



Dear Educator,

I am honored to introduce you to the Wyoming Stewardship Project. I want you to know, this unit was written with you and your students in mind. Developing this project has been a thoughtful process and multi-year commitment to offer lessons for classrooms across the state.

Wyoming educators, in collaboration with field experts and the Wyoming Department of Education, wrote, piloted, and revised the unit you are about to teach in your classroom. We are tremendously grateful for their efforts. These units are not intended to be a burden but were created purposefully to be easy-to-use, cross-curricular, and comprehensive. Units build on each other throughout the grades. However, they can be used independently without loss of integrity.

Found in the Educator Essentials document is everything needed to be prepared to teach this unit. We outline the Higher Order Thinking Skills and how to identify them throughout the units. We have compiled a material list of everything you need to complete all lessons: worksheets, PowerPoints, and video links are included in individual lessons. Additionally, a '101' sheet has been included to give you background information for the highlighted industry in Wyoming.

Our hope for the Wyoming Stewardship Project is to empower students to be our critical thinkers and problem solvers of tomorrow. We believe the stewardship definition captures the overall intent: As Wyoming citizens, we are stewards entrusted with the responsible development, care, and use of our resources to benefit current and future generations.

Thank you again for your effort in the classroom, presenting these lessons to your students, and helping advance this pivotal project for our state. Please don't hesitate to contact us with questions!

*Jessie Dafoe*





Executive Director  
Wyoming Agriculture in the Classroom





## **Teacher Preparation and Required Materials**

The critical work of Higher Order Thinking Skills (HOTS) involves breaking down complex material into parts, detecting relationships, combining new and familiar information creatively within limits set by the context, and combining and using all previous levels in evaluating or making judgments. Within each lesson you'll find reference to the Higher Order Thinking Skills that are part of the work students will be doing using language from Bloom's Taxonomy: Analysis, Synthesis, Application, and Evaluation.

- Analysis skills are used in areas with this symbol: 
- Synthesis skills are used in areas with this symbol: 
- Application skills are used in areas with this symbol: 
- Evaluation skills are used in areas with this symbol: 

### **The following ideas and content will be important to know for this unit:**

- Wyoming has abundant sources of minerals and energy. They are an important part of our economy and culture. Wyoming is the country's leading producer of coal, bentonite, uranium, and trona.
- How each of Wyoming's energy resources are turned into useable power
- Pros and cons of Wyoming's energy resources
- How enhanced oil recovery systems work

**The following materials will be needed for this unit:**

- Chart/Poster paper
- Maps from the Wyoming Geographic Alliance, Wyoming Student Atlas.  
Available at:  
<http://uwmaps.wygisc.org/studentAtlas/index.html?page=1>
- Markers, colored pencils, etc.
- White boards and markers (optional)
- White paper
- Masking tape
- Sticky notes
- Chips, tokens, etc. (optional)
- Supplies to build oil recovery model: (one set for whole class)
  - Small disposable plastic containers (1-2 cup) with tight-fitting lid
  - Plastic water bottles for injection reservoir and oil collection (one for the “extracted” oil, and one for water. Additional bottles may be needed for alternate design methods.)
  - Rocks or gravel (Gravel that has been sifted or had the sand removed would work best.)
  - Vegetable Oil
  - ¼ inch plastic tubing (two 30cm pieces)
  - Material to make a watertight seal (ex: Goop, silicone caulk, hot glue)
  - Food coloring for the inlet water \*optional
  - Bucket or container for disposal of liquids
  - Seal-able container for disposal of oil
  - Metric measuring cup or graduated cylinder for liquids
  - Water
- Additional materials and liquids of your choice use for design challenge
- Supplies for whatever project method teacher decides his/her class should do (Lesson 11)
- Invitations if class is inviting parents, community members, other classes, administrators, etc. to visit their fair.

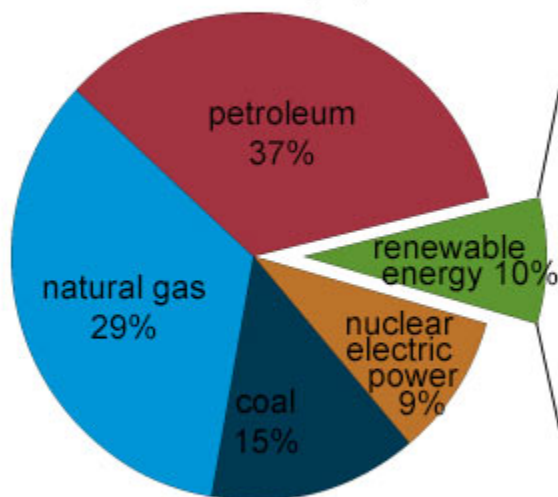


# Minerals & Energy 101

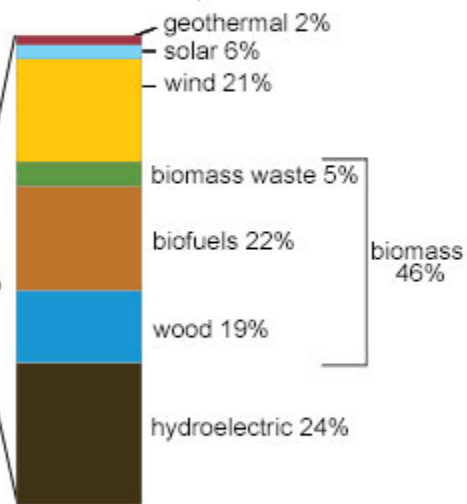
Energy consumption at a glance:

## U.S. energy consumption by energy source, 2016

Total = 97.4 quadrillion  
British thermal units (Btu)



Total = 10.2 quadrillion Btu



Note: Sum of components may not equal 100% because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2017, preliminary data



The Wyoming Stewardship Project reviews all energy sources to provide a full picture of energy and mineral production. We encourage educators to review the overview below and the basics of the energy sources provided before teaching the units. The following statistics are from the Petroleum Association of Wyoming's: *Wyoming Oil and Gas, Facts and Figures, 2018*. These figures help quantify the economic importance of this industry for Wyoming:

Crude oil and natural gas production paid over \$292 million in severance taxes, about 55% of all the severance taxes paid by minerals produced in 2017.

#### Severance Taxes - 2017

Production Crude Oil	\$147,933,678
<u>Natural Gas</u>	<u>\$144,407,308</u>
Oil and Gas Total	\$292,340,986

Coal	\$215,469,300
Trona	\$ 18,704,634
<u>All Others</u>	<u>\$ 3,397,189</u>
Total All Minerals	\$529,912,110

In fiscal year 2017 oil and gas production contributed the following to state and local governments:

Property Taxes	\$307.0 million
Severance Taxes	\$292.0 million
Federal Royalties	\$ 1.2 million
Federal Lease Revenues	\$174.0 million
State Royalties	\$117.0 million
Sales and Use Taxes	\$ 8.2 million
<u>Conservation Mill Levy</u>	<u>\$ 3.2 million</u>
TOTAL FOR STATE	\$902.6 million

That is a direct payment of nearly \$1,542 for every person living in Wyoming.

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## Wyoming Minerals & Energy Overview

Oil, gas, and mining have been important in Wyoming for over 130 years. The Wyoming mineral and energy industries have been a major contributor to employment and state money (revenue). These include the oil and gas industry, minerals, and power production.

Wyoming has the smallest population of any state but is a top supplier of energy and other mineral resources to the nation. Wyoming produces more

energy than the lowest-ranking 28 states combined. In 1884, the first oil well was drilled near Lander and oil production continues throughout the state today.

Wyoming's clean coal produces electricity in more than 30 states. Wyoming is also the top supplier of uranium for energy across the country. Additionally, Wyoming has large amounts of minerals such as trona, bentonite, and rare earth minerals, which are used in many products we use today, like toothpaste, glass, and magnets. Wyoming mines more bentonite than any other state in the United States and has 70% of the world's known supply. 5 million tons of bentonite were produced in Wyoming in 2014. Wyoming also has the world's largest deposit of trona, supplying about 90% of the nation's soda ash. 17 million tons were mined in 2014. Northeast Wyoming is home to one of the highest grade rare earths deposits in the world.

Ancient seas that once covered what is now Wyoming helped create our natural resources. Seas expanded and retreated many times over millions of years, leaving behind plant and animal matter as well as mineral deposits. Marine sediments worked together to form and preserve hydrocarbon deposits. Under ideal geologic conditions of pressure and temperature, coal, oil, and natural gas deposits were formed and preserved. Historically, humans have used these natural resources since ancient times.

Another important aspect of energy is the generation and transmission process. Generation is the process of converting the energy sources into electricity. After electricity is generated, it is transported through transmission lines. The final stage is distribution, which is the process of carrying electricity from transmission substations to homes and businesses.

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## **Wyoming Oil and Gas Basics**

Oil and gas products include crude oil, natural gas, and helium. These are used for reliable heating and power for things like our homes, schools, and businesses. Natural gas produces approximately 34% of the nation's electricity; much of which comes from Wyoming. This industry pays the largest amount of taxes to the state to fund infrastructures, like schools and roads.

According to the Petroleum Association of Wyoming:

- Nationally, Wyoming ranked 6<sup>th</sup> in production of crude oil in 2017 and 8<sup>th</sup> in natural gas production during 2017.
- Campbell County was the leading crude oil producer in 2017 followed by Converse and Laramie counties.
- Sublette County was the largest natural gas producer, with Sweetwater and Fremont Counties following.
- During 2017, 355 companies/operators produced Wyoming's crude oil and 228 produced natural gas.

## **Wyoming Mineral Basics**

### **COAL**

Wyoming has an abundant supply of coal, with a total resource of 6,681 million short tons. Coal produced in Wyoming goes to U.S. electricity production with 32 states obtaining coal from Wyoming. Wyoming produced 42% of all coal mined in the United States in 2015. Coal is an important source of income for Wyoming, and is the second largest source of tax revenue for state and local governments. Coal mining companies pay taxes, royalties, and fees to all branches of government, federal, state, and local. Coal's estimated contribution to Wyoming in 2015 was almost \$1.2 billion.

### **TRONA**

Trona, which comes out of Sweetwater County, is the number one export for Wyoming, which produces 90% of the nation's soda ash. Wyoming trona is used to create soda ash that is used in a variety of products like glass, baking soda, cosmetics, toothpaste, and soaps.

### **BENTONITE**

According the Wyoming Mining Association, Wyoming produces 70% of the world's supply of bentonite. This mineral is used for a variety of products including drilling fluids, compounds needed for absorption, cat litter, and lipstick.

## **Wyoming Renewable Basics**

The following is taken directly from the U.S. Energy and Information Administration website and is an overview for renewable energy in Wyoming:



Wyoming has some of the largest wind resources in the nation, especially in the southeast corner of the state. Sustained winds are funneled through mountain passes and out across the high prairie, giving Wyoming wind farms high operating capacity factors. The amount of installed wind-powered generating capacity has grown rapidly during the last 10 years, with Wyoming ranked 15<sup>th</sup> in the nation in 2016 at nearly 1,500 megawatts of wind power capacity. Several large-scale projects are in development, including a 3,000-megawatt project at Chokecherry-Sierra Madre, which may become the largest wind project in the nation. Wyoming officials are actively seeking customers for the state's wind power in California and Colorado, which have significant renewable energy requirements. The Wyoming Infrastructure Authority is encouraging several large transmission projects aimed at transporting Wyoming's wind-generated electricity to Nevada, Arizona, and California.

Most of Wyoming's hydroelectric dams are relatively small, old, and owned by the federal government. Though the state has significant potential solar resources, no utility-scale solar generation has been installed, in part because of Wyoming's relatively low electricity rates. A small amount of distributed small-scale solar photovoltaic (PV) capacity, located mostly on residential rooftops, has been installed around the state. While Wyoming does not have a renewable portfolio standard (RPS) or other requirement to generate electricity from renewable energy, the state does provide net metering for residential, commercial, and industrial customers with renewable energy systems smaller than 25 kilowatts, including solar PV panels, wind turbines, biomass plants, and hydroelectric generators.

Wyoming's geothermal resources are used mainly in Yellowstone National Park and Hot Springs State Park. Geothermal energy is also used in the state to heat buildings, water, and roadways. Wyoming does have adequate geothermal resources to support geothermal heat pumps for supplying heat in new buildings or in retrofits of existing buildings.

<https://www.eia.gov/state/analysis.php?sid=WY>



# Stewardship

*As Wyoming citizens, we are entrusted with the responsible development, care, and use of our resources to benefit current and future generations.*



