



# SCIENCE DISSECTED

## *Renewable and Non-Renewable Resources Model-Evidence Link Diagram (MEL)*

Energy sources are divided into two groups — renewable (an energy source that can be easily replenished) and nonrenewable (an energy source that we are using up and cannot recreate). Renewable and nonrenewable energy sources can be used to produce secondary energy sources including electricity and hydrogen.

About 92% of the energy consumed in the United States comes from non-renewable energy sources, which include uranium ore and the fossil fuels — coal, natural gas, and petroleum. Renewable energy sources including biomass, hydropower, geothermal, wind, and solar provide 8% of the energy used in the United States. Most renewable energy goes to producing electricity.

**Model A:** *Renewable energy resources are the most effective way to support a community and satisfy consumers.*

**Model B:** *Non-Renewable energy resources are the most effective way to support a community and satisfy consumers.*

**Evidence #1:** Oil emissions release carbon dioxide gas into the atmosphere which have negative impacts on the environment and human health.

**Evidence #2:** Wind power does not release emissions that pollute the air or water, thus it is a cleaner energy resource than fossil fuels.

**Evidence #3:** Although Solar energy does not burn fossil fuels, it has other environmental hazards, such as releasing toxic materials and chemicals and impacting animals and their habitats.

**Evidence #4:** 81% of carbon dioxide emissions in 2010 came from Coal which is detrimental to the environment and human health.

**The following is a suggestion for using this MEL with students:**

1. Hand out the Renewable and Non-Renewable Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the four evidence texts presented.
2. Handout the four evidence text pages (pages 3-7).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-4 (pages 4-7).
5. Handout page 2 for the students to critically evaluate their links and construct

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of renewable and non-renewable resources and create questions that they might explore in the future.

Name: \_\_\_\_\_ Period: \_\_\_\_\_

**Directions:** draw two arrows from each evidence box. One to each model. You will draw a total of 8 arrows.

**Key:**

	The evidence <b>supports</b> the model
	The evidence <b>STRONGLY supports</b> the model
	The evidence <b>contradicts</b> the model (shows its wrong)
	The evidence has <b>nothing to do with</b> the model

Standard: P8C4, N8B1

**Evidence #1:**  
Oil emissions release carbon dioxide gas into the atmosphere which have negative impacts on the environment and human health.

**Model A**  
Renewable energy resources are the most effective way to support a community and satisfy consumers.

**Evidence #3**  
Although Solar energy does not burn fossil fuels, it has other environmental hazards, such as releasing toxic materials and chemicals and impacting animals and their habitats.

**Evidence #2**  
Wind power does not release emissions that pollute the air or water, thus it is a cleaner energy resource than fossil fuels.

**Model B**  
Non- Renewable energy resources are the most effective way to support a community and satisfy consumers.

**Evidence #4**  
81% of carbon dioxide emissions in 2010 came from Coal which is detrimental to the environment and human health.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

- A. Write the number of the evidence you are writing about.
- B. Circle the appropriate descriptor (**strongly supports** | **supports** | **contradicts** | **has nothing to do with**).
- C. Write the letter of the model you are writing about.
- D. Then write your reason.

1. Evidence # \_\_\_\_ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model \_\_\_\_ because:

2. Evidence # \_\_\_\_ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model \_\_\_\_ because:

3. Evidence # \_\_\_\_ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model \_\_\_\_ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)										Highly Plausible
<b>Model A</b>	1	2	3	4	5	6	7	8	9	10	
<b>Model B</b>	1	2	3	4	5	6	7	8	9	10	

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct
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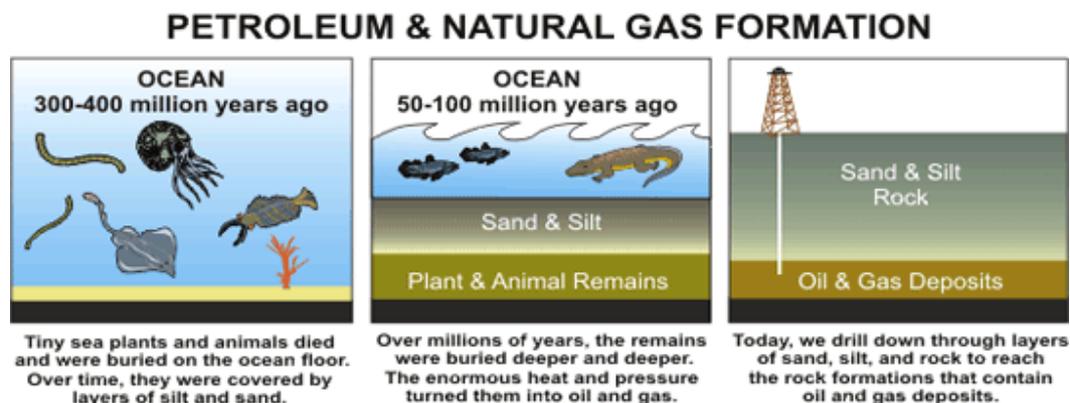
## Evidence #1:

**Oil emissions release carbon dioxide gas into the atmosphere which have negative impacts on the environment and human health.**

## Oil (petroleum) Basics

### How Was Oil Formed?

Oil was formed from the remains of animals and plants (diatoms) that lived millions of years ago in a marine (water) environment before the dinosaurs. Over millions of years, the remains of these animals and plants were covered by layers of sand and silt. Heat and pressure from these layers helped the remains turn into what we today call crude oil. The word "petroleum" means "rock oil" or "oil from the earth."



Source: U.S. Energy Information Administration (Public Domain)

Crude oil is a smelly, yellow-to-black liquid and is usually found in underground areas called reservoirs. Scientists and engineers explore a chosen area by studying rock samples from the earth. Measurements are taken, and, if the site seems promising, drilling begins. Above the hole, a structure called a 'derrick' is built to house the tools and pipes going into the well. When finished, the drilled well will bring a steady flow of oil to the surface.

### How Does Oil Impact the Environment?

Products from oil (petroleum products) help us do many things. We use them to fuel our airplanes, cars, and trucks, to heat our homes, and to make products like medicines and plastics. Even though petroleum products make life easier — finding, producing, moving, and using them can harm the environment through air and water pollution.

### Emissions and Byproducts Are Produced from Burning Petroleum Products

## Carbon monoxide (CO)

- Sulfur dioxide (SO<sub>2</sub>)
- Nitrogen oxides (NO<sub>x</sub>) and Volatile Organic Compounds (VOC)
- Particulate matter (PM)
- Lead and various air toxics such as benzene, formaldehyde, acetaldehyde, and 1,3-butadiene may be emitted when some types of petroleum are burned

Nearly all of these byproducts have negative impacts on the environment and human health:

- Carbon dioxide is a greenhouse gas and a source of global warming.<sup>1</sup>
- SO<sub>2</sub> causes acid rain, which is harmful to plants and to animals that live in water, and it worsens or causes respiratory illnesses and heart diseases, particularly in children and the elderly.
- NO<sub>x</sub> and VOCs contribute to ground-level ozone, which irritates and damages the lungs.
- PM results in hazy conditions in cities and scenic areas, and, along with ozone, contributes to asthma and chronic bronchitis, especially in children and the elderly. Very small, or “fine PM” is also thought to cause emphysema and lung cancer.
- Lead can have severe health impacts, especially for children, and air toxics are known or probable carcinogens.

[http://www.eia.gov/kids/energy.cfm?page=oil\\_home-basics](http://www.eia.gov/kids/energy.cfm?page=oil_home-basics)

## **Evidence #2:**

**Wind power does not release emissions that pollute the air or water, thus it is a cleaner energy resource than fossil fuels.**

Wind: A Clean Source of Energy

Wind Farm at The Cerro Gordo Project, West of Mason City, Iowa



Source: National Renewable Energy Laboratory (Public Domain)

Wind is a clean source of energy, and overall, the use of wind for energy has fewer environmental impacts than using many other energy sources. Wind turbines (often called windmills) do not release emissions that pollute the air or water (with rare exceptions), and they do not require water for cooling. They may also reduce the amount of electricity generated from fossil fuels and therefore reduce the amount of air pollution, carbon dioxide emissions, and water use of fossil fuel power plants.

A wind turbine has a small physical footprint relative to the amount of electricity it can produce. Many wind projects, sometimes called wind farms, are located on farm, grazing, and forest land. The extra income from the turbines may allow farmers and ranchers to stay in business and keep their property from being developed for other uses. For example, wind power projects have been proposed as alternatives to mountain top removal coal mining projects in the Appalachian mountains of the U.S. Off-shore wind turbines on lakes or the ocean may have smaller environmental impacts than turbines on land.

[http://www.eia.gov/kids/energy.cfm?page=wind\\_home-basics](http://www.eia.gov/kids/energy.cfm?page=wind_home-basics)

### **Evidence #3:**

**Although solar energy does not burn fossil fuels, it has other environmental hazards, such as releasing toxic materials and chemicals and impacting animals and their habitats.**

## **Solar Energy & the Environment**

An Array of Solar Panels Supplies Energy for Use at Marine Corps Air Ground Combat Center in Twentynine Palms, California



Source: U.S. Marine Corps photo by Pfc. Jeremiah Handeland/[Released](#) (Public Domain)

Using solar energy produces no air or water pollution and no greenhouse gases, but does have some indirect impacts on the environment. For example, there are some toxic materials and chemicals, and various solvents and alcohols that are used in the manufacturing process of photovoltaic cells (PV), which convert sunlight into electricity. Small amounts of these waste materials are produced.

In addition, large solar thermal power plants can harm desert ecosystems if not properly managed. Birds and insects can be killed if they fly into a concentrated beam of sunlight, such as that created by a "solar power tower." Some solar thermal systems use potentially hazardous fluids (to transfer heat) that require proper handling and disposal.

Solar thermal power plants use the sun's rays to heat a fluid to very high temperatures. The fluid is then circulated through pipes so it can transfer its heat to water to produce steam. The steam, in turn, is converted into mechanical energy in a turbine and into electricity by a conventional generator coupled to the turbine.

So solar thermal power generation works essentially the same as generation from fossil fuels except that instead of using steam produced from the combustion of fossil fuels, the steam is produced by the heat collected from sunlight. Solar thermal technologies use concentrator systems to achieve the high temperatures needed to heat the fluid.

[http://www.eia.gov/kids/energy.cfm?page=solar\\_home-basics](http://www.eia.gov/kids/energy.cfm?page=solar_home-basics)

## Evidence #4:

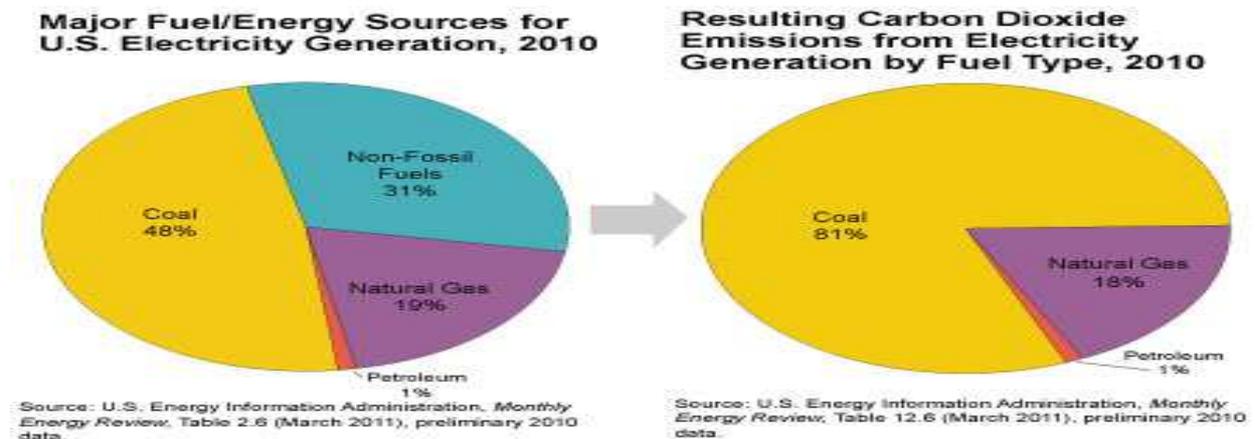
**81% of carbon dioxide emissions in 2010 came from Coal which is detrimental to the environment and human health.**

## Coal & the Environment

Coal is an abundant fuel that is relatively inexpensive to produce and convert to useful energy. However, producing and using coal has many impacts on the environment.

### Emissions from Burning Coal

In the United States, most coal is used as a fuel to generate electricity. Burning coal produces numerous emissions that adversely affect the environment and human health.



The principal emissions resulting from coal combustion are:

- Sulfur dioxide (SO<sub>2</sub>), which contributes to acid rain and respiratory illnesses
- Nitrogen oxides (NO<sub>x</sub>), which contributes to smog and respiratory illnesses
- Particulates, which contribute to smog, haze, and respiratory illnesses and lung disease
- Carbon dioxide (CO<sub>2</sub>), which is the primary greenhouse gas emission from the burning of fossil fuels (coal, oil, and natural gas)
- Mercury and other heavy metals, which has been linked with both neurological and developmental damage in humans and other animals. Mercury concentrations in the air usually are low and of little direct concern. However, when mercury enters water — either directly or through deposition from the air — biological processes transform it into methylmercury, a highly toxic chemical that accumulates in fish and the animals (including humans) that eat fish.
- [http://www.eia.gov/kids/energy.cfm?page=coal\\_home-basics](http://www.eia.gov/kids/energy.cfm?page=coal_home-basics)