Sustainability Education, Aviation Biofuels and NARA

Michael Froehly

Making biofuels and their life cycle relevant to High School students


NARA
Northwest Advanced Renewables Alliance
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 ~60 GALLONS ISOBUTANOL OR ~45 GALLONS BIOJET
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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NARA SUPPLY CHAIN

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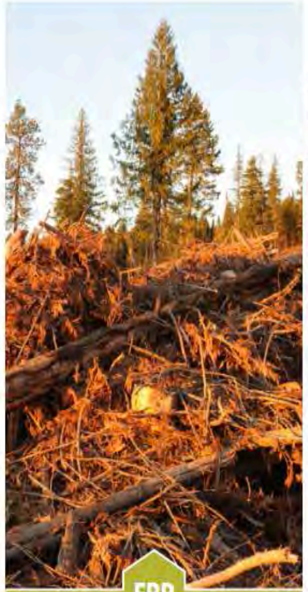

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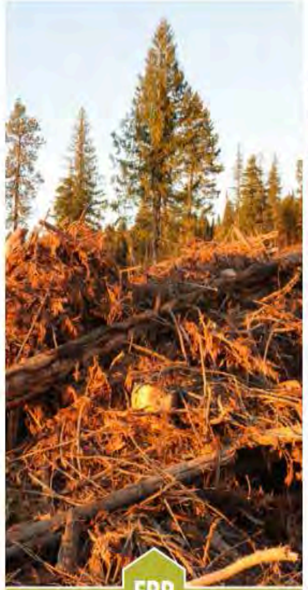

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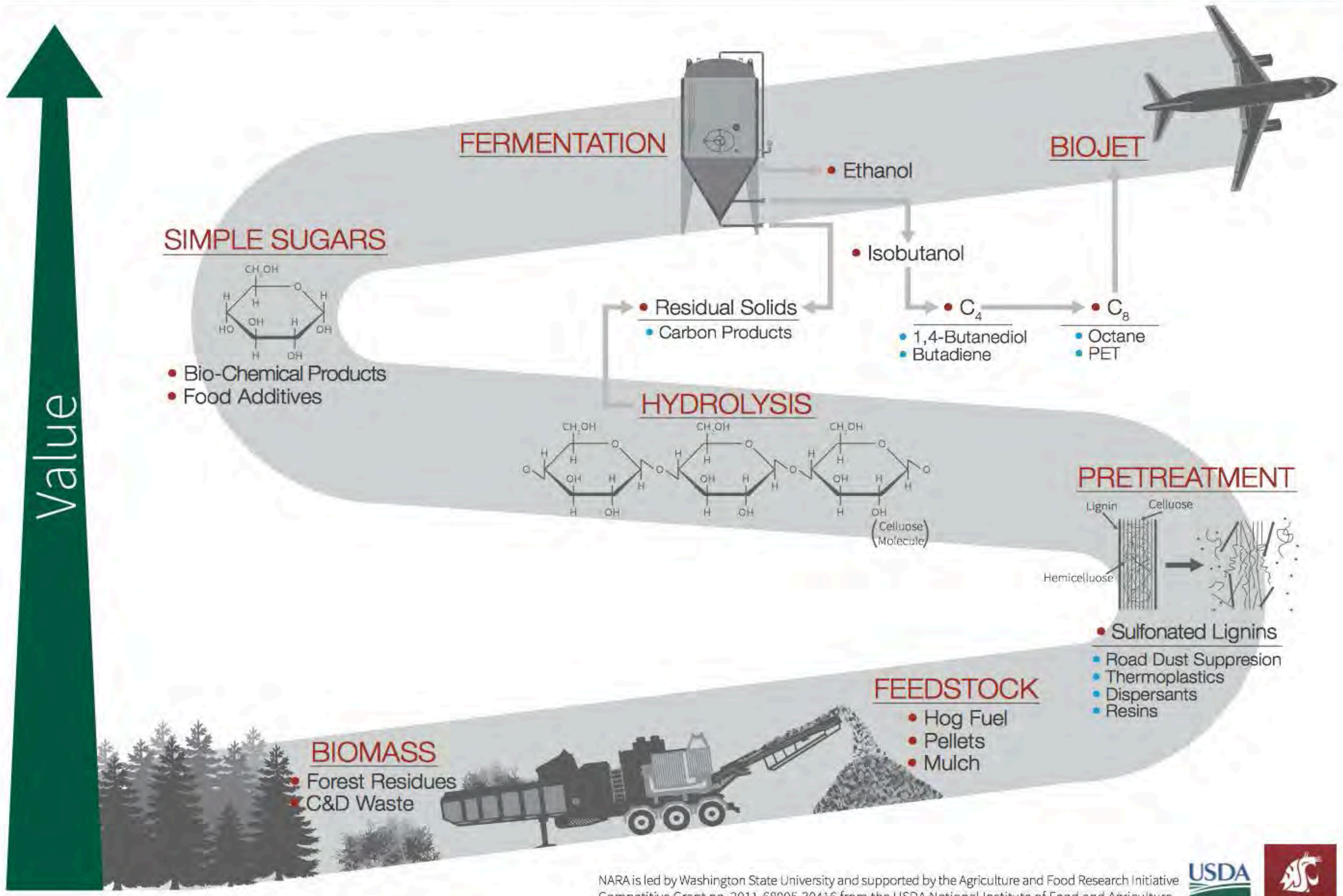

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SUPPLY CHAIN PRODUCTS

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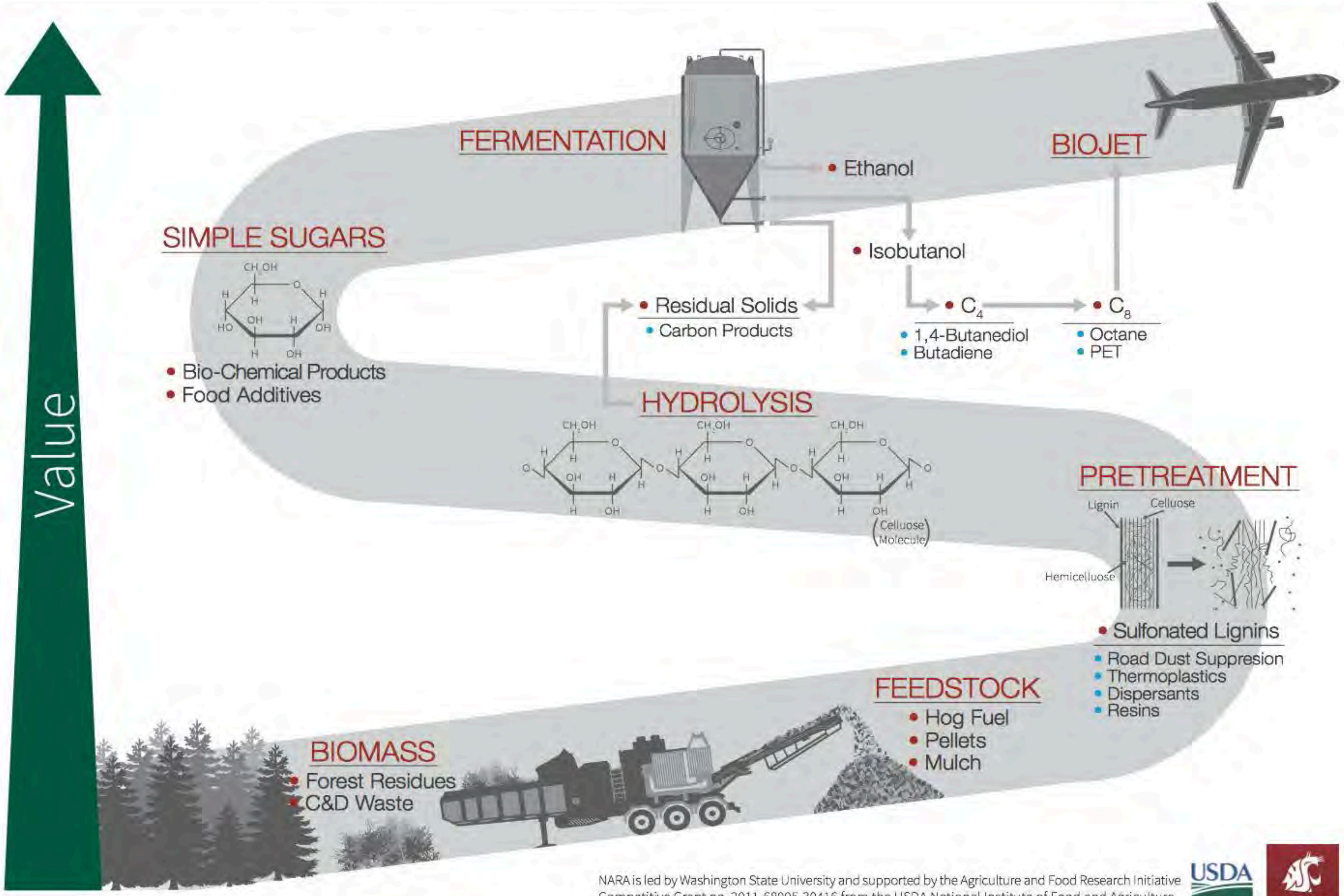

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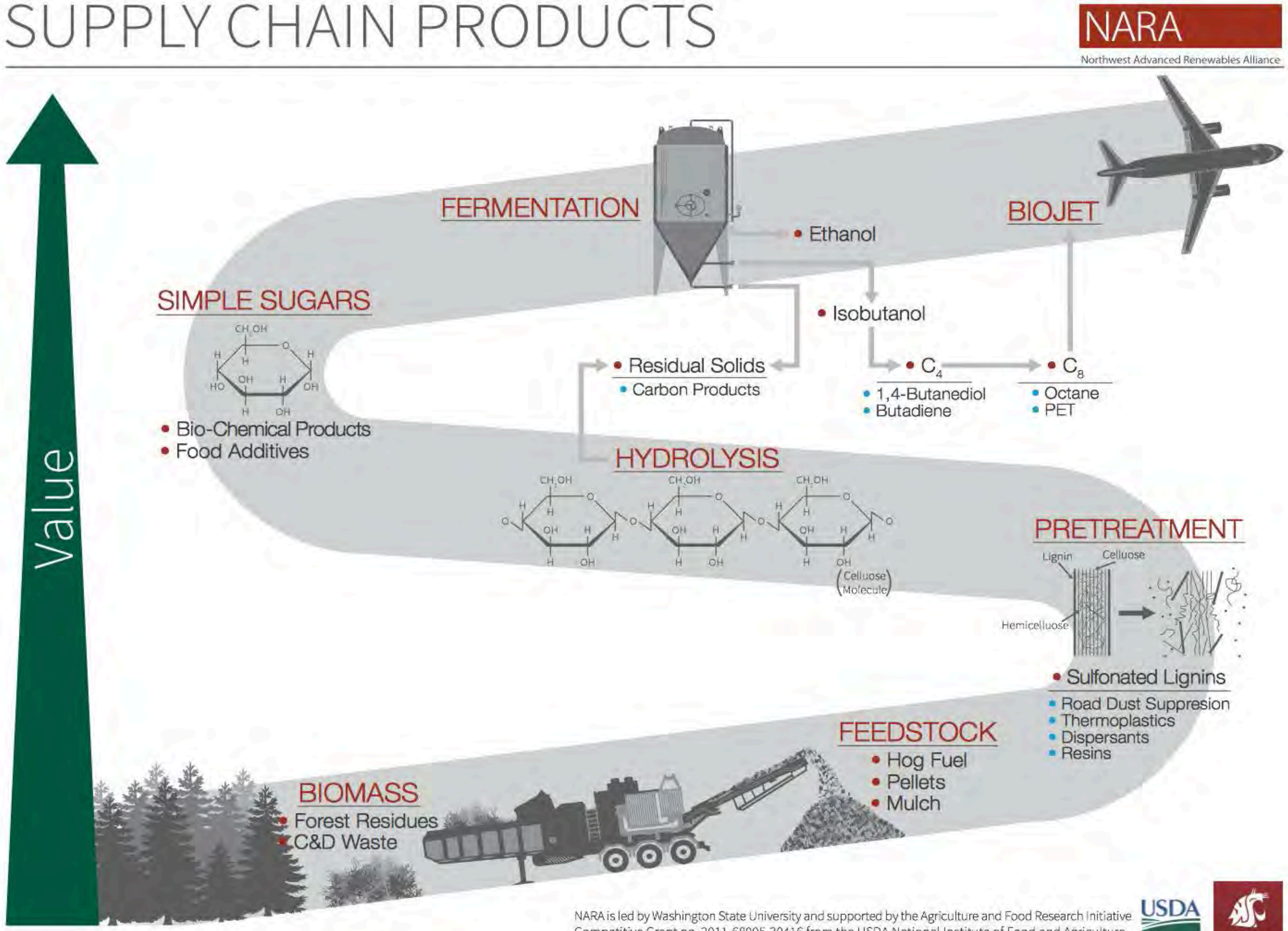

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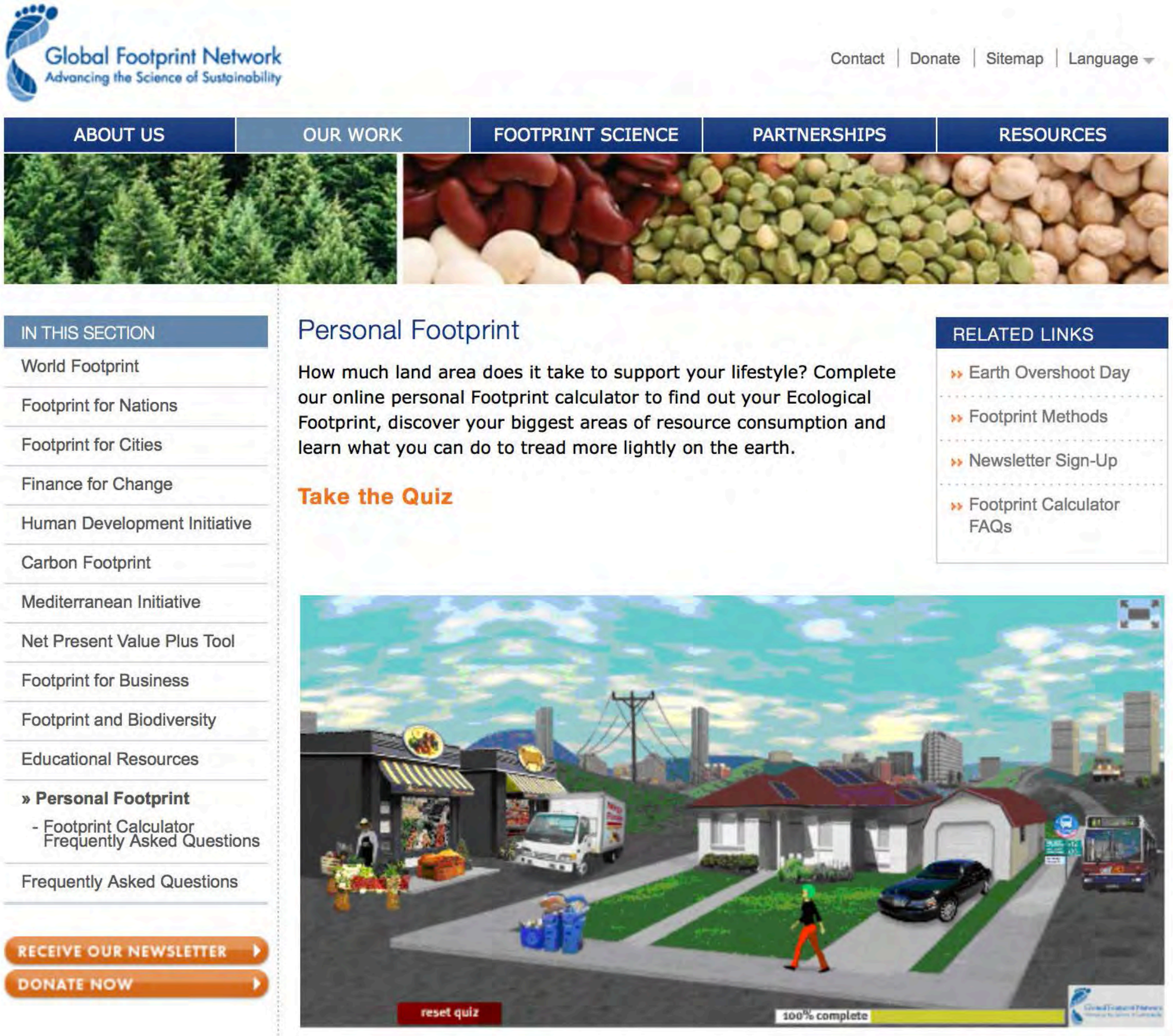
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- Carbon Footprint
- Mediterranean Initiative
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How much land area does it take to support your lifestyle? Complete our online personal Footprint calculator to find out your Ecological Footprint, discover your biggest areas of resource consumption and learn what you can do to tread more lightly on the earth.

Take the Quiz

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Life Cycle Assessment:
Scenario Guide

Carbon Footprint Results:

1. How many earths do you need?
   - ____________________
2. How much carbon do you release per year (tons), based on your lifestyle?
   - ____________________
3. How much carbon have you potentially released over the course of your life so far (tons)?
   - _____________________
4. What are 3 steps you can take every day that will aid in reducing your carbon footprint?
   - ____
     ____
     ____
   - ____
     ____
     ____
   - ____
     ____
     ____
5. Describe 1 lifestyle change you could make that could significantly reduce your carbon footprint by at least 60%, and how you would go about making/implementing this change.
   - ____
     ____
     ____
     ____
     ____
     ____
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     ____
6. Retake the test and see if your adjustments have reduced your carbon emissions by 60%.

Life Cycle Assessment:
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6. Retake the test and see if your adjustments have reduced your carbon emissions by 60%.

60 % Reduction

Guided Worksheet

LCA Background Information:
Now that you all have looked at an assessment of your own lives, and how much carbon dioxide you released based on different actions you take, let's investigate the Life Cycle Assessment of a biofuel.

A supply chain coalition has been developed to evaluate the feasibility of creating biofuel from woody biomass. Since they are approaching this challenge from a business perspective they are interested in understanding if it will be economically viable. But this group is also interested in the social and environmental impact of this process. To look at environmental impacts specifically they are using a process called LCA. They are hoping that this process will lead to a 60% reduction in greenhouse gas emissions when this process is compared to conventional jet fuels. But they are also interested in other local emissions on this process. Using the information below, figure out what the balance CO2 emissions and other gases based on different scenarios. Then, you'll figure out if this process is "good" overall — does it reduce greenhouse gas emissions on balance? Are the local emissions socially acceptable? How would you go about making this evaluation of "good"?

How to find the volume* of a tree:

$$V = \pi r^2 \times h$$

*this volume equation is conceptual for the purposes of this exercise, and is not an intended to be a precise caution of tree volume.

LCA Interactive Spreadsheet Scenarios:

Using the LCA Spreadsheet, determine the following:

Jet Fuel and Co-Products
Scenario: You have a logging site containing 450 trees; they have a DBH of ~2.5ft and a height of ~65ft

1. What is the potential weight of the bone dry woody biomass that can be produced from the 453 tree?
   - ________________LBS
2. What is the the potential amount of bio jetfuel that can be produced?
   - ________________GALS
3. What is the potential amount of Lignin that can be produced?
   - ________________LBS
4. What is the potential amount of Isobutanol that can be produced?
   - ________________LBS

Feedstock Production
Scenario: You have a logging site containing 450 trees; they have a DBH of ~2.5ft and a height of ~65ft

1. From the Feedstock Production, how much CO_2 is emitted?
   - ________________LBS
2. From the Feedstock Production, how much 0_3 is emitted?
   - ________________LBS

Transportation
Scenario: You have a logging site containing 450 trees; they have a DBH of ~2.5ft and a height of ~65ft

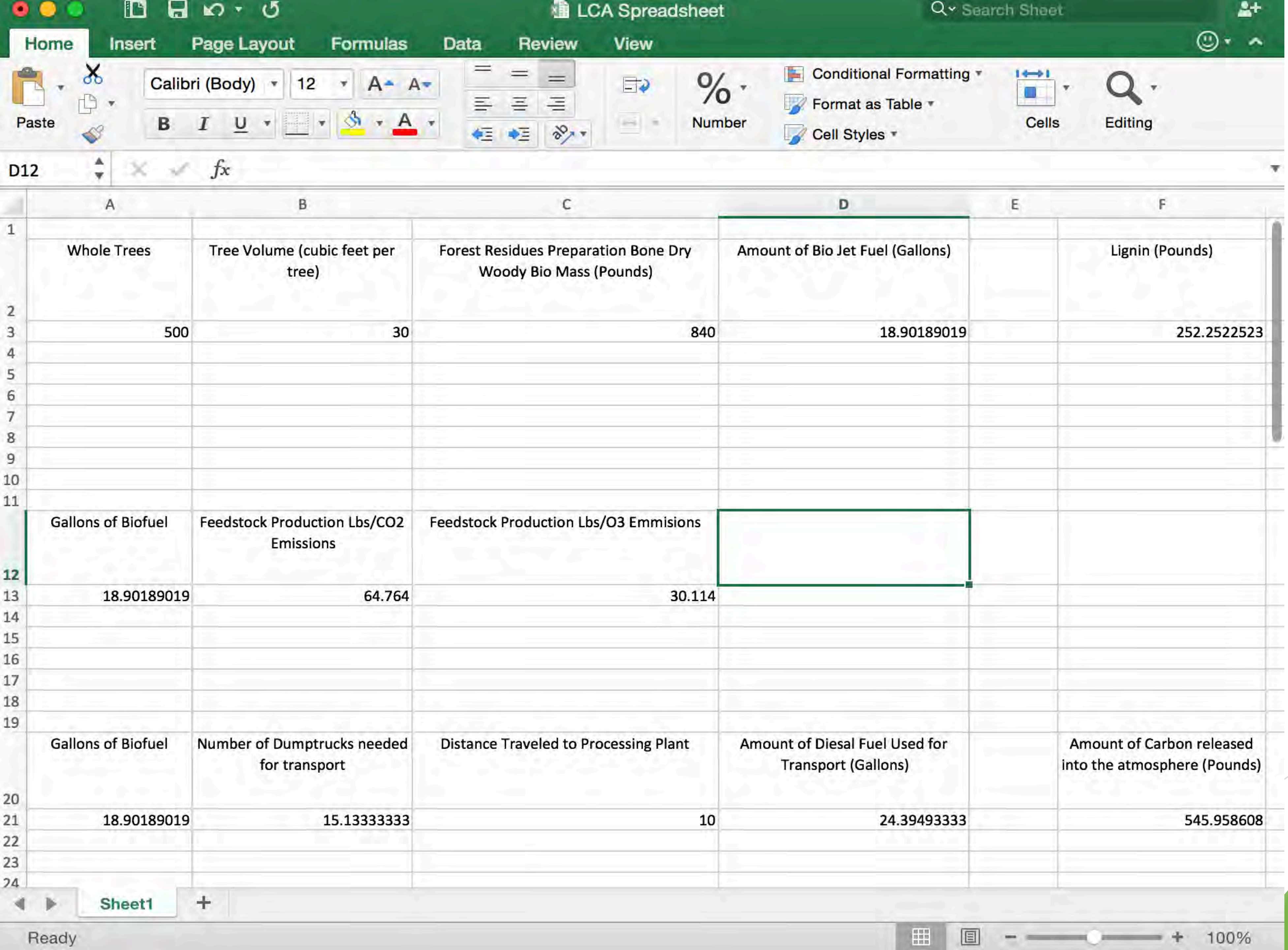
1. If you need to travel 47 miles to the processing station, how much CO_2 will be emitted throughout the transportation of the biomass?
   - ________________LBS
2. If you need to travel 47 miles to the processing station, how much diesel fuel will be needed to transport of the biomass?
   - ________________GALS
3. If you need to travel 100 miles to the processing station, how much CO_2 will be emitted throughout the transportation of the biomass?
   - ________________LBS
4. If you need to travel 100 miles to the processing station, how much diesel fuel will be needed to transport of the biomass?
   - ________________GALS
5. If you need to travel 13 miles to the processing station, how much CO_2 will be emitted throughout the transportation of the biomass?
   - ________________LBS
6. If you need to travel 13 miles to the processing station, how much diesel fuel will be needed to transport of the biomass?
   - __________________GALS

LCA Spreadsheet

	A	B	C	D	E	F
1						
2	Whole Trees	Tree Volume (cubic feet per tree)	Forest Residues Preparation Bone Dry Woody Bio Mass (Pounds)	Amount of Bio Jet Fuel (Gallons)		Lignin (Pounds)
3	500	30	840	18.90189019		252.2522523
12	Gallons of Biofuel	Feedstock Production Lbs/CO2 Emissions	Feedstock Production Lbs/O3 Emmisions			
13	18.90189019	64.764	30.114			
20	Gallons of Biofuel	Number of Dumptrucks needed for transport	Distance Traveled to Processing Plant	Amount of Diesal Fuel Used for Transport (Gallons)		Amount of Carbon released into the atmosphere (Pounds)
21	18.90189019	15.13333333	10	24.39493333		545.958608

Sheet1

Ready



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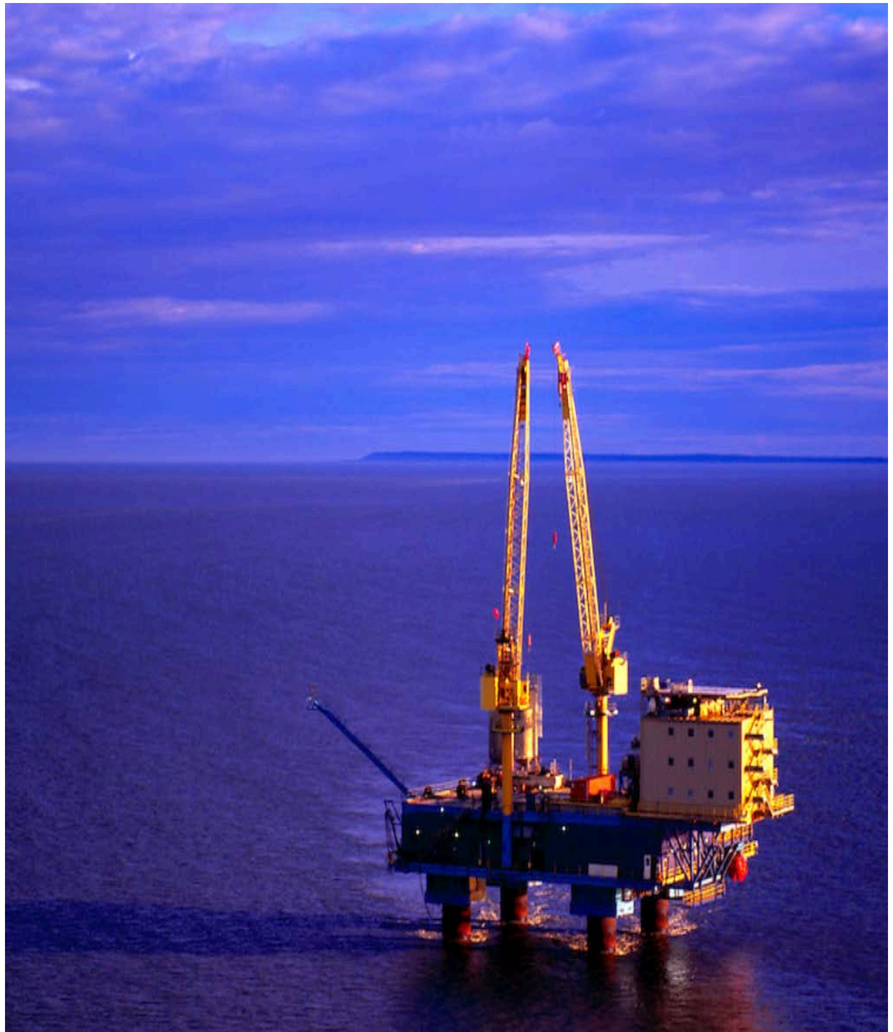
Research



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