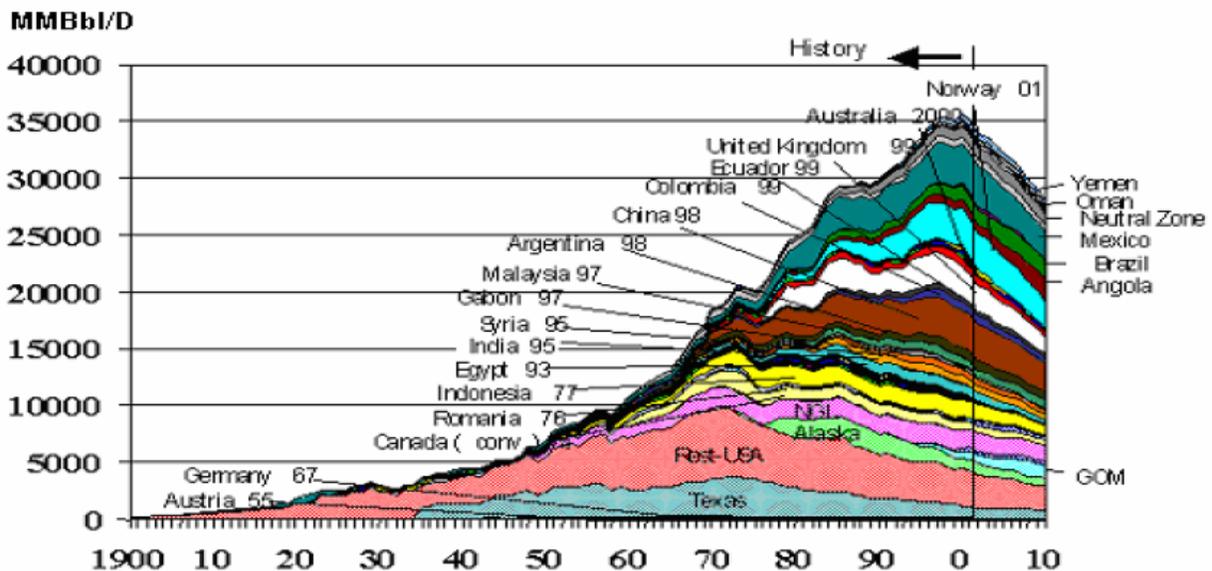
*Quads — Quadrillion Btu's

This chart is from National Renewable Energy Lab website <http://www.nrel.gov/dtet/about.html>

How much fuel do we have left?

There is a great deal of debate regarding how much non-renewable fuel (oil, natural gas and coal) remains on there earth. Some people think that petroleum production has peaked and will decline as predicted by the **Hubbert Peak Model**. Others counter that higher price will lead to more exploration and therefore more production. Please note that this curve is only related to oil production, many experts suggest that there is plenty of coal remaining for 100s of years of use but this will come with a high cost as coal as currently used creates a great deal of pollution and CO₂ which is a greenhouse gas.

Non-OPEC, non-FSU Oil Production Has Peaked and is Declining



Hubbert peak graph from public domain document "Strategic Significance of America's Oil Shale Resource Volume I Assessment of Strategic Issues"