

The NARA logo consists of the letters "NARA" in a white, sans-serif font, centered within a dark gray rectangular box. A thin red horizontal line is positioned at the bottom edge of the gray box.

# Education at the Speed of Research:

## An Overview of the NARA Approach to BioEnergy Literacy

*Danica Hendrickson, Western Washington University  
On behalf of the NARA Education Team*

*National Energy Education Summit*

*American University*

*June 7, 2016*

*Northwest Advanced Renewables Alliance*





# Education at the Speed of Research: An Overview of the NARA Approach to BioEnergy Literacy

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# NARA Education Team



Steve Hollenhorst, Michael Wolcott, Tammi Laninga, Karla Eitel, Greg Fizzell

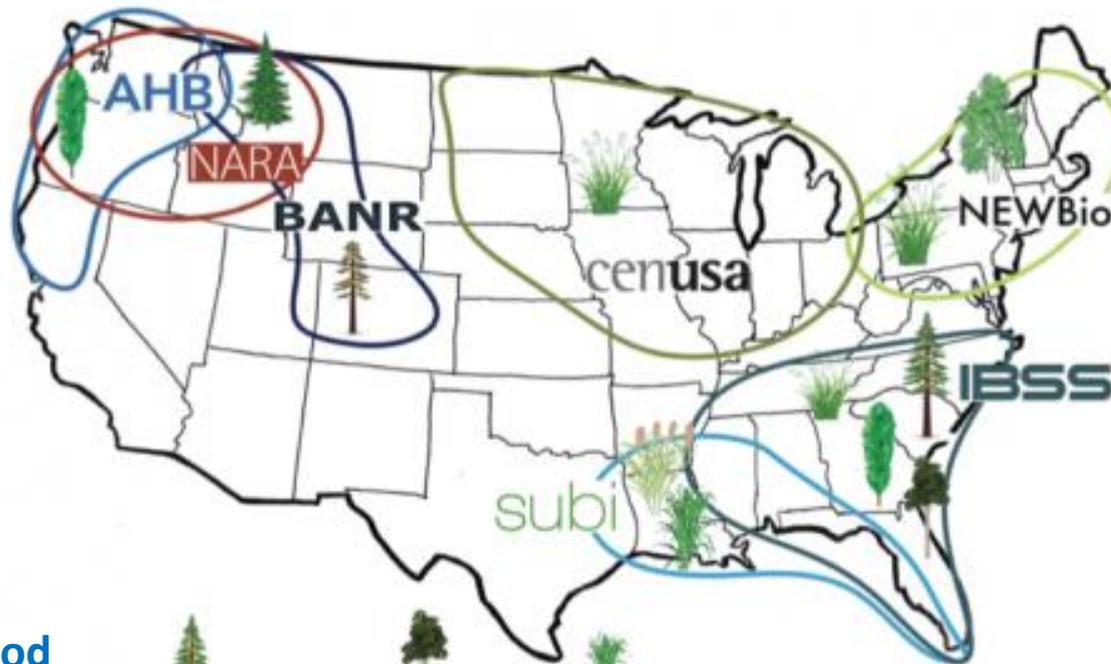
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Danica Hendrickson





# A NIFA Agriculture Food and Research Initiative Project



Non-food dedicated biomass feedstocks:



# Biojet Fuel Supply Chain



FRP

## FOREST RESIDUES PREPARATION

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



T

## TRANSPORTATION

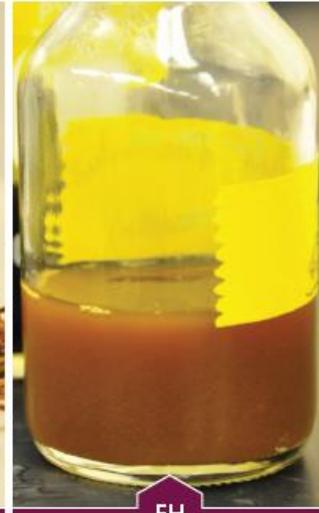
Feedstocks are transported from the collection site to a conversion facility. Chipping can take place at the loading or in a preprocessing facility.



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



NARA

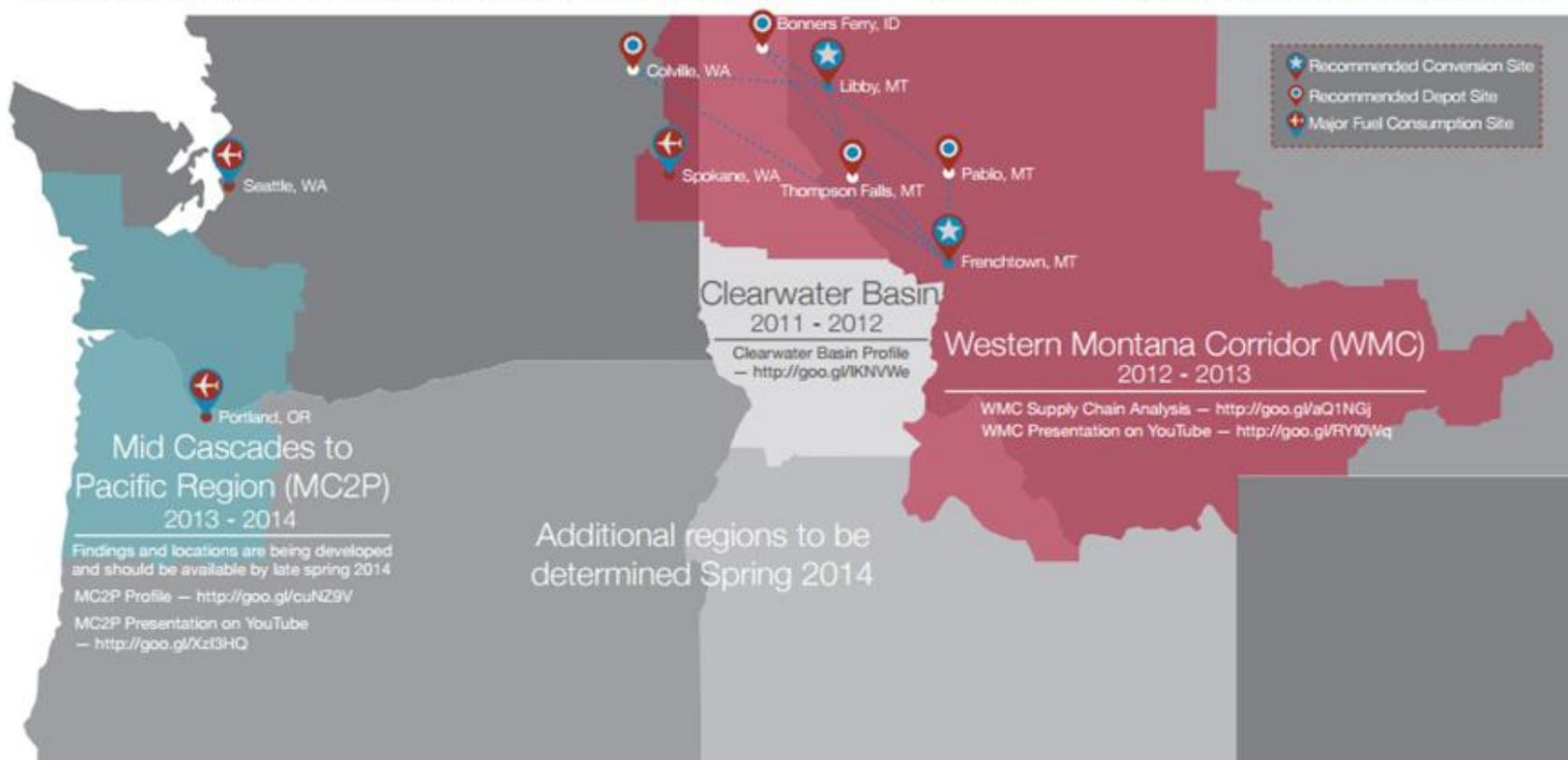


# WOOD TO WING



## 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.

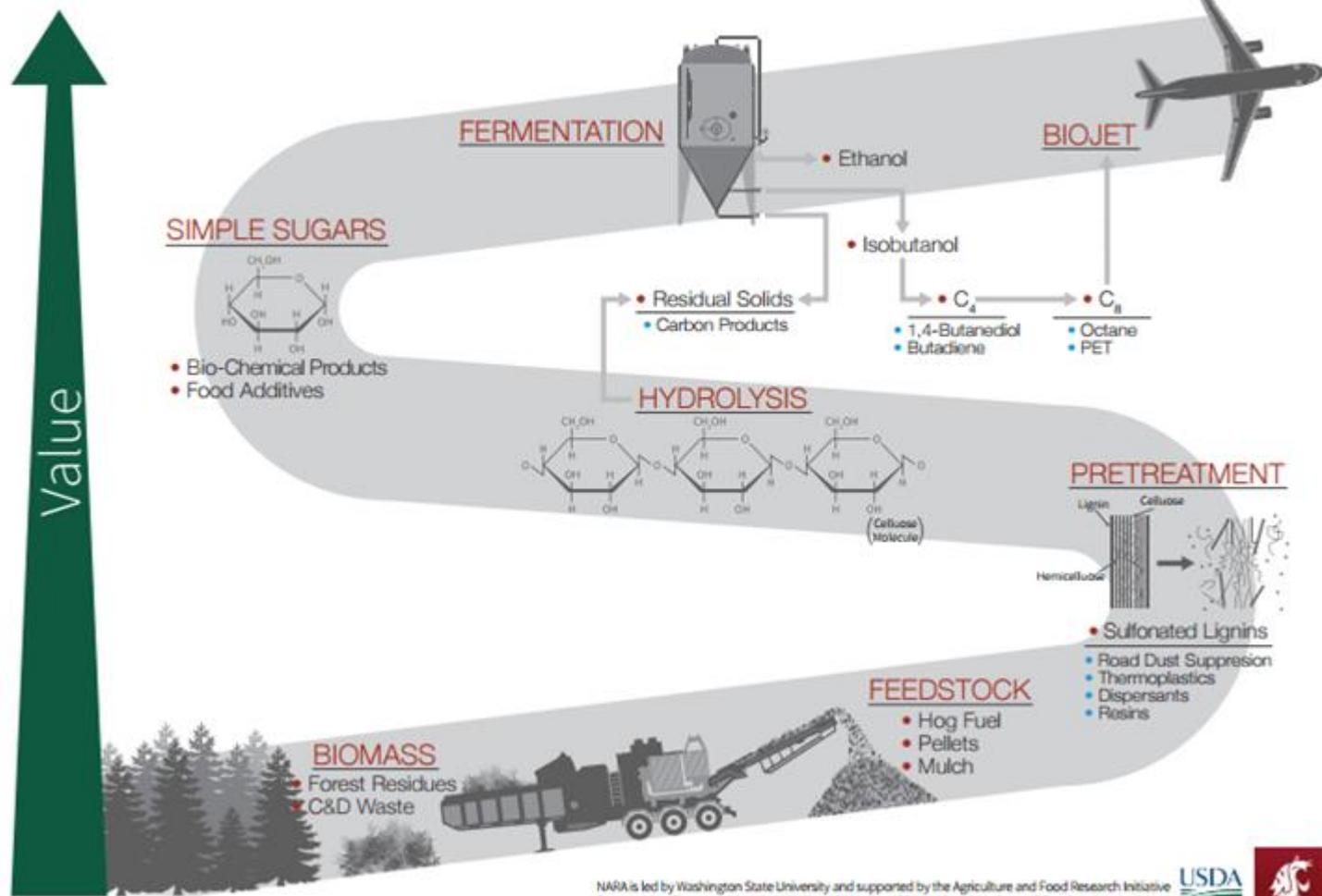




## SUPPLY CHAIN PRODUCTS

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.



NARA



### Teams



#### Education

Engage citizens, meet future workforce needs, enhance science literacy in biofuels, and help people understand how they're going to fit into the new energy economy.



#### Sustainability Measurement

Evaluate and assess environmental, social, and economic viability of the overall wood to biofuels supply chain, guiding the project as it goes forward.



#### Feedstocks

Take a multi-pronged approach for the development and sustainable production of feedstocks made from wood materials, including forest and mill residues, municipal solid waste, and specialty energy crops.



#### Conversion

Provide a biomass-derived replacement for aviation fuel and other petroleum-derived chemicals in a way that is economically and technologically feasible.



#### Outreach

Serve as a conduit between researchers and community stakeholders, helping to transfer the science and technology of biofuels and important co-products to communities in the Northwest.



# 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](http://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](http://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](http://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](http://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](http://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](http://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.wvu.edu](http://www.huxley.wvu.edu)

[nararenewables.org](http://nararenewables.org)

## Education and Outreach Connections



### ③ Education and Outreach Products & User Groups

- 1) K-12
- 2) Outdoor Science Ed.
- 3) Webinars and Workshop
- 4) Collegiate Course Work

### ② Research Products

- 1) Research Data
- 2) Academic Publishing
- 3) Social Media
- 4) Print Media
- 5) Digital Media

### ① NARA Supply Chain

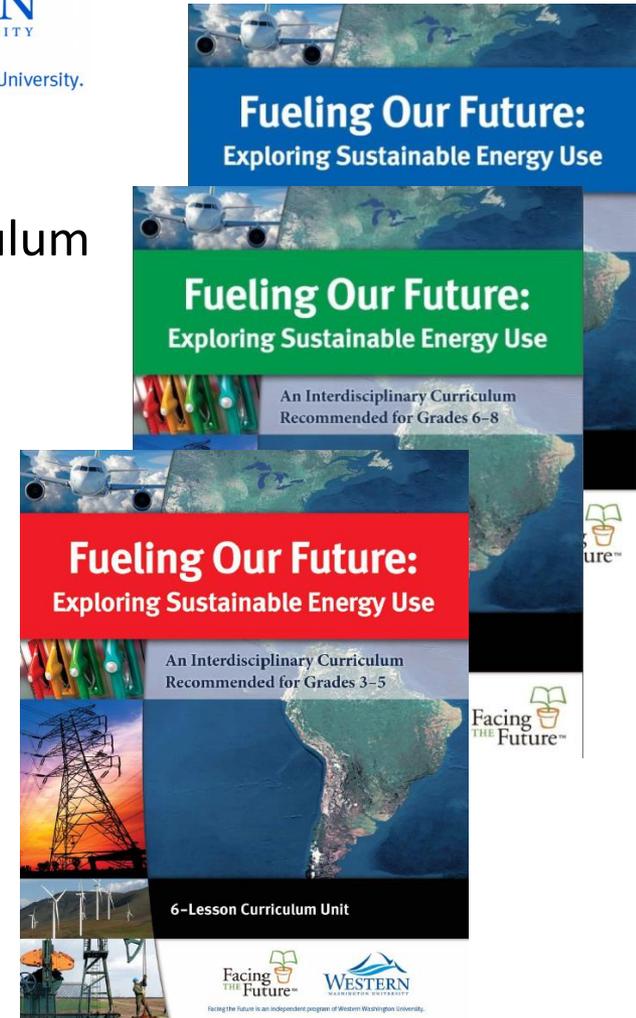
- 1) Forest Residues Preparation
- 2) Transportation
- 3) Pretreatment
- 4) Enzymatic Hydrolysis
- 5) Fermentation
- 6) Biojet + Co-products





Facing the Future is an independent program of Western Washington University.

- Elementary (3-5<sup>th</sup>), Middle, and High School Curriculum
  - 716 free lessons and units
  - Over 21,000 students reached
- Professional Development for Teachers
- Peer Educator Program focused on energy
  - Over 15 events and 240 teachers
- [www.facingthefuture.org](http://www.facingthefuture.org)





## *University of Idaho McCall Outdoor Science School (MOSS)*

### **Curricula and Programming**

- Energy literacy lessons taught to 2,500 K-12 students annually
- MOSS graduate students creating and teaching energy literacy lessons
- Dozens of vetted energy literacy lessons
- Undergraduate SURE interns creating and teaching energy literacy lessons
- K-12 teacher workshops, training, mentoring and collaborating annually
- E-book – coming soon!

### **Assessment**

- Middle school and high school energy literacy assessment tool created, piloted tested and analyzed
- Validated 22 question energy literacy test
- Statistically significant increase in energy literacy each year for K-12 students



Karla Eitel  
Associate Professor and Director of Education  
[keitel@uidaho.edu](mailto:keitel@uidaho.edu)



# UPHAM WOODS

Upham Woods



Outdoor Learning Center

“These lands are to be used as an outdoor laboratory and camp for youth, such as 4-H clubs and other people cooperating with the University of Wisconsin in the advancement of conservation, of agriculture and rural culture.”

—Elizabeth and Caroline Upham, 1941

For more information, please contact Upham Woods at:  
608-254-6461 or uphamwoods@ces.uwex.edu  
http://fyi.uwex.edu/uphamwoods/

**UW**  
**Extension**  
University of Wisconsin-Extension

An EEO/AA employer, University of Wisconsin Extension provides equal opportunities in employment and programming, including Title IX and ADA requirements. Please make requests for reasonable accommodations to ensure equal access to educational programs as early as possible preceding the scheduled program, service or activity.

# K-12 Outdoor Education Lessons

**NSTA** National Science Teachers Association

Member Login  
 Email or Last Name:   
 Password or ID:  **LOG IN**  
 Lost Password? | Not Registered? | Help

Home > Your Middle School Science Classroom [View printer-friendly version](#)

**TEACHER RESOURCES**  
 Find the best teacher-approved books, software, online professional development, and more, targeted to your grade level.

Visit us on Facebook

**Middle Level Materials**

- NSTA Press® Books
- NSTA Press® Book Chapters
- SciGuides®
- NSTA Learning Center Science Objects
- e-Books
- Science Store Home

**Position Statements**

- Science Education for Middle Level Students
- Environmental Education
- K-16 Coordination
- Gender Equity in Science Education
- All NSTA Position Statements

**Competitions**

- The DuPont Challenge
- eCYBERMISSION
- Shell Science Lab Challenge
- Siemens We Can Change the World Challenge
- Toshiba ExploraVision

**ONLINE INTERACTION**  
 Rich opportunities for nuts-and-bolts discussion. Ask questions, talk about issues, make new connections in your professional community.

- NSTA Communities

**Middle School Science Classroom**

## SCIENCE SCOPE

NSTA's peer-reviewed journal for middle level and junior high school science teachers

Science Scope is now available to NSTA members in a digital version. Same great content, but now NSTA members can read it on the computer as well as the Kindle Fire, Android tablet/phone, and iPad/iPhone. For more information, please go to our digital journals page. Questions? e-mail us at [digitaljournals@nsta.org](mailto:digitaljournals@nsta.org).

September 2013

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**NSTA & SciStarter present:**  
 Water, Water, Everywhere (and Water Projects Tool)

project

**Featured Articles:**

**Free** - Cross-Disciplinary Writing: Scientific Argumentation, the Common Core, and the ADI Model

Developing and Using Models to Align With NGSS

**Free** - Editor's Roundtable: Start Your Engines—Time to Take the NGSS out for a Test Drive

Other featured articles on the right sidebar include: BEOP Cybermission, picoSpin NMR for education, Thermo Scientific, Protect Students from Cancer, and I choose the RIGHT balance...

# THE VALUE OF A TREE

## COMPARING CARBON SEQUESTRATION TO FOREST PRODUCTS

by Jennifer Schon, R. Justin Hougham, Karla Eitel, and Steve Hollenhorst

What is the value of a tree? Of a forest? How do we manage our forests to ensure that we minimize our impact on the environment while creating the products we use and fuel we need to power our energy-rich lives? As Earth Day approaches, wise and efficient use of energy is on our minds—it is an important and timely topic for students, consumers, policy makers, scientists, and educators. With an increasing world population and decreasing supply of fossil fuels, finding a reliable, abundant, and sustainable source of energy is a high priority. One current research effort is being led by the U.S. Department of Agriculture-funded Northwest Advanced Renewables Alliance (NARA), which combines research efforts from industry and education institutions to build a renewable supply chain for aviation biofuel.

The best-known examples of renewable (liquid) biofuels for transportation applications are biodiesel and ethanol blends—in both cases, they are used for automobiles (see Biofuels sidebar for more information). Standards that increase efficiency and decrease emissions are being rolled out in all energy sectors and will affect cars, municipal power, electronics, and mass transportation. Recently there is an increasing focus on aviation fuel, as well. The United States Department of Agriculture and many other governmental and private industry groups are working to create biofuels from forest, mill, and construction waste to be refined into

March 2014 3



Imagine Tomorrow challenges 9th through 12th graders to seek energy and sustainability solutions in four topical areas:

- The Boeing Aerospace Challenge
- The NARA Biofuels Challenge
- The McKinstry Built Environment Challenge
- Food/Energy/Water

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

Students researched complex topics, then innovated technologies, designs, or plans to mobilize behavior. They forged connections in their communities and create positive change.

In this energy competition, as in life, solutions were limited only by imagination. The ninth competition was held in Pullman WA on May 21, 2016 attracting over 400 students and over 1000 judges from industry, academia and the community.

***Tribal Partnerships and  
Undergrad, Grad, &  
Doctoral Studies***

NARA

Tribal Partnership Projects (TPP)  
Summary of Grant Activities

University of Washington

Laurel James, NARA TPP Program Manager  
Daniel T. Schwartz, NARA TPP Principal Investigator

*Northwest Advanced Renewables Alliance*



# Tribal Partnerships

June 2016



Partnerships have been carried out with the Confederated Salish & Kootenai Tribes (CSKT)  
And the Muckleshoot Indian Tribe (MIT)



CSKT



MIT

CSKT & MIT contributed to the NARA 1,000 gallons.  
Other tribes wanted to participate however; lack of raw materials or supporting infrastructure prevented their participation.



NARA

# Education – Research Training Partnerships



*The NARA TPP engaged in a partnership with CSKT and our NARA Scholars.*

*In addition, education & training was made possible with other tribal nations due to our alliance with the Intertribal Timber Council*



*Schwartz, Lipscomb (Energy Keepers, Inc.), Hough  
Confederated Salish & Kootenai Tribes*



*Moore-Drougas, Schwartz, Brooks  
White Mountain Apache Tribe*

- Biomass Availability
- Tribal - Federal partnership potential in biomass sourcing (stewardship agreements) between tribes & USFS.
- Policy – RINs, Carbon credits
- Fire Management and Air Quality/Emissions



NARA



# Education – Focus on Native Scholars

*American Indian/Alaska Natives received 1.3% of all Science & Engineering (S&E) associate's degrees in the US and less than 1% of S&E bachelor's, master's and doctoral degrees.*

~ NATIONAL SCIENCE FOUNDATION (2012)

LESS THAN 1% !!!

The NARA TPP focused on increasing these numbers via recruitment for Summer Internships and Graduate Fellowships



Thru June, 2016 - NARA TPP scholars have achieved the following degrees:

	Native	Non-Native
<b>AAS</b>	1	0
<b>Bachelor's</b>	8	2
<b>Master's</b>	2	1
<b>PhD</b>	1	1
<b>Total</b>	<b>12</b>	<b>4</b>

**4 of our Native Scholars graduated from a Tribal College/University**



# Summer Undergrad Research Experience in Biofuels – BF SURE



NARA included 34 undergraduate students in project research ranging from conversion technologies to supply chain analysis

## Who:

Undergraduate students

## Why:

Experience **research firsthand**

## What:

Develop laboratory, fieldwork and research skills in the broad area of **biofuels research**. Full time research (for 9.5 weeks).

## When:

Program dates are roughly **May 28 – July 31, 2015** (varies by location)

## Where:

Any of the **participating Universities and Colleges within NARA**.

All students will participate in the poster session on July 31 in Pullman, WA.

## How much:

Students are paid a stipend of **\$5000** for the full summer and expected to work full time. Housing and travel are covered.

## Apply NOW:

Application and info at [nararenewables.org/ed](http://nararenewables.org/ed)

### Questions?

Contact Shelley Pressley at [spressley@wsu.edu](mailto:spressley@wsu.edu)



**Interdisciplinary studio course** at Washington State University

- **Audience:** Upper-level undergraduate & graduate students (168 total)
- Bioregional Planning
- Civil & Mechanical Engineering
- Architecture & Landscape Architecture



Olympic Peninsula, WA  
Hermann Brothers Logging



Longview, WA  
KapStone Paper & Packaging

**Outputs:**

- Supply Chains Analyzes
- Site Selection for Biofuels Production
- Site Designs for Biofuels Facilities
- Partnered with industry, governmental, & stakeholders



## Supply Chain Reports: <https://nararenewables.org/features/supply-chain-analyses>



ABOUT FEATURES

### Supply Chain Analyses



#### Olympic Peninsula (OP) [Supply Chain Analysis](#)

This site provides supply chain data and analysis generated by NARA research for the region identified as the Olympic Peninsula, located in Western Washington.



#### Pacific Northwest (PNW) [Supply Chain Analysis](#)

This site provides supply chain data and analysis generated by NARA research for the region identified as the Pacific Northwest, which includes Montana, Idaho, Washington, and Oregon.



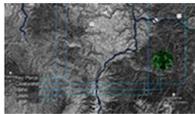
#### Mid-Cascades to Pacific (MC2P) [Supply Chain Analysis](#)

This site provides supply chain data and analysis generated by NARA research for the region identified as Mid-Cascades to Pacific, which includes the western sections of Washington and Oregon.



#### Western Montana Corridor (WMC) [Supply Chain Analysis](#)

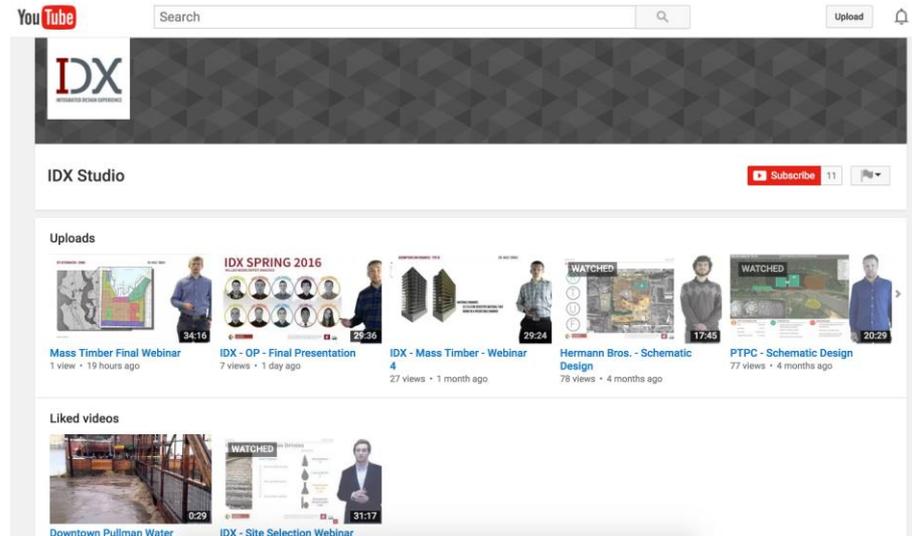
This site provides supply chain data and analysis generated by NARA research for the region identified as the Western Montana Corridor, which includes the western section of Montana, Northern Idaho and northeast Washington.



#### Clearwater Basin [Supply Chain Analysis](#)

This site provides supply chain data and analysis generated by NARA research for the region identified as the Clearwater Basin, located in central Idaho.

## Webinars: search “IDX Studio YouTube”



Western Washington University

# INSTITUTE FOR ENERGY STUDIES



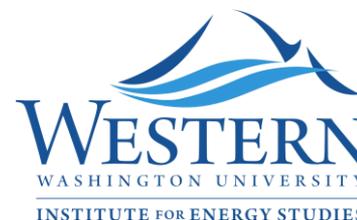
BA:  
Energy Policy &  
Management

Minor:  
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.”*



# Searchable Collection of Educational Resources



> About Us > Contact Us

[SEARCH](#) [ABOUT NARA](#) [CONTACT US](#)

## 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 from the resources in the matrix.



### TEACH

Easily teach what the matrix has provided.

**R. Justin Hougham**

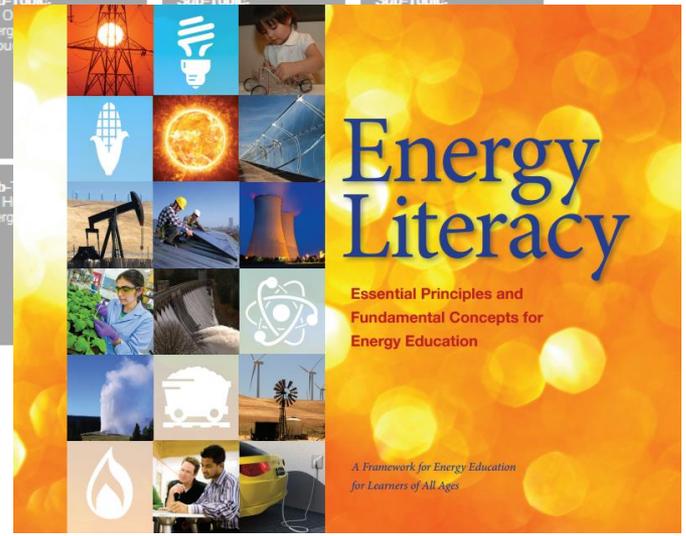
**Assistant Professor at University of Wisconsin-Extension  
Director of Upham Woods Outdoor Learning Center**





NARA

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





NARA

Thank you!

[www.nararenewables.org](http://www.nararenewables.org)

This work, as part of the Northwest Advanced Renewables Alliance (NARA), was supported by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

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*Northwest Advanced Renewables Alliance*

