Energy Literacy as a Co-Product of the NARA Supply Chain:

Closing the gap from emerging science to education

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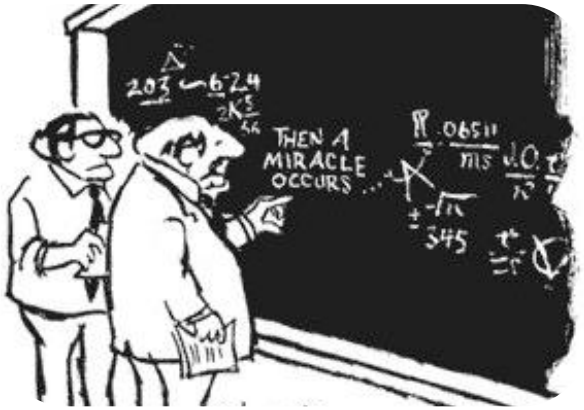
A Few of the Education Team Goals:



Strengthen overall science literacy of students in areas particular to biofuels

Improve energy and biofuels literacy of teachers educating our future citizens

Support bioenergy workforce development

Educating and assessing “the pipeline”

31,674 K12 students	845 Teachers	173 Undergrads	159 Graduate	Assessment	Digital Asset Management
Facing the Future	Facing the Future	SURE	IDX Integrated Design Experience	Upham Woods Outdoor Learning Center UW Extension	Upham Woods Outdoor Learning Center UW Extension
MOSS McCall Outdoor Science School	MOSS McCall Outdoor Science School	IDX Integrated Design Experience	Tribal Partnership Program	Facing the Future	MOSS McCall Outdoor Science School
Upham Woods Outdoor Learning Center UW Extension	Upham Woods Outdoor Learning Center UW Extension	Tribal Partnership Program	MOSS McCall Outdoor Science School	MOSS	Facing the Future
Imagine Tomorrow		Western Washington University		Imagine Tomorrow	

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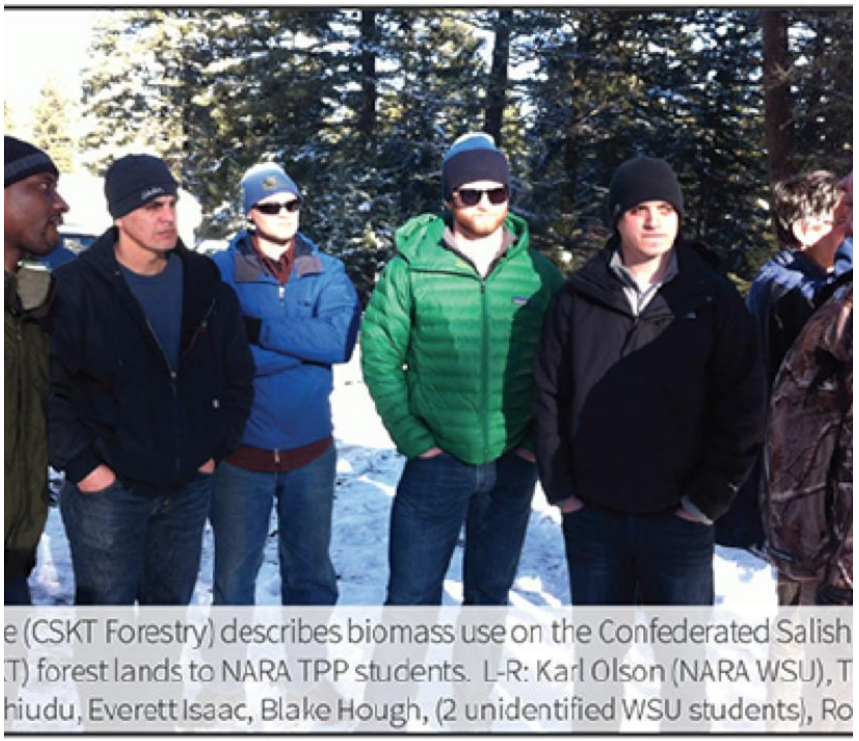
31,674 K12 Students

845 Teachers

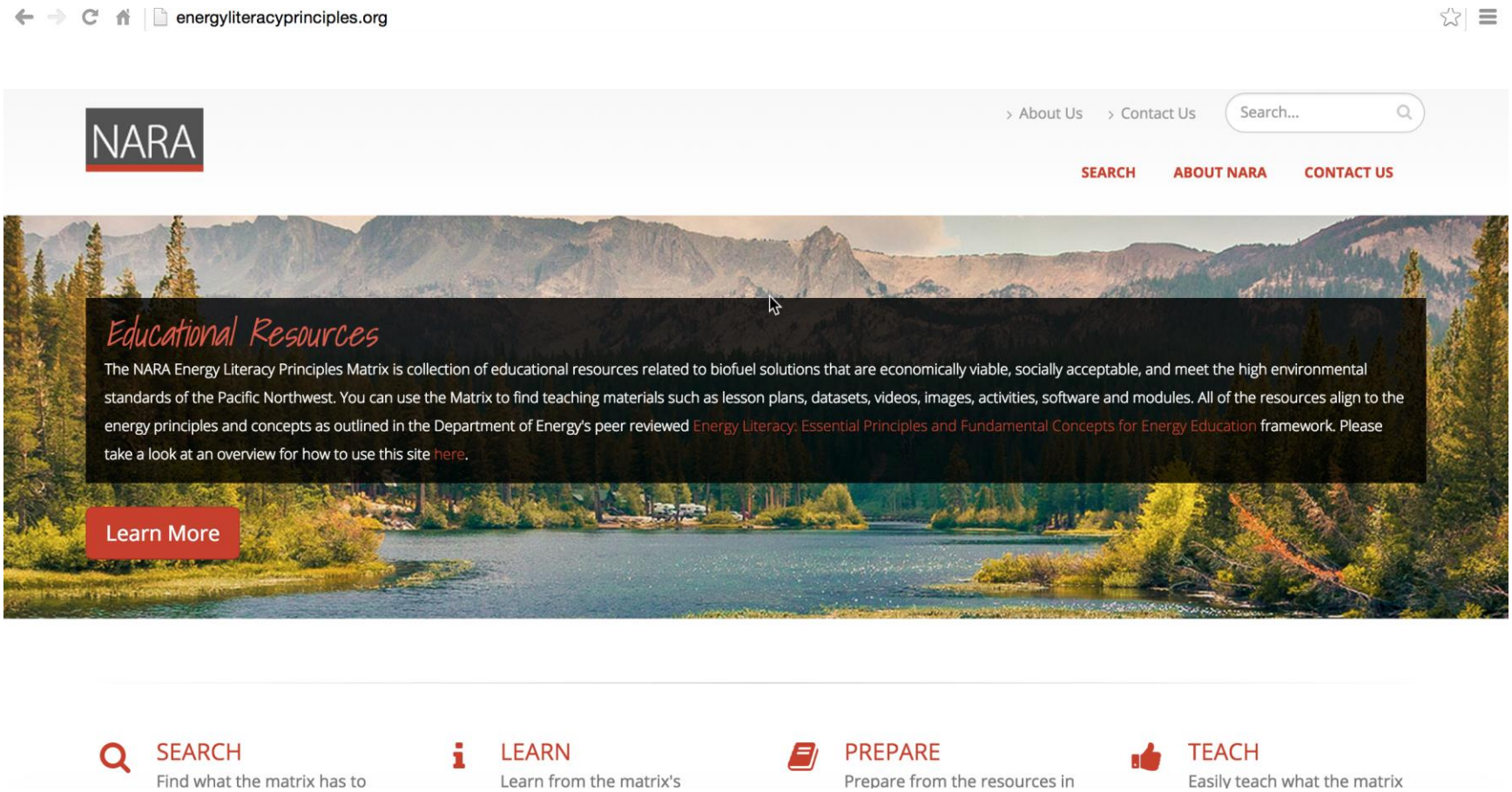
173 Undergraduates

159 Graduate students



e (CSKT Forestry) describes biomass use on the Confederated Salish
T) forest lands to NARA TPP students. L-R: Karl Olson (NARA WSU), T
hiudu, Everett Isaac, Blake Hough, (2 unidentified WSU students), Ro

Digital Asset Management



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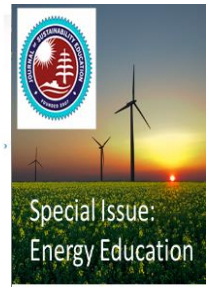
More than 60 lessons have been developed

60 webinars have been produced

2 energy literacy instruments have been developed and validated by the NARA education team



16 Peer Reviewed Publications

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Assessment Results

Teachers

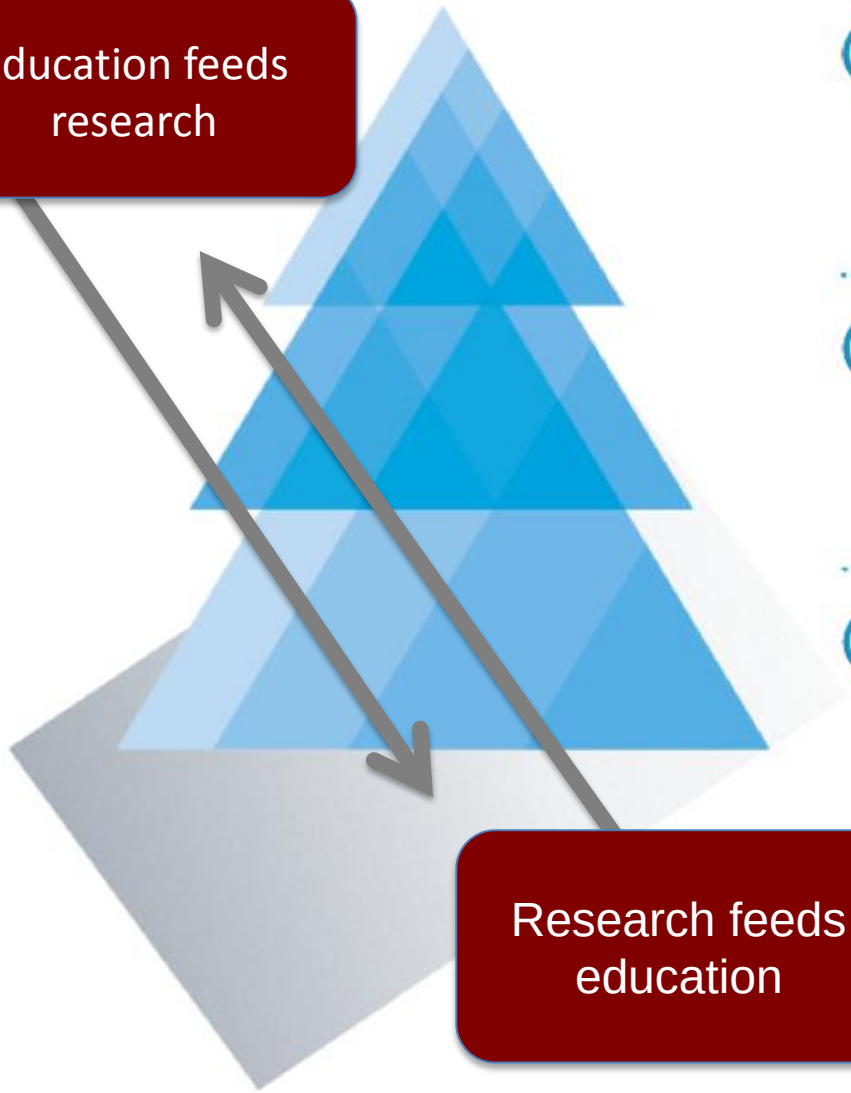
- are **more knowledgeable** about biofuels and biofuels research
- have **more informed opinions** about bioenergy
- Incorporate biofuels into their curriculum
- Are more likely to use problem-based learning in the classroom

K12 Students are

- **More knowledgeable** about bioenergy
- Interested in pursuing STEM careers

Education and Research Connections

Education feeds research



Research feeds education

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

IDX
EDUCATION FEEDING RESEARCH

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Supply Chain Analyses

Pacific Northwest (PNW)
Supply Chain Analysis

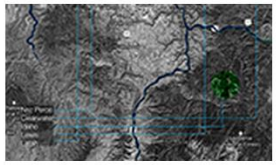
This site provides supply chain data and analysis generated by NARA research for the region identified as the Pacific Northwest, which includes Montana, Idaho, Washington, and Oregon.

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.

NEWS & FEATURES

- Feature Stories
- News Releases
- Newsletter
- NARA Cumulative Reports
- Publications and Patents
- In the News

NARA SURE
EDUCATION FEEDING RESEARCH

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SURE Participants (35 total)

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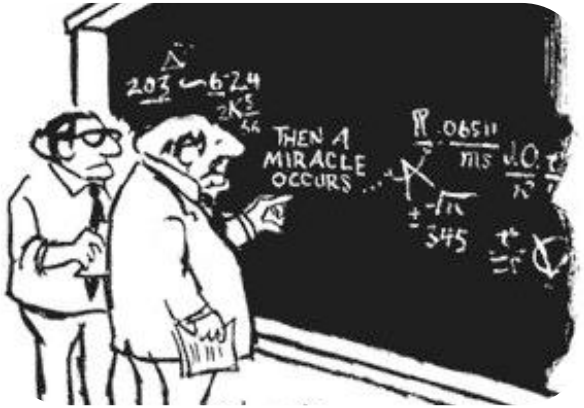
NARA SURE Goals: Support Bioenergy Workforce Development



Develop skills for future biofuels and bioproducts research careers

Excite undergraduate students about research in biofuels and bioproducts

Increase number of students participating in biofuels and bioproducts research, including those from schools without research programs

Possible Benefits of Doing Research (Ranked based on their 2015 Experience)	'Extremely valuable' or 'valuable' benefit
Learned what it's like to be a researcher	80%
Determined that I want to continue studying science or engineering	60%
Travel to an interesting/different/new place	70%
I found a particular field of research offered through this program very interesting	60%
Learned what it's like to do research for grad school	50%
Obtained hands-on experience to go with my class experience	80%
Get experience/publications that I'm proud of and can put on my resume	80%
Financially benefit	90%
I want to improve my analytical abilities.	70%
Something different than I've done before.	90%
This was my only option/job possibility for this time during the summer.	70%

TRIBAL PARTNERSHIP PROGRAM EDUCATION FEEDING RESEARCH

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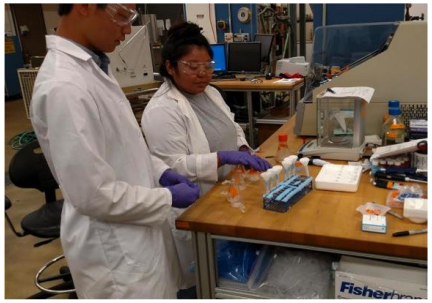

The TPP project has greatly contributed to the number of Native Scholars pursuing and achieving both their undergraduate and Graduate degrees!

Photo courtesy: Karl Oleson – UW NARA TPP

- **Student participation in research:** 15 Undergraduate students and 9 graduate students have participated in the Tribal Partnership Program. Students are members of Yakama Nation, Navajo Nation, Crow, Blackfeet, Pit River Nation, Confederated Salish & Kootenai Tribes.

- **Support Tribal research projects** on biofuels and biorefining, economic development and forest restoration

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Tribes contribute to NARA's 1,000 Gallon

Confederated Salish & Kootenai Tribes (MT)

Muckleshoot Indian Tribe (WA)

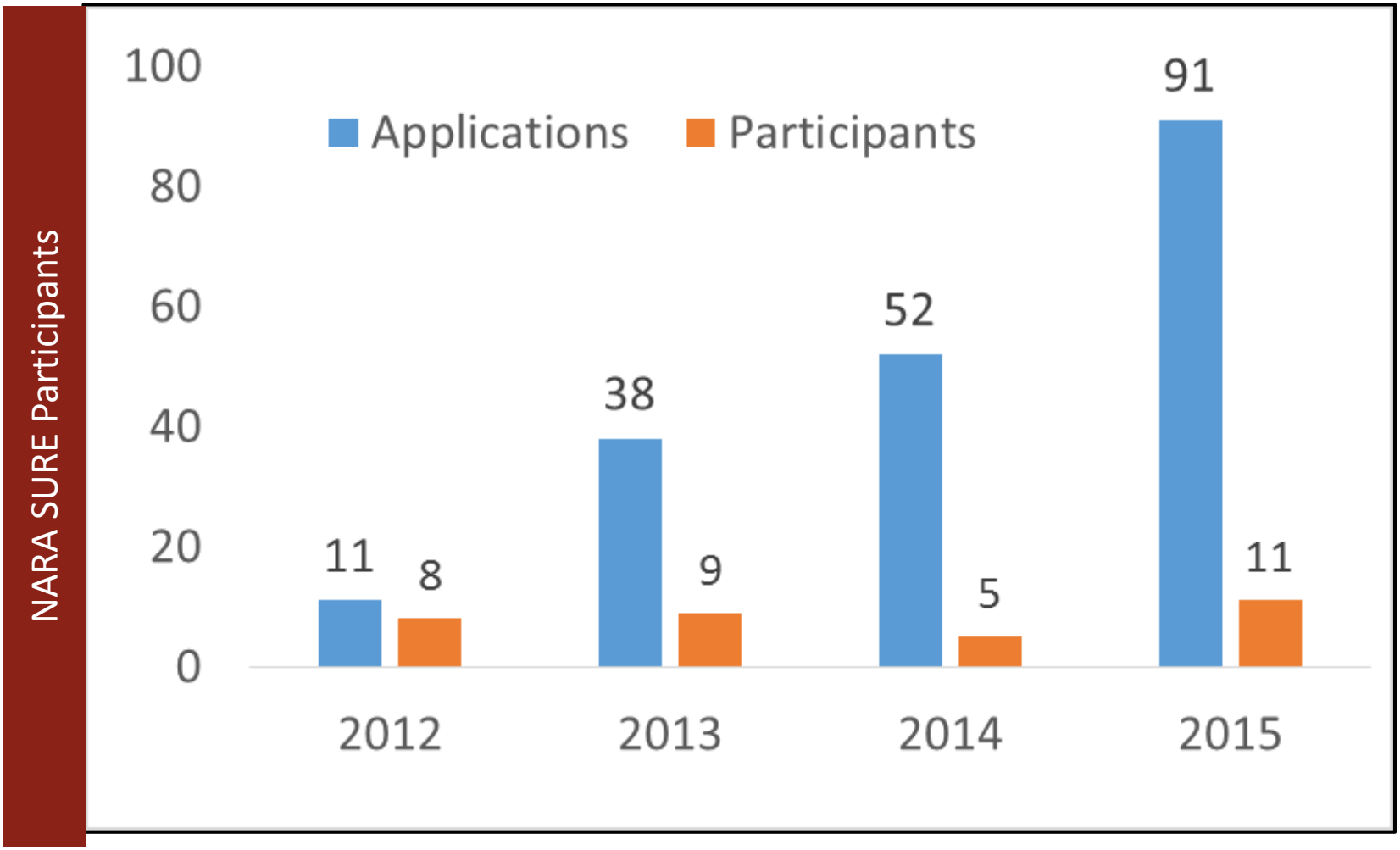
2 truckloads from CSKT and 1 truckload from MIT

Other tribes contacted and could not participate for various reasons.

Photos courtesy: John Sessions – NARA OSU

What's Next?

Next up for Year 5



Interest is growing! Planning a proposal to USDA in 2016.

Next up for Year 5

Plant&Cell&Walls&to&Alcohols&

Overview:& This'lesson'looks'at'the'break'down'of'plant'material'to'demonstrate'the' production'of'biofuels."
Keywords:& Biofuel,'biomass,'lignocellulosic,'pretreatment,'hydrolysis,'distillation,'lignin,' cellulose,'hemicelluloses"
Ages&&Grade&Range:& 9th=12th"
Background:& Biofuel'is'a'source'of'renewable'energy'that'can'be'used'as'an'alternative'to' nonrenewable'fossil'fuels.'There'are'several'types'of'biomass'that'can'be' used'to'manufacture'**biofuel**'(any'fuel'that'is'made'from'biological'organisms' or'their'products);'common'categories'include'biodiesels'and'alcohols."
Alcohols'such'as'ethanol'or'isobutanol'can'be'produced'from'starch=based'or' lignocellulosic'sources."This'lesson'will'address'conversion'of'lignocellulosic' biomass'to'alcohol."
"
Lignocellulosic&biomass'is'a'plant'material'feedstock'that'contains'as'its'two' primary'constituents'lignin'and'cellulose.'The'cells'comprising'plant'tissue' have'cell'walls,'and'upon'plant'death'and'desiccation'the'cell'walls'remain." (Liquid'and'organelles'that'were'housed'inside'the'cell'wall'during'the'cell's' life'fly'up'and'their'contribution'to'biomass'is'negligible.)"Thus'cell'wall' material'makes'up'the'bulk'of'plant'biomass'that'is'used'for'fuel'production.""
&
Plant'cell'walls'are'constructed'of'a'matrix'of'cellulose'and'hemicellulose' (starches)'and'lignin,'a'complex'compound'that'is'difficult'for'organisms'to' break'down'and'digest.'Celluloses'and'hemicelluloses'are'the'raw'material' that's'the'goal'for'subsequent'conversion'to'alcohols."Lignin'essentially' binds'the'cellulose'and'hemicelluloses'together'and'prevents'access'to'these' starches'by'other'organisms."Thus'lignin'helps'to'protect'the'plant'from' predators'and'provides'rigidity'to'the'cell'wall."
&
Just'as'in'the'natural'world,'it's'the'starches'that'are'of'most'interest'in' current'biofuel'production'processes,'as'they're'readily'broken'down'to' release'energy.'The'presence'of'lignin'in'biomass'presents'challenges'in'fuel' production'that'are'analogous'to'those'faced'by'organisms'trying'to'consume' plants'for'their'starchy'components."
&
What'follows's'a'discussion'of'the'steps'of'lignocellulosic'biomass'conversion"

MOSS
McCall Outdoor Science School

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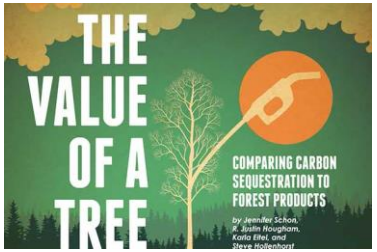
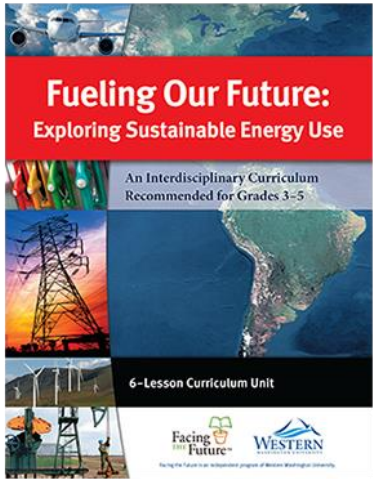
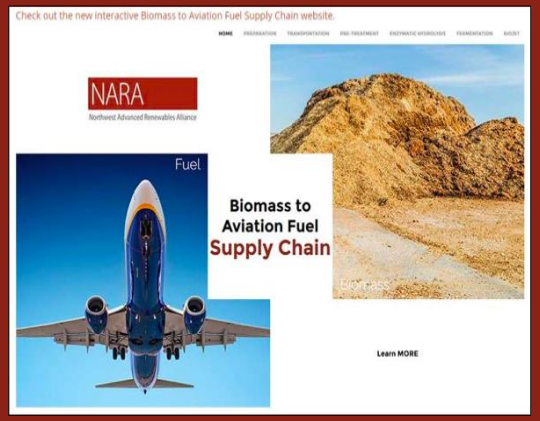
Educational Products





Interactive Venues



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