



POWER EFFICIENCY PROJECT

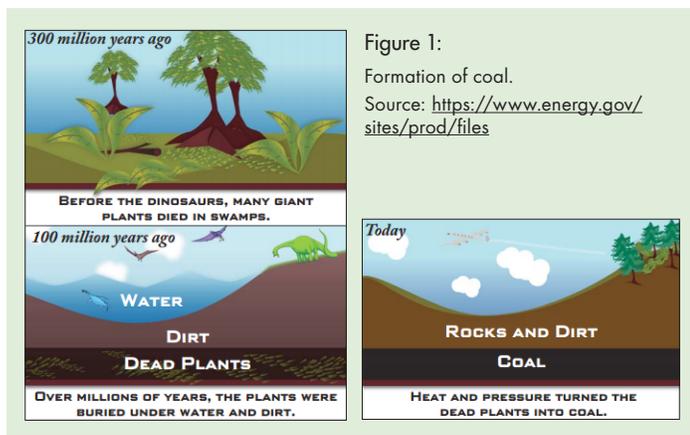
Professor Max Powers' Power Efficiency Project (PEP) is brought to you by the Kansas Corporation Commission and Kansas State University Engineering Extension. Funding provided by a grant from the U.S. Department of Energy.



How Fossil Fuel Energy is Collected and Distributed

What is a Fossil Fuel?

A **fuel** is any substance that can be burned to generate thermal energy. **Fossil fuels** originated approximately 286 to 360 million years ago during the **Carboniferous Period**. The environment during this geologic time period consisted of vast algae-filled oceans and wet, humid swamps which created the perfect condition for the formation of the fossil fuels.¹ First, **organic matter** from dead plants and animals sank to the bottom of the swamp or ocean and, over the next hundreds of thousands of years, formed layers of organic waste. Over millions of years, Earth's environment and climate changed. Rocks and sediments



started to layer on top of the organic matter. The layers of rock and sediment began to increase the pressure on the layer of matter until the pressure became too much and forced water out. **Oil, natural gas,** and **coal** were the resultant fossil fuels (see **Figure 1** for an example of coal formation). Each fossil fuel is formed slightly different due to organic matter composition, the amount of time the fuel remains buried, and the **temperature** and **pressure** conditions of the geographic region.

Fossil Fuel Power Plants

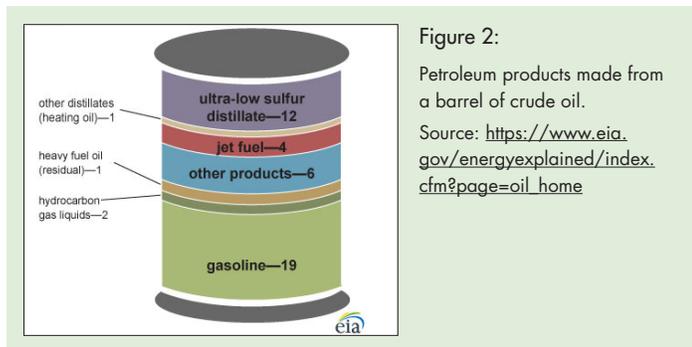
Coal, oil, and natural gas have become critically important to the modern world in generating steam, electricity, and powering transportation systems.² In 2015, fossil fuels made up 67 percent of the total electricity generated in the U.S. while renewable fuels made up only 13 percent and nuclear fuels, 20 percent.³ The world needs fossil fuels to generate enough electricity to sustain modern lifestyles.

Since fossil fuels are buried underground, many different techniques including **surface mining, underground mining, vertical drilling, horizontal drilling,** and **hydraulic fracturing,** can be used to access them. The U.S. Energy Information Administration utilizes online software to share the national coal mining sites, oil and natural gas well sites, and the surrounding source rock formations (website details can be found in Appendix A).

The conventional **steam power plant** generates electricity similarly for each fossil fuel. First, fuel enters the **combustion chamber** where it is burned to boil water and produce steam, thus the chemical energy within the fuel is transformed into **thermal energy**. The steam then flows into and spins a **turbine**. As a result, the thermal energy is converted into mechanical energy by the spinning of the **rotor**. The rotor of the turbine is connected to the generator where the **mechanical energy** is converted into **electrical energy**. The only difference between the fossil fuel power generation technologies is the combustion chamber which burns each fuel uniquely to maintain health, the environment, and safety regulations. Globally, over 65 percent of electrical energy “is generated by steam turbine generators burning fossil fuels as their source of energy.”⁴

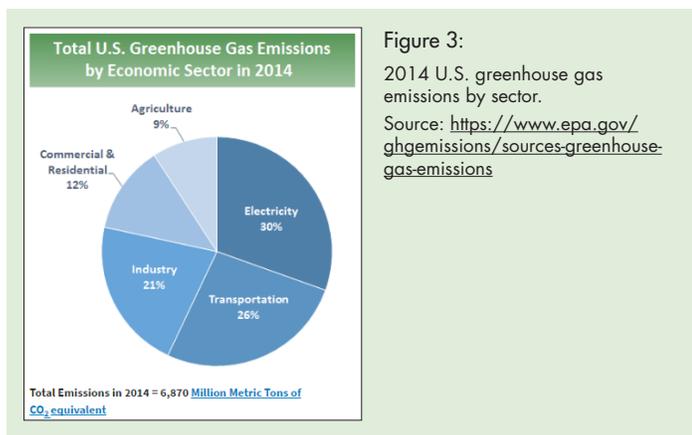
Appendix A identifies the coal, oil, and natural gas power plants across the United States. Additionally, oil is used to manufacture

products, including plastic, chemicals, asphalt, and the fuel used to power a car. **Refineries** are facilities where crude oil is made into different products and fuels.⁵ The term **crude oil** signifies the state of oil directly after being mined from the earth. Crude oil is converted into other liquids and **petroleum** products that people use every day. **Figure 2** displays products made from one barrel of crude oil.



Fossil Fuels and the Environment

During the process of **combustion**, pollutants such as **carbon dioxide** and **nitrous oxide** are emitted and enter the atmosphere. These contaminants are called **greenhouse gases**. Long-wave solar **radiation** is trapped in the Earth's atmosphere by greenhouse gases, which are causing regional and global warming. Additionally, another greenhouse gas called **methane** is released during the production and transport of coal, oil, and natural gas. Recently, power plant technologies have improved to reduce the amount of pollutants entering the atmosphere. However, these efforts are not sufficient in reducing greenhouse gas emissions. **Figure 3** illustrates the electricity generation and transportation sectors contributing 56 percent of the greenhouse gas emissions in 2014. The U.S. Department of Energy and the U.S. Environmental Protection Agency are working towards ensuring the responsible development of fossil fuel production and continuing the development of technologies "to reduce carbon emissions and ensure fossil energy sources play a role in America's clean energy future."⁶



Fossil Fuels in Kansas

In Kansas, "54 percent of net electricity generation...came from six coal-fired electric power plants" in 2015.⁷ Wind energy was the second largest electricity generator at 24 percent while nuclear energy accounted for 19 percent. Additionally, in 2015, Kansas ranked in the top 10 states in crude oil production.⁷ Appendix A on the following page includes location data for fossil fuel production and electricity generation for Kansas.

Curriculum & Activity Links

Primary

- Coal Factsheet, Grades K-2, <http://www.need.org/files/curriculum/infobook/CoalP.pdf>
- Coal Factsheet, Grades 3-5, <http://www.need.org/files/curriculum/infobook/CoalE.pdf>
- Oil, Gas and Their Energy: Teacher Guide, Grades K-2, <http://www.need.org/files/curriculum/guides/OilGasandTheirEnergy.pdf>
- Activity: Conserving Electric Energy, Grade K-5, https://www.energy.gov/sites/prod/files/2013/04/f0/Conserving_Electric_Energy.pdf
- Activity: Coal Word Search, Grade 4-5, https://www.energy.gov/sites/prod/files/2013/04/f0/WordSearch_Coal.pdf
- Activity: Coal Crossword Puzzle, Grade 4-5, https://www.energy.gov/sites/prod/files/2013/04/f0/crossword_puzzle.pdf

Intermediate

- Fossil Fuel Study Guide: Coal, https://www.energy.gov/sites/prod/files/2013/04/f0/MS_Coal_Studyguide_draft1.pdf
- Fossil Fuel Study Guide: Natural Gas, https://www.energy.gov/sites/prod/files/2013/04/f0/MS_NatGas_Studyguide_draft1.pdf
- Fossil Fuel Study Guide: Oil, https://www.energy.gov/sites/prod/files/2013/04/f0/MS_Oil_Studyguide_draft1.pdf
- Coal Factsheet, Grades 6-8, <http://www.need.org/files/curriculum/infobook/Coall.pdf>
- Understanding Coal: Teacher Guide, Grades 6-8, <http://www.need.org/Files/curriculum/guides/UnderstandingCoal.pdf>
- Fossil Fuels to Products: Teacher Guide, Grades 6-12, <http://www.need.org/Files/curriculum/guides/FossilFuelsToProducts.pdf>
- Activity: Coal Crossword Puzzle, Grade 6-8, https://www.energy.gov/sites/prod/files/2013/04/f0/crossword_puzzle.pdf

Secondary

- Fossil Fuel Study Guide: Coal, https://www.energy.gov/sites/prod/files/2013/04/f0/HS_Coal_Studyguide_draft1.pdf
- Fossil Fuel Study Guide: Natural Gas, https://www.energy.gov/sites/prod/files/2014/02/f8/HS_NatGas_Studyguide_draft2.pdf
- Fossil Fuel Study Guide: Oil, https://www.energy.gov/sites/prod/files/2013/04/f0/HS_Oil_Studyguide_draft2.pdf
- Coal Factsheet, Grades 9-12, <http://www.need.org/files/curriculum/infobook/CoalS.pdf>
- Exploring Coal: Teacher Guide, Grades 9-12, <http://www.need.org/Files/curriculum/guides/ExploringCoal.pdf>
- Fossil Fuels to Products: Teacher Guide Grades 6-12, <http://www.need.org/Files/curriculum/guides/FossilFuelsToProducts.pdf>

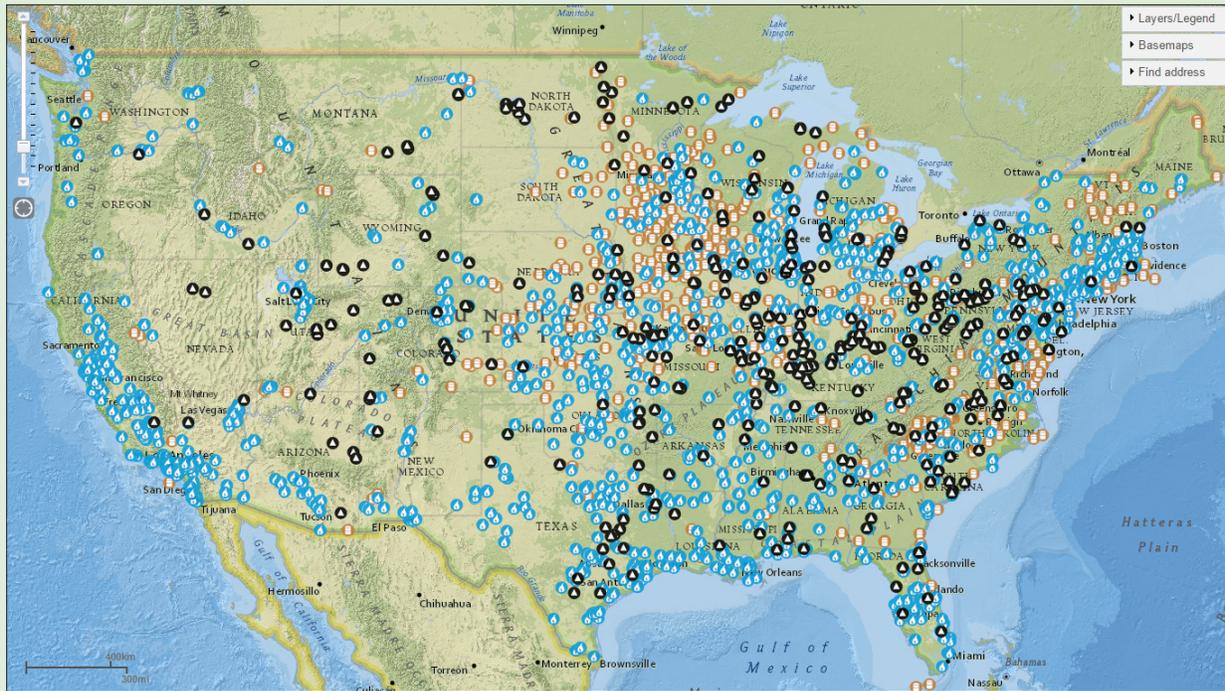
References

- "Where Fossil Fuels Come From." Energy Quest. California Energy Commission, 2012. Web. 9 Jan. 2017. <http://www.energyquest.ca.gov/story/chapter08.html>
- "Fossil Fuels." IER. Institute for Energy Research, n.d. Web. 26 Jan. 2017. <http://instituteforenergyresearch.org/topics/encyclopedia/fossil-fuels/>
- "What Is U.S. Electricity Generation by Energy Source?" Frequently Asked Questions. US Energy Information Administration, n.d. Web. 26 Jan. 2017. <https://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3>
- "Electrical Power Generation from Fossil Fuels." Battery and Energy Technologies. Woodland Communications Ltd, 2005. Web. 23 Feb. 2017. http://www.mpoweruk.com/fossil_fuels.htm
- "Refining Crude Oil." Energy Explained. US Energy Information Administration, 16 June 2016. Web. 23 Feb. 2017. https://www.eia.gov/energyexplained/index.cfm?page=oil_refining
- "Fossil." Energy.gov. US Department of Energy, n.d. Web. 26 Jan. 2017. <https://energy.gov/science-innovation/energy-sources/fossil>
- "Profile Overview." State Profile and Energy Estimates. US Energy Information Administration, n.d. Web. 24 Feb. 2017. <https://www.eia.gov/state/?sid=KS>

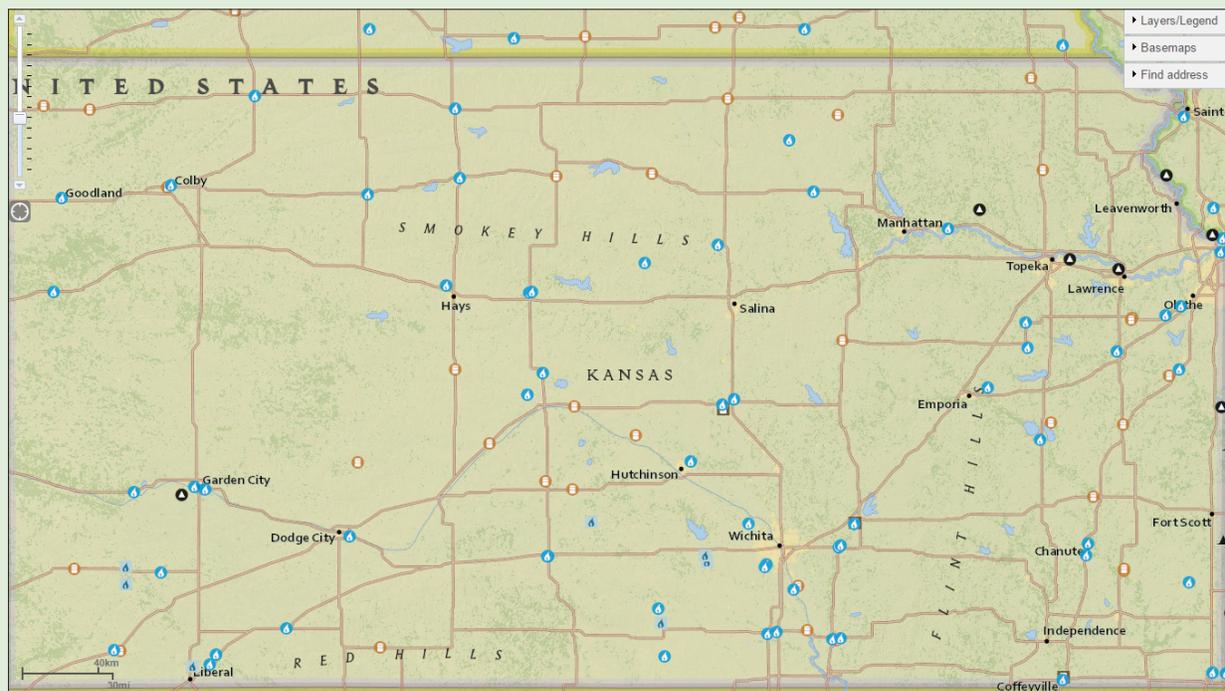
For more information on how fossil energy is collected and distributed, contact Kansas State University Engineering Extension at 785-532-4998 or dcarter@ksu.edu.

Appendix A:

From the U.S. Energy Information Administration, U.S. Energy Mapping System, which can be found at <https://www.eia.gov/state/maps.cfm>.



U.S. coal (black), oil (orange), and natural gas (blue) power plant locations.



Kansas fossil fuel production and generation locations; for more information, please visit <https://www.eia.gov/state/?sid=KS#tabs-3>

For more information on how fossil energy is collected and distributed, contact Kansas State University Engineering Extension at 785-532-4998 or dcarter@ksu.edu.