



# Integrating Research and Education: Education at the Speed of Research

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Sustainable BioJet  
Valuable Lignin Co-Products  
Rural Economic Development  
Supply Chain Coalitions  
Energy Literacy

**NATIONAL MODEL**







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.

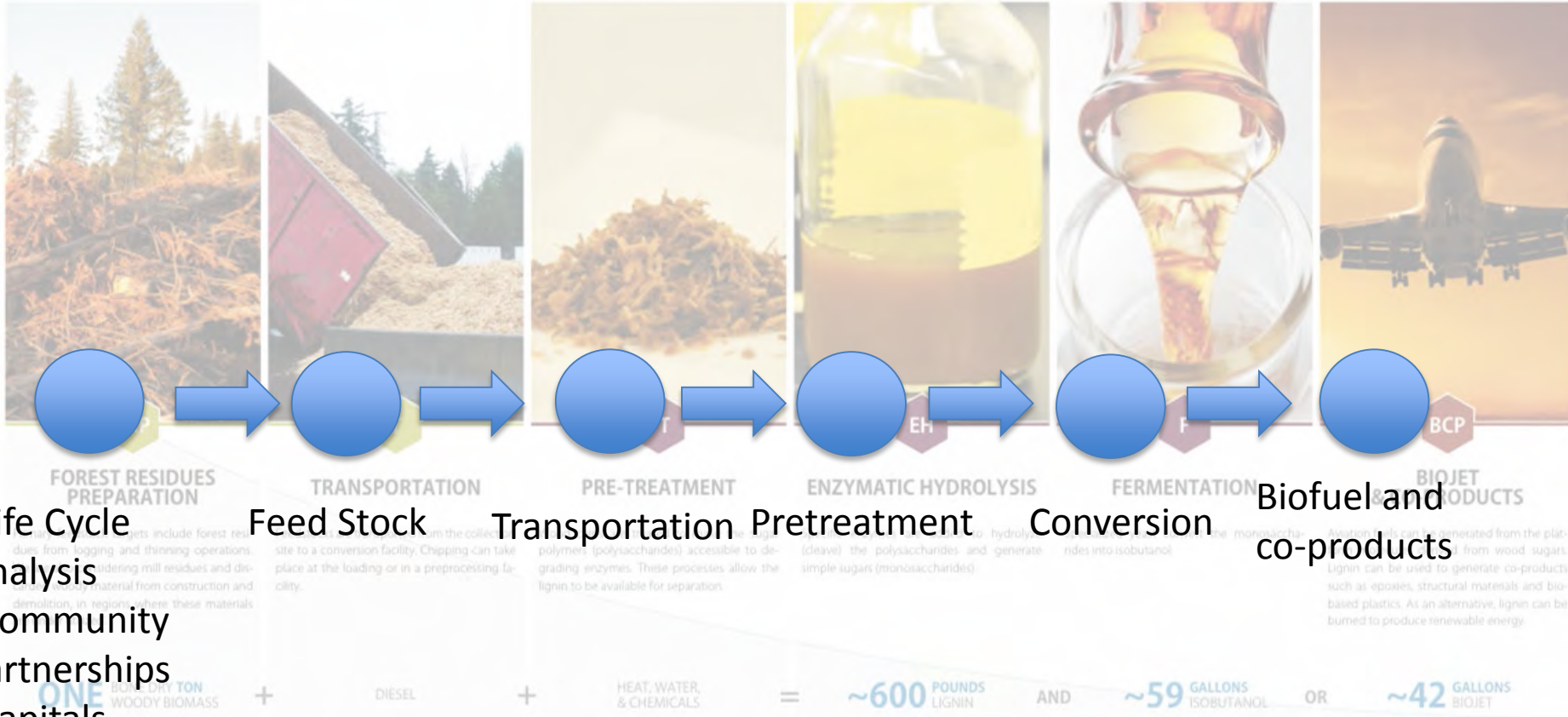
ONE BONE DRY TON WOODY BIOMASS + DIESEL + HEAT, WATER, & CHEMICALS = ~600 POUNDS LIGNIN AND ~59 GALLONS ISOBUTANOL OR ~42 GALLONS BIOJET



# Flow for Education and Outreach of NARA research

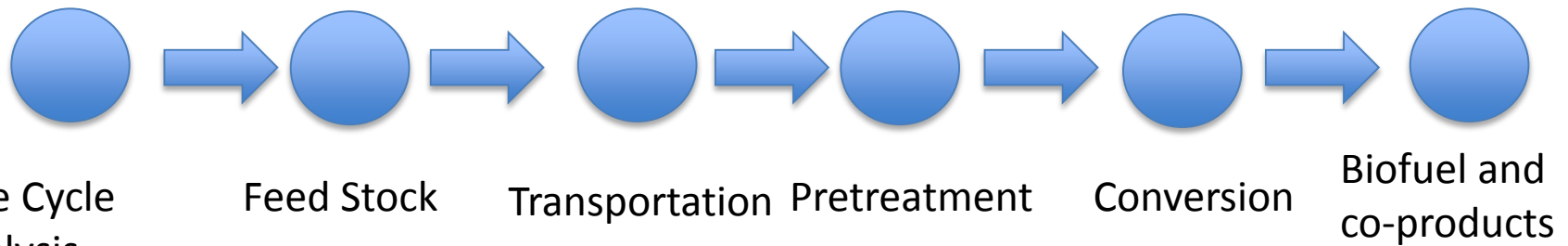


## SUPPLY CHAIN



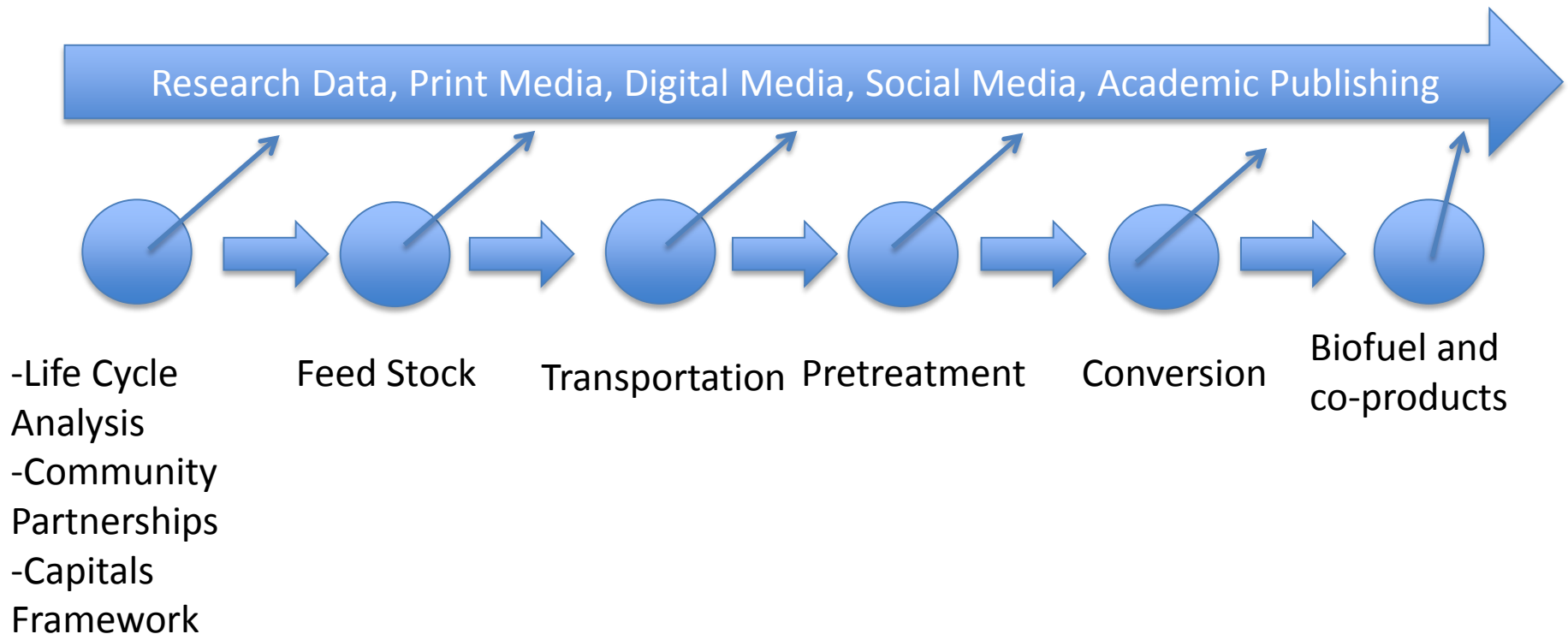
-Life Cycle  
Analysis  
-Community  
Partnerships  
-Capitals  
Framework

# Flow for Education and Outreach of NARA research

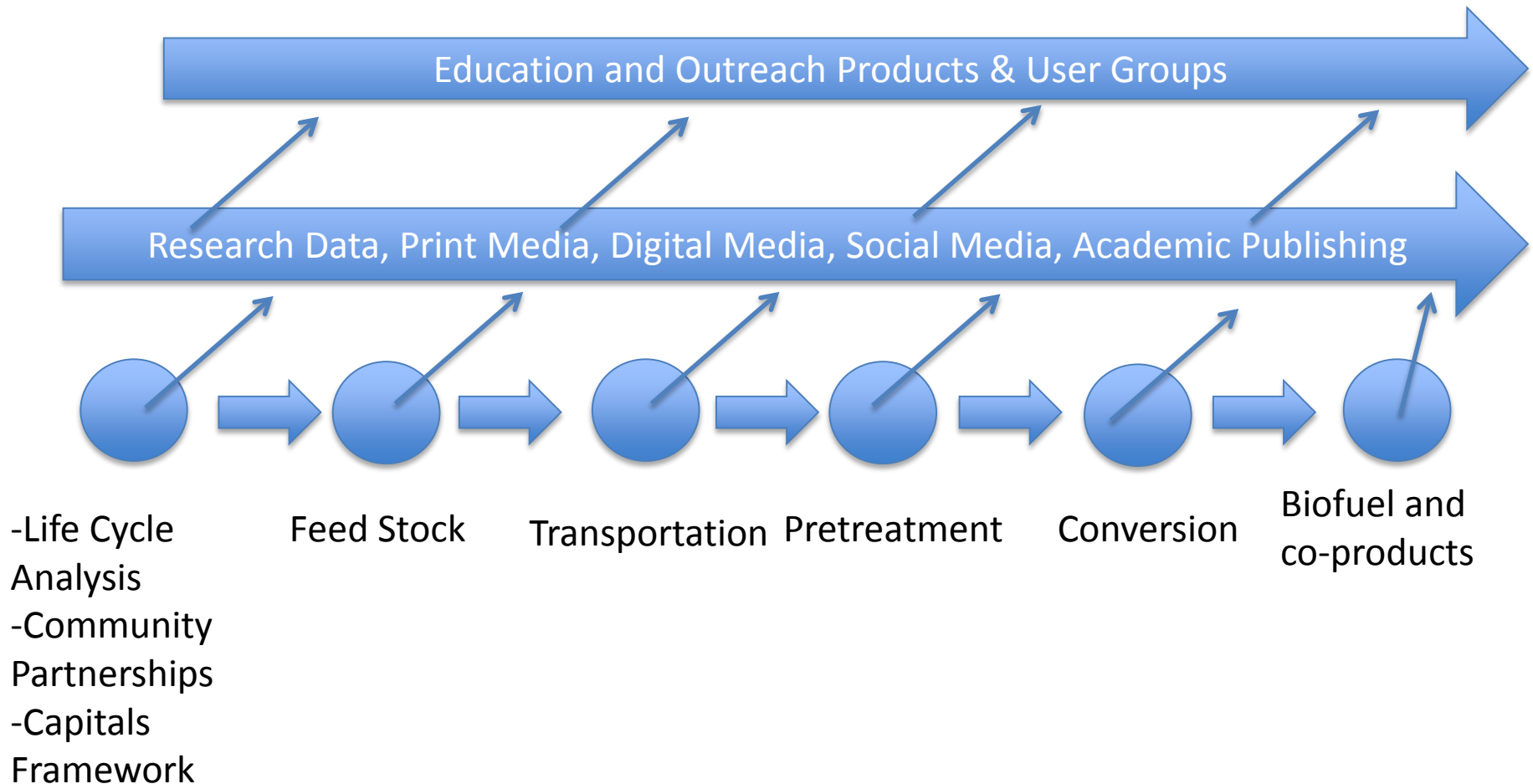


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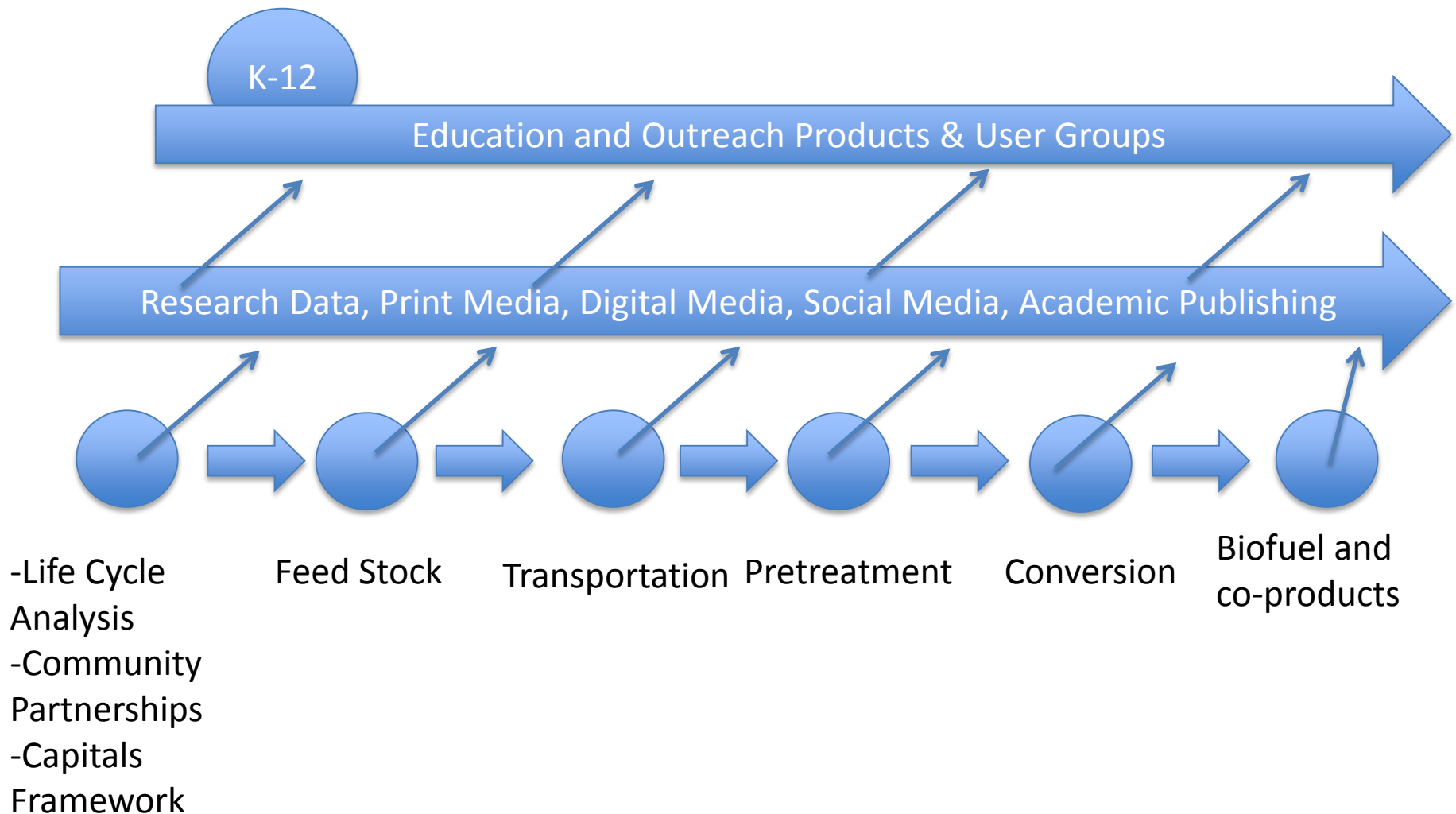
# Flow for Education and Outreach of NARA research



# Flow for Education and Outreach of NARA research

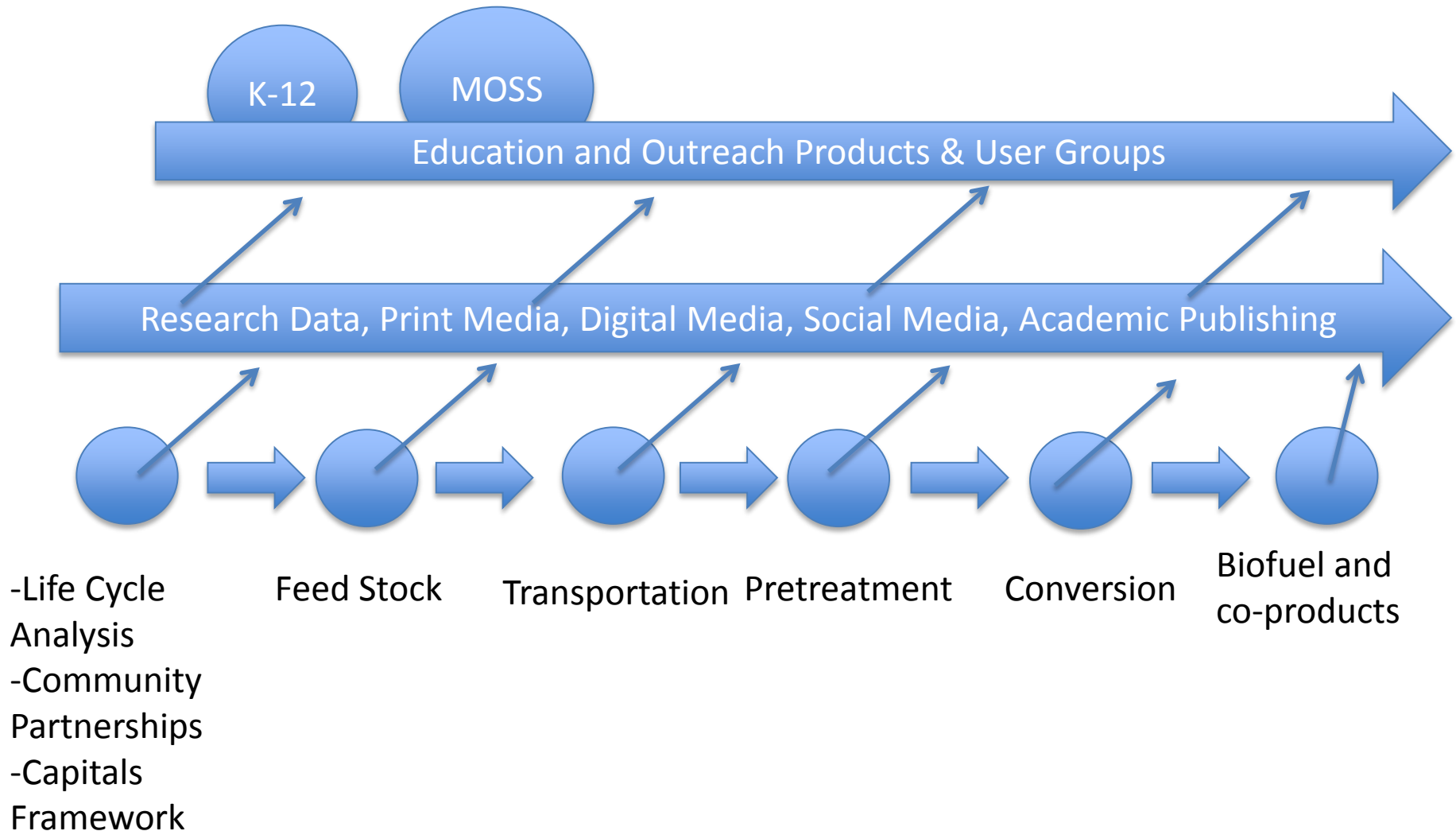


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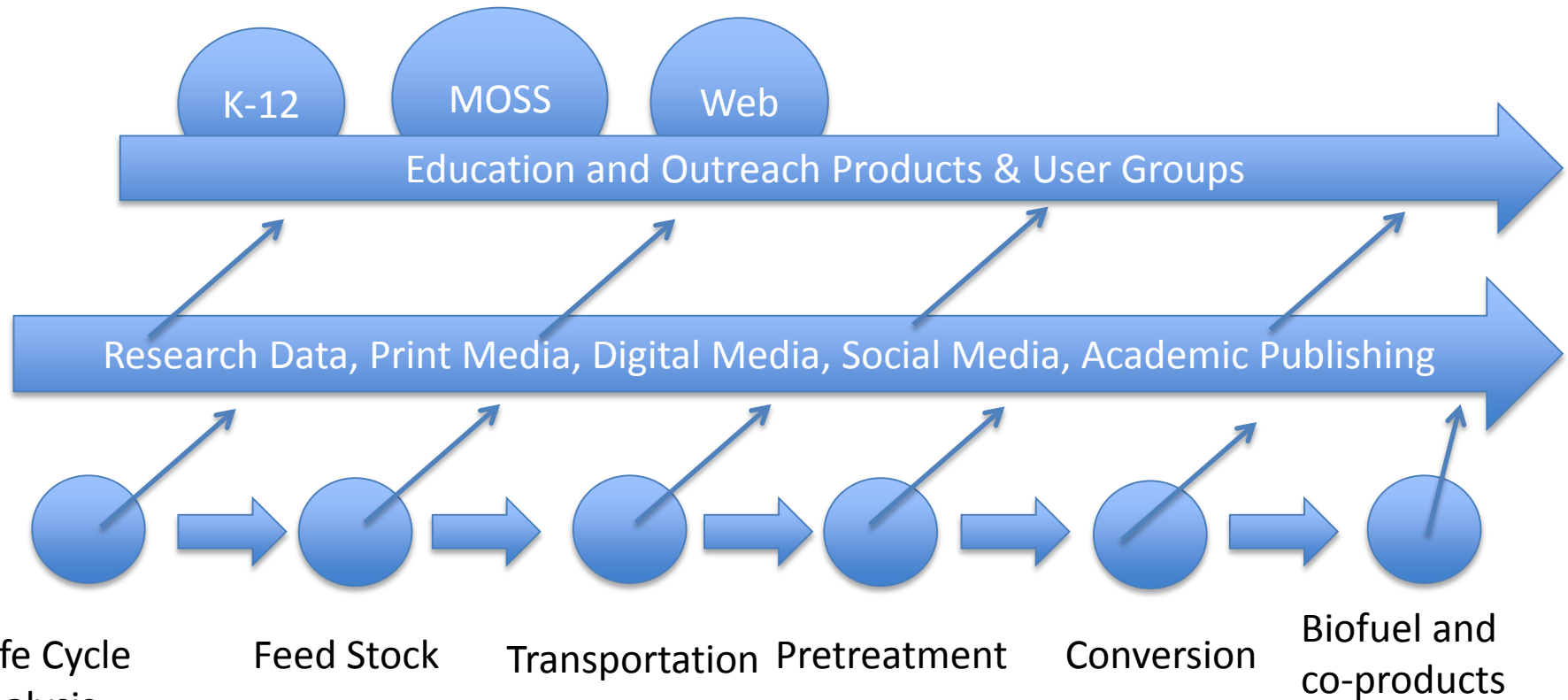




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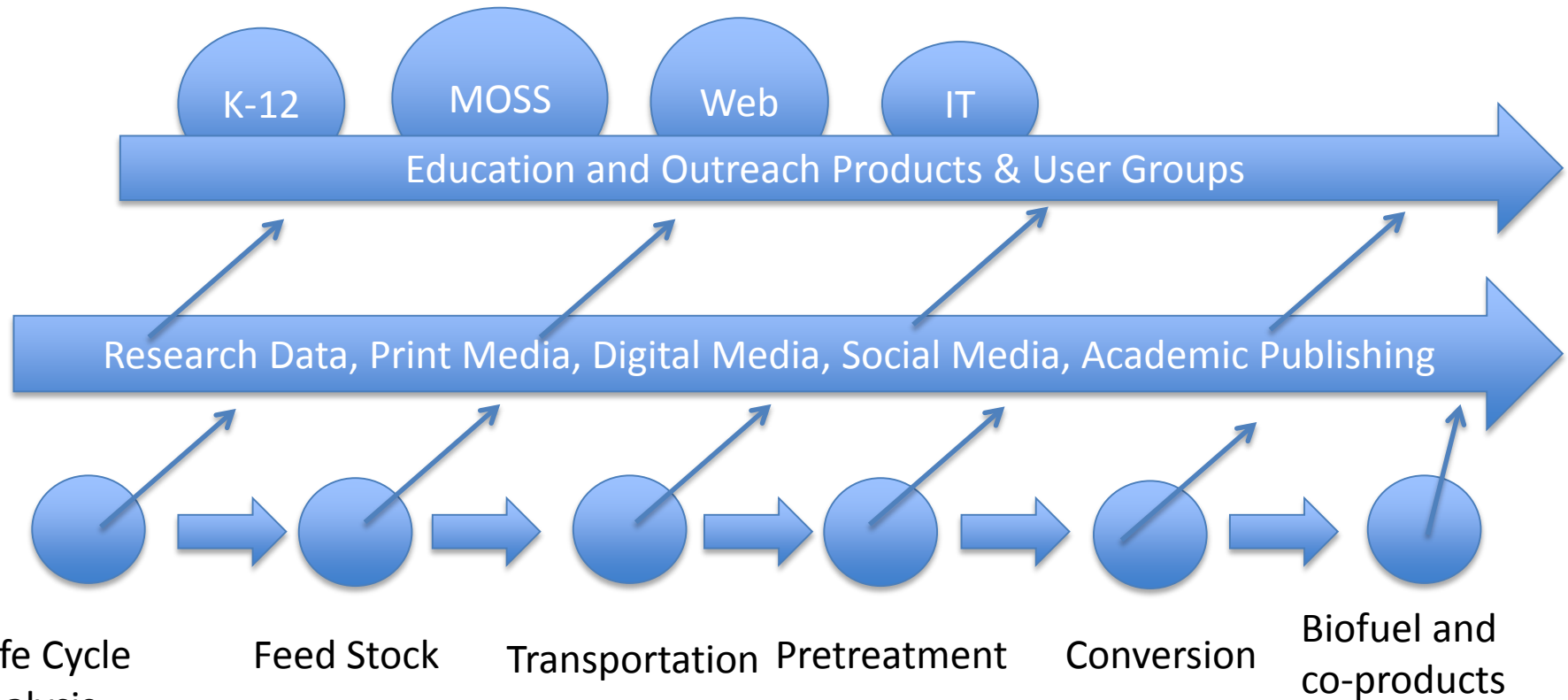


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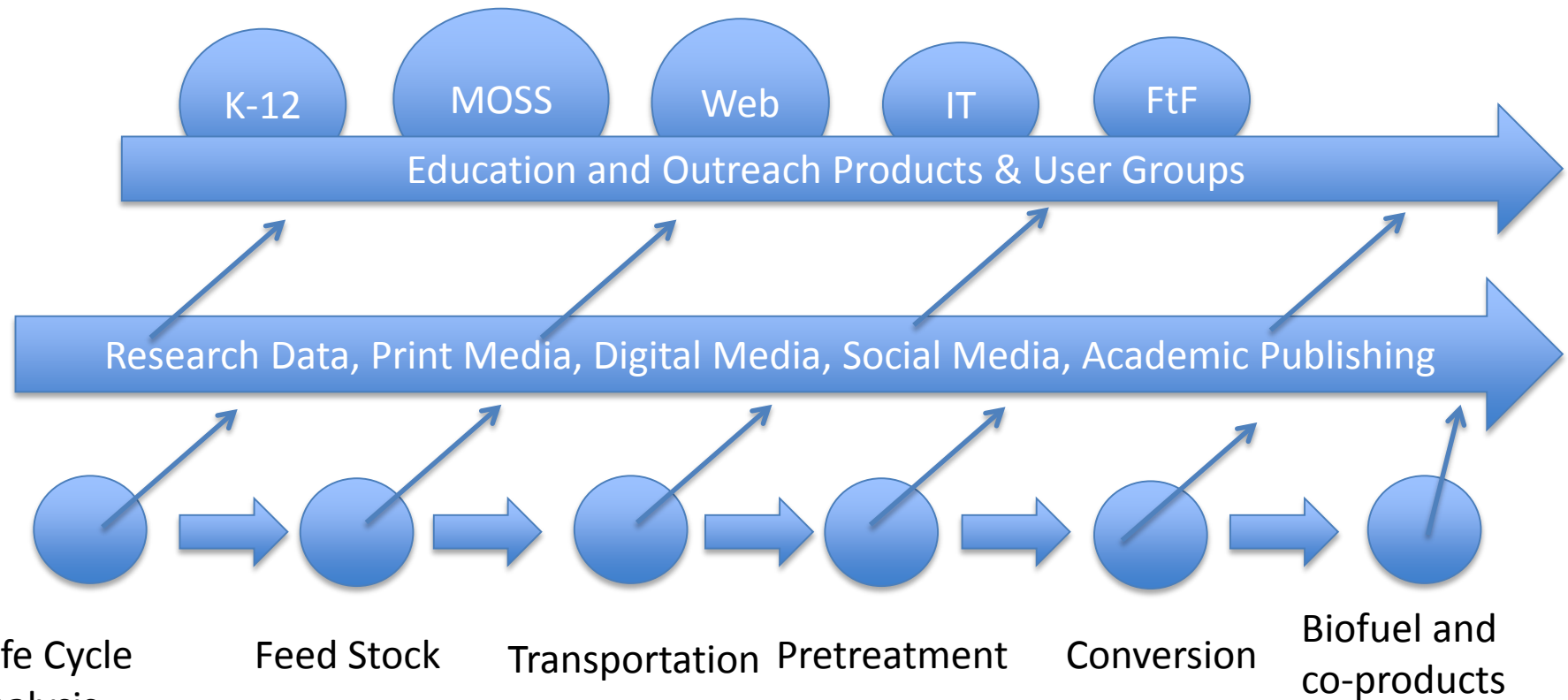
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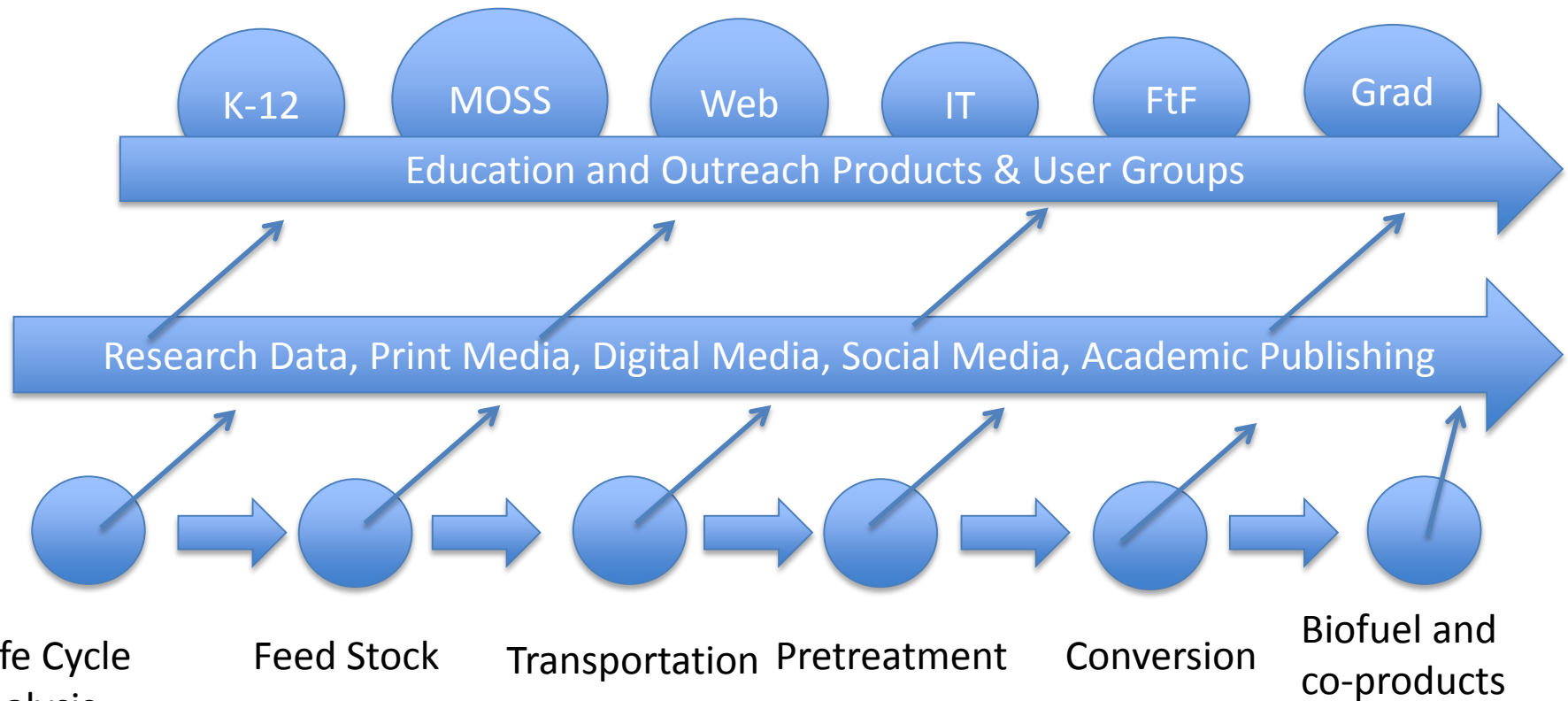
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# Flow for Education and Outreach of NARA research



-Life Cycle  
Analysis  
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Partnerships  
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Framework

# Flow for Education and Outreach of NARA research

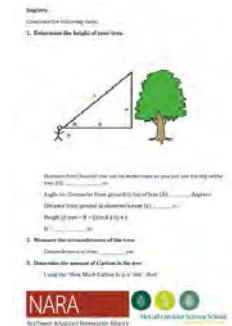
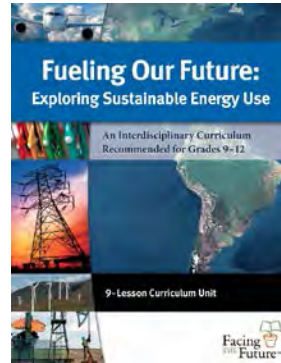


-Life Cycle  
Analysis  
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-Capitals  
Framework



## Energy Literacy

- Curriculum
- Media
- Assessment

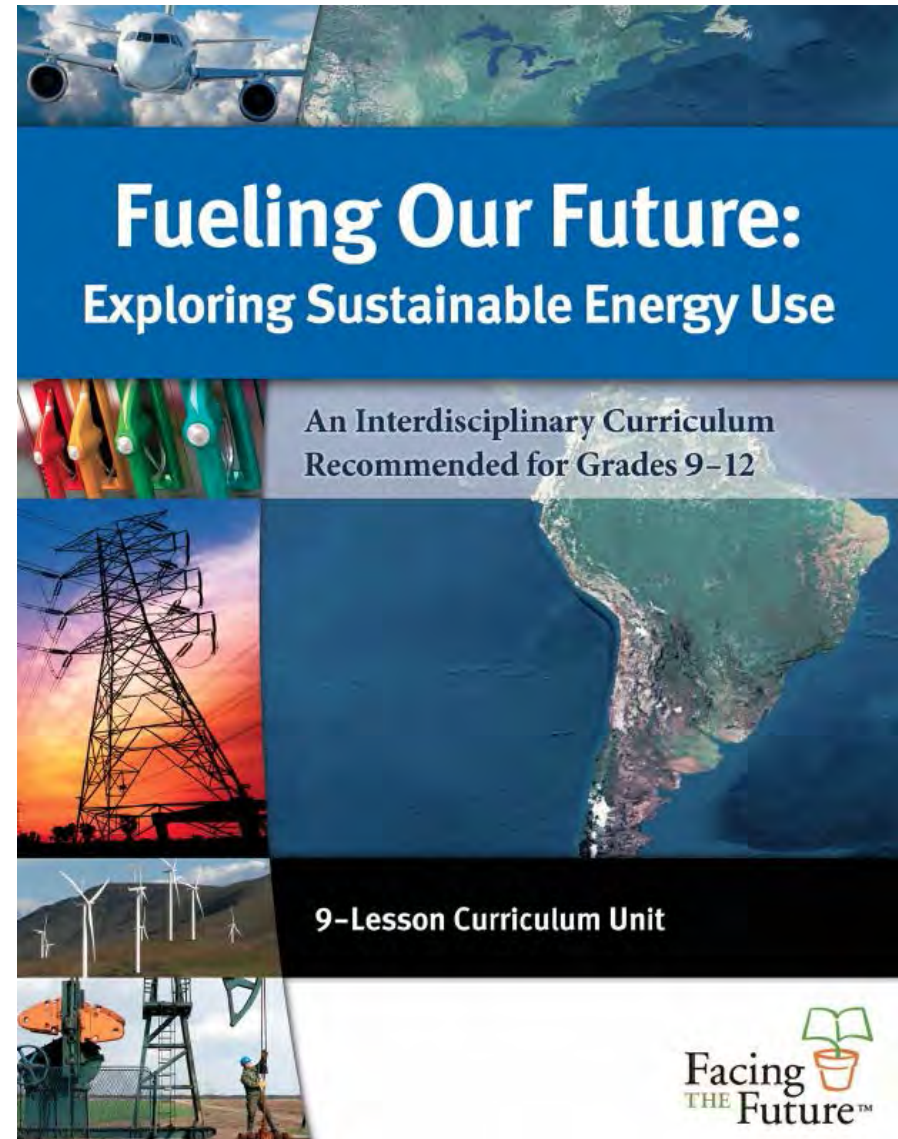


- 2500 k-12 students/yr through direct instruction
- 60 teachers/yr through direct instruction
  - 2600 K-12 students through these teachers
- 16 graduate students/yr through year-long coursework
- 1000's of contacts through web-based resources
  - Blog
  - Matrix



# Cases: Facing the Future

Curriculum created by Facing the Future  
2013 Launch  
Online and print resource



# Cases: Facing the Future

## Exploring energy literacy and biofuels - Activities parallel some NARA functions

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

### 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?*



# Cases: Facing the Future

## Stakeholder activity

Name	Date	Class
<b>Product 3: Stakeholder Position Analysis, page 1</b> (Group Activity)		
<b>Group Members:</b> _____		
<b>Stakeholder:</b> _____		
<b>Directions:</b> Complete the <i>Stakeholder Position Analysis</i> below as a group. You should use the <i>Feedstock Fact Sheets</i> and <i>Stakeholder Profile</i> to complete this product and to help you prepare for the Pacific Northwest Regional Biofuel Council Meeting. This product is worth 20 points.		
<b>1.</b> Based on your stakeholder's perspective and interests, summarize in 3 to 4 sentences who you represent. (2 points)		
_____		
_____		
_____		
_____		
_____		
<b>2.</b> Based on your stakeholder's perspective, complete the following chart below. Use evidence from the feedstock handouts to explain your thinking. You may have to make inferences. (8 points)		

## Stakeholder activity

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

### Product 4: Stakeholder Meeting (Group Activity)

At the stakeholder meeting, your stakeholder group will need to negotiate with other groups in order to create a policy recommendation for a sustainable biofuel mix in the Pacific Northwest. Along with the Stakeholder Position Analysis you complete in preparation for the stakeholder meeting, your group participation in the meeting will also be assessed based on the following rubric. All students in a group are expected to speak up equally.

#### Rubric for Negotiation

	4	3	2	1
<b>Collaboration</b>	<ul style="list-style-type: none"><li>• Negotiates in ways that are respectful</li><li>• Effectively communicates to move the conversation forward</li><li>• Effectively engages</li></ul>	<ul style="list-style-type: none"><li>• Tries to negotiate in ways that are respectful</li><li>• Effectively communicates and sometimes moves the conversation forward</li></ul>	<ul style="list-style-type: none"><li>• Sometimes tries to negotiate in ways that are respectful</li><li>• Attempts to communicate, but does not always move conversation forward</li></ul>	<ul style="list-style-type: none"><li>• Does not negotiate in ways that are respectful</li><li>• Does not attempt to communicate or move conversation forward</li></ul>



## Supply chain

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

### Product 2: Supply Chain Evaluation, page 1 (Individual Activity)

**Directions:** After you have participated in the Gallery Walk, reflect on what you have learned about biofuel supply chains by answering the following questions. Be sure your answers show critical thinking and evidence where necessary. Each question is worth 2 points.

1. Describe either a) the similarities and differences between the biofuels you learned about, or b) a pattern you observed among the different biofuel supply chains.

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2. How did the suggestions provided by your classmates compare to your ideas about improving the sustainability of your supply chain?

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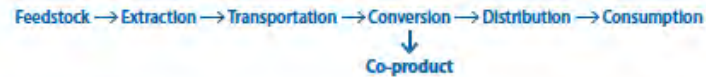
# Cases: Facing the Future

## Use of NARA field data and media

5. Now use the flow chart to outline the supply chain for one specific biofuel, corn-based ethanol. Consider writing this on a

*difference between biomass feedstocks and petroleum feedstocks is that the biomass feedstocks absorb carbon dioxide.)*

### The Supply Chain of a Fuel



8 The Life of a Fuel

125

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**Option:** Use one of the following videos to review the carbon cycle and the unique impact that fossil fuels have on the natural balance of this cycle.

- *The Hydrologic and Carbon Cycles: Always Recycle! – Crash Course Ecology#8*  
<http://www.youtube.com/watch?v=2D7hZpiYICA>

This video provides a fun, fast-paced explanation of the carbon and hydrologic cycles. To skip ahead to the carbon cycle, press play 5 minutes into the video. The carbon cycle segment is 5 minutes long.

2. Explain that small groups will conduct research on the supply chain of a particular biofuel to assess its sustainability in the Pacific Northwest. They will then create *Product 1: The Life of a Fuel Poster*.
3. Refer students to *Product 1: The Life of a Fuel Poster* in their packet and discuss the guidelines for completing this product.
4. Divide the class into groups of 3-4 students and assign each group 1 of the 4 feedstocks listed below. Depending on your class size, you may have more than one group researching the same topic.



# Cases: Facing the Future

Credit to partners

## Acknowledgements

**Curriculum Development**  
Danica Hendrickson, MEd  
Danielle Shaw, JD  
Sheeba Jacob, MEd  
Alicia Keefe, MEd  
Laura Skelton, MS

**Design and Layout**  
DECODE, Inc.  
**Copy Edit**  
Christie Heyer

## Field Testing

Thank you to the following educators and their students for field testing this curriculum.

**Erica Bergamini**  
Math and Science Teacher  
The Northwest School  
Washington

**Denise Clemens**  
Environmental Science Teacher  
Northwestern High School  
South Dakota

**Elise Cooksley**  
Social Studies Teacher  
Two Rivers School  
Washington

**Sandra DeSimone**  
Environmental Science Teacher  
Walter Reed Middle School  
California

**Tim Frykoda**  
Science Teacher  
Strathclair Community School  
Manitoba, Canada

**Shannon Granger**  
Physical Science Teacher  
Genesis Prep  
Idaho

**Ann Holstrom**  
Special Education Teacher  
Chehalis Valley Middle School  
Oregon

**Lori Lawton**  
Environmental Awareness Teacher  
Moscow Middle School  
Idaho

**Daniel Lieberman**  
Natural Resources Teacher  
North Olympic Peninsula Skills Center  
Washington

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

**Carly Moss**  
Enrichment Teacher  
Lockport School  
Manitoba, Canada

**Mary Smith**  
Exploratory Science Teacher  
eStem Middle School  
Louisiana

**Holly Uber**  
Science Teacher  
International School of Stavanger  
Norway

**Cynthia Varamo**  
Science Teacher  
St. Mary's School  
New Jersey

# Cases: Facing the Future

## Credit to partners

- Indroneil Ganguly
- Tait Bowers
- Nathan Meehan
- MOSS Team

## Additional Contributions

Thank you to the following individuals for reviewing, editing, and contributing ideas to this curriculum.

**Char Alkire**  
Science Education Consultant  
Washington

**Sean Baughn**  
Language Arts and Social Studies  
Teacher  
Eckstein Middle School  
Washington

**Christine Benita**  
Science Specialist  
Jane Addams K-8 School  
Washington

**Tait Bowers**  
Research Assistant  
University of Washington School of  
Environmental and Forest Sciences  
Washington

**Kimberly Corrigan**  
Partnerships and Professional  
Development Director  
Facing the Future  
Washington

**Debbie Hammel**  
Senior Research Specialist  
Natural Resources Defense Council  
Washington

**California Carrie Lee**  
Staff Scientist  
Stockholm Environment Institute  
Washington

**Jessica C. Levine**  
Science Teacher  
Eckstein Middle School  
Washington

**Nathan Meehan**  
Research Forester  
Weyerhaeuser  
Oregon

**Justine Miley**  
Development Director  
Facing the Future  
Washington

**Anthony Pancotti, PhD**  
Propulsion Research Scientist  
MSNW  
Washington

**Kristina Peterson, PhD**  
Math and Science Teacher  
Lakeside Middle School  
Washington

**Lee Ann Richardson**  
Chemistry Teacher  
Rivendale High School  
Tennessee

**Justine Way, PhD**  
History Teacher  
Rainier Scholars  
Washington

**Dave Wilton**  
Professional Development Manager  
Facing the Future  
Washington

A special thanks to the staff and graduate students of University of Idaho's McCall Outdoor Science School (MOSS) and other members of the NARA Education Team for their collaboration in the development and field testing of this curriculum.

**Karla Bradley Eitel, PhD**  
Director of Education  
MOSS  
Idaho

**Greg Fizzell**  
Program Director  
MOSS  
Idaho

**Steven Hollenhorst, PhD**  
Dean  
Huxley College of the Environment  
Washington

**R. Justin Hougham, PhD**  
Assistant Research Professor  
Washington State University  
Washington

**Tammi Laninga, PhD**  
Assistant Professor  
University of Idaho  
Idaho

**Jennifer Schon**  
Program Coordinator  
MOSS  
Idaho

**Shannon Vidoni**  
Program Assistant  
MOSS  
Idaho

# Cases: McCall Outdoor Science School

Field-based inquiries for  
graduate students  
teachers  
k-12 students





# Cases: McCall Outdoor Science School

MOSS Graduates Field testing curriculum





# Cases: McCall Outdoor Science School

MOSS k-12 students in the field

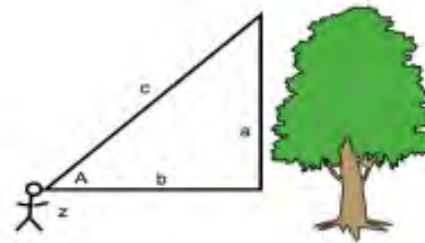


# Cases: McCall Outdoor Science School

## Explore:

Complete the following steps.

### 1. Determine the height of your tree.



Distance from base of tree out on meter tape so you can see the top of the tree (b): \_\_\_\_\_ m

Angle on clinometer from ground to top of tree (A): \_\_\_\_\_ degrees

Distance from ground to observer's eyes (z): \_\_\_\_\_ m

Height of tree =  $H = ((\tan A \times b) + z)$

H = \_\_\_\_\_ m

### 2. Measure the circumference of the tree.

Circumference of tree: \_\_\_\_\_ cm

### 3. Determine the amount of Carbon in the tree

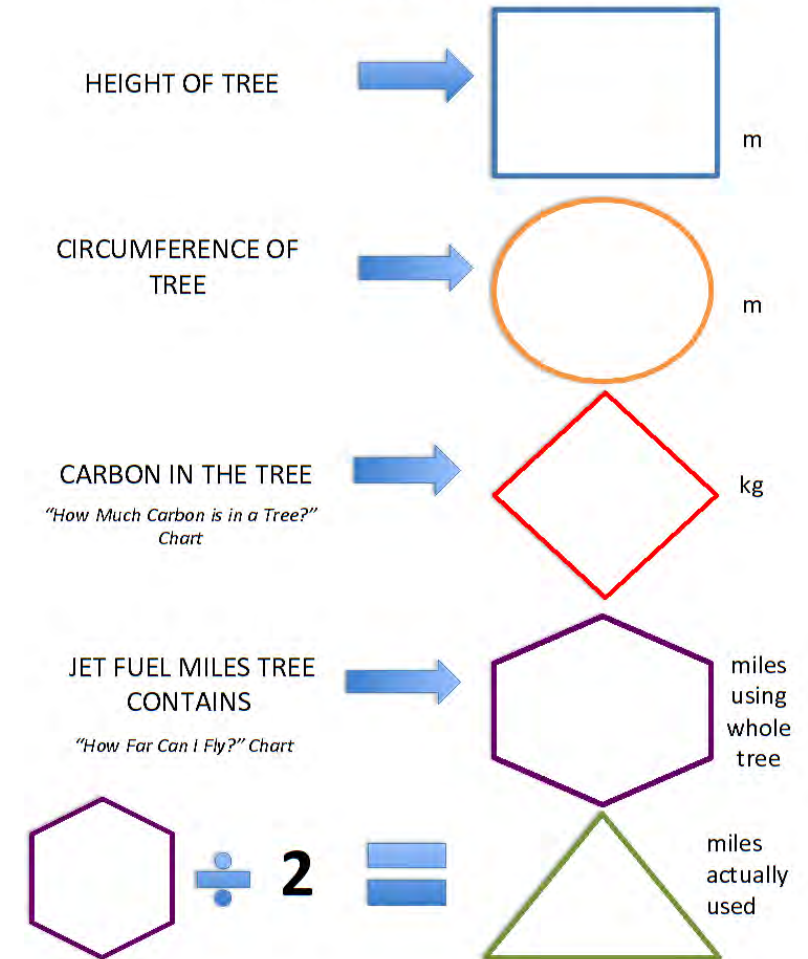
Using the "How Much Carbon Is in a Tree" chart



# Cases: McCall Outdoor Science School

Testing curriculum development with graduates adds value and usability

## JET FUEL CALCULATIONS





# Cases: McCall Outdoor Science School

Curriculum published for national teacher audience

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**September 2013**

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**in this issue:**

Aligning your science curriculum with the new *Next Generation Science Standards* can be a difficult and time-consuming task. Before you take on this challenge, check out the articles in this issue of *Science Scope* to learn how other middle school science teachers have made the transition from the *National Science Education Standards* to NGSS.

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- Free** • Cross-Disciplinary Writing: Scientific Argumentation, the Common Core, and the ADI Model
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**BEADAM**  
THE RIGHT BALANCE  
I chose the RIGHT balance...



# Cases: McCall Outdoor Science School

Credit and acknowledgement to NARA:  
Dwight Anderson (Catchlight)  
MOSS Staff, Grads, and Faculty

Have students complete the following:

Your tree can fly \_\_\_\_\_ miles, it can produce \_\_\_\_\_ pieces of paper, it can sequester \_\_\_\_\_ kg of CO<sub>2</sub> per year, which is equal to about \_\_\_\_\_ days of a school bus driving. What's the best use of your tree?

Student's ability to answer the question will reflect their understanding of the assignment and the complexity of the question. There is no right answer in deciding to use slash from harvested trees for biofuel and lumber material or to leave them for carbon sequestering. The important concept is to understand that there needs to be a balance and that the answer is not an easy one.

## References:

Anderson, Dwight. Catchlight Energy. (personal communication, June 7<sup>th</sup>, 2012).

*Conservation*. Trees into Paper (2012). Retrieved September 5<sup>th</sup>, 2012 from <http://www.easybib.com/reference/guide/apa/website>

*Plant-Trees*. How to Calculate the Amount of CO<sub>2</sub> Sequestered in a Tree Per Year (2012). Retrieved from July 9<sup>th</sup>, 2012 from <http://www.plant-trees.org/>

*Project Learning Tree*. Focus on Forests Activity 8-Climate Change and Forests (2010). American Forest Foundation. Retrieved from July 9<sup>th</sup>, 2012 from <http://www.plt.org/focus-on-forests-activity-8---climate-change-and-forests>

Math! How much CO<sub>2</sub> is released by Aeroplane? (May 8, 2007). Environment, Math! Retrieved July 9<sup>th</sup>, 2012 from <http://micpohling.wordpress.com/2007/05/08/math-how-much-co2-released-by-aeroplane/>



# Cases: Imagine Tomorrow

Annual high school problem-solving competition  
**Imagine Tomorrow**

**May 30–June 1, 2014**  
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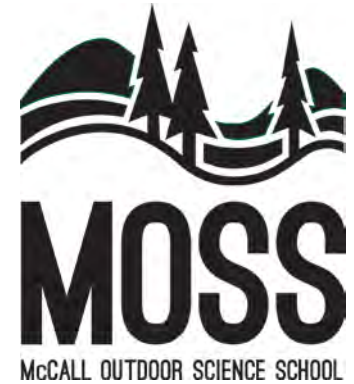
**REDESIGN. REFORM. REFUEL.**



# Cases: Imagine Tomorrow

## Teacher professional development model

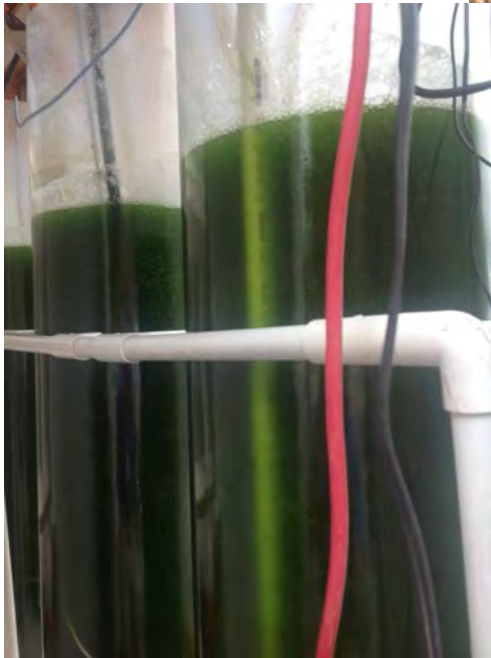
- Support and workshops for teachers
- Direct support from NARA researchers
  - Natalie Martinkus
  - Indroneil Ganguly





# Cases: Imagine Tomorrow

Student projects from across the state brought to Pullman to compete




# Cases: Imagine Tomorrow

Specific example of teacher and students from a NARA community.


## Slash Savvy

Emma Eccles and Cassandra Voight  
Students



### Background

This study focuses on the Clearwater Basin, an area rich in potential for the woody biomass industry. Woody biomass, wasted and burned as slash, is a viable feedstock used to produce an alternative transportation fuel, in particular bio-jet fuel. A survey was designed and administered to gain an understanding of knowledge and perceptions of people in the Clearwater Basin. Stakeholder groups surveyed include Lewiston High School students, teachers, workers in the forestry industry and other community members with an emphasis on students. The survey indicates that students know little to nothing about the potential of woody biomass as an alternative fuel. The survey also reveals other factors that could affect the future of using woody biomass as an alternative bio-jet fuel.




### Methods

- 209 Lewiston High School students were surveyed
- Over 75% of students surveyed knew very little about woody biomass and its uses (figure 1).
- The largest obstacles that students saw were lack of financial and community support (figure 2).
- When asked their level of agreement on several different uses for woody biomass, it was apparent that students did not have enough information to form strong opinions (figure 3).
- This was a recurring theme throughout the survey. For several open-ended questions, students declined to answer because they felt they did not know enough about the topic.

### Teachers

- Over half of the teachers surveyed were unfamiliar with woody biomass or knew little terminology (figure 1).
- A strong majority of the teachers felt woody biomass had staying potential (figure 2).
- They cited lack of community and financial support as obstacles in the usage of the alternative fuel (figure 3).
- Teachers generally agreed with all usage options we presented

### Figure 3: Agreement with Usage Possibilities



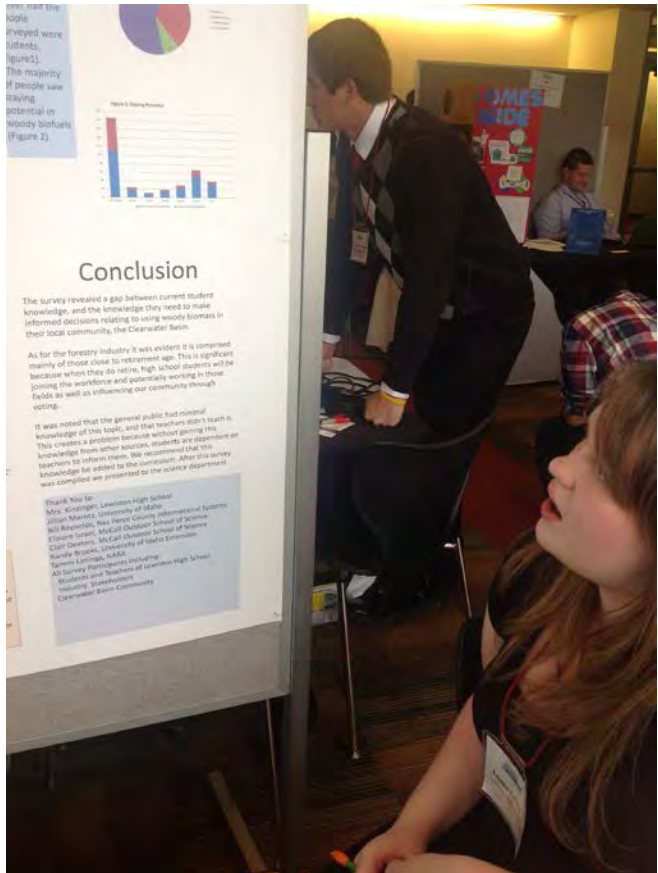
### Conclusion

The survey revealed a gap between current student knowledge, and the knowledge they need to make informed decisions relating to using woody biomass in their local community, the Clearwater Basin.

As for the forestry industry it was evident it is comprised mainly of those close to retirement age. This is significant because when they do retire, high school students will be joining the workforce and potentially working in those fields as well as influencing our community through voting.

It was noted that the general public had minimal knowledge of this topic, and that teachers didn't teach it. This creates a problem because without gaining this knowledge from other sources, students are dependent on teachers to inform them. We recommended that this knowledge be added to the curriculum. After this survey was completed we presented to the science department.

Thank You to:  
Mrs. Krieger, Lewiston High School  
Jill Moore, University of Idaho  
Bill Reynolds, Nez Perce County International Systems  
Elinor Soren, ANU Outdoor School of Science  
Cory Oertgen, McColl Outdoor School of Science  
Randy Brooks, University of Idaho Extension  
Tanner Lough, NARA  
All Survey Participants including:  
Students and Teachers of Lewiston High School  
Industry Stakeholders  
Clearwater Basin Community





# Cases: Imagine Tomorrow

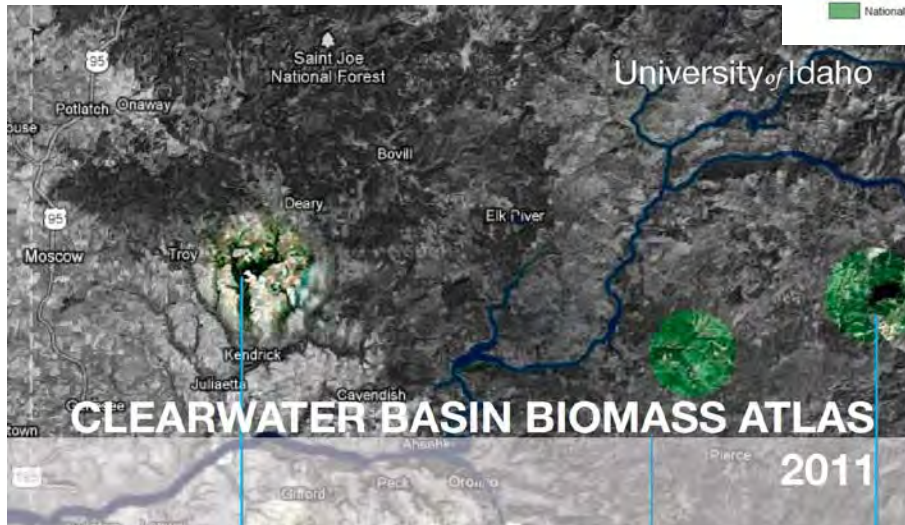
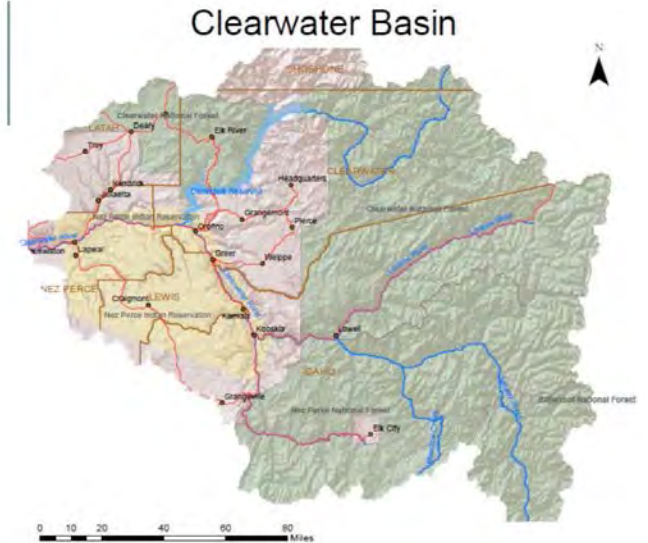
Tammi Laninga  
Jillian Moroney  
MOSS Graduate Students  
IDEX Students  
Imagine Tomorrow Teachers

**Figure 1: Clearwater Basin in the State of Idaho**

Source: Jason Boal and Dan Callister with data obtained from Inside Idaho, <http://cloud.insideidaho.org>.

**Legend**

- Cities\_Towns
- Highways
- County\_Boundary
- Rivers
- Reservoir
- Nez\_Perce\_Tribe
- National\_Forest





# Cases: Long Term Soil Productivity

LCA  
Sustainability  
and  
Context



# Cases: Long Term Soil Productivity

Academic and research  
publishing



## Tree growth ten years after residual biomass removal, soil compaction, tillage, and competing vegetation control in a highly-productive Douglas-fir plantation



Scott M. Holub<sup>a,\*</sup>, Thomas A. Terry<sup>b</sup>, Constance A. Harrington<sup>c</sup>, Robert B. Harrison<sup>d</sup>, Rod Meade<sup>e</sup>

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### ARTICLE INFO

#### Article history:

Received 12 February 2013

Received in revised form 16 May 2013

Accepted 17 May 2013

### ABSTRACT

Forest residual biomass harvesting is a potential concern in regions where this primarily branch and needle material is removed to provide a source of renewable energy or where total-tree yarding takes place. Concern arises from the removal of nutrients present in residual biomass, as well as from heavy equipment trafficking used to collect the material. The Fall River Long-term Soil Productivity (LTSP) Trial in

# Cases: Long Term Soil Productivity

Methodology that informs inquiry

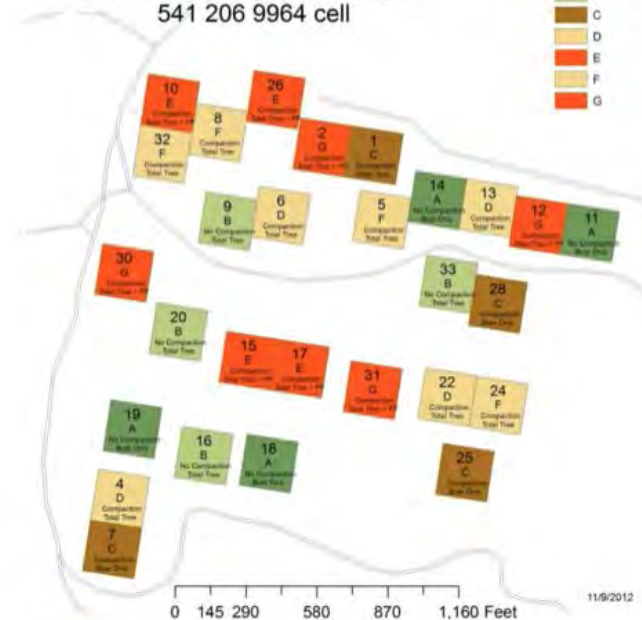
## NARA LTSP - TREATMENT LAYOUT

Harvest Scheduled for March/April 2013

Contact Scott Holub  
scott.holub@weyerhaeuser.com  
541 206 9964 cell

Legend  
NARALayout  
Treatment

Treatment	Color
A	Dark Green
B	Light Green
C	Dark Brown
D	Light Brown
E	Red
F	Orange
G	Yellow



8/5/2013

11/9/2012



# Cases: Long Term Soil Productivity

Methodology that informs inquiry

## NARA LTSP Treatments (5 + 2)

-----Levels of Compaction-----

-Levels of Slash Removal-	<i>Compaction</i> <i>OM Removal</i>	C0 – No compaction	C1 Moderate compaction	C2 Heavy compaction
	OM0 – Boles only	OM0 C0 Boles removed / No compaction	OM0 C1 Boles removed / Moderate compaction	OM0 C2 Boles removed / Heavy compaction
	OM1 - Boles and crowns removed	OM1 C0 Boles and crowns removed / No compaction	OM1 C1 Boles and crowns removed / Moderate compaction	OM1 C2 Boles and crowns removed / Heavy compaction
	OM2 - Boles, crowns, forest floor removed	OM2 C0 Boles, crowns, forest floor removed / No compaction	OM2 C1 Boles, crowns, forest floor removed / Moderate compaction	OM2 C2 Boles, crowns, forest floor removed / Heavy compaction

F = D + mid-rotation fertilization

G = E + mid-rotation fertilization

5 | 8/5/2013





# Cases: Long Term Soil Productivity

Scott Holub  
Nathan Meehan  
Weyerhaeuser



# Cases: Outreach Efforts





## Cases: Outreach Efforts



# Cases: Outreach Efforts





## Cases: Outreach Efforts



## Cases: Outreach Efforts





## Cases: Outreach Efforts



## Cases: Outreach Efforts





## Cases: Outreach Efforts





## Cases: Outreach Efforts





## Cases: Outreach Efforts




# Cases: Outreach Efforts

Teevin Brothers  
Greenway Recycling  
Eini Lowell  
BioPacific  
Vik Yadama  
Karl Englund  
Natalie Martinkus  
Scott Leavengood  
Peter Grey  
Gifford Pinchot Task  
Force






# Cases: Websites and Blogs




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## Educational Resources


The NARA Matrix is a vast 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.

[Click Here to 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.



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NARA is primarily supported by an Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.



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# Cases: Websites and Blogs

NARA

SEARCH

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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 cellulose materials 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 biomass and 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 Pre-ferment processes makes sugars more available.

**Sub-Topic:**  
1.4 Energy available to do useful work decreases as it is transferred from system to system.

**Sub-Topic:**  
2.4 Water plays a major role in the storage and transfer of energy in the Earth system.

**Sub-Topic:**  
3.4 Energy flows through food webs in one direction, from producers to consumers and decomposers.

**Sub-Topic:**  
4.4 Humans transport energy from place to place.

**Sub-Topic:**  
5.4 Energy decisions are influenced by economic factors.

**Sub-Topic:**  
6.4 Earth has limited energy resources.

**Sub-Topic:**  
7.4 Increasing demand for and limited supplies of fossil fuels affects quality of life.

**Sub-Topic:**  
8.4 The conversion processes includes adding specific enzymes to make simple sugars available.

**Sub-Topic:**  
1.5 Energy comes in different forms and can be divided into categories.

**Sub-Topic:**  
2.5 Movement of matter between reservoirs is driven by Earth's conservation of energy.

**Sub-Topic:**  
3.5 Ecosystems are affected by changes in the availability of energy and matter.

**Sub-Topic:**  
4.5 Humans generate electricity in multiple ways.

**Sub-Topic:**  
5.5 Energy decisions are influenced by political factors.

**Sub-Topic:**  
6.5 Social and technological innovation affects the amount of energy used by humans.

**Sub-Topic:**  
7.5 Access to energy resources affects quality of life.

**Sub-Topic:**  
8.5 Fermentation processes use specialized yeasts to convert starch to sugar.



# Cases: Websites and Blogs

NARA

SEARCH

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## Advanced Search

Use the advanced search feature to narrow results to specific areas of the matrix, topic, or resource type.

Search:

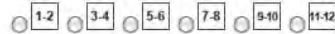
Filter By Topic:

Filter By Sub-Topic:

Filter By Type:



Filter By Grade Level:



Search

## Search Results

### Biomass Feedstock Pre-Processing- Part 1: Pre-Treatment

The two main sources of biomass for energy generation are purpose-grown energy crops and waste materials (Larkin et al., 2004). Energy crops, such as Miscanthus and short rotation woody crops (coppice), are cultivated mainly for energy purposes and are associated with the food vs. fuels debate, which is concerned with whether land should be used for fuel rather than food production. The use of residues from agriculture, such as barley, canola, oat and wheat straw, for energy generation circumvents the food vs. fuel dilemma and adds value to existing crops (Chico-Santamarta et al., 2009). In fact, these residues represent an abundant, inexpensive and readily available source of renewable lignocellulosic biomass (Liu et al., 2005).

Associated Grade Levels:

☐ 9-10 ☒ 11-12

### Wood Biomass in the Carbon Cycle

A colorful diagram of the carbon cycle highlights the forestry industry considering wood products as part of carbon sequestration. Lignocellulosic biomass (wood waste) is considered as potential clean energy. Fossil fuels and emissions from vehicles and forest fires are also included.

Associated Grade Levels:

☒ 3-4 ☒ 5-6 ☒ 7-8 ☒ 9-10 ☒ 11-12

### Enzymatic Cellulose Hydrolysis for Production of Liquid Biofuels from Lignocellulosic Biomass

A video presentation on enzymatic cellulosic saccharification for biofuel production

Associated Grade Levels:

☒ 9-10 ☒ 11-12

### Effect of Mixing on Enzymatic Hydrolysis of Steam-pretreated Spruce: a Quantitative





# Cases: Websites and Blogs

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## Basic Search

Quickly find results through a basic key word search. Enter the key word in the search box below. If you want narrow results to specific areas of the matrix, topic, or resource types please use the [advanced search feature](#).

Search:

## Search Results

### A Case Study for a Biomass Logging Operation -- Texas Forest Service

With the recent prices of oil and gas having increased substantially, biomass from forests has generated substantial interest as an energy source. Several potential bio-energy projects in different, preliminary stages of planning in East Texas could need substantial supplies of woody biomass. Logging contractors may ask 1) what does it take to start a logging business for woody biomass, 2) how much does it cost to produce, and 3) is it profitable? Potential customers may want to know what the delivered price may be. To answer these questions, Texas Forest Service presents the following case study and attached spreadsheet of itemized costs of a logging business for woody biomass.

Associated Grade Levels:

☐ 9-10 ☐ 11-12

### A Sustainable Woody Biomass Biorefinery

the objective of this paper is a focused review on the selected processes for a particular approach to biorefinery: incremental deconstruction of woody biomass in the absence of waste generation steps such as pretreatment and detoxification. In particular, integrated studies on hot-water based biochemical approach is systematically reviewed. In particular, hot-water extraction based "pretreatment" processes are discussed in detail.

Associated Grade Levels:

☐ 9-10 ☐ 11-12

### Carbon Emission Reduction Impacts from Alternative Biofuels

Using life-cycle analysis to evaluate alternative uses of wood including both products and fuels reveals a hierarchy of carbon and energy impacts characterized by their efficiency in reducing carbon emissions and/or in displacing fossil energy imports.

Associated Grade Levels:

☐ 9-10 ☐ 11-12

### Challenges of the Utilization of Wood Polymers: How Can They be Overcome?

This mini-review provides an overview of major wood biopolymers, their structure, and recent developments in their utilization to develop biofuels. Advances in genetic modifications to overcome the recalcitrance of woody biomass for biofuels are discussed and point to a promising future.

Associated Grade Levels:

☐ 9-10 ☐ 11-12

### Comparing Life-Cycle Carbon and energy Impacts for biofuel, Wood Product, and Forest













# Cases: Websites and Blogs


## Teaching AL@MOSS

*Education @ the Speed of Adventure*




AboutWhat's the issue?AgendaInterviewsMedia ArchiveResources


Group looks to turn forest waste into fuel for jets




NARA Bio Fuels in the News




Energy and Climate Literacy



Biofuels: Can we turn trees into jet fuel?



Water Resources and one of the toughest jobs...



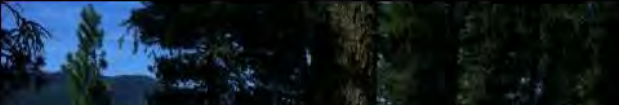
What will your team do?

« PREV » NEXT »

August 2013


LEAVE A COMMENT

### Energy Literacy: A new team begins the year at the McCall Outdoor Science School




# Cases: Websites and Blogs


Real time connections to stakeholders and educators




NARA Bio Fuels in the News




Energy and Climate Literacy



Biofuels: Can we turn trees into jet fuel?



Water Resources and one of the toughest jobs...



What will your team do?

« PREV » « NEXT »

---

June 24  
2013

**Presentations posted!**

13 COMMENTS

Hi folks,

If you haven't already checked out the resources section, you should definitely cruise on over. I've just added the presentations that we saw on Thursday so that the followers at home can take a look. Natalie Martinkus presented on using GIS as a decision-making tool in supply-chain analysis, and Indroneil Ganguly presented on life cycle assessment.

In addition to these presentations, we've linked to resources for teaching about water, energy and climate change. We hope that you will use them to get involved!

[MOOSE GIS Presentation\\_Martinkus](#)

[LCA Initiatives' training\\_6.20.13](#)

Posted By: karlaeitel Category: Alternative energy, Biofuels, climate, Climate change, energy, Uncategorized

# Cases: Websites and Blogs

Real time connections to stakeholders and educators



[About](#) [News & Features](#) [Teams](#) [Members](#) [Blog](#)

## On The Road: NARA Researchers and Team Members Visit with Stakeholders in Southwest Washington and Northwest Oregon



July 9-11 NARA researchers visited several sites in the greater Portland area to learn more about resources and relationships that will shape our understanding of biomass issues. This trip included visits with wood recyclers, biofuel processors, environmental organizations and a log yard.

Teevin Brothers Log Yard was our first stop in Washington outside of Longview. At this facility, logs are collected from trucks, sorted, stored and shipped to various markets.

<http://www.teevinbros.com/>



### RECENT POSTS

[Co-product development: lignin-based molecules for commercial epoxies](#)

September 4, 2013

[Forest Inventory and Utilization Data](#)

September 4, 2013

[Improving simple sugar yields from wood residuals](#)

September 4, 2013

[John Sessions to receive national award from the Society of American Foresters](#)

August 28, 2013

[Energy Literacy: A new team begins the year at the McCall Outdoor Science School](#)

August 20, 2013

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[Co-products](#)

[Creating Biojet Fuel](#)

[Energy Literacy](#)

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[Sustainability and Job Creation](#)

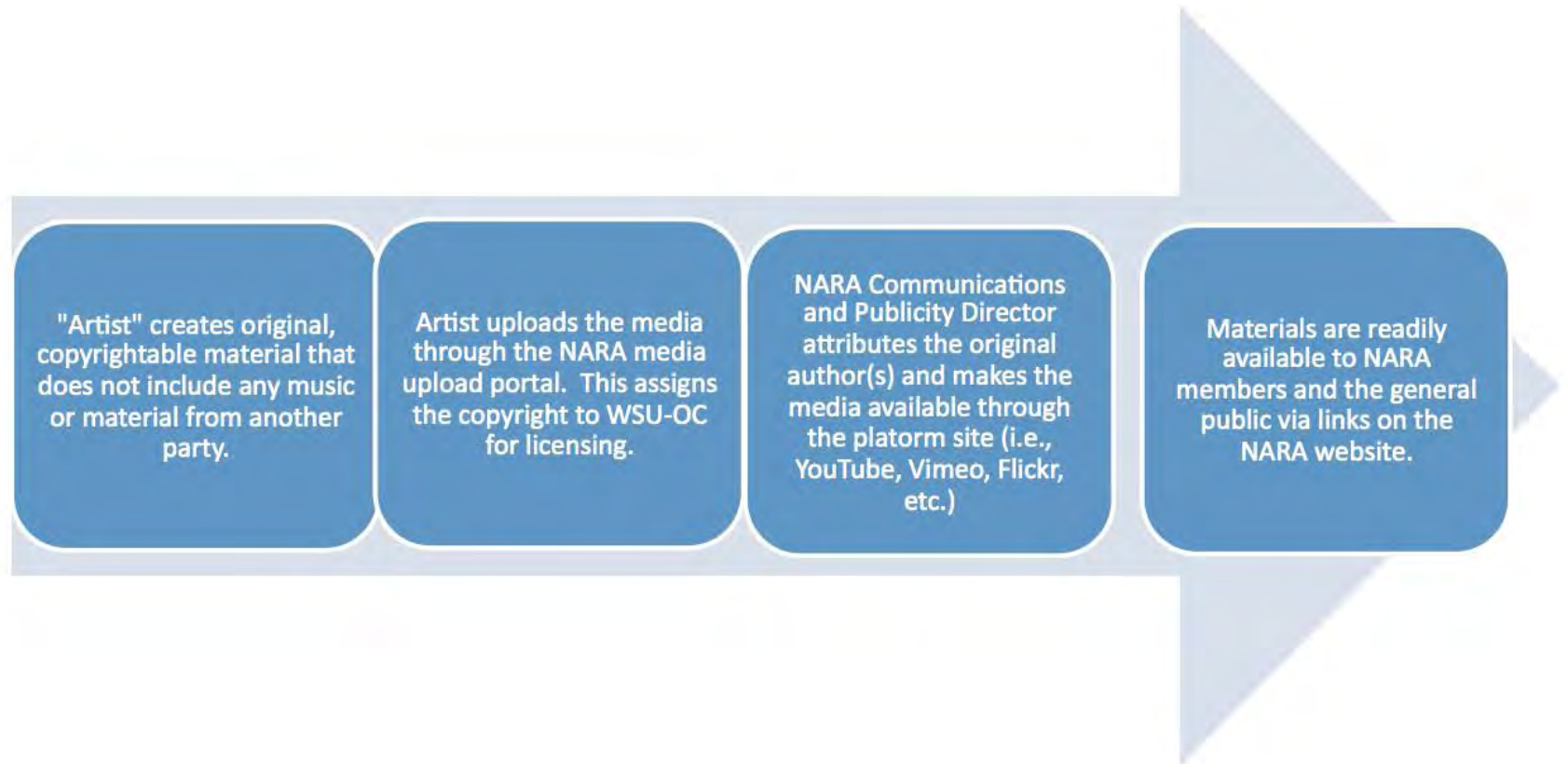
### ARCHIVES

[September 2013 \(3\)](#)

[August 2013 \(2\)](#)

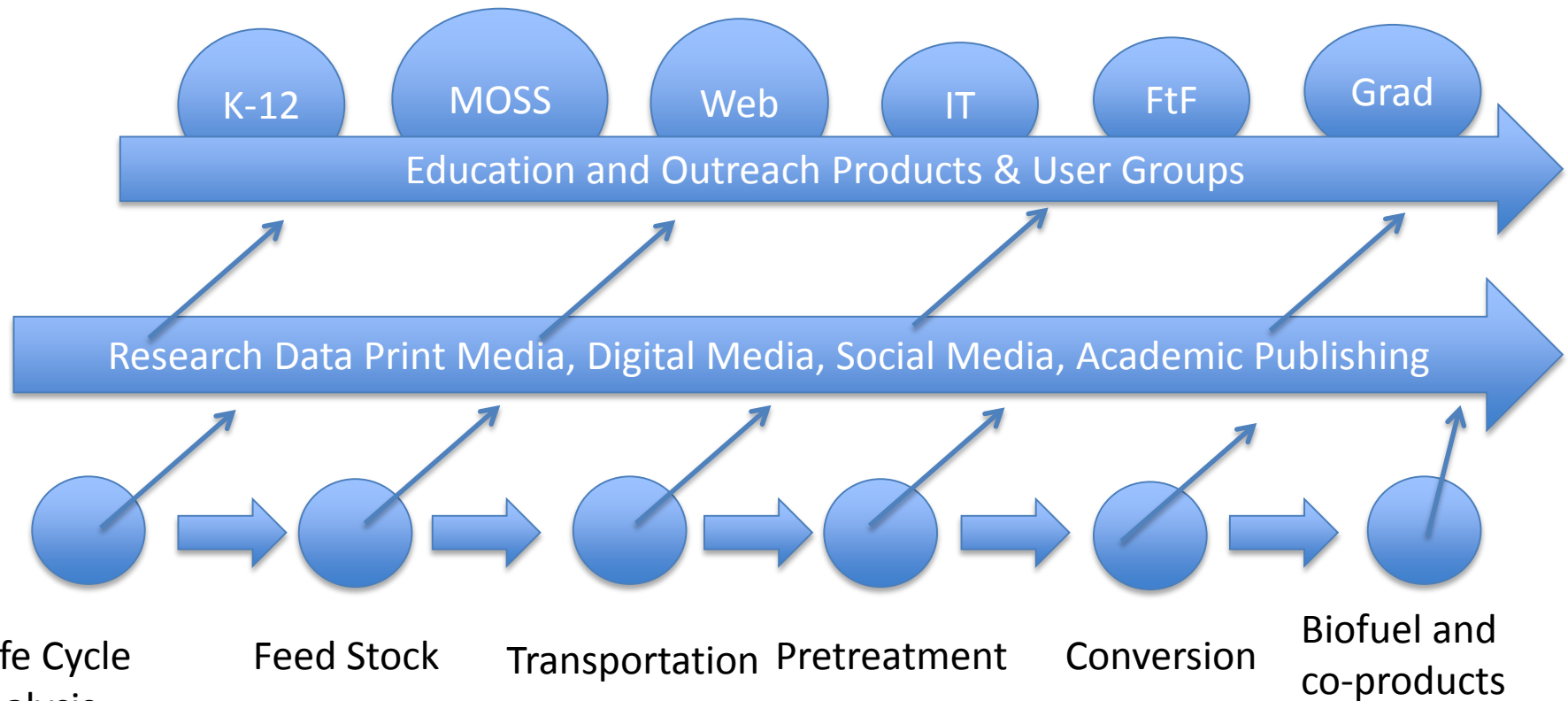
# Copyright

## Media artifacts and creative work





# Flow for Education and Outreach of NARA research



-Life Cycle  
Analysis  
-Community  
Partnerships  
-Capitals  
Framework

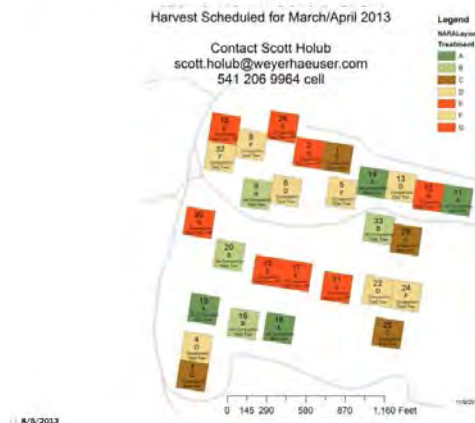
# Moving Forward

## Ways to contribute to the Energy Literacy supply chain:

- Data
- Graphics
- Guest talk
- Editorial
- Student and teacher support

Design objective: Timely, inspiring, accurate and complete

## NARA LTSP - TREATMENT L





# Integrating Research and Education: Education at the Speed of Research

R. Justin Hougham  
NARA Education and Outreach  
Assistant Professor, Washington State University  
[justin@nararenewables](mailto:justin@nararenewables)