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Fueling Our Future: Exploring Sustainable Energy Use

Snohomish County PUD and Facing the Future, WWU

February 27, 2016

Snohomish County PUD
Public Utility District No. 1

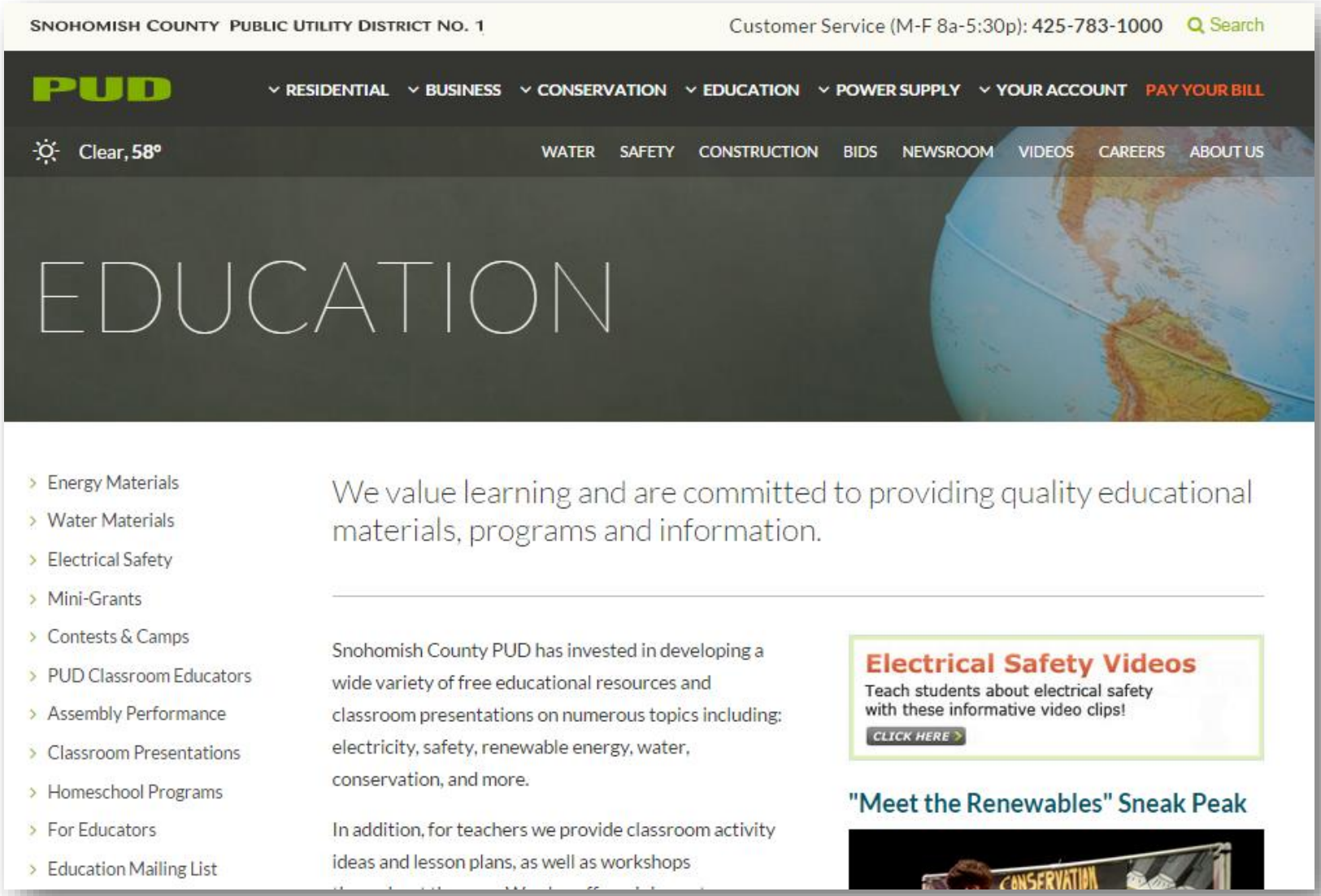
Facing the Future™
Global Sustainability Curriculum & Teacher PD

Western Washington University

Northwest Advanced Renewables Alliance

USDA NIFA

www.snopud.com



www.facingthefuture.org

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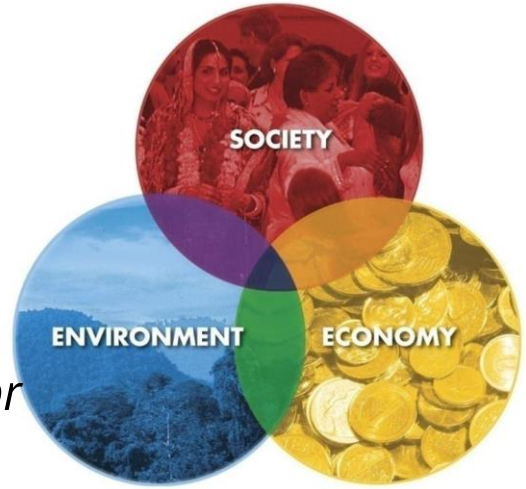


FTF's 3-part Framework:

Global Issues *– those that pose significant challenges for humanity and the planet today, such as energy, climate change, food security, and governance.*

Sustainable Solutions *– remedies that attempt to balance the interconnections between environment, society, and economy.*

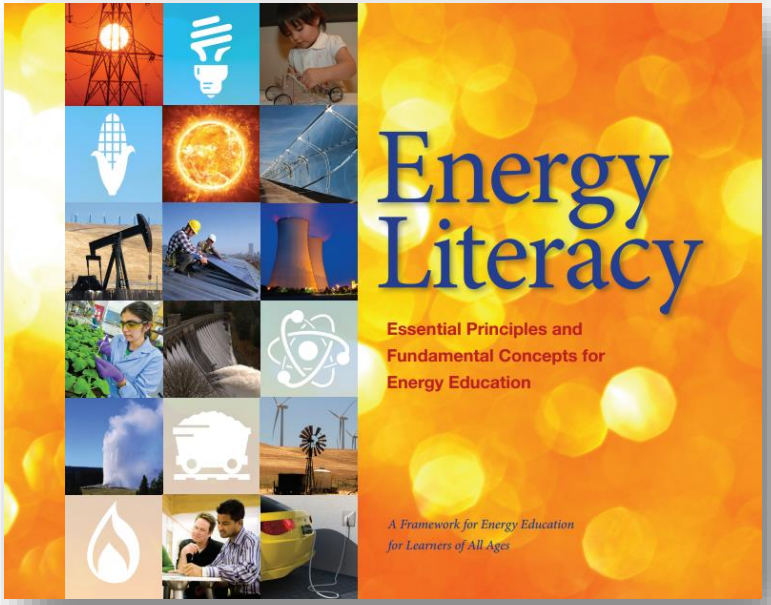
Positive Action *– stories of hope and positive actions that people of all ages have taken; ways to engage students through action and involvement*

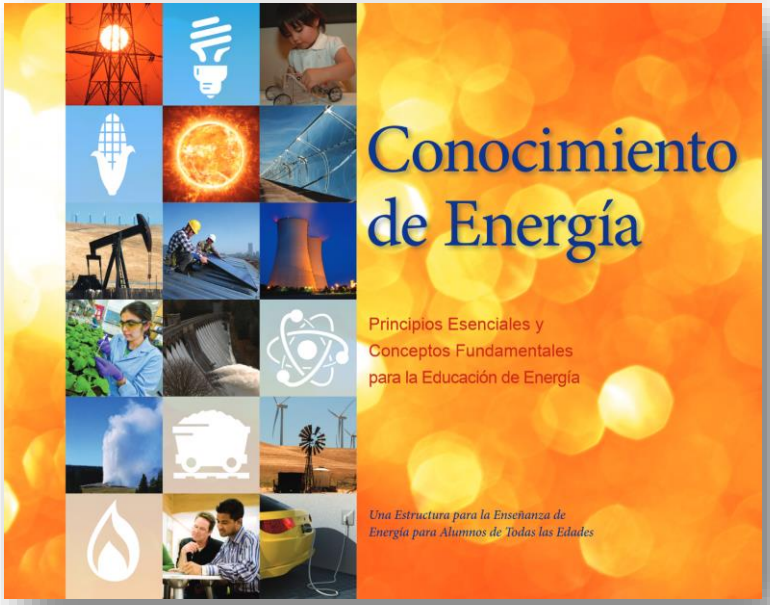
Small Group Activity

- *Define energy literacy.*

- *What can an energy literate person **do**?*
- *What does an energy literate person **know**?*
- *What **attitudes** are embodied by an energy literate person?*

- *Are you energy literate?*



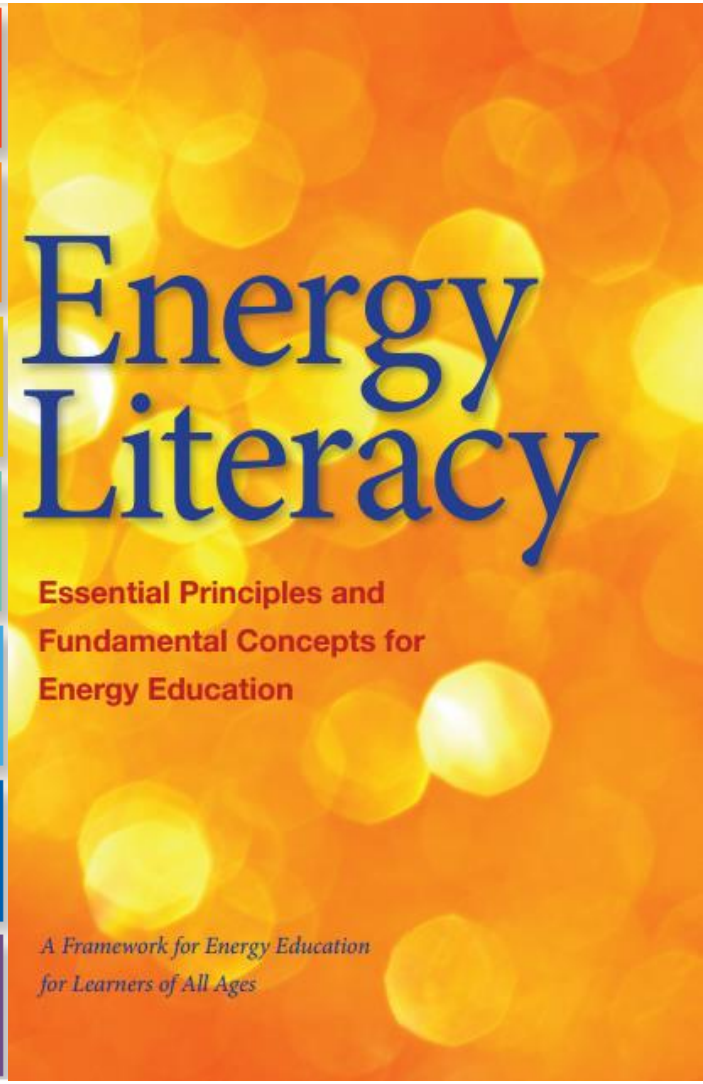


How close was your definition/description of energy literacy to this framework?

Any 'aha's' while browsing this resource?

Energy Literacy Videos

1. Energy is a physical quantity that follows precise natural laws.
2. Physical processes on Earth are the result of energy flow through the Earth system.
3. Biological processes depend on energy flow through the Earth system.
4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.
5. Energy decisions are influenced by economic, political, environmental, and social factors.
6. The amount of energy used by human society depends on many factors.
7. The quality of life of individuals and societies is affected by energy choices.



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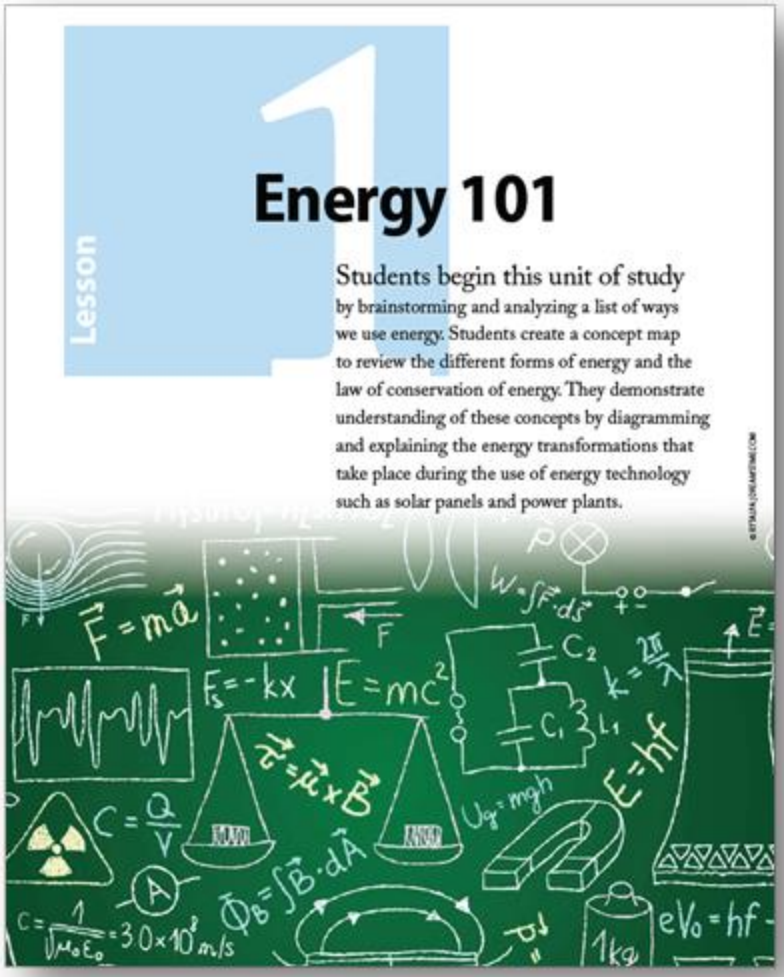

How do you use energy?

You have 1 minute to think of and write down as many ways you use energy as you can!

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Just Add Energy!

HOT WATER PHONE CHARGER CEMENT LIGHTING

PAPER PRODUCTION HEAT PUMPING WATER THINKING

RUNNING COOLING/FREEZING FOOD REFINING OIL

STADIUM LIGHTING AIR CONDITIONING DISHWASHER

CLOTHES DRYER PRINTER PLANE FARMING EQUIPMENT

CAR ROASTING MARSHMALLOWS COMPUTER TV

AUTOMATIC PENCIL SHARPENER TRUCK BIKING

MICROWAVE SEWING MACHINE MINING FOR COAL

WALKING EXTRACTING OIL EATING FOOD PLAYING MUSIC

MANUFACTURING FAN LAWN MOWER SLEEPING

PACKAGING GROWING FOOD TRANSPORTING GOODS TO STORES

MANUAL PENCIL SHARPENER RECYCLING PAPER FERTILIZER

HAIR DRYER DVD PLAYER STOVE

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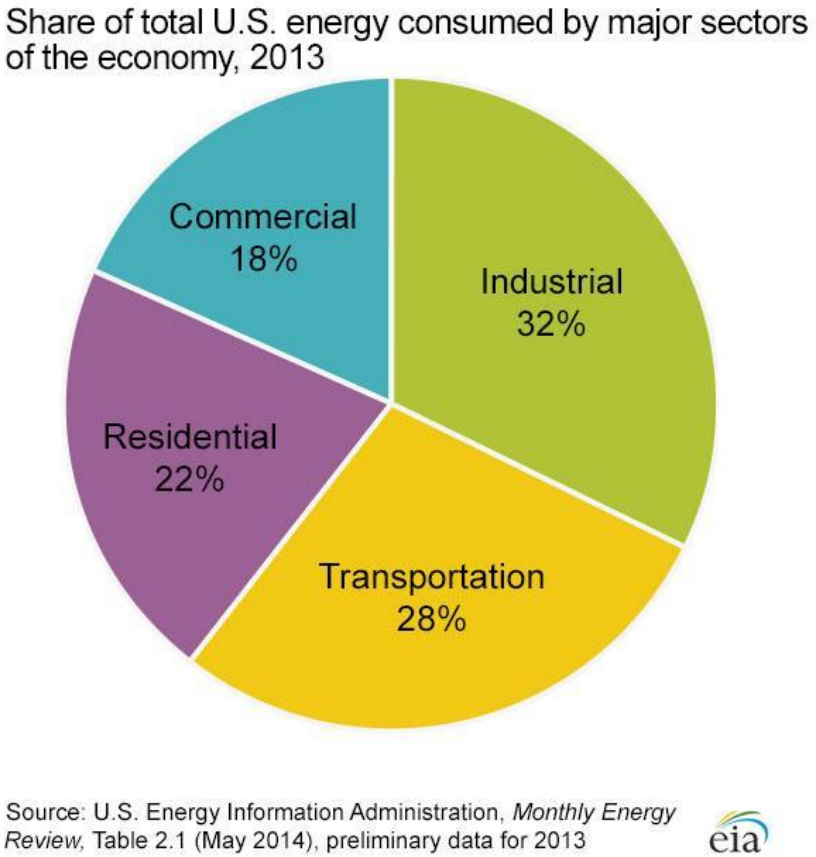
Categorizing Energy Use

Energy for a Sustainable Future

THE SECRETARY-GENERAL'S ADVISORY GROUP ON ENERGY AND CLIMATE CHANGE (AGECC)

UN Sustainable Energy For All Initiative



US Energy Information Administration

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How would you define energy (with your scientist hat on)?

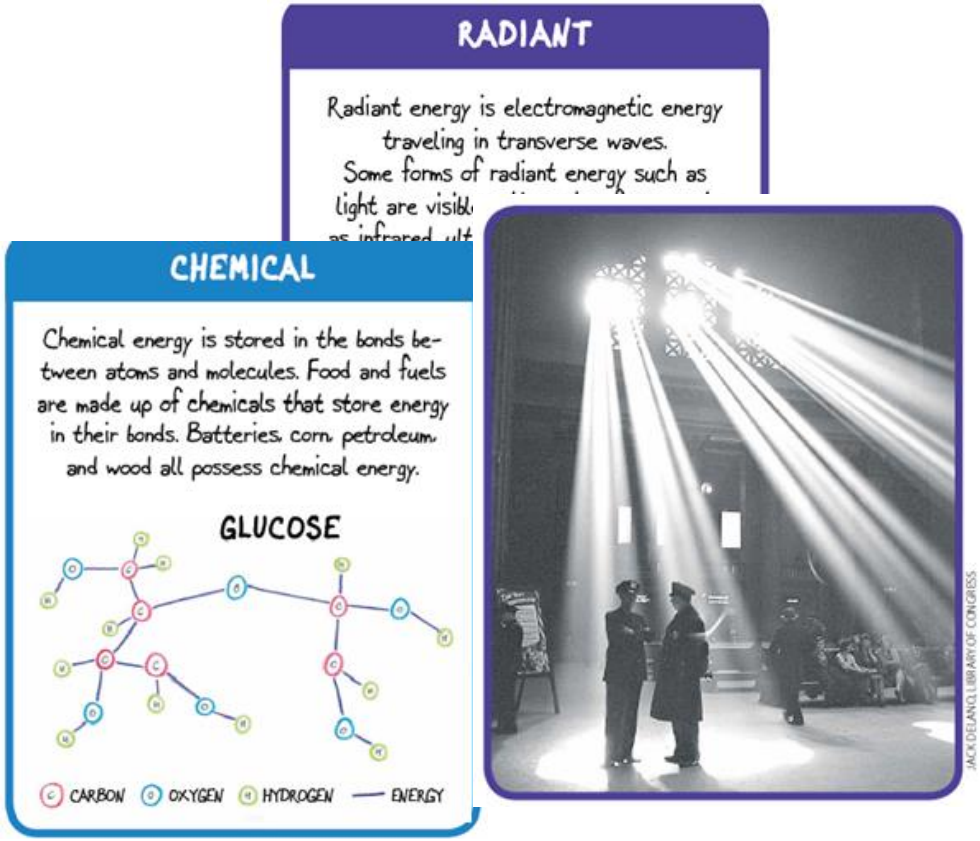
- ***energy:*** *The ability of a system to do work or cause change*
- ***kinetic energy:*** *Working energy, or the energy of motion*
- ***potential energy:*** *Stored energy, or forms of energy that result from an object's position or relationship with another object*

Energy 101

What are the different forms of energy?

Which forms are classified as:

- *Potential Energy?*
- *Kinetic Energy?*



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ENERGY

the ability of a system to perform work or cause change

IS

CAN BE

transferred to different objects or transformed into different forms

CANNOT BE

created or destroyed

LAW OF CONSERVATION OF ENERGY

CAN BE CLASSIFIED AS

KINETIC ENERGY

working energy or the energy of motion

INCLUDES

- **Sound Energy** — SUCH AS: music
- **Radiant Energy** — SUCH AS: sunlight
- **Thermal Energy** — SUCH AS: hot cup of cocoa
- **Electrical Energy** — SUCH AS: electric power lines
- **Motion Energy** — SUCH AS: runner

POTENTIAL ENERGY

forms of energy that result from an object's position or relationship with another object

INCLUDES

- **Gravitational Potential Energy** — SUCH AS: parachute
- **Chemical Energy** — SUCH AS: corn, gasoline, pizza
- **Elastic Energy** — SUCH AS: stretched rubber band
- **Nuclear Energy** — SUCH AS: uranium

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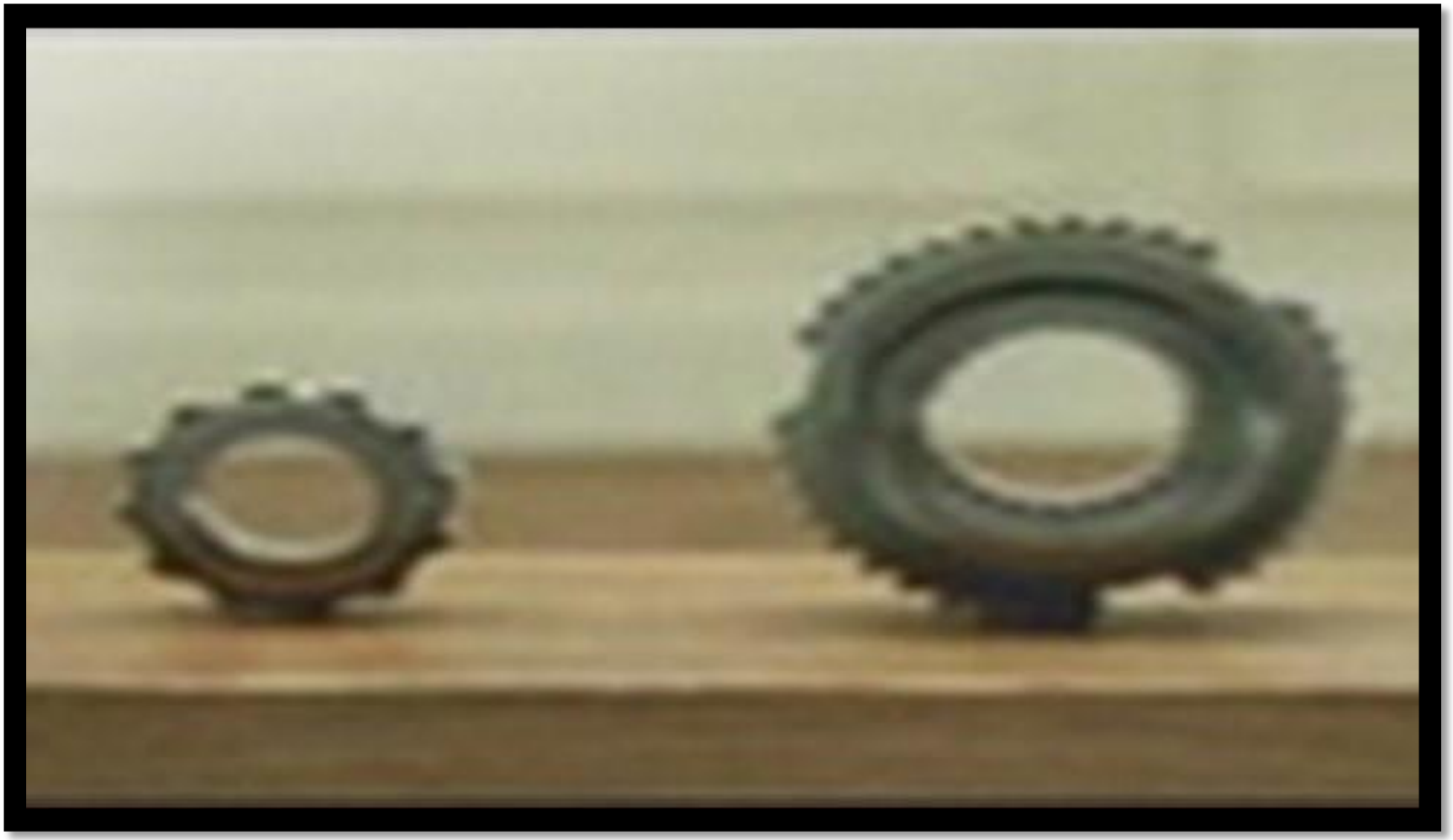
Energy Transfer vs. Transformation

Marbles | Michael Roper | www.flickr.com

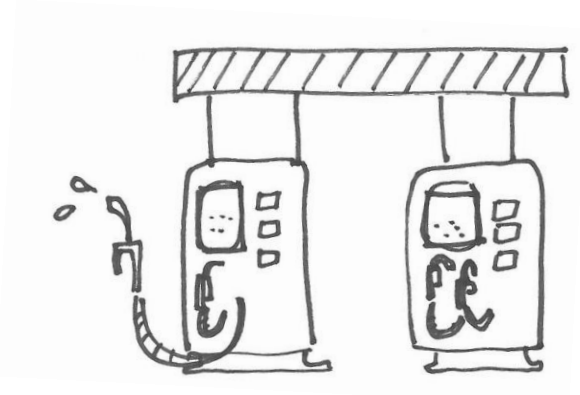
Allana Rumble | with permission

Energy Transfer vs. Transformation

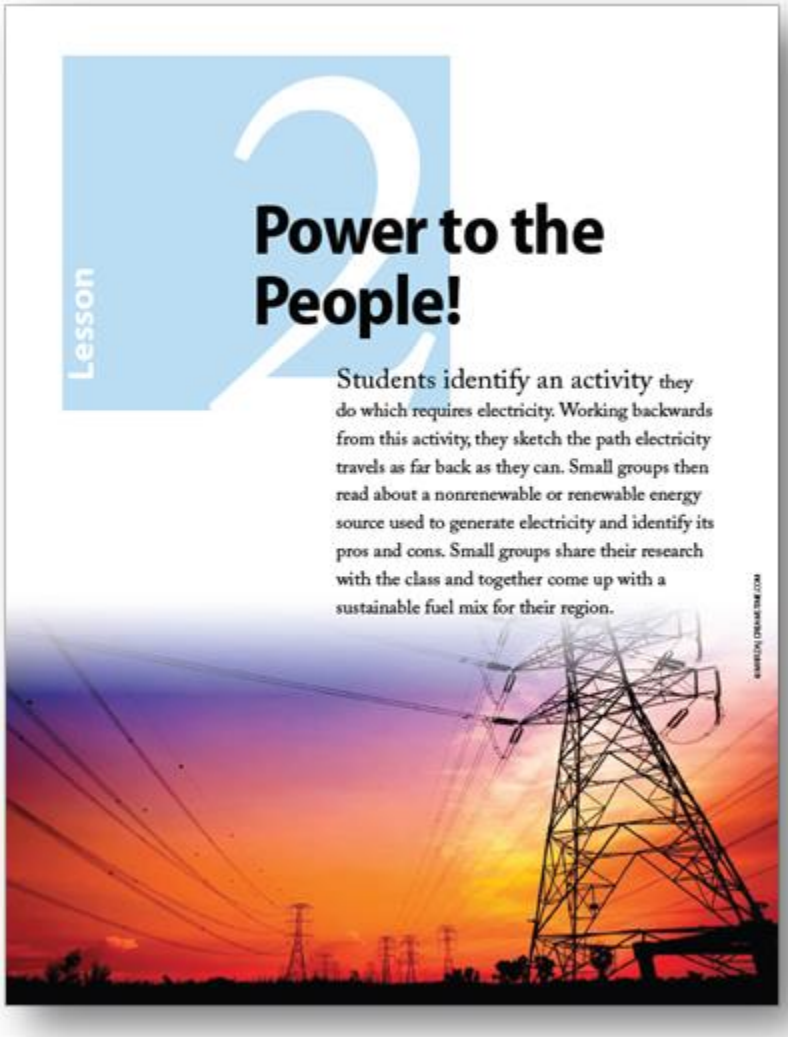


Discussion Questions

- *How is energy related to your daily life?*
- *Why must you continue to fill your gas tank with gas?*
- *For human energy needs, which forms seem most useful? least useful?*
- *What are some misconceptions people might have with these phrases below?*
  - *saving energy*
  - *energy conservation*



Sources of Energy



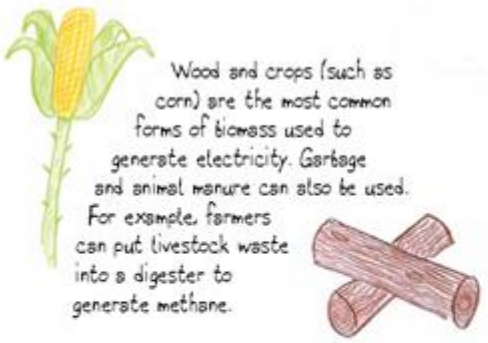
Energy 101:
Electricity Generation

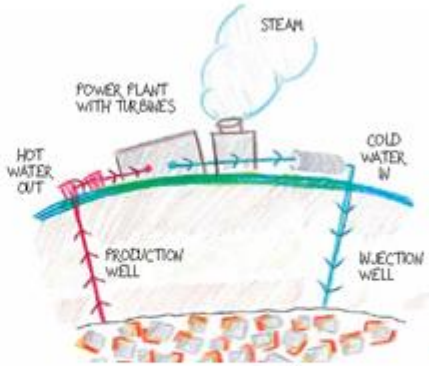
NPR: Visualizing the
U.S. Electric Grid

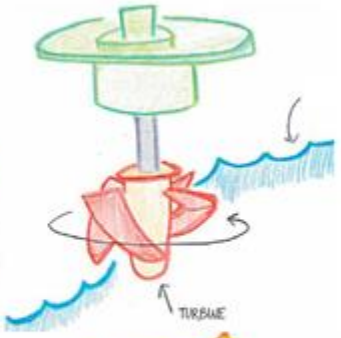
U.S. EPA's Power Profiler

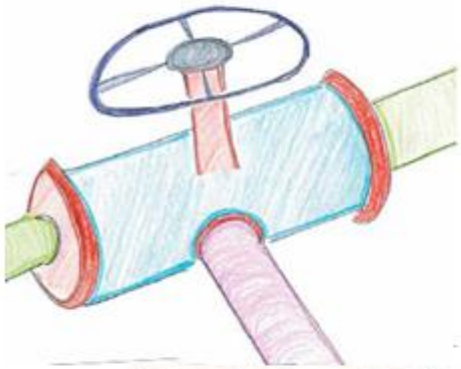
U.S. EIA

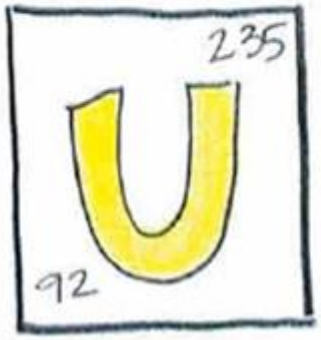
Energy Sources

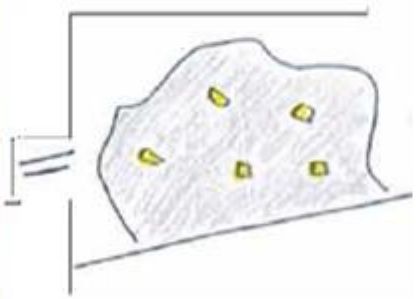


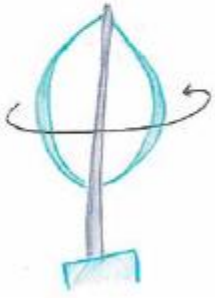












Energy Source Packets

NEED
National Energy Education Development Project

Facing THE Future™
Global Sustainability Curriculum and Teacher PD

Fueling Our Future
Page References

Elementary
- pages 65-67

Middle School
- page 29

High School
- pages 31-32

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Fuel Use and Carbon Emissions

	Renewable	***Nonrenewable***
use directly produces ***carbon emissions***		
use does not directly produce carbon emissions		

Carbon Combustion: $\boldsymbol{C + O_2 \rightarrow CO_2 + heat}$

Discussion Questions

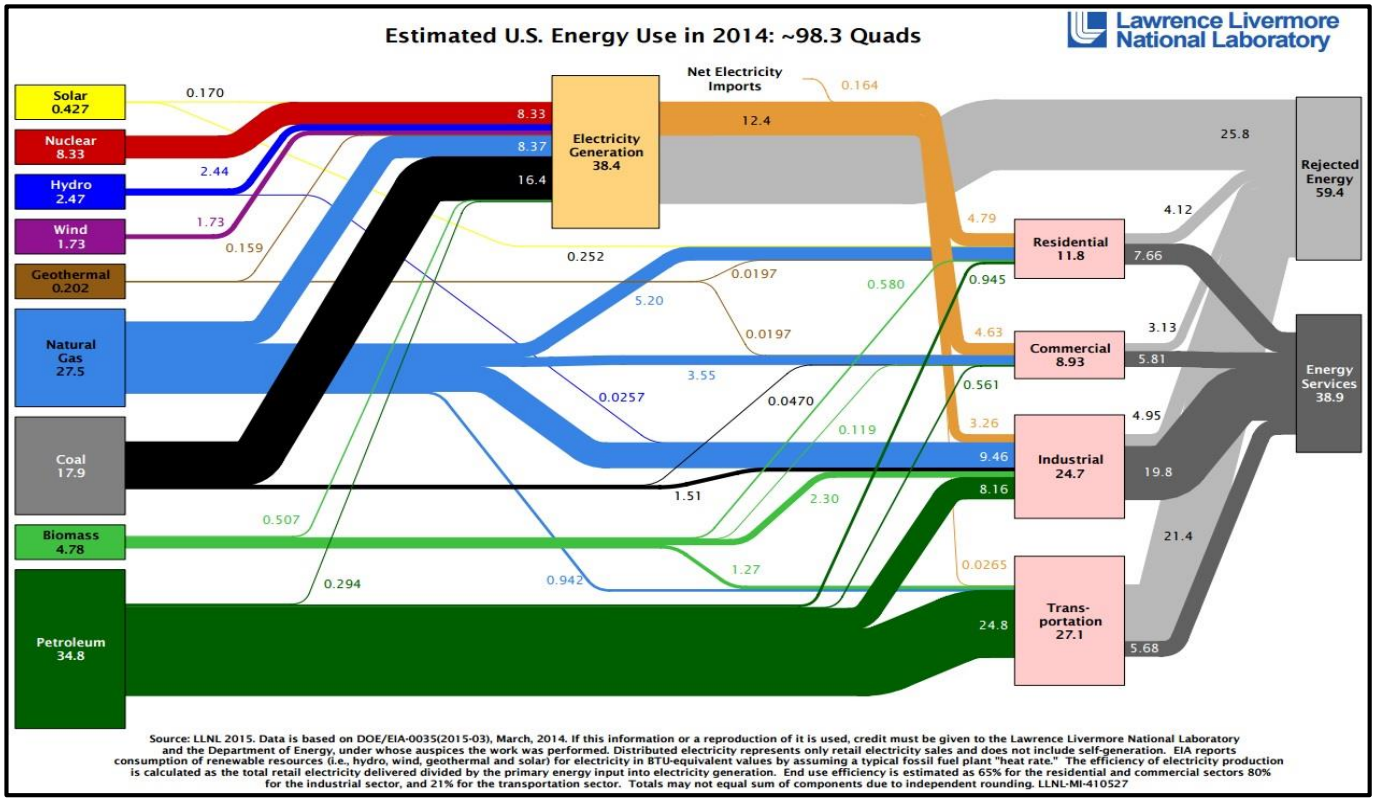
- *When you take into account the pros and cons of each energy source, which source(s) seem most sustainable? Why?*

- *What could be some advantages/disadvantages of using many different energy sources (fuel diversity) to produce electricity?*

- *What are some patterns about energy sources you observe in this chart?*

Think.Pair.Share

Draw 2 conclusions from this diagram.
Make 1 prediction about carbon emissions.



Source: Lawrence Livermore National Laboratory, www.llnl.gov
State Energy Flow Charts also available!!

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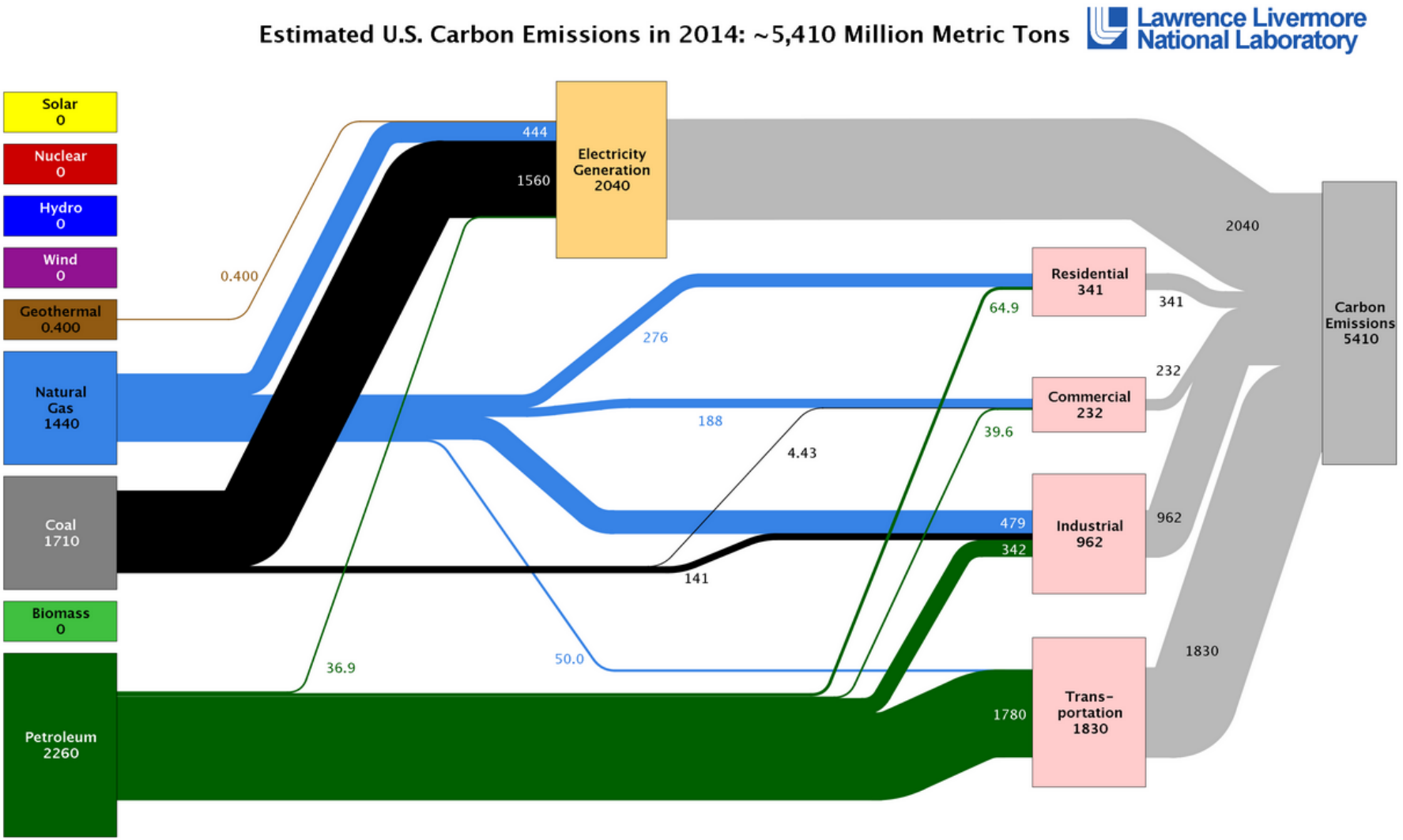
U.S. Carbon Emissions



Source: LLNL 2015. Data is based on DOE/EIA-0035(2015-03), March, 2015. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Carbon emissions are attributed to their physical source, and are not allocated to end use for electricity consumption in the residential, commercial, industrial and transportation sectors. Petroleum consumption in the electric power sector includes the non-renewable portion of municipal solid waste. Combustion of biologically derived fuels is assumed to have zero net carbon emissions – the lifecycle emissions associated with producing biofuels are included in commercial and industrial emissions. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

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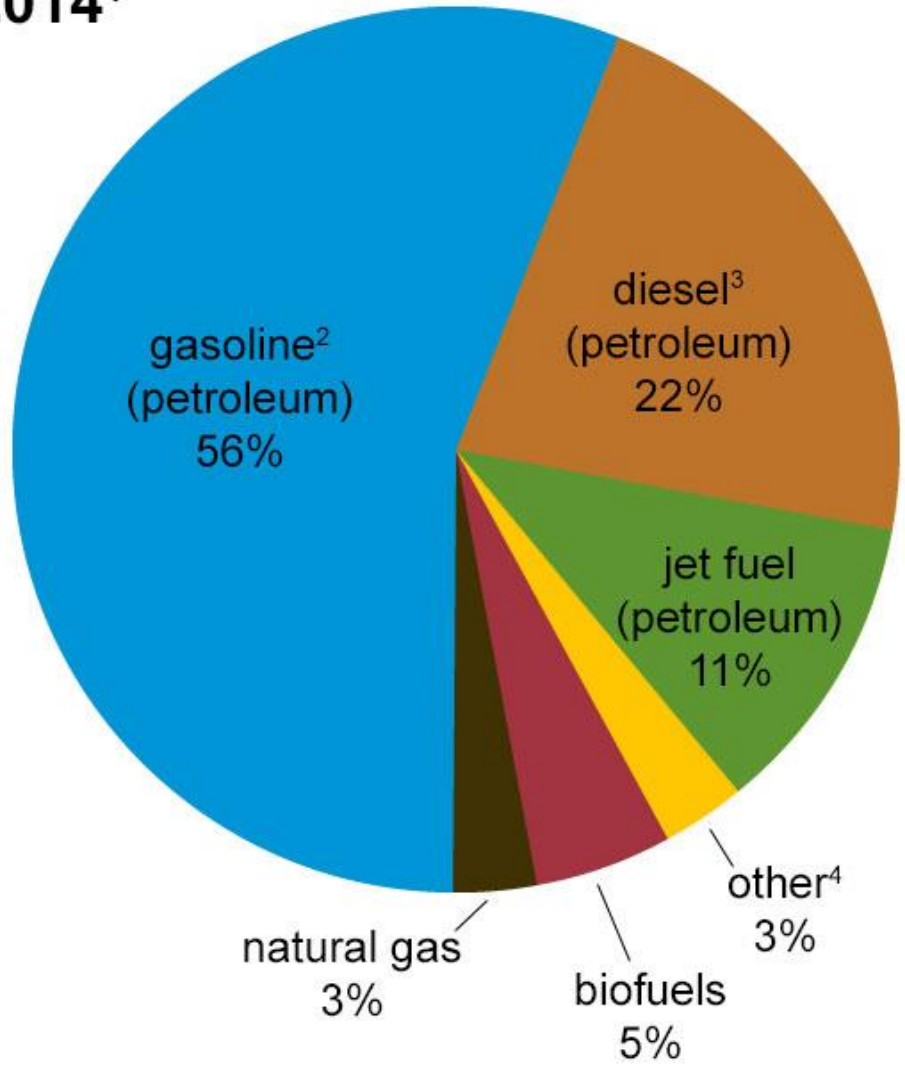
Fuel used for U.S. transportation, 2014[1]



[1] Based on energy content
[2] Motor gasoline and aviation gas; excludes ethanol
[3] Excludes biodiesel
[4] Electricity, liquid petroleum gas, lubricants, residual fuel oil, and other fuels

Source:

U.S. Energy Information Administration, *Monthly Energy Review* (March 2015), Tables 2.5 and 3.8c, preliminary data

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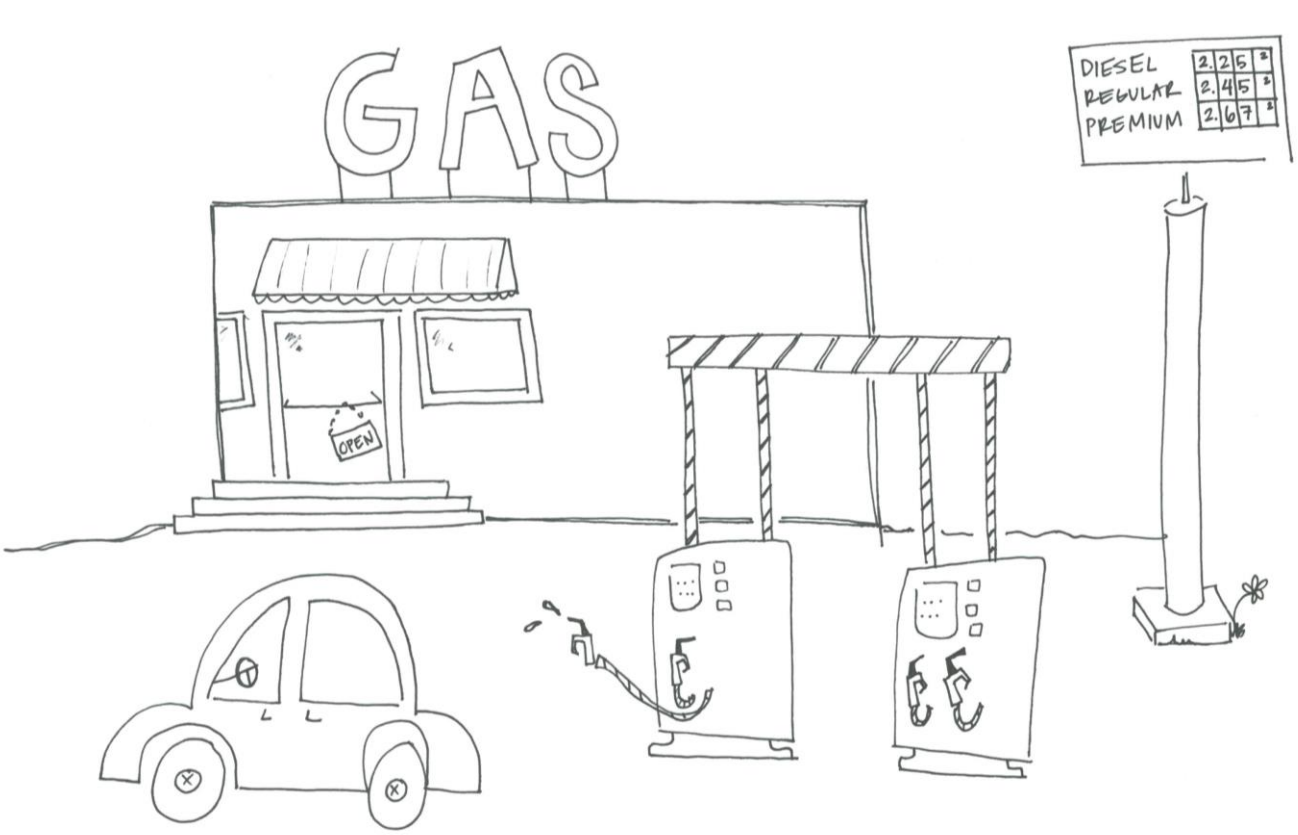
NGSS 4-ESS3-1

- Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

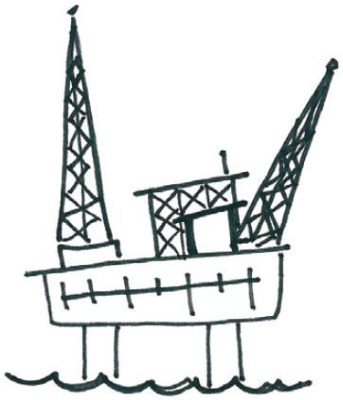
Energy Literacy Framework

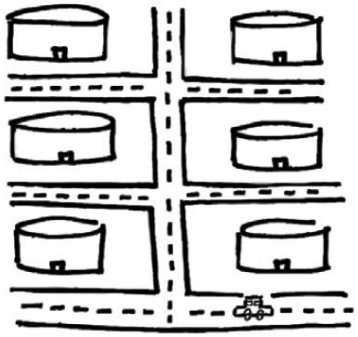
- 4.1 Humans transfer and transform energy from the environ. into forms useful for human endeavors.
- 5.2 Energy infrastructure has inertia.
- 7.4 Increasing demand for and limited supplies of fossil fuels affects quality of life.

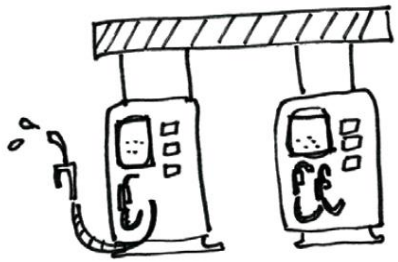
What happens in between well and wheel?



The Supply Chain of Gasoline







Oil Well → **Refinery** → **Terminals** → **Gas Station**

Consumption
The process of using natural resources or manufactured products to satisfy human wants and needs.

Economy
The system of production, distribution, and consumption of goods and services.

Supply and Demand
The amount of a product that is available (supply) and the amount of a product that is wanted by customers (demand).

Supply Chain
All the steps, resources, people, and businesses it takes to get a product or service from supplier to customer.

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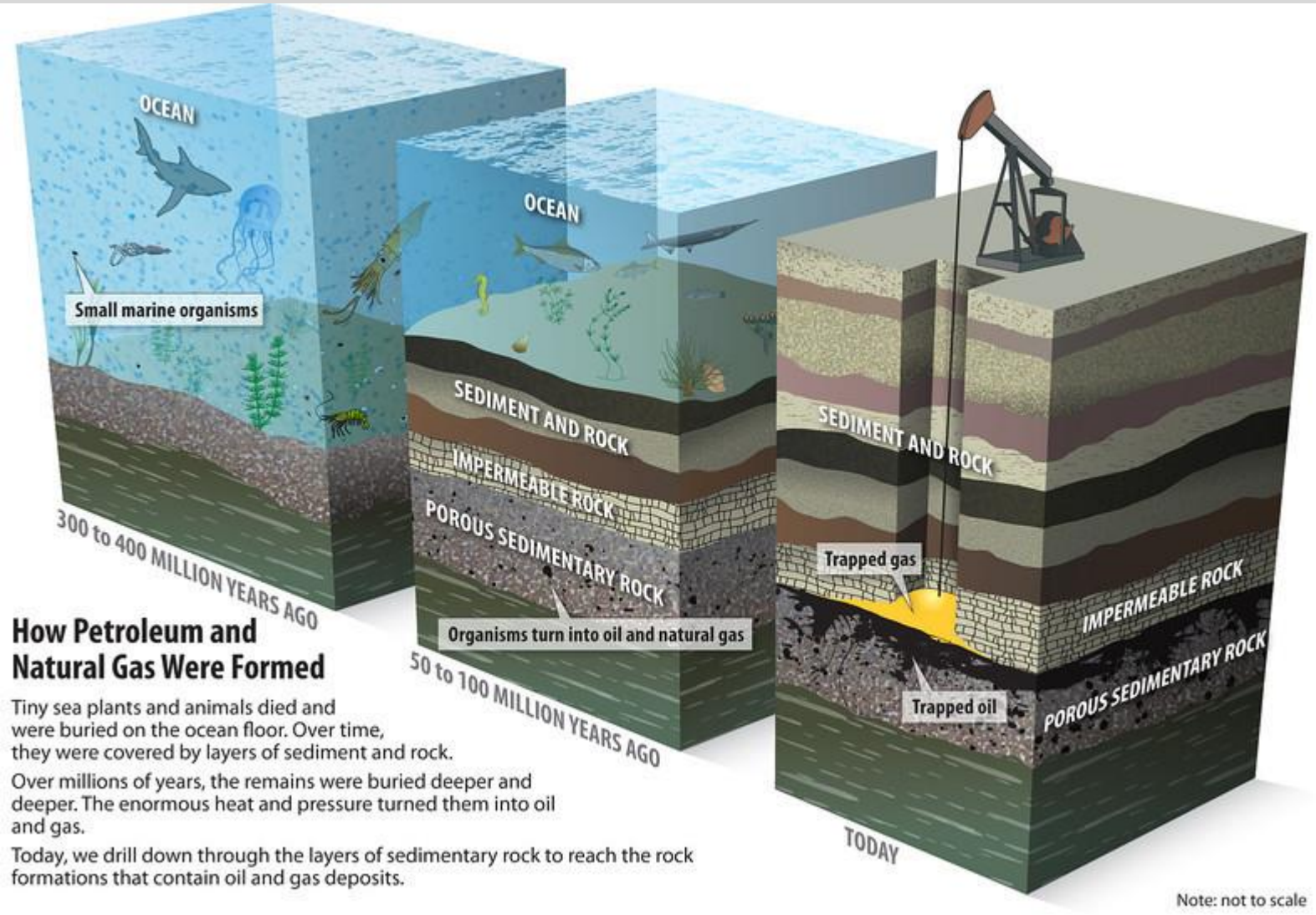


How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

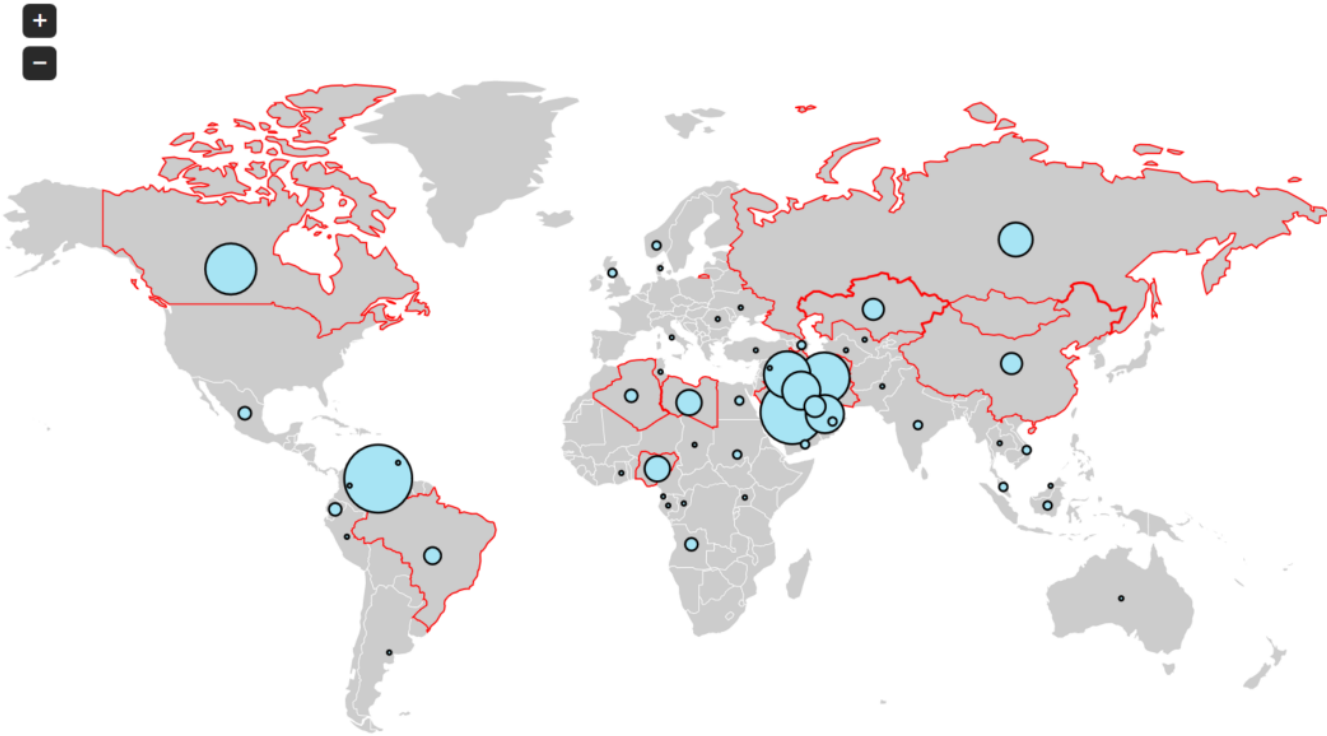
Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

Source: The Houston Museum of Natural Science; http://blog.hmns.org/tag/petroleum/

Crude Oil Proved Reserves - 2015 ›

Billion Barrels

1. Venezuela
2. Saudi Arabia
3. Canada
4. Iran
5. Iraq
6. Kuwait
7. United Arab Emirates
8. Russia
9. Libya
10. Nigeria
11. Kazakhstan
12. China
13. Qatar
14. Brazil
15. Algeria



U.S. Energy Information Administration

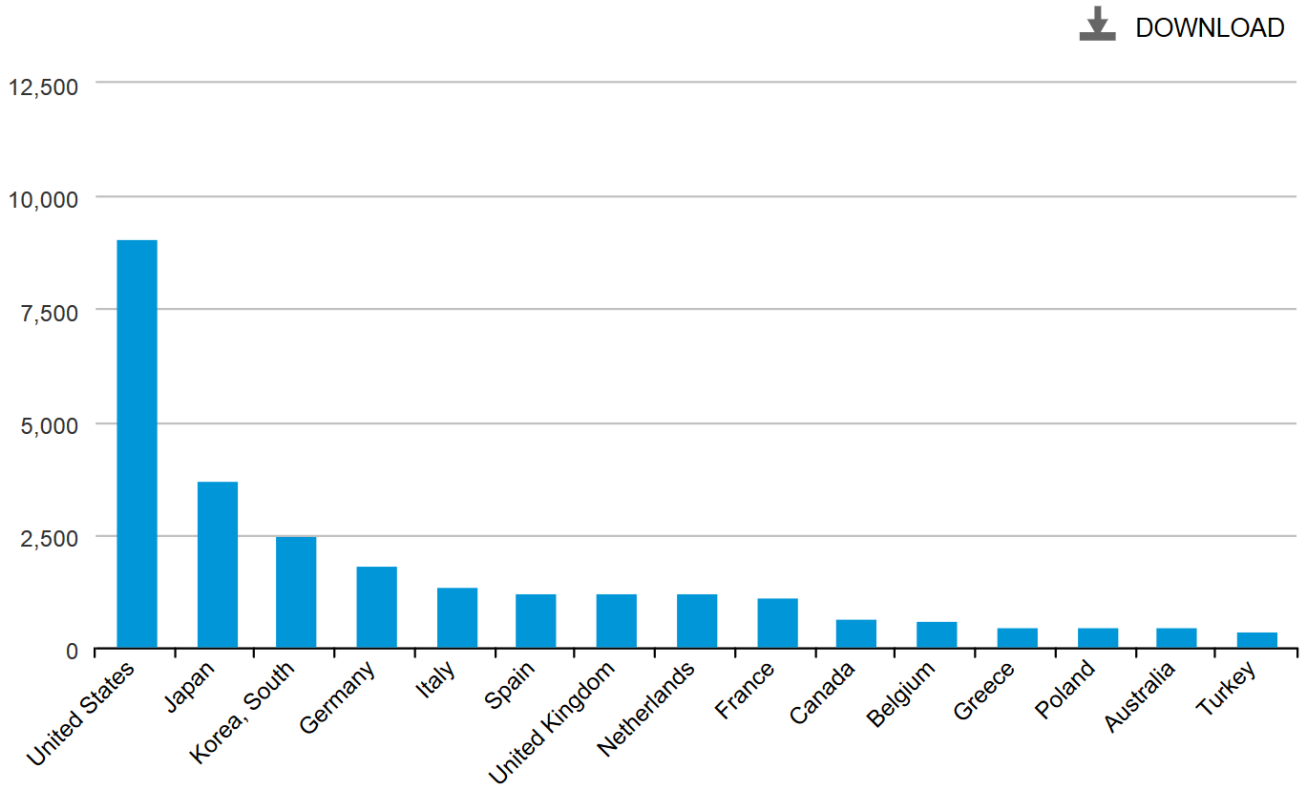
www.eia.gov

Imports of Crude Oil including Lease Condensate - 2013* ›

(*most recent year with sufficient data for ranking)

Thousand Barrels Per Day

1. United States
2. Japan
3. Korea, South
4. Germany
5. Italy
6. Spain
7. United Kingdom
8. Netherlands
9. France
10. Canada
11. Belgium
12. Greece
13. Poland
14. Australia
15. Turkey

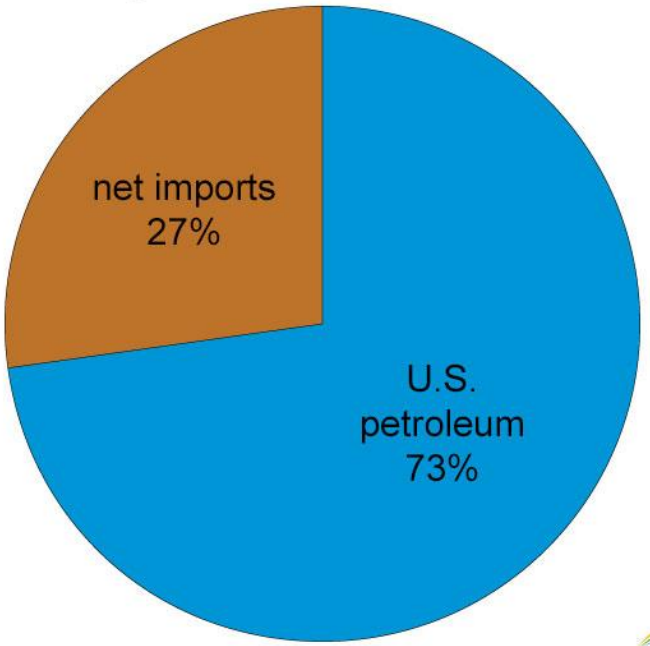


U.S. Energy Information Administration, www.eia.gov

http://www.eia.gov/beta/international/index.cfm?view=consumption

Where does our oil come from?

Net imports and domestic petroleum as shares of U.S. demand, 2014



Note: Petroleum includes crude oil, petroleum products, and biofuels.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 3.1 (February 2015), preliminary data

Main sources of U.S. net crude oil and petroleum products, 2014

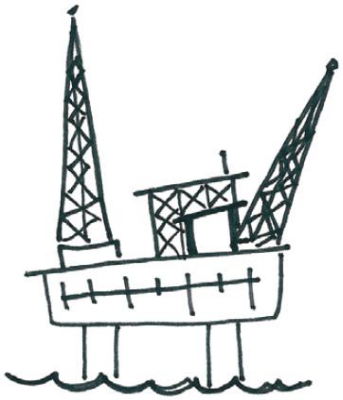
- Canada (38%)
- Saudi Arabia (17%)
- Venezuela (10%)
- Iraq (5%)
- Russia (5%)

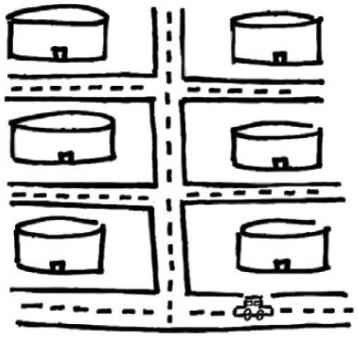
Petroleum Administration for Defense Districts (PADDs)

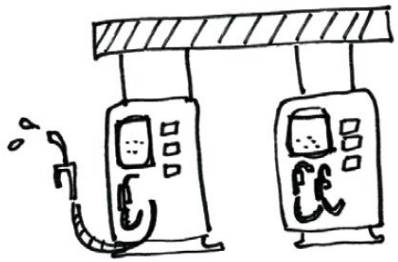
Figure 1. Petroleum Administration for Defense Districts (PADDs)

Source: U.S. Energy Information Administration

The Supply Chain of Gasoline







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Discussion Questions

- *What are some of the insights you gained during this activity?*
- *What might your students gain from an activity like this?*
- *What are some of the social, environmental, and economic impacts of this supply chain?*
- *How would life be different without this supply chain?*
- *How might this activity encourage systems thinking?*
- *How is driving a global issue?*

Energy is the golden thread…

" Sustainable energy is the golden thread that connects economic growth, increased social equity and an environment that allows the world to thrive. Low-carbon growth can foster decent jobs, empower women, promote equality, provide access to sustainable energy, make cities more sustainable and enhance the health of both people and the planet."

UN SECRETARY-GENERAL BAN KI-MOON

MESSAGE TO THE CLEAN ENERGY MINISTERIAL MEETING
MAY 2014

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Energy: Interdisciplinary and Interconnected

Why might it be helpful to understand how and why global issues are interconnected?

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Roderick Paige, former us secretary of education

"Ours is a world of 24-hour-news cycles, global markets, and high-speed Internet. We need to look no further than our morning paper to see that our future, and the future of our children, is inextricably linked to the complex challenges of the global community. And for our children to be prepared to take their place in that world and rise to those challenges, they must first understand it."

Transportation Fuels

- What factors do people consider when deciding which fuel to use in their vehicle?
- How are transportation fuels related to sustainability?

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What's In Your Tank?

	Fuel 1	Fuel 2
Price at the Pump	*$3.52/gal*	*$3.24/gal*
Miles to Fuel Station	*0.4 miles*	*24.0 miles*
Price per Unit Energy	*$30.52/mBTU*	*$39.69/mBTU*
Flex Fuel Car Needed?	*No*	*Yes*
Feedstock Type	*Petroleum*	*Sugarcane*
Fuel Type	*Gasoline*	*Ethanol (E85)*

Feedstocks & Sustainability

feedstock:
The raw material used in manufacturing or processing.

biofuel:
Fuel made from biomass (living/recently living organic matter).

USDA awards $136M for advanced biofuels
September 28, 2011 | admin
Biofuels Digest

"Five university-led consortia receive $15M-$40M grants for diesel, gasoline, and renewable jet fuels."

1. *University of Washington, $40M, sustainably grown woody energy crops to biogas and renewable aviation fuel*
2. *Washington State University, $40M, from closed timber mills to renewable aviation fuel*
3. *Iowa State University, $25M, from native perennial grasses to advanced biofuels and biochar*
4. *Louisiana State University, $17.2M, from energy cane and sorghum to reinvigorate sugar and chemical industries*
5. *University of Tennessee, $15M, sustainable feedstock production (switchgrass and woody biomass)*

Source: http://www.biofuelsdigest.com/bdigest/2011/09/28/usda-awards-136m-for-advanced-biofuels/

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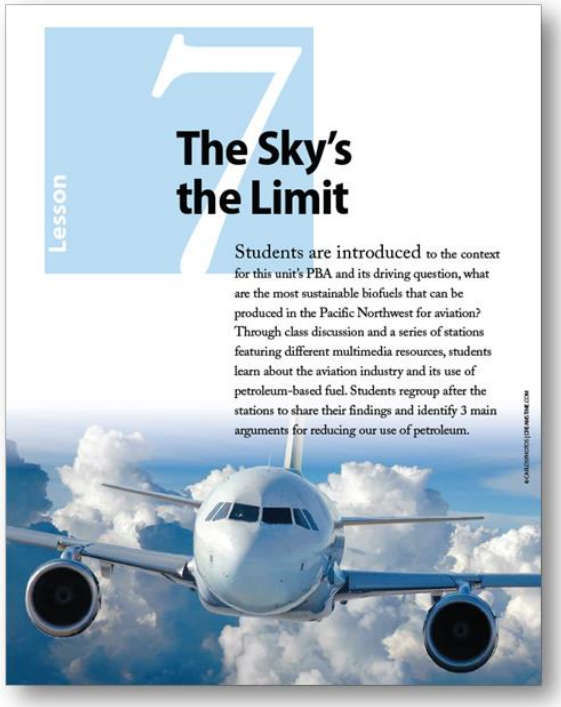
Why would the federal government want to reduce the amount of crude oil used in our nation?

- *National security*
- *Environmental protection*
- *Economics*
- *Nonrenewable resource*
- *Secure, consistent supply*



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"Breaking" News

- ***As Ethanol Takes Its First Steps, Congress Proposes a Giant Leap***
  (New York Times, 2007)

- ***Bioenergy: Fuelling the food crisis?***
  (BBC News, 2008)

- ***Is Ethanol a Solution, or a Problem?***
  (New York Times, 2011)

- ***USDA awards $136M for advanced biofuels***
  Five university-led consortia receive $15M-$40M grants for diesel, gasoline, and renewable jet fuels (Sept 2011)

- ***US Navy, DOE, USDA award $210M for 3 biorefineries and mil-spec fuels*** *(Sept 19, 2014 | Jim Lane | Biofuels Digest)*

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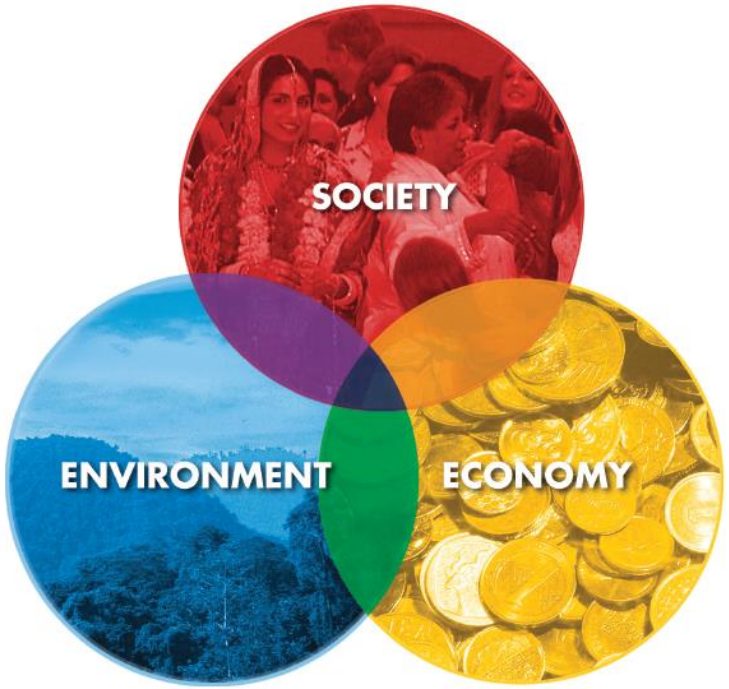
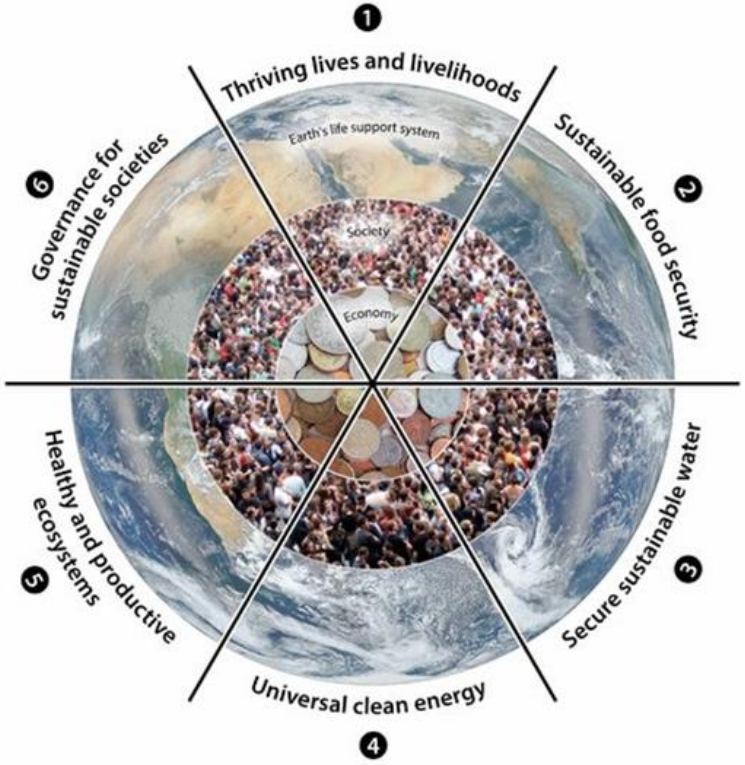
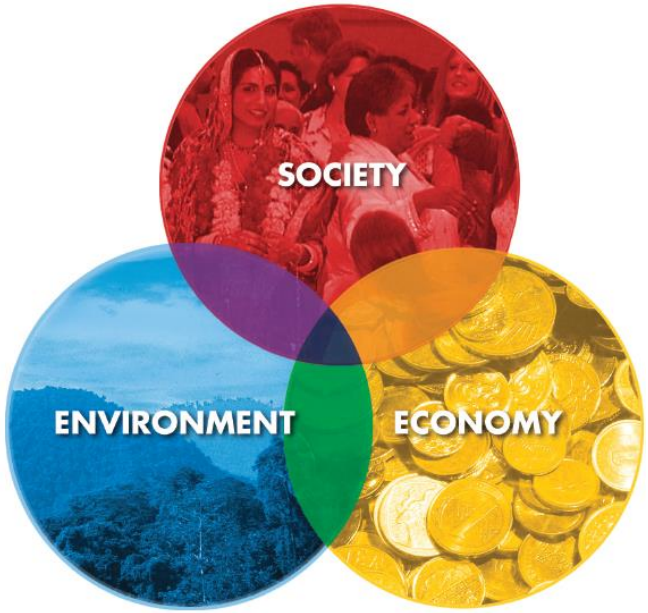
How would you define sustainability?





Society

- How are people's lives affected?
- How are cultures affected?
- Do some people benefit at the expense of others?



Environment

- How are living organisms affected?
- How are air, water, and soil affected?
- What is the long-term impact on the environment?

Economy

- How are local, national, and international economies affected?
- What is the cost-benefit?
- Is there a long-term economic gain for people and communities?

NOT SUSTAINABLE

COMPLETELY SUSTAINABLE

1 2 3 4 5

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Discussion Questions

- *What was the value of addressing social, economic, and environmental aspects of energy?*
- *What drives fuel production? What are the roles and responsibilities of consumers?*
- *Does renewable = sustainable?*
- *What are the characteristics of a sustainable fuel? Could the same feedstock be produced both sustainably and unsustainably?*
- *What else would you recommend investing in?*

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What if this…

Photo courtesy of R. Justin Hougham

…could fuel this?

©carlosphoto | dreamstime.com

Think.Pair.Share.

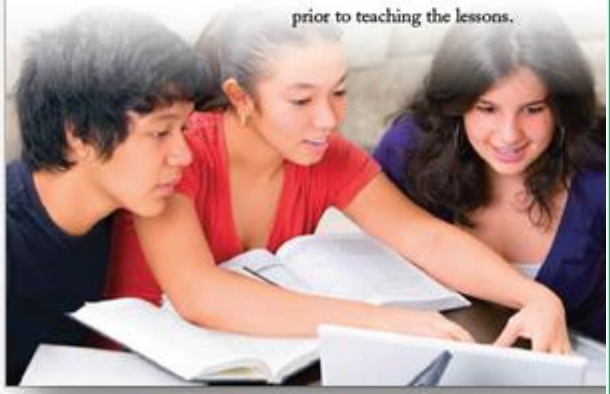
Should we do it? Why or why not?

Performance-based Assessment

Performance-based Assessment

Sustainable Flight in the Pacific Northwest

The following performance-based assessment (PBA) for this unit is designed to assess student learning of content and skills through multiple products. The assessment's driving question is based on an authentic real-life question facing
in the Pacific Northwest region of the U
The PBA is intended to motivate studen
active participants in the learning proces
designed to be conducted with Lessons 7
You can familiarize yourself with the asse
prior to teaching the lessons.



Performance-based Assessment

Lesson 7: The Sky's the Limit

Students critically assess information from different multimedia resources to identify the motivation to shift from petroleum-based aviation fuels to alternative fuels.

Lesson 8: The Life of a Fuel

Students research the steps required to produce different biofuels and consider environmental impacts on the Pacific Northwest.

Lesson 9: Sustainable Flight: A Stakeholder Meeting

Students represent stakeholder interests to negotiate a sustainable aviation biofuel mix for the Pacific Northwest.

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Reflection

- *What aspects of human energy use do you think your students would most relate to?*
- *How is energy related to some of the big ideas that you teach?*
- *Biggest take-away so far?*

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Flying Planes with Trees?

Overview of Wood-based Aviation Biofuels Supply Chains in the Pacific Northwest

Dr. Tammi Laninga
Assistant Professor
Huxley College of the Environment
Western Washington University

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Energy Literacy Matrix
energyliteracyprinciples.org

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Topic: 1. Energy is a physical quantity that follows precise natural laws.	Topic: 2. Physical processes on Earth are the result of energy flow through the Earth system.	Topic: 3. Biological processes depend on energy flow through the Earth system.	Topic: 4. Various sources of energy are used to power human activities.	Topic: 5. Energy decisions are influenced by economic, political, environmental, and social factors.	Topic: 6. The amount of energy used by human society depends on many factors.	Topic: 7. The quality of life of individuals and societies is affected by energy choices.	Topic: 8. Wood based bio-fuels are one form of energy that is renewable
Sub-Topic: 1.1 Energy is a quantity that is transferred from system to system.	Sub-Topic: 2.1 Earth constantly changes as energy flows through the system.	Sub-Topic: 3.1 The Sun is the major source of energy for organisms and the ecosystems of which they are a part	Sub-Topic: 4.1 Humans transfer and transform energy from the environment into forms useful for human endeavors	Sub-Topic: 5.1 Decisions concerning the use of energy resources are made at many levels.	Sub-Topic: 6.1 Conservation of energy has two very different meanings.	Sub-Topic: 7.1 Economic security is impacted by energy choices.	Sub-Topic: 8.1 Sources of cellulosic residuals used are found in forest operations and in industry process
Sub-Topic: 1.2 The energy of a system or object that results in its temperature is called thermal energy.	Sub-Topic: 2.2 Sunlight, gravitational potential, decay of radioactive isotopes, and rotation of the Earth	Sub-Topic: 3.2 Food is a biofuel used by organisms to acquire energy for internal living processes.	Sub-Topic: 4.2 Humans use of energy is subject to limits and constraints.	Sub-Topic: 5.2 Energy infrastructure has inertia.	Sub-Topic: 6.2 One way to manage energy resources is through conservation.	Sub-Topic: 7.2 National security is impacted by energy choices.	Sub-Topic: 8.2 Transportation and logistic considerations shape cost and feasibility within supply chains.
Sub-Topic: 1.3 Energy is neither created nor destroyed.	Sub-Topic: 2.3 Earth's weather and climate are mostly driven by energy from the Sun.	Sub-Topic: 3.3 Energy available to do useful work decreases as it is transferred from organism to organism.	Sub-Topic: 4.3 Fossil and biofuels are organic matter that contain energy captured from sunlight.	Sub-Topic: 5.3 Energy decisions can be made using a systems-based approach.	Sub-Topic: 6.3 Human demand for energy is increasing.	Sub-Topic: 7.3 Environmental quality is impacted by energy choices.	Sub-Topic: 8.3 Pretreatment processess makes sugars more available.

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BIOENERGY IN EDUCATION

Facing the Future

GS MS HS UG GR PR

A NW regional nonprofit developing inquiry based curricula for grades 6-12 on biofuel development.

www.facingthefuture.org

MOSS

GS MS HS UG GR PR

Promotes biofuel literacy to K-12 students, Grad students, and teaching professionals.

uidaho.edu/cnr/moss

BioFuels SURE

GS MS HS UG GR PR

Summer research experience for undergraduates aimed at giving them hands on skills in biofuels and bio-products research.

nararenewables.org/ed

IDeX

GS MS HS UG GR PR

A year long course for UI and WSU students providing supply chain analysis for an emerging wood products to biofuels industry.

idexstudio.org

Imagine Tomorrow with BioFuels

GS MS HS UG GR PR

Engages high school students to create solutions for a developing biofuel industry.

www.imagine.wsu.edu

Salish Kootenai College

GS MS HS UG GR PR

This tribal university provides research opportunities tied to biofuels and bio-products from woody biomass.

www.skc.edu

Western Washington University

GS MS HS UG GR PR

Offers undergraduate degrees in renewable energy with science and policy tracks.

www.huxley.wwu.edu

nararenewables.org

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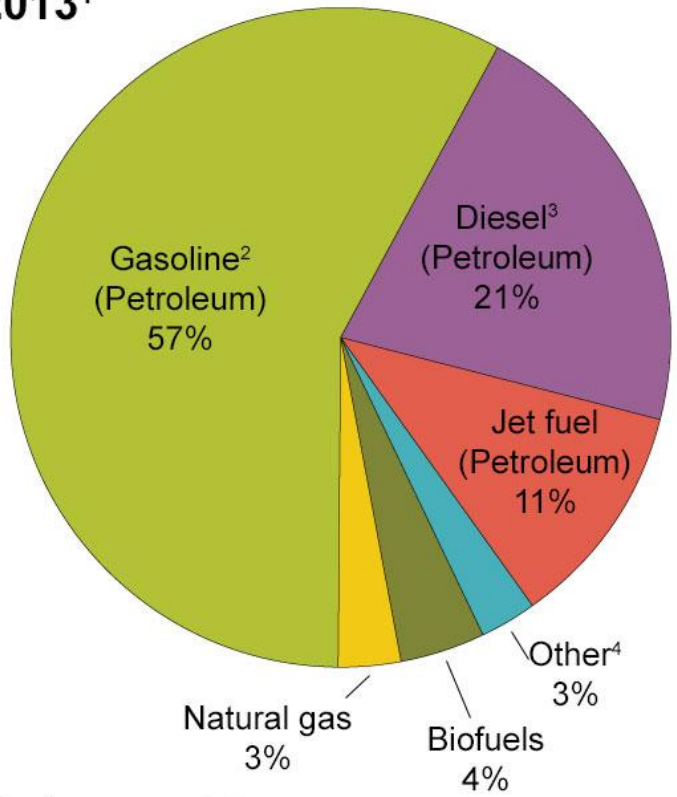
Fuel used for U.S. transportation, 2013[1]



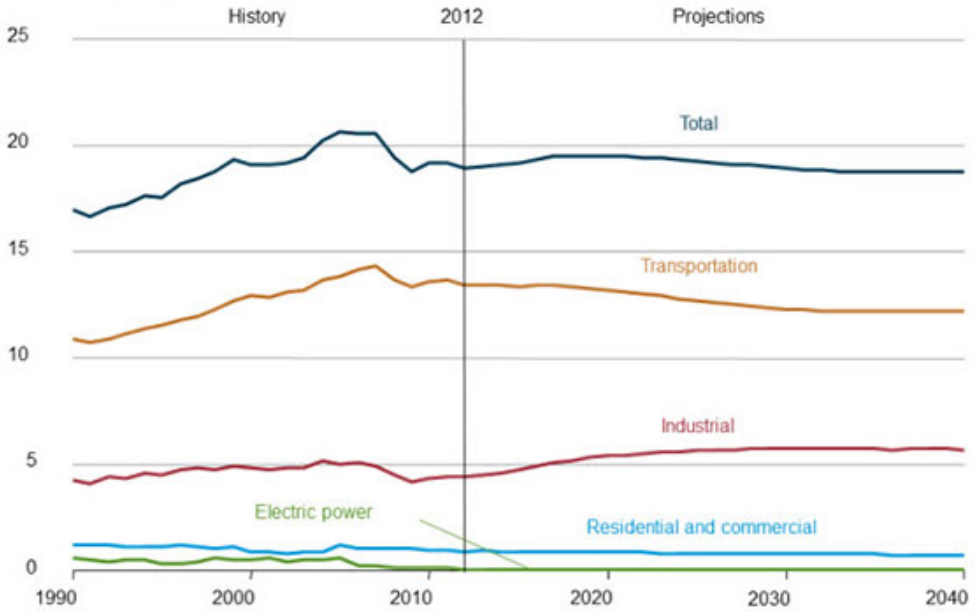
[1] Based on energy content
[2] Motor gasoline and aviation gas; excludes ethanol
[3] Excludes biodiesel
[4] Electricity, liquid petroleum gas, lubricants, residual fuel oil, and other fuels

Note: Due to rounding, data may not sum to exactly 100%.

Source: U.S. Energy Information Administration, *Monthly Energy Review June 2014,* tables 2.5 and 3.8c, preliminary data for 2013

Consumption of petroleum and other liquids by sector, 1990-2040

million barrels per day



Source: U.S. Energy Information Administration, Annual Energy Outlook, Figure MT-50 (April 2014)

WOOD TO WING

Measuring the environmental impact of converting forest residuals into bio-jet fuel and other co-products.

Converting forest residuals into chemical products such a bio-jet fuel is anticipated to provide numerous benefits to society. As biofuels displace fossil fuels, U.S. energy independence is strengthened and net carbon emissions are reduced. A novel use for forest residuals can stimulate rural economic development and reduce fuel loads in the forest.

NARA funds research to determine how using forest residuals affects forest ecosystems, water and air quality so that regional stakeholders and society can make informed decisions.

WILDLIFE

NARA researchers are studying the potential impact of forest residual removal on vertebrate abundance.
http://goo.gl/lbJQRe

AIR QUALITY

NARA is completing a "Life Cycle Assessment" that compares petroleum-based jet-fuel to forest residual-based blended jet-fuel for greenhouse gas emissions, ozone depletion, and smog emissions.
http://goo.gl/90JQIZ http://goo.gl/pYAyLD

WATER QUALITY

Models to predict water quality, quantity, and the effects on stream channels under various residual harvest scenarios are being developed.
http://goo.gl/4GuwmU

MICROFAUNA

NARA researchers are collecting and examining microbial communities at test spots to understand the effects of forest residual removal and harvesting on microfauna.
http://goo.gl/RgrOS3

SOIL NUTRIENTS

NARA is funding research to ensure that soil nutrient pools remain sustainable in working forests when limited forest residuals are removed.
http://goo.gl/RDasmB http://goo.gl/Jm25RC

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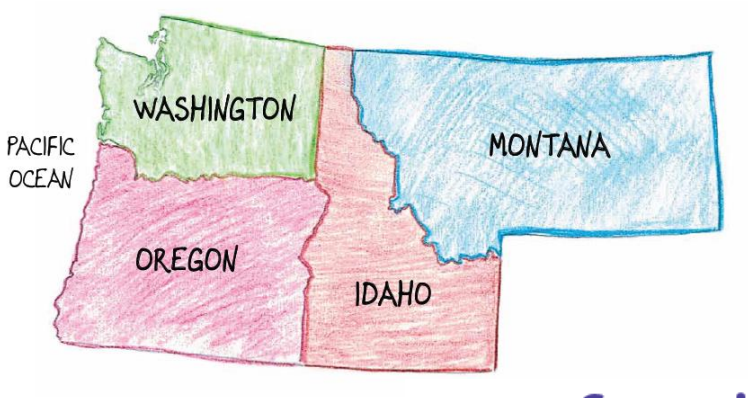
NARA is led by Washington State University and supported by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

USDA



Scenario: Sustainable Flight in the Pacific Northwest

The federal government has mandated that an increasing amount of biofuel be mixed into jet fuel over the next few years in order to reduce the amount of crude oil used in the nation. The federal government has established regional councils to help identify the most sustainable biofuel feedstock(s) for different regions in the nation. You have been selected to be a part of the Pacific Northwest Regional Biofuel Council. This region includes Washington, Idaho, Montana, and Oregon. Over the next few days, you will:

- identify and understand the reasons for developing aviation biofuels,
- conduct research on different kinds of biofuels and consider their impacts on the environment,
- represent a specific stakeholder at a negotiation, identify other stakeholders' perspectives, and create a policy that identifies a sustainable fuel mix for the Pacific Northwest region,

so that you can answer the following question:

What are the most sustainable biofuels that can be produced in the Pacific Northwest for aviation?

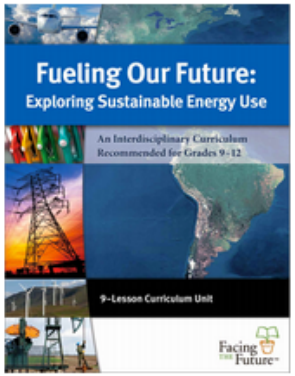
The Journal of Sustainability Education

ARCHIVES EDUCATION SETTINGS GEOGRAPHY TOPICS ABOUT US

JANUARY 10TH, 2015

Global Sustainability: An Authentic Context for Energy Education

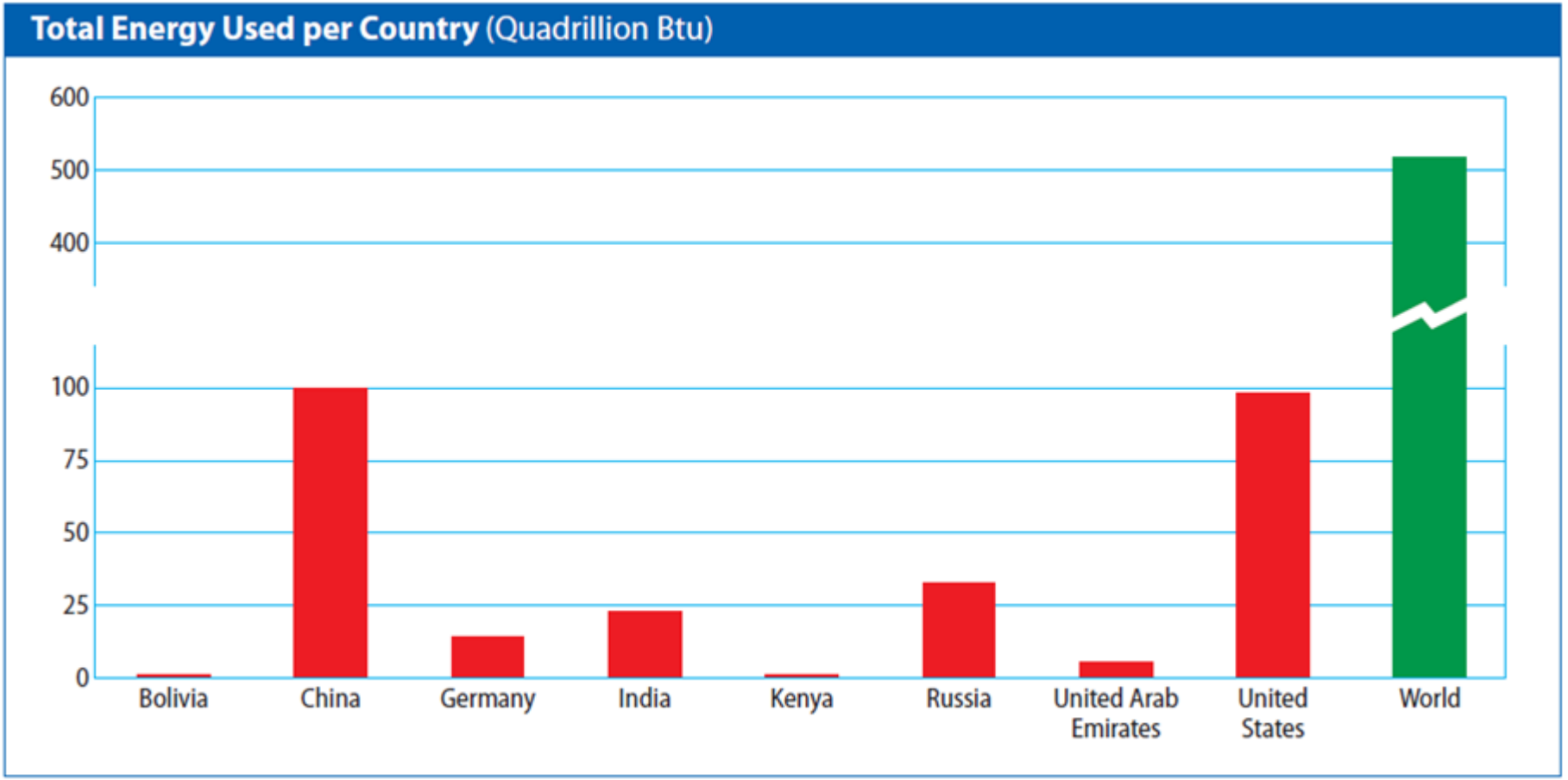
By Danica Hendrickson, Kimberly Corrigan, Alicia Keefe, Danielle Shaw, Sheeba Jacob, Laura Skelton, Jennifer Schon, Karla Bradley Eitel and Justin Hougham

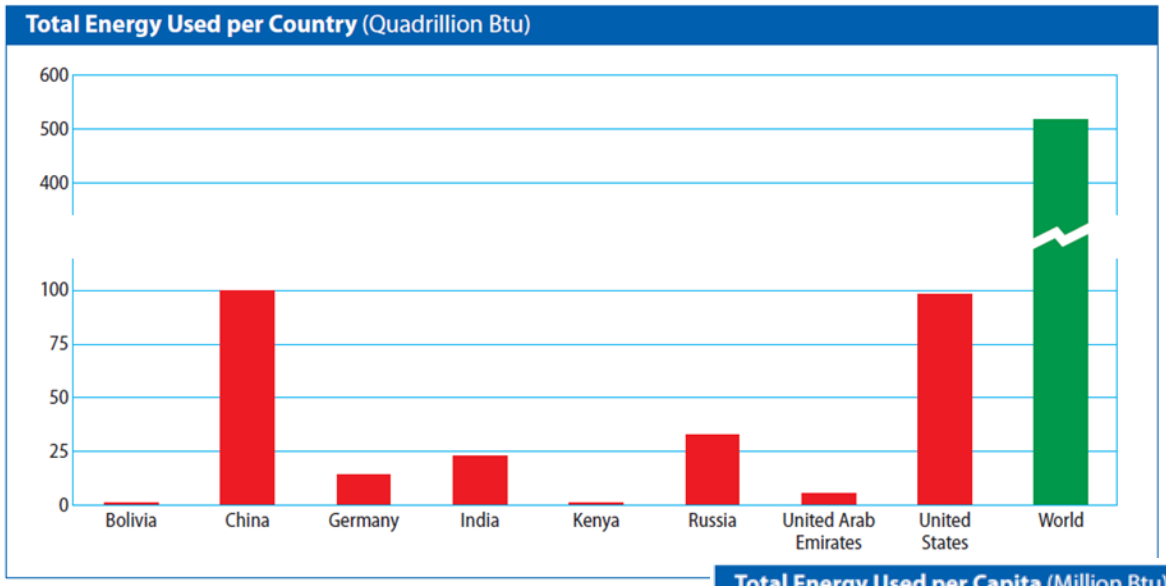


Hendrickson et al JSE Vol 8 Jan 2015 PDF Ready

Abstract: Reimagining energy education involves moving beyond the basics of energy use, conservation, and efficiency toward a more robust exploration of energy. This exploration should address energy access and equity, the impacts of energy choices, and personal attitudes, beliefs, and behaviors related to sustainable energy solutions. One approach to encourage this evolution is to use a learning context that inspires educators and students to delve deeply and methodically into the social, economic, and environmental interconnections of energy issues —in other words, to learn about energy within the context of global sustainability. In this article, we share Facing the Future's definition of global sustainability education (GSE), explain why GSE is an effective context for energy education, and use Facing the Future's newest energy curriculum to demonstrate how GSE can be employed to develop engaging and rigorous interdisciplinary energy curriculum.

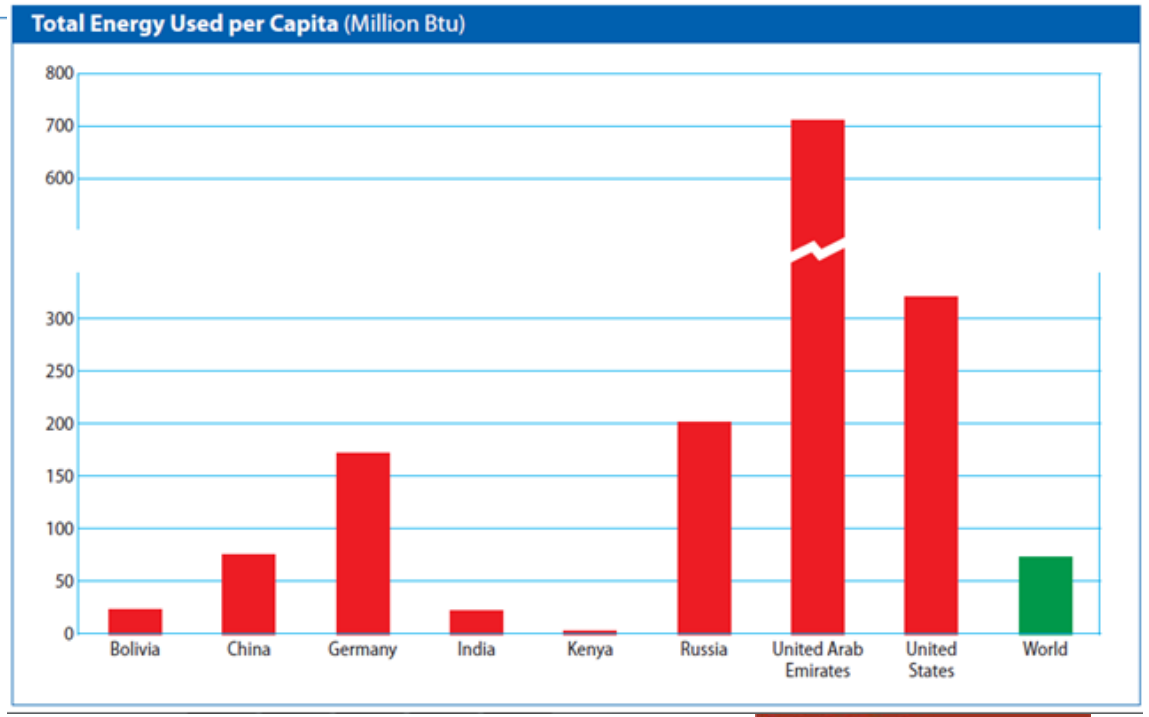
Energy Consumption: Choosing Your Lens





Total Energy Used per country

Total Energy Used per capita



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UN Sustainable Energy for All

Sustainable Solutions

- *personal solutions*
- *structural solutions*
- *leapfrog technology*

PSA

Linkin Park supporting SE4ALL

Sustainable Energy for All