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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

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

Authors:

Karla Bradley Eitel, PhD

Chad Gotch, PhD

Liv Haselbach, PhD

Danica Hendrickson, MEd

Steve Hollenhorst, PhD

R. Justin Hougham, PhD

Laurel James, PhD Candidate

Tammi Laninga, PhD

Karl Olsen, PhD

Shelley Pressley, PhD

Jennifer Schon, PhD

Daniel Schwartz, PhD

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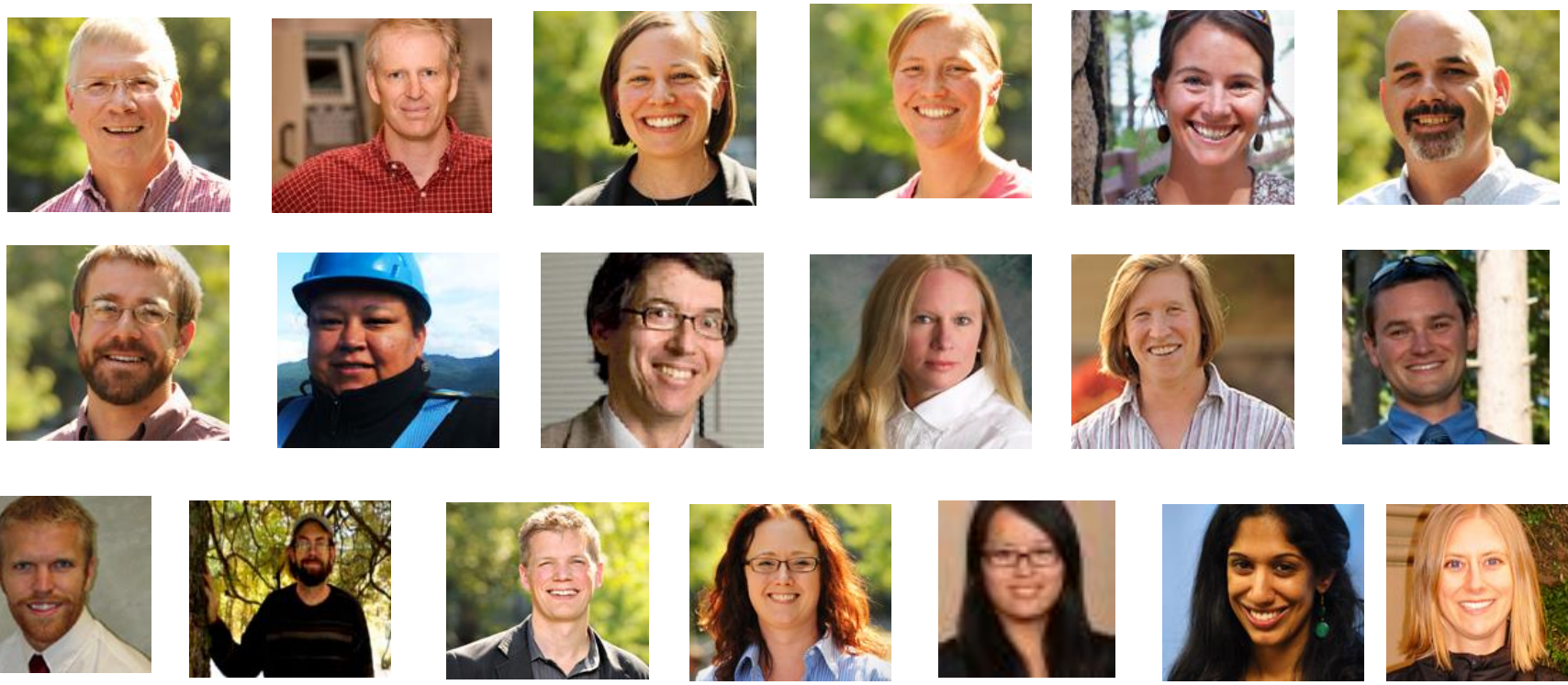
NARA Education Team



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

Justin Hougham, Laurel James, Dan Schwartz, Liv Haselbach, Shelley Pressley, Blake Hough

Karl Olsen, Adrian Leighton, Todd Beyreuther, Michelle Vachon, Yalan Liu, Sheeba Jacob, Danica Hendrickson

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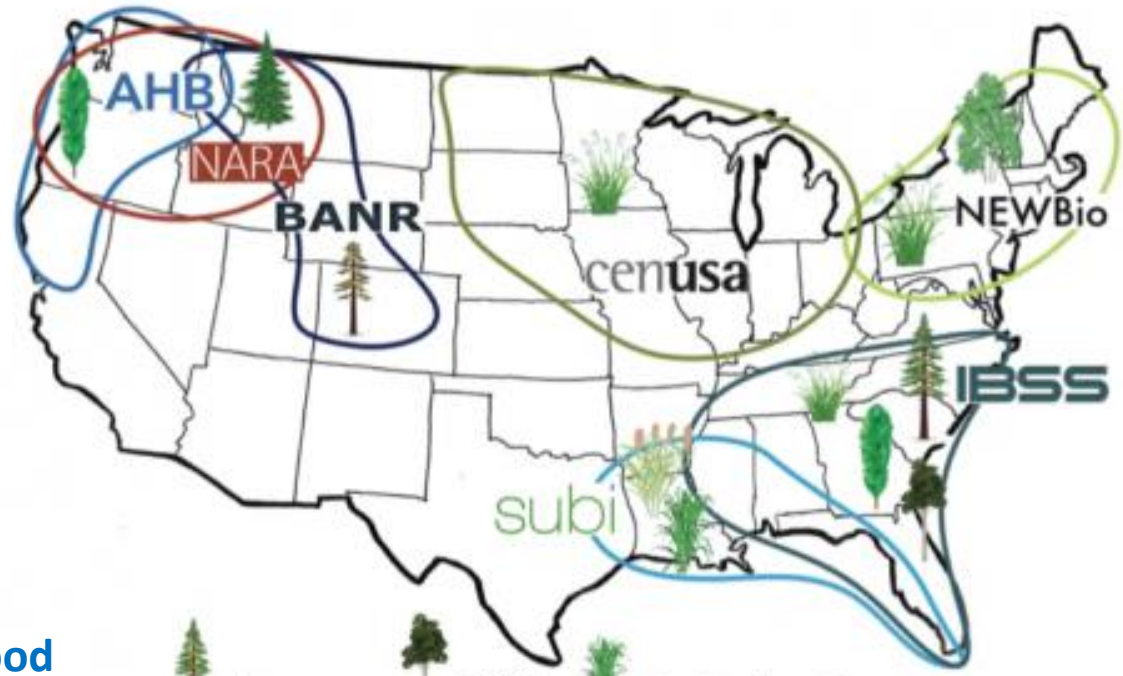
A NIFA Agriculture Food and Research Initiative Project



Non-food dedicated biomass feedstocks:

Image from www.nararenewables.org

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

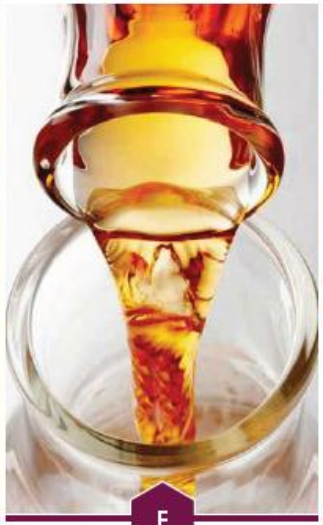
PRE-TREATMENT

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

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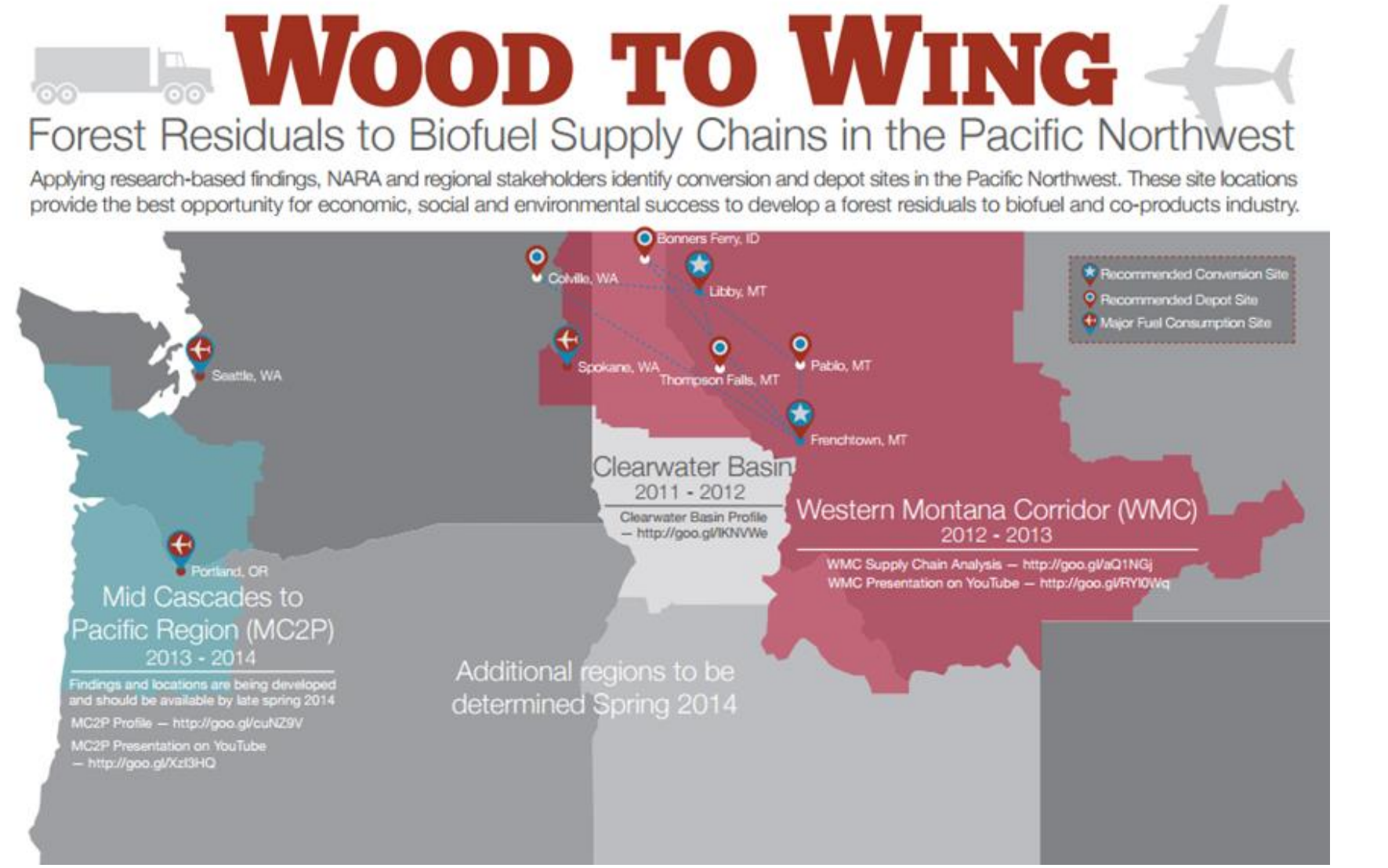
Mapping a Supply Chain



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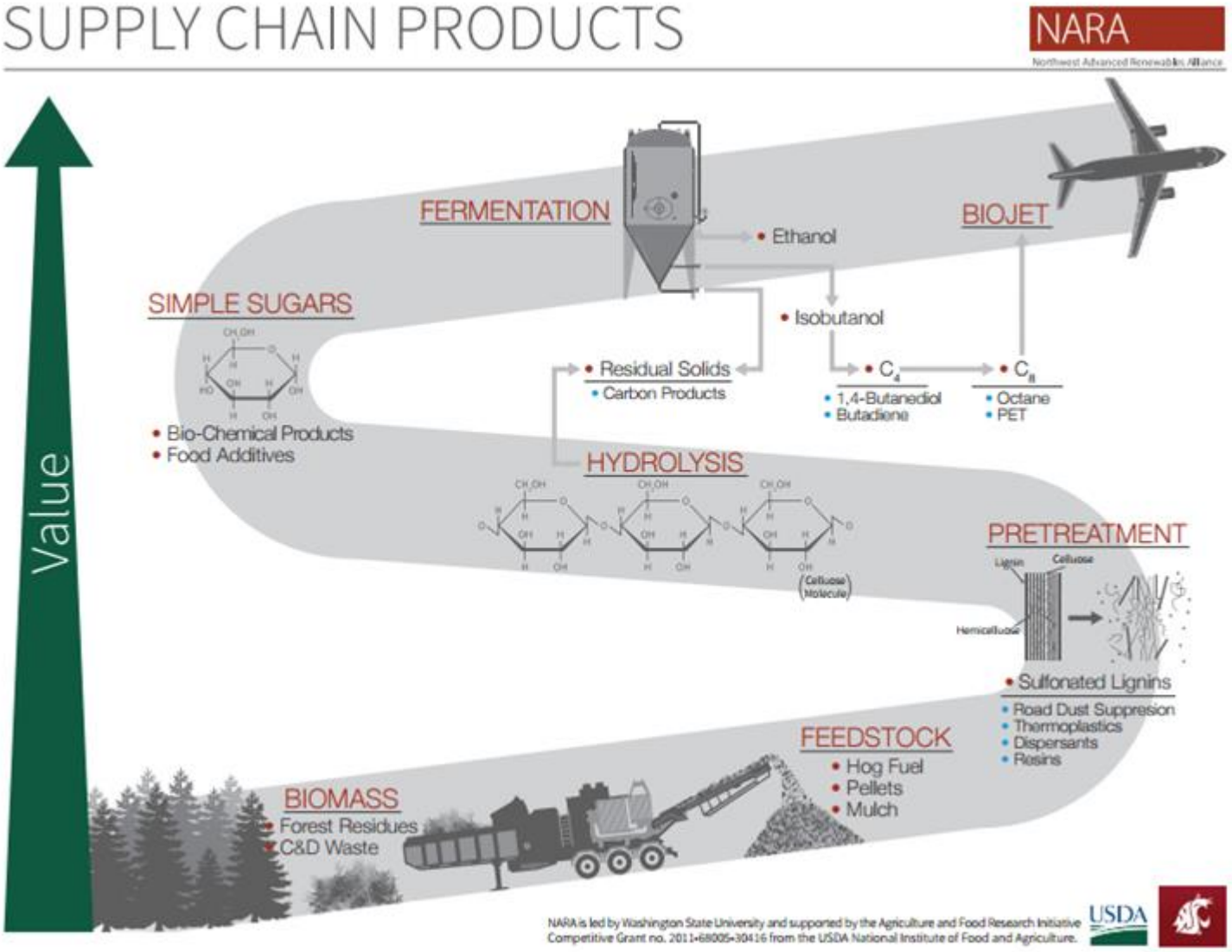
Conversion


SUPPLY CHAIN PRODUCTS
NARA
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Value
FERMENTATION
• Ethanol
BIOJET
SIMPLE SUGARS
• Bio-Chemical Products
• Food Additives
• Isobutanol
• Residual Solids
• Carbon Products
• C_4
• 1,4-Butanediol
• Butadiene
• C_8
• Octane
• PET
HYDROLYSIS
(Cellulose Molecule)
PRETREATMENT
Lignin
Cellulose
Hemicellulose
• Sulfonated Lignins
• Road Dust Suppresion
• Thermoplastics
• Dispersants
• Resins
FEEDSTOCK
• Hog Fuel
• Pellets
• Mulch
BIOMASS
• Forest Residues
• C&D Waste
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.
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A Collaborative Effort

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Northwest Advanced Renewables Alliance

ABOUT FEATURES NEWS TEAMS MEMBERS BLOG CONTACT

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.

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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

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Education at the Speed of Research

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

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K-12 Formal Education

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

- Elementary (3-5th), 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

K-12 Outdoor Education, Teacher PD, and Graduate Students

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

MOSS
McCALL OUTDOOR SCIENCE SCHOOL

Karla Eitel
Associate Professor and Director of Education
keitel@uidaho.edu

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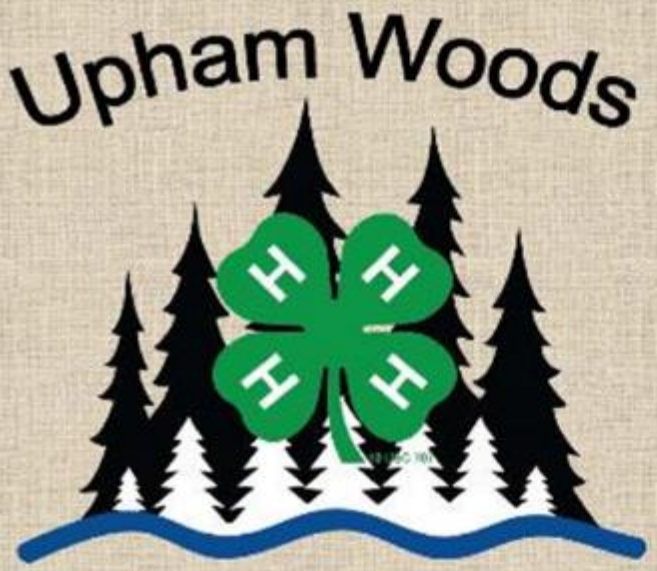
UPHAM WOODS



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

K-12 Outdoor Education Lessons

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High School Problem Solving Competition

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

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Tribal Partnership Projects (TPP)
Summary of Grant Activities

University of Washington

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

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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.

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

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Education – Focus on Native Scholars

LESS THAN 1% !!!

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)

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
AAS	1	0
Bachelor's	8	2
Master's	2	1
PhD	1	1
Total	**12**	**4**

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

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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

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)

Why:

Experience **research firsthand**

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**

Questions?
Contact Shelley Pressley at spressley@wsu.edu

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Integrated Design Experience – Undergrad and Grad

Interdisciplinary studio course at Washington State University

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

Longview, WA
KapStone Paper & Packaging

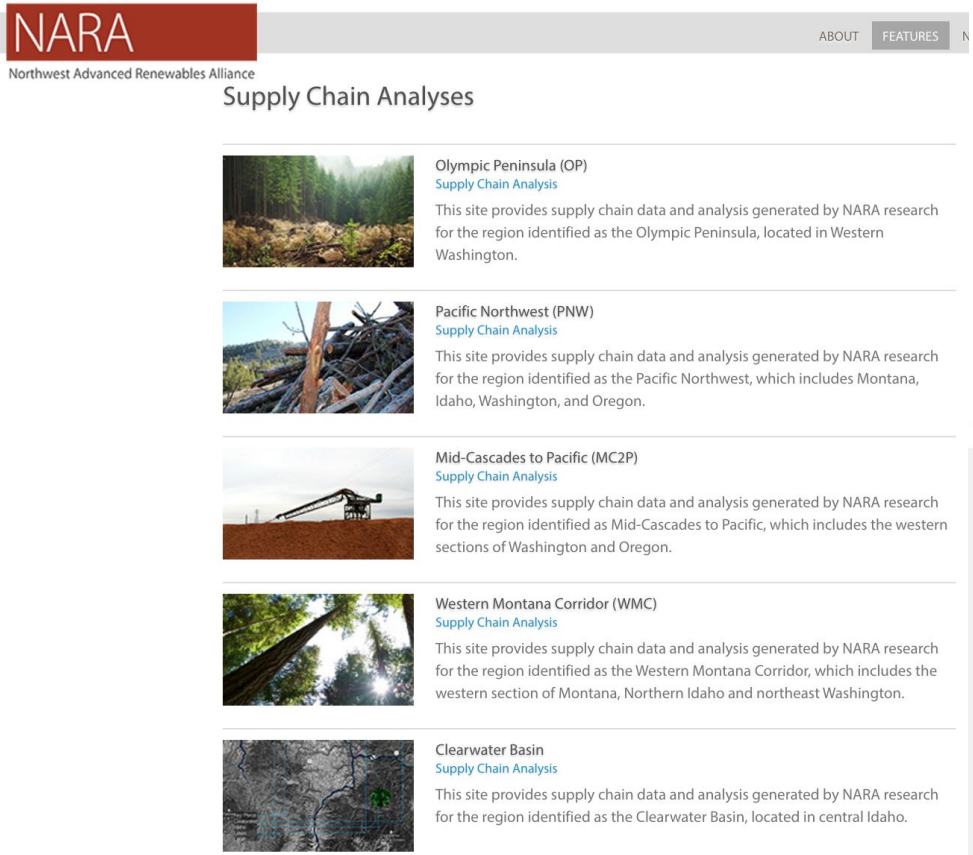
Olympic Peninsula, WA
Hermann Brothers Logging

Outputs:

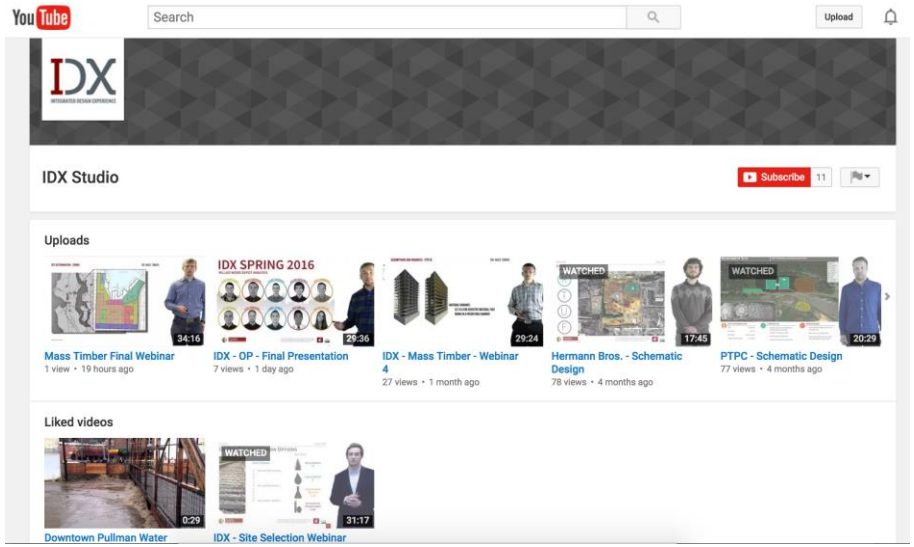
- Supply Chains Analyzes
- Site Selection for Biofuels Production
- Site Designs for Biofuels Facilities
- Partnered with industry, governmental, & stakeholders

IDX Outputs

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



Webinars:
search “IDX Studio YouTube”



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Western Washington University

INSTITUTE FOR ENERGY STUDIES

BA: Energy Policy & Management

Minor: Energy Policy

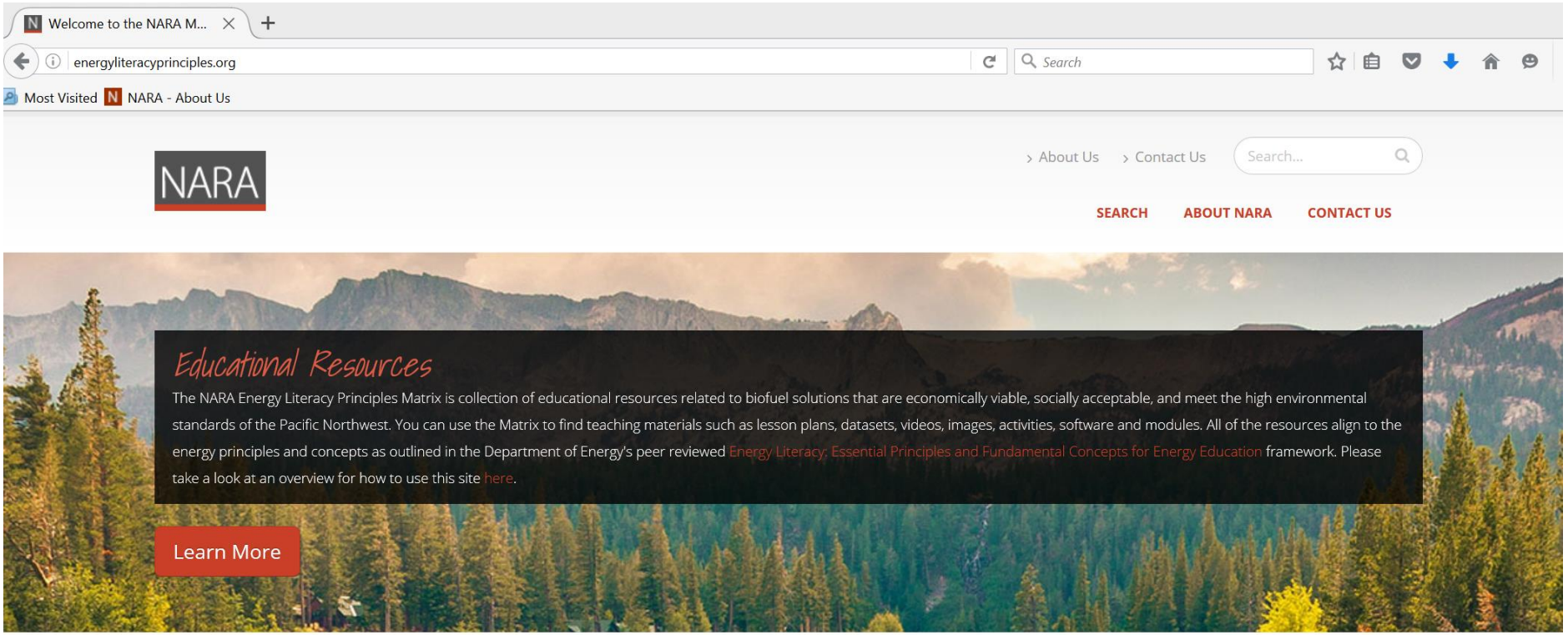
Minor: Energy Science

BS: Electrical Engineering w/ Energy Concentration

"Educating the leaders for our clean and efficient energy future through interdisciplinary studies and research."

WESTERN WASHINGTON UNIVERSITY
INSTITUTE FOR ENERGY STUDIES

Searchable Collection of Educational Resources



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

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energyliteracyprinciples.org

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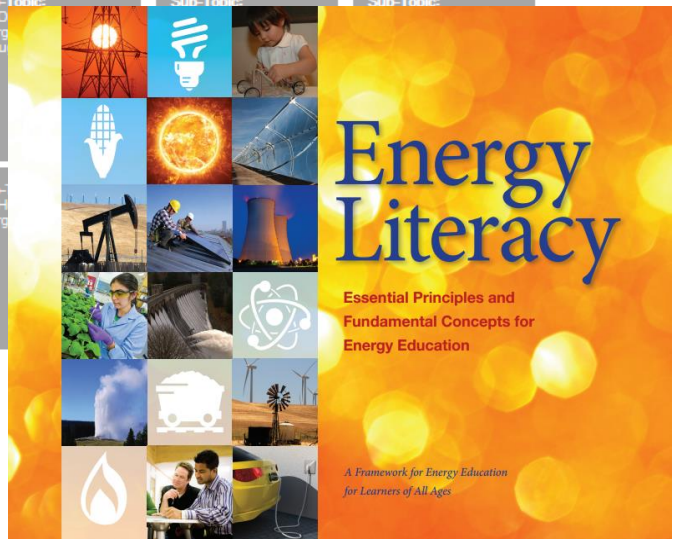
SEARCH ABOUT NARA CONTACT US

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 O... energ... throu...	Sub-Topic:	Sub-Topic:
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 H... energ...		



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Thank you!

www.nararenewables.org

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Danica Hendrickson

danica@nararenewables.org

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