

Climate, Education and Sustainability

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AFFILIATE FACULTY
SEATTLE UNIVERSITY CEJS

Roadmap

Environmental, Economic, and Social Impacts of Climate



Education's Role in Sustainable Development



Climate & Energy Education in the U.S.



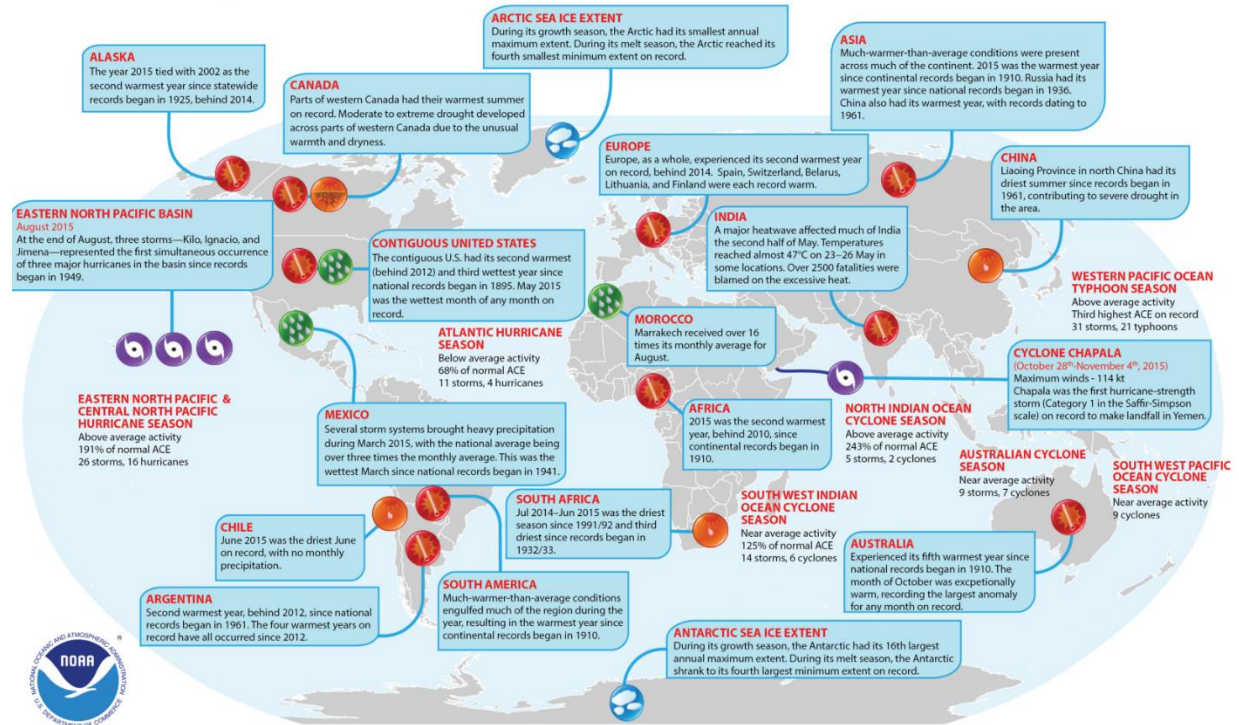
Sustainable Solutions



Photo: [SounderBruce | flickr.com](https://www.flickr.com/photos/sounderbruce/)

Climate Impacts: Environmental

Selected Significant Climate Anomalies and Events in 2015



Please Note: Material provided in this map was compiled from NOAA's NCEI State of the Climate Reports, the WMO Provisional Status of the Climate in 2015, and authorship for this report. For more information please visit: <http://www.nccdc.noaa.gov/sotc>

Climate Impacts: Economic



Hurricane Sandy, NY: \$68 billion damage¹



Wildfire suppression: \$15 billion, 2004 - 13²

Photos: [Timothy Krause | Flickr.com](#); [USDA | Flickr.com](#)

Climate Impacts: Social

- Over 1 billion people do not have access to energy.¹
- Over 2.9 billion people still lack access to clean cooking.²
- Women's annual pay in 2015 is the same as the amount of pay men received in 2005.³
- More than 88 percent of the current burden of disease related to climate change occurs in children under age 5.⁴

Education's Role in Sustainable Development

United Nations Decade of Education for Sustainable Development (2005 - 2014)

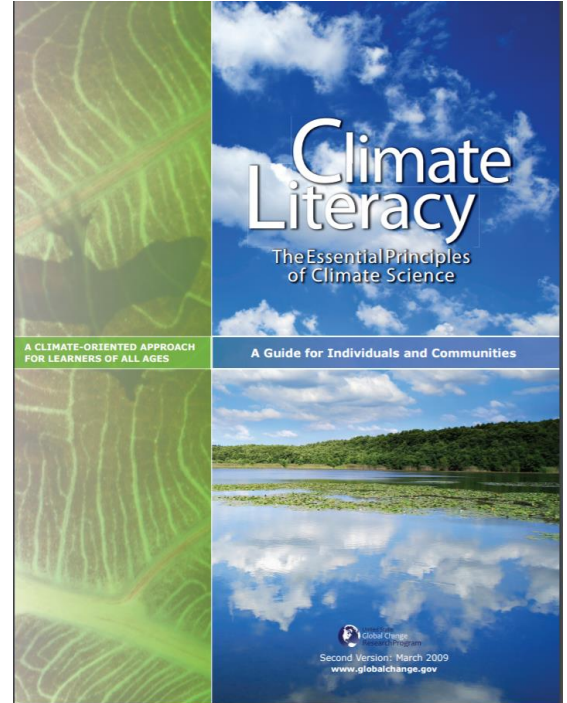


UNESCO Global Action Programme on Education for Sustainable Development

UNESCO and Sustainable Development Goals

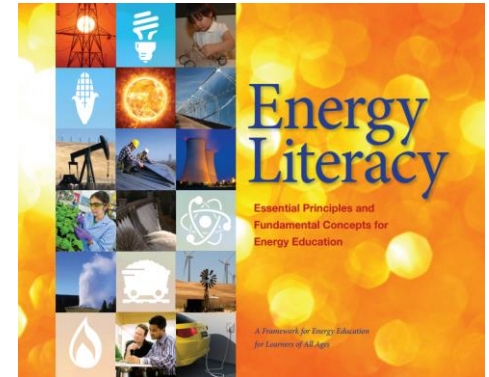


U. S. Climate Education



U.S. Energy Education

- Energy a Crosscutting Concept in Next Generation K-12 Science Standards
- National Energy Education Summit
- Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education
- Universities Creating New Energy Programs and Institutes



Energy and the Greenhouse Effect

Energy production and use represent $\frac{2}{3}$ the world's greenhouse gas emissions.

-International Energy Agency, 2015

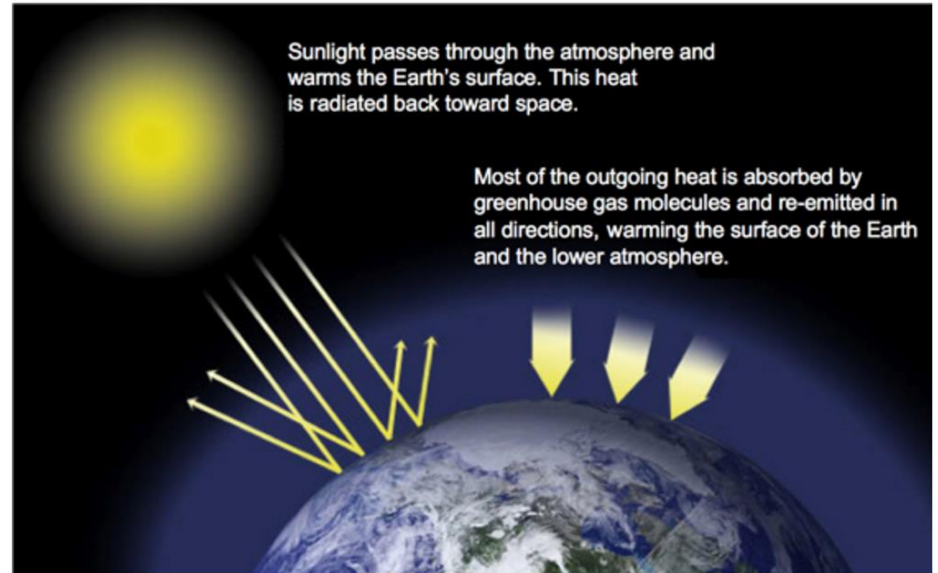
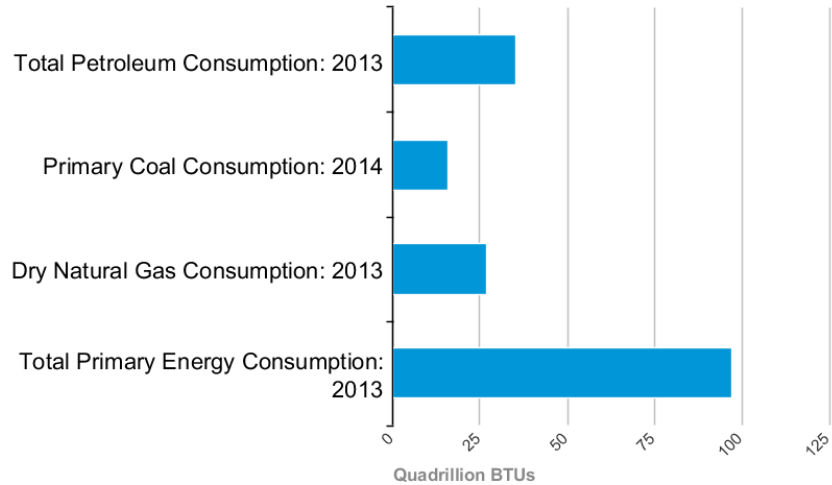


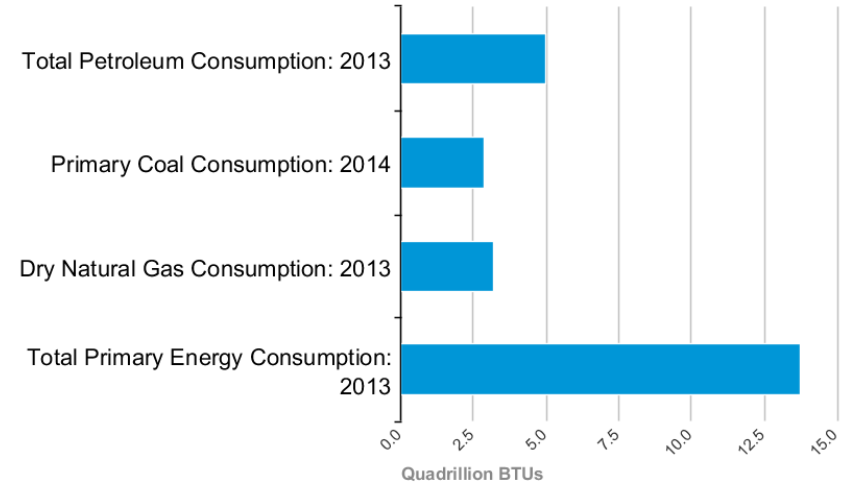
Image: NASA's Global Climate Change website
<http://climate.nasa.gov/causes/>

U.S. Fossil Fuel Consumption



 Source: U.S. Energy Information Administration

German Fossil Fuel Consumption

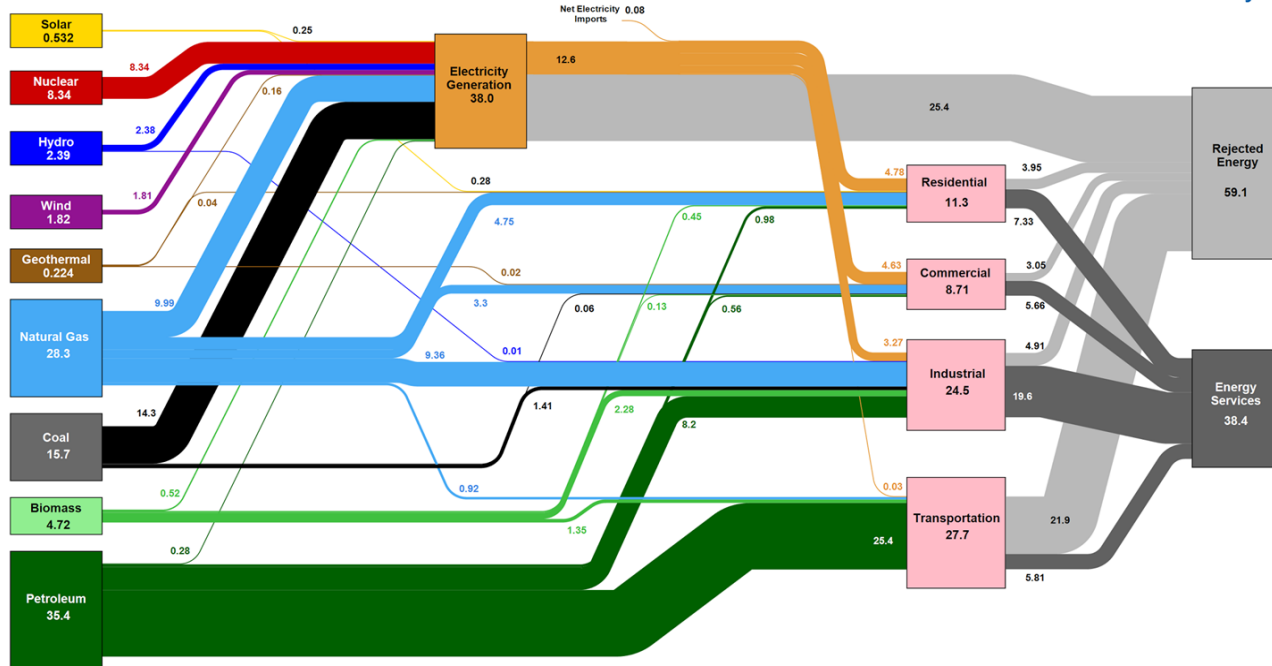


 Source: U.S. Energy Information Administration

Source: U.S. Energy Information Administration


U. S. Energy Consumption

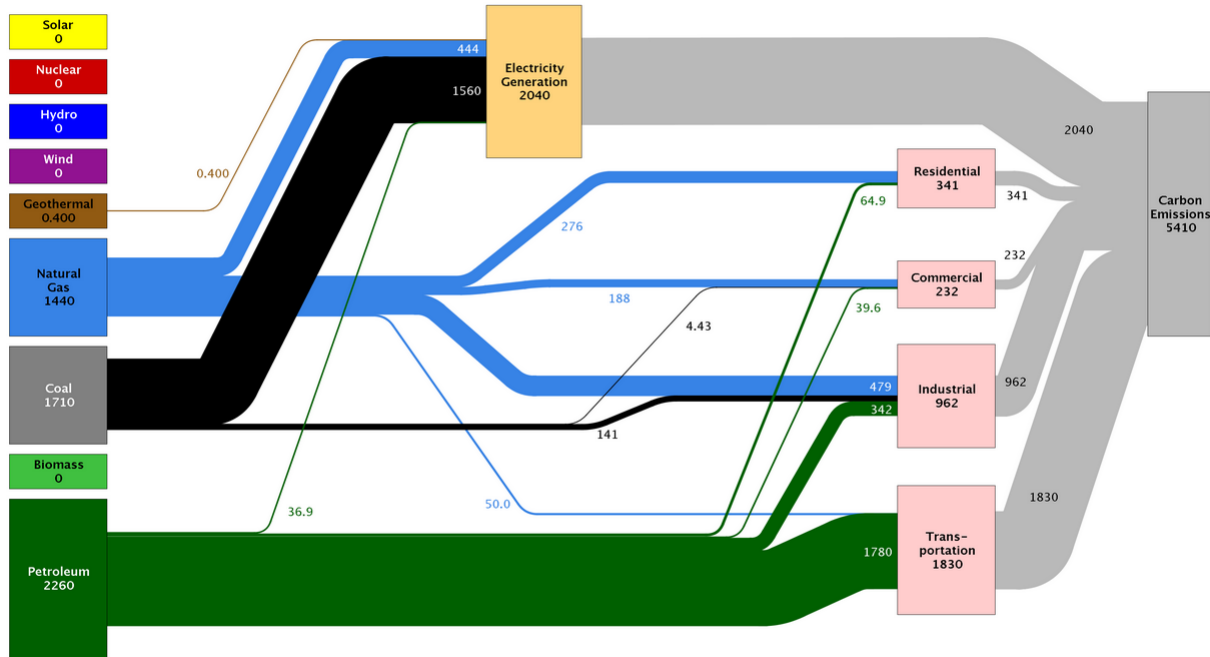
Estimated U.S. Energy Consumption in 2015: 97.5 Quads



Source: LLNL March, 2016. Data is based on DOE/EIA MER (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. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 63% for the residential sector, 63% for the commercial sector, 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

U.S. Carbon Emissions Related to Energy Use

Estimated U.S. Carbon Emissions in 2014: ~5,410 Million Metric Tons 



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

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

Energy as an Opportunity

“ 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

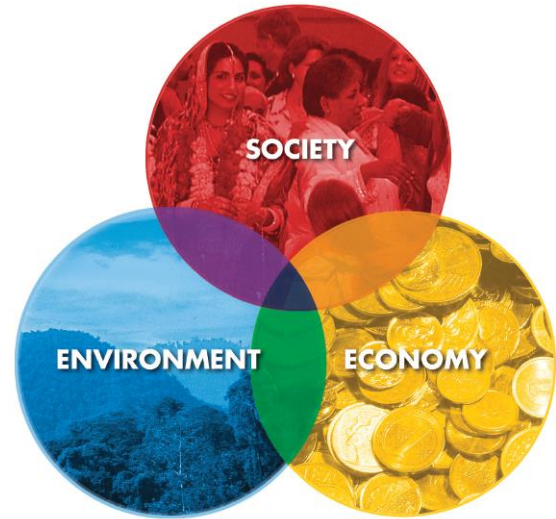
MESSAGE TO THE CLEAN ENERGY MINISTERIAL MEETING

MAY 2014

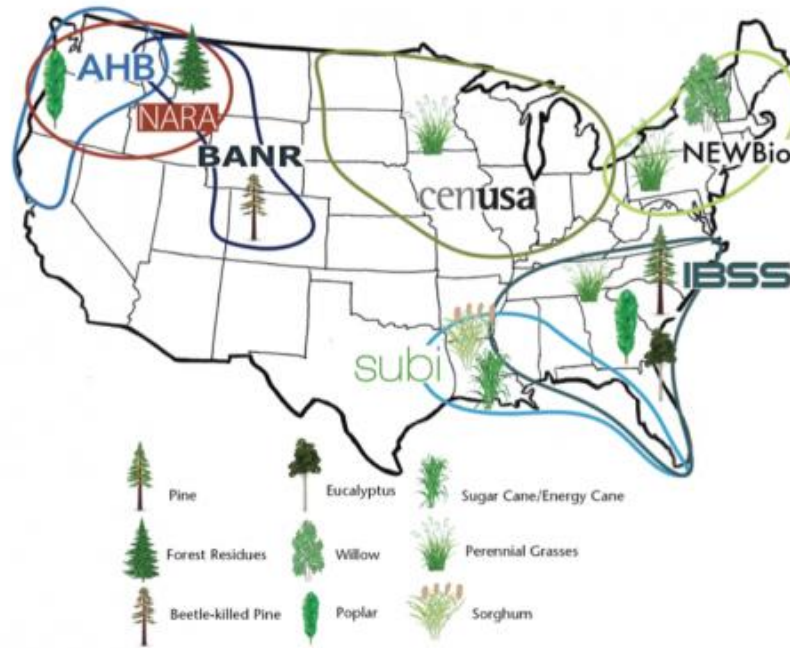


Components of Sustainable Solutions

- Intergenerational Responsibility
- Interconnectedness
- Systems Thinking
- Multiple Perspectives
- Structural Solutions
- Personal Solutions



Sustainable Solutions: Examples from the Pacific Northwest



Northwest Advanced Renewables Alliance (NARA)



FRP

FOREST RESIDUES PREPARATION

Primary feedstock targets include forest residues from logging and thinning operations. We are also considering mill residues and discarded woody materials from construction and demolition, in regions where these materials are under utilized.



T

TRANSPORTATION

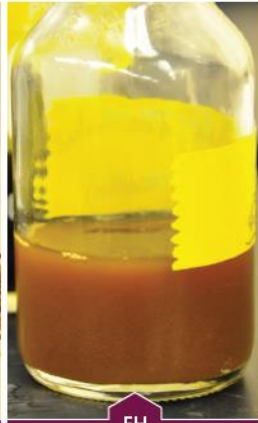
Feedstocks are transported from the collection site to a conversion facility. Chipping can take place at the loading or in a preprocessing facility.



PT

PRE-TREATMENT

Wood chips are treated to make the sugar polymers (polysaccharides) accessible to degrading enzymes. These processes allow the lignin to be available for separation.



EH

ENZYMATIC HYDROLYSIS

Specific enzymes are added to hydrolyze (cleave) the polysaccharides and generate simple sugars (monosaccharides).



F

FERMENTATION

Specialized yeast convert the monosaccharides into isobutanol.



BCP

BIOJET & CO-PRODUCTS

Aviation fuels can be generated from the platform molecules derived from wood sugars. Lignin can be used to generate co-products such as epoxies, structural materials and bio-based plastics. As an alternative, lignin can be burned to produce renewable energy.

ONE BONE DRY TON WOODY BIOMASS

+

DIESEL

+

HEAT, WATER, & CHEMICALS

=

~600 POUNDS LIGNIN

AND

~59 GALLONS ISOBUTANOL

OR

~42 GALLONS BIOJET

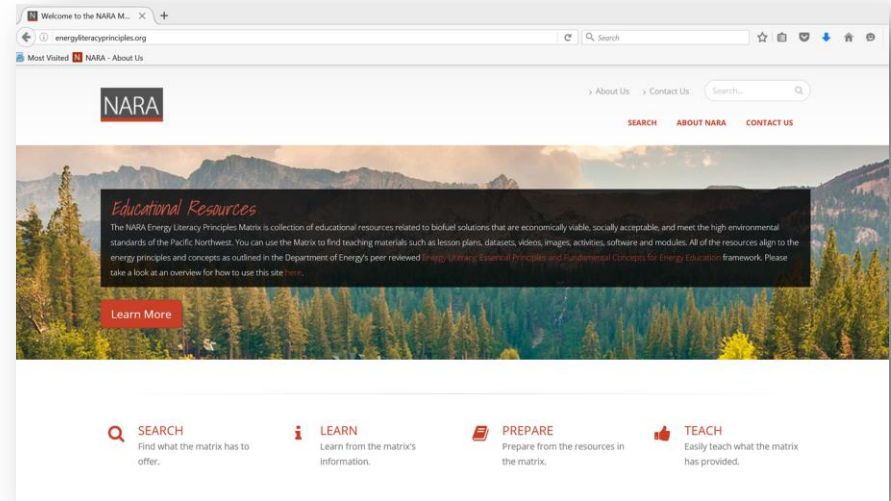
Education at the Speed of Research

BIOENERGY IN EDUCATION

Facing the Future A NW regional nonprofit developing inquiry based curricula for grades 6-12 on biofuel development. www.facingthefuture.org	MOSS Promotes biofuel literacy to K-12 students, Grad students, and teaching professionals. uidaho.edu/cnr/moss	BioFuels SURE Summer research experience for undergraduates aimed at giving them hands on skills in biofuels and bio-products research. nararenewables.org/ed	IDeX A year long course for UI and WSU students providing supply chain analysis for an emerging wood products to biofuels industry. indexstudio.org
Imagine Tomorrow with BioFuels Engages high school students to create solutions for a developing biofuel industry. www.imagine.wsu.edu	Salish Kootenai College This tribal university provides research opportunities tied to biofuels and bio-products from woody biomass. www.skc.edu	Western Washington University Offers undergraduate degrees in renewable energy with science and policy tracks. www.huxley.wvu.edu	

nararenewables.org

www.nararenewables.org



Welcome to the NARA M...
energyliteracyprinciples.org
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Educational Resources

The NARA Energy Literacy Principles Matrix is collection of educational resources related to biofuel solutions that are economically viable, socially acceptable and meet the high environmental standards of the Pacific Northwest. You can use the Matrix to find teaching materials such as lesson plans, datasets, videos, images, activities, software and modules. All of the resources align to the energy principles and concepts as outlined in the Department of Energy's peer reviewed [Energy Literacy, Essential Principles and Fundamental Concepts for Energy Education](#) framework. Please take a look at an overview for how to use this site [here](#).

Learn More

SEARCH Find what the matrix has to offer.
LEARN Learn from the matrix's information.
PREPARE Prepare for the resources in the matrix.
TEACH Easily teach what the matrix has provided.

www.energyliteracyprinciples.org

R. Justin Hougham, Ph.D,
University of Wisconsin-Extension

Other Education Efforts

- Global Sustainability Curriculum - www.facingthefuture.org
- WA State K-12 Integrated Environmental and Sustainability Learning Standards
- WA Green Schools
- University Centers and Programs:
 - Seattle University | Center for Environmental Justice and Sustainability
 - University of Washington | Clean Energy Institute
 - Western Washington University | Institute for Energy Studies





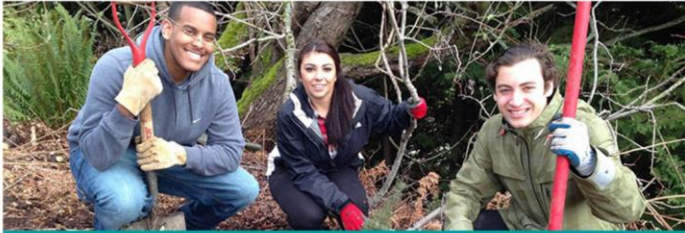
TICKETS

MEMBERSHIP

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VISIT THE ZOO ANIMALS & PLANTS CONSERVATION FOR EDUCATORS CAMPS & PROGRAMS MEMBERSHIP

- CAMPS
- PROGRAMS & CLASSES
 - Child & Family Programs
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 - Adult Programs
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SEATTLE YOUTH CAN



TEENS TAKING ACTION FOR CLIMATE CHANGE

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Youth-led Solutions

Community/City Solutions

- Capitol Hill EcoDistrict
- Seattle 2030 District
- International Living Future Institute:
Living Building Challenge

<http://living-future.org/>

<http://capitolhillecodistrict.org/>

<http://www.bullittcenter.org/>



Personal Solutions

- Home
- Travel Driving/Flying
- Food and Diet
- Recycling and Waste
- Stuff
- WWF - UK | footprint.wwf.org.uk/
- The Nature Conservancy | www.nature.org/greenliving/carboncalculator/
- Carbon Footprint of Nations | carbonfootprintofnations.com/



Acknowledgements:

Konrad Adenaur Stiftung

US Consulate General Hamburg

Hamburg Climate Week

USDA-NIFA NARA

THANK YOU!



Additional Resources:

- Facing the Future | Western Washington University: www.facingthefuture.org
- NARA Energy Literacy Principles Matrix: www.energyliteracyprinciples.org
- Climate Voices Science Speaker Network: <http://climatevoices.org/>
- Climate Literacy and Awareness Network: www.cleanet.org
- Global Action Programme on Education for Sustainable Development: <http://en.unesco.org/gap>
- Energy Literacy Framework: <http://energy.gov/eere/education>

References

United Nations, *Sustainable Development Goals: Goal 13: Take urgent action to combat climate change and its impacts*, accessed September 26, 2016, <http://www.un.org/sustainabledevelopment/climate-change-2/>.

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EPA. 2015. Climate Change in the United States: Benefits of Global Action. United States Environmental Protection Agency, Office of Atmospheric Programs, EPA 430-R-15-001, <https://www.epa.gov/sites/production/files/2015-06/documents/cirareport.pdf>.

United Nations, *Sustainable Development Goals: Goal 10: Reduce inequality within and among countries*, accessed September 26, 2016, <http://www.un.org/sustainabledevelopment/inequality/>.

UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development, (United Nations Educational, Scientific, and Cultural Organization, Paris, France, 2014), <http://unesdoc.unesco.org/images/0023/002305/230514e.pdf>.

Jan DeWaters and Susan Powers. (2008, October 22-25) Energy Literacy among Middle and High School Youth. In Session T1A of the 38th ASEE/IEEE Frontiers in Education Conference, Saratoga Springs, NY. 978-1-4244-1970-8/08

International Energy Agency. (2015). *World Energy Outlook Special Report: Energy and Climate Change*, Paris, France: OECD/IEA.

U.S. EIA, "Fossil fuels still dominate U.S. energy consumption despite recent market share decline," *Today in Energy*, July 1, 2016, <http://www.eia.gov/todayinenergy/detail.cfm?id=26912>.

Capitol Hill EcoDistrict, accessed September 26, 2016, <https://capitolhillecodistrict.org/>.

2030 Districts, Seattle 2030 District, accessed September 26, 2016, <https://capitolhillecodistrict.org/>.

Bullitt Center, accessed September 26, 2016, <http://www.bullittcenter.org/>; International Living Future Institute, accessed September 26, 2016, <http://www.bullittcenter.org/>.

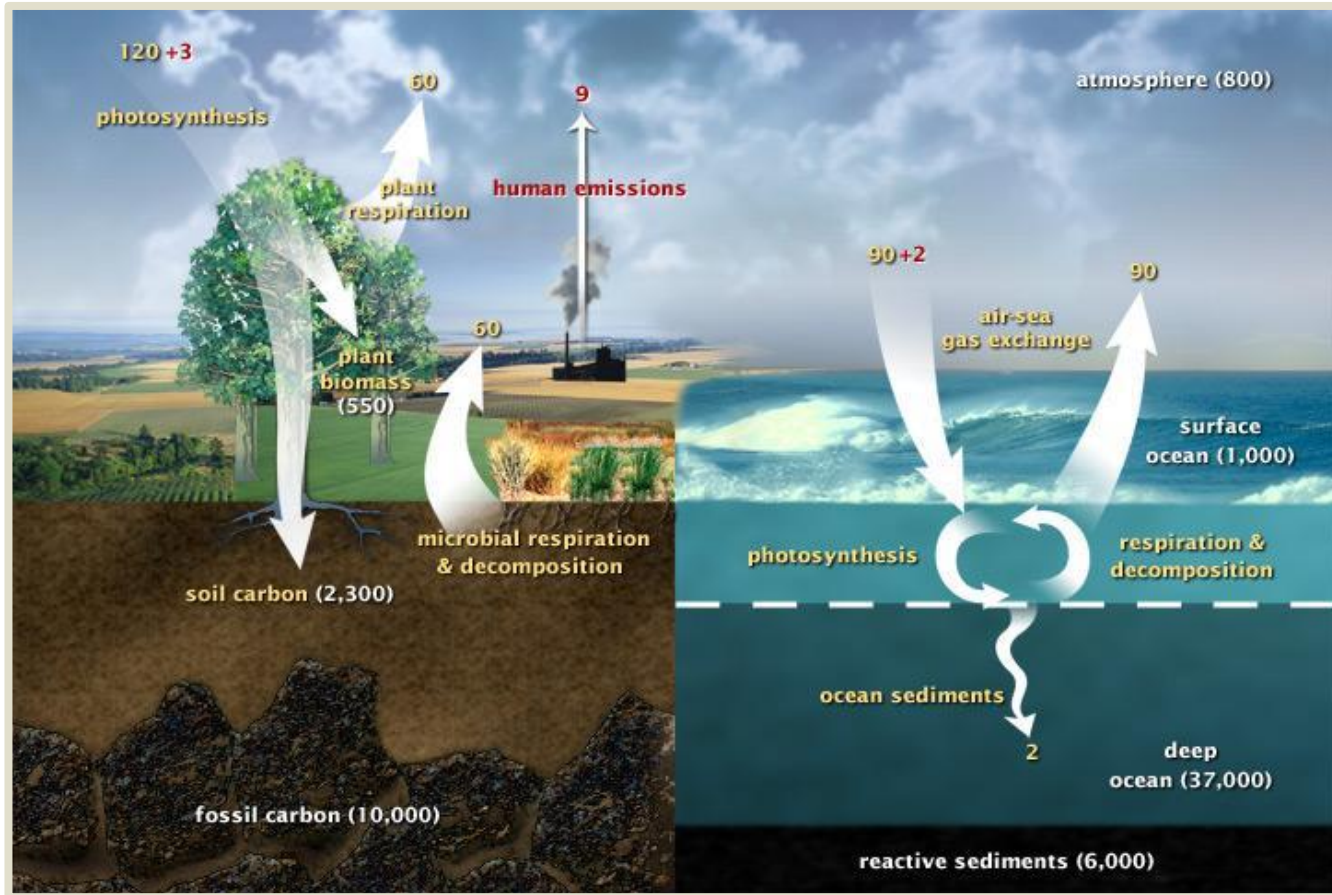


Image: NASA, <http://earthobservatory.nasa.gov/Features/CarbonCycle/>

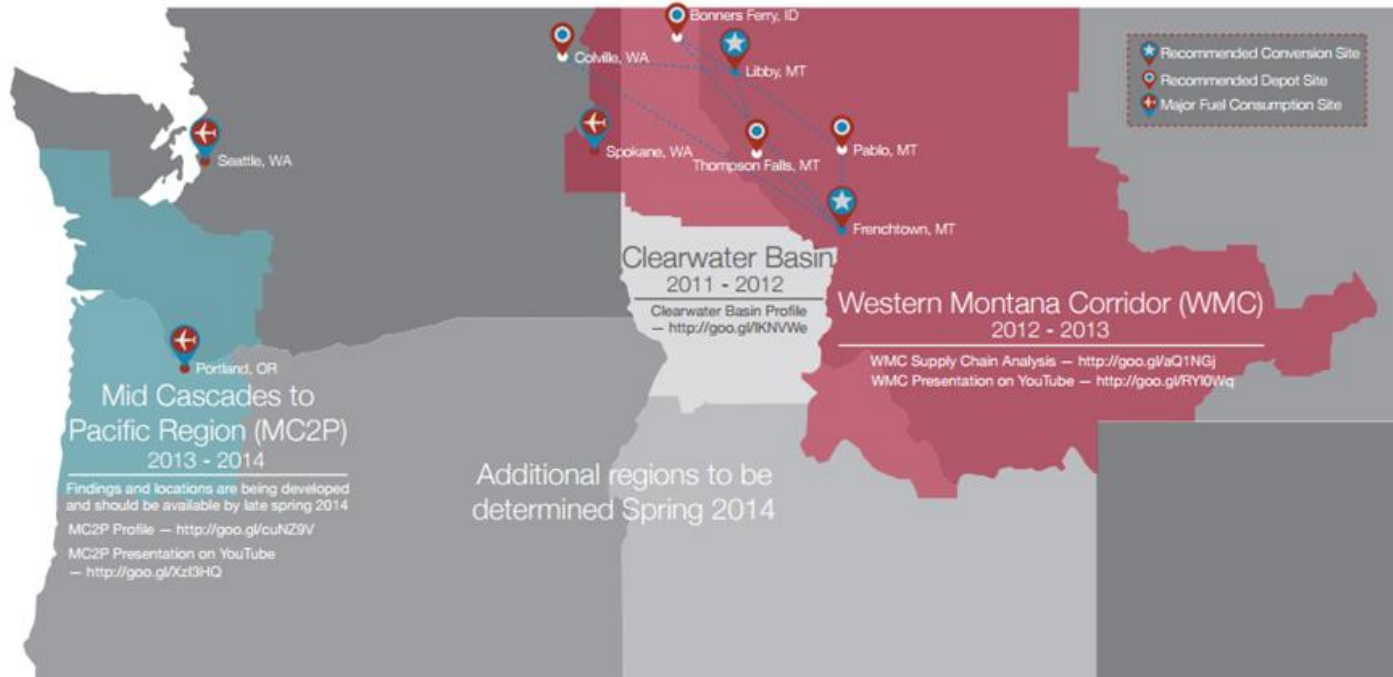


WOOD TO WING



Forest Residuals to Biofuel Supply Chains in the Pacific Northwest

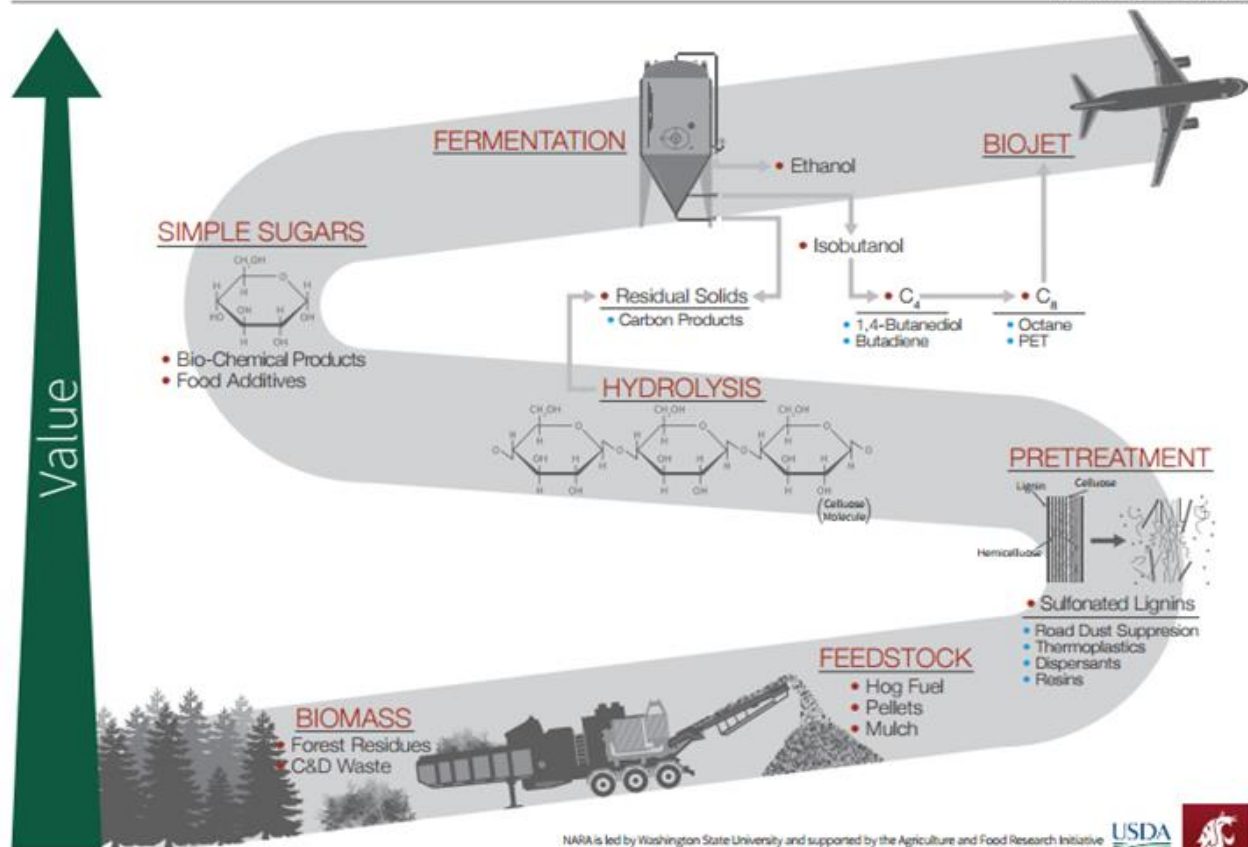
Applying research-based findings, NARA and regional stakeholders identify conversion and depot sites in the Pacific Northwest. These site locations provide the best opportunity for economic, social and environmental success to develop a forest residuals to biofuel and co-products industry.



SUPPLY CHAIN PRODUCTS

NARA

Northwest Advanced Renewable Alliance



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.



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.

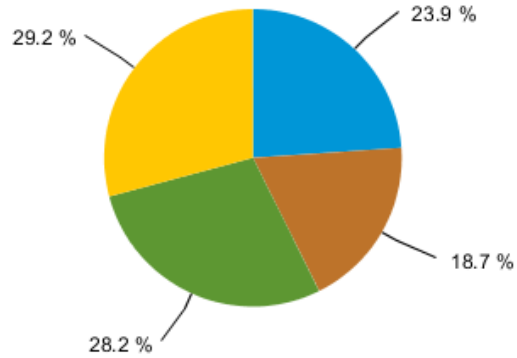
Sub-Topic:

7.3 Environmental quality is impacted by energy choices.

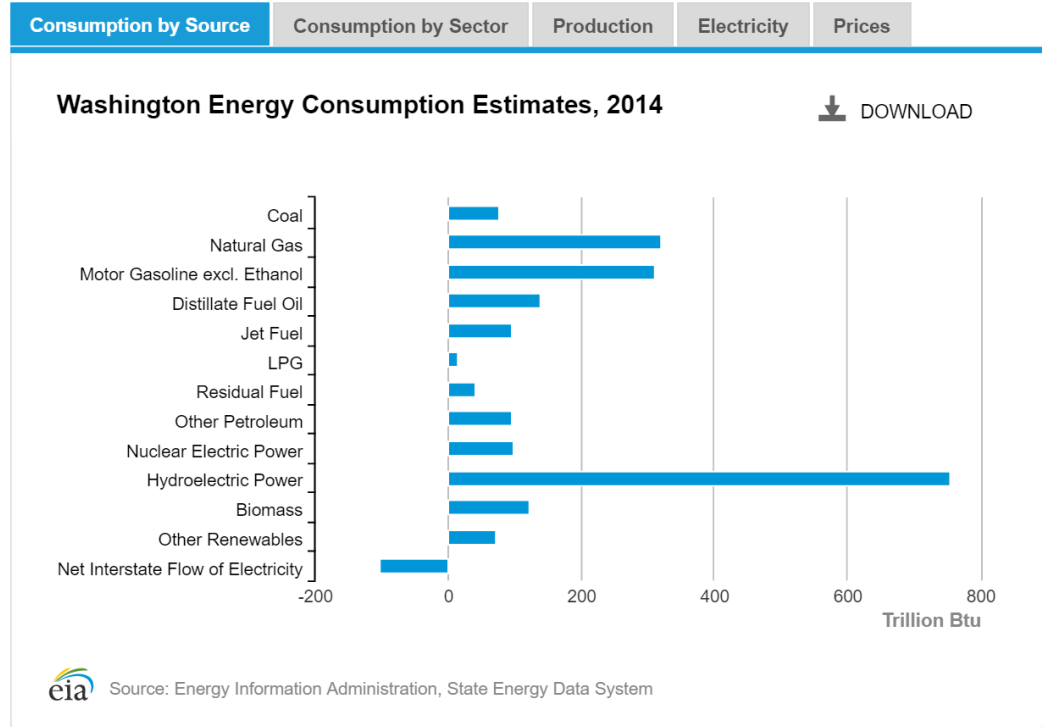
Sub-Topic:

8.3 Pretreatment processes makes sugars more available.

Washington Energy Consumption by End-Use Sector, 2014



 Source: Energy Information Administration, State Energy Data System



“*Literacy* implies not only the understanding of a particular, relevant body of knowledge and set of relationships, but moreover, the ability and willingness to *use* that knowledge in a functional manner - to read and write, to communicate, to participate in society.”

J.E. DeWaters, S. E. Powers, and M. Graham

“Developing an Energy Literacy Scale.”

Energy Literacy

**Essential Principles and
Fundamental Concepts
for Energy Education**

*A Framework for Energy Education
for Learners of All Ages*

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.



Annual High School Problem-solving Competition



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How to Compete
Dates & Deadlines
Event Weekend
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Media Release Form
Energy Program Library

Annual high school problem-solving competition

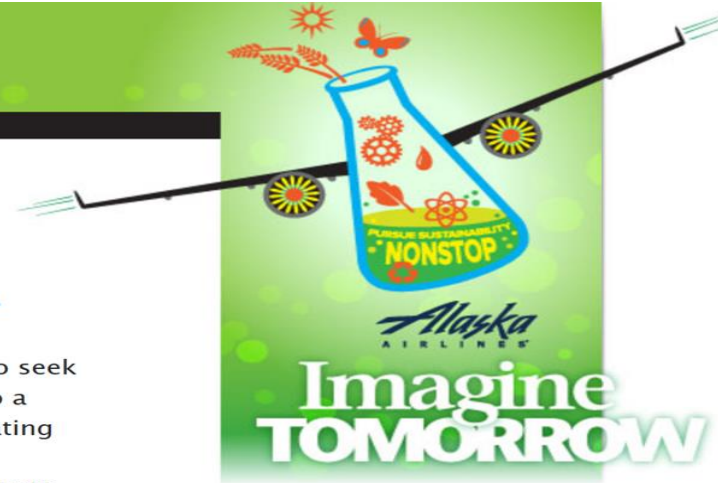
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<http://imagine.wsu.edu/>

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INSTITUTE FOR ENERGY STUDIES



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Energy Policy &
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Energy
Policy

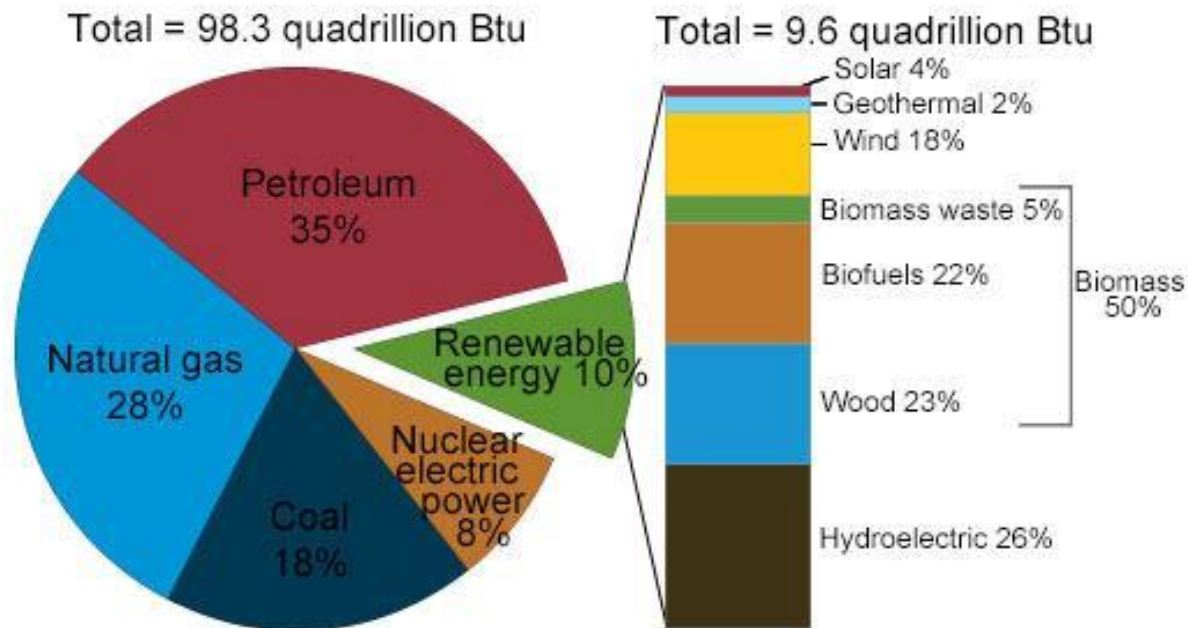
Minor:
Energy
Science

BS: Electrical
Engineering
w/ Energy
Concentration

*“Educating the leaders for our clean and
efficient energy future through
interdisciplinary studies and research.”*



U.S. energy consumption by energy source, 2014



Note: Sum of components may not equal 100% as a result of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1 (March 2015), preliminary data



Case Study: Northwest Advanced Renewables Alliance



Photo courtesy of R. Justin
Hougham

A Changing World: Urbanization

1950: 30% world's population urban
2014: 54% world's population urban
2050: 66% world's population urban*

*United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).



Photo: [Sergey Vladimirov](#) | [Flickr.com](#)