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Ruby Parker, from Bellingham High School, describes her team's Imagine Tomorrow project to a judge. Photo by Bob Hubner - WSU

Students, Teachers and Judges Explore Energy Solutions at the Imagine Tomorrow Competition

"We took a jet engine from a KC 135 military plane and converted it to run on biodiesel. We will start it up outside if you want to see it operate", said Colton Beierman, a student from Ephrata High School, to visitors at his booth.

He was one of 542 students (a nearly equal number of females and males) who came to Washington State University (WSU) to participate in the Imagine Tomorrow competition held May 30th, 2014.

This competition started at WSU in 2008 and offered Washington high school students an opportunity to present creative energy solutions to business and industry leaders. In 2012, NARA provided resources to expand the opportunity to high school students in Oregon, Idaho and Montana. In addition, a new "biofuels challenge" category was added to the existing challenge categories of behavior, design and technology.

The Imagine Tomorrow competition has since grown from 86 teams in 2008 to 140 teams at the most recent 2014 event. For NARA, sponsoring Imagine Tomorrow fits well with the goal of increasing bioenergy literacy and creating a future workforce for an emerging wood residual to biofuel and co-products industry.

Diverse Projects in the Biofuels Challenge

In 2014, 22 teams competed in the biofuels challenge and the presentations were impressive for their originality, level of inquiry and diversity.

Stem High School in Redmond WA placed first in the biofuels challenge. Their project explored how genetic modifications in yeast could affect ethanol production when supplied varied feedstocks. A first place award earned each student $1,000 and the school $5,000. In addition, this team earned an all expense paid trip to present their project at the Biomass 2014 conference held in Washington D.C which was sponsored by the US Department of Energy.

Second place was awarded to students from Thomas Jefferson High School in Lakeland North, WA. They collected microbes from multiple water sources in the Puget Sound area and tested them for methane production to be used in anaerobic digesters.

Students from Bellevue High School took third place with a project that compared various strands of algae for lipid production. They then developed extraction and processing methods for retrieving the lipids.

Eastlake High School in Sammamish placed a gene into yeast, which allowed the yeast to produce ethanol from wastewater. Their project won fourth place.

Cash awards were also given to second, third and forth place finishers. By the enthusiasm expressed by the students and the 124 judges who invested their Saturday reviewing projects and talking with students, it seemed as though all were glad to be there.

Stem High School, Redmond Washington: First place team in 2014 Imagine Tomorrow biofuels category. From left to right: Oisin Doherty, Pavan Kumar, Mike Town (Coach), Andrew Wang, Ethan Perrin, Isaak Nanneman

Tracking STEM Career Choices and Bioenergy Literacy

NARA is developing assessments to measure the level of impact the Imagine Tomorrow competition has on participating students. One area being assessed is whether students select STEM (Science, Technology, Engineering and Math) fields for college study. This is the second year that students received surveys that inquire about their future career decisions. The initial results from the 2013 competition survey suggest that the competition has a very positive effect on the students' interest in STEM careers. Beginning this year, the survey will provide data regarding student education choices made after high school.

To measure the level of bioenergy literacy gained from this event, a scoring rubric was developed that measures the literacy reflected in the presentation materials (abstracts and posters). This novel approach to measure energy literacy was recently published in the ASCE Journal of Professional Issues in Engineering Education and Practice assesses the Imagine Tomorrow abstracts from 2009 to 2013 and posters in 2013.

View the Artifact-Based Energy Literacy Assessment Utilizing Rubric Scoring here

Together these assessments should provide an impact measurement attributed to this competition. When Mike Town, the coach from Stem High School which produced the winning biofuels category team, was asked about the impact this event had on his students and school, he replied,

"The impact is pretty impressive. Each of the groups who attended learned to work in a team, compile research, delineated responsibilities, and make presentations. The teams that placed well received prize money and the opportunity to document the experience on their college application. Several of our students are now interested in biofuel research as a potential career.

However, perhaps the greatest value is how the Imagine Tomorrow experience impacts our school culture. We ran our own contest to select the 8 teams out of 14 teams (70 students total) that wanted to compete at the contest. Imagine Tomorrow provides an environment in which our students want to compete, and they strive to do the best job possible because our teams do well."

NARA Provides Resources and Coaching

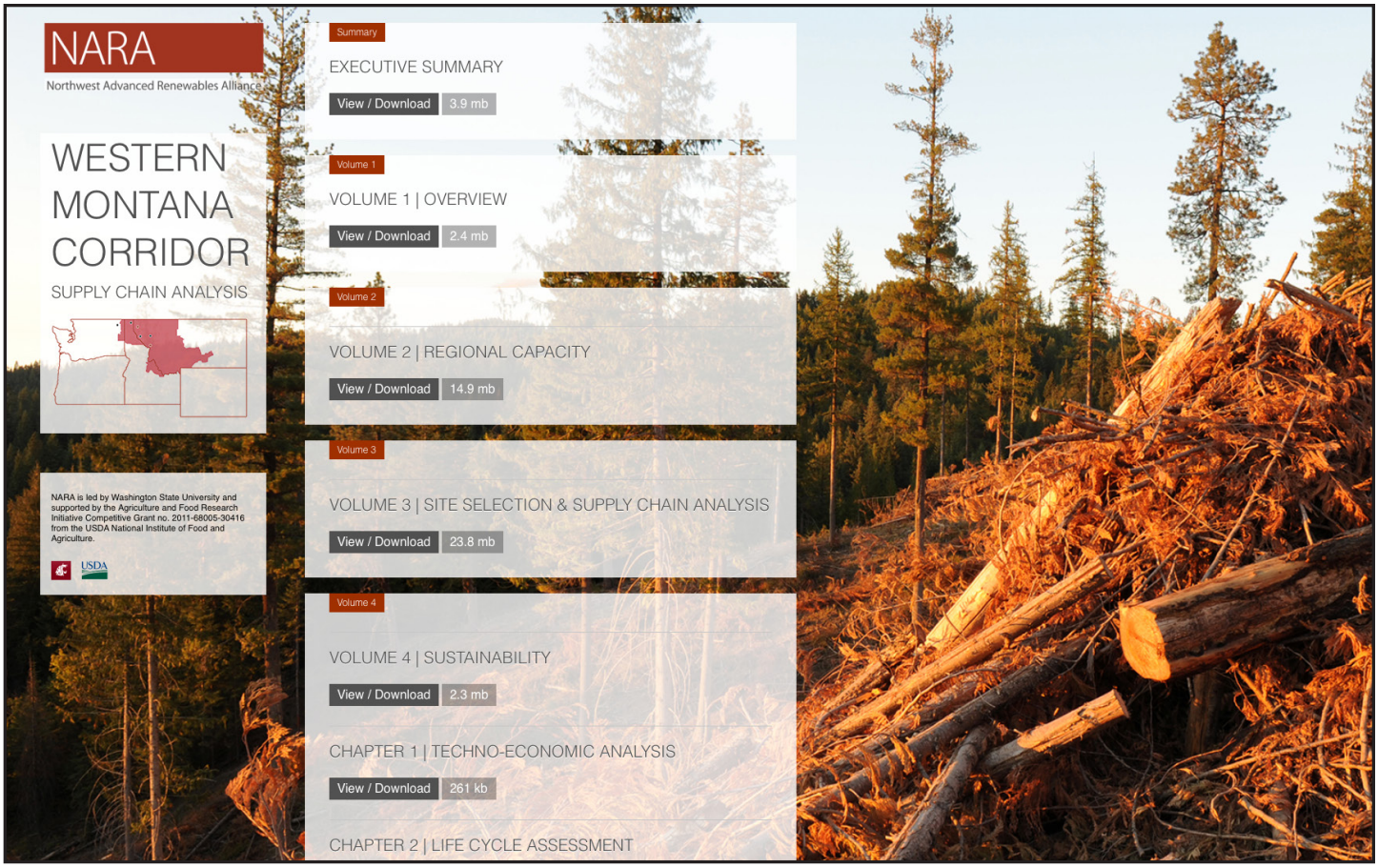
In an effort to increase the level of team participation, especially in the recently included states ID, OR and MT, and to enhance the presentation quality and experience, the University of Idaho's McCall Outdoor Science School (MOSS), a NARA affiliate, provides educational programs and financial support to Imagine Tomorrow high school teams. This year, MOSS delivered a summer workshop and a biofuel webinar series, featuring NARA researchers, to high school teachers/ Imagine Tomorrow coaches. In addition, graduate students affiliated with MOSS, provided guidance to teams throughout their project development.

View the MOSS webinars offered to teachers

At the Imagine Tomorrow competition, eleven teachers, all of whom had teams entered, met with MOSS staff members to evaluate MOSS' contribution. Providing funds for equipment, assistance with lodging and paperwork, and a forum for students to rehearse their presentations were examples given on how MOSS made a positive difference in addition to the training. Teachers suggested that MOSS adjust the webinar times, include previous Imagine Tomorrow projects on the MOSS website, and provide a list of researchers who would be willing to talk directly with teachers and students. Apparently, those students who contacted scientists directly completed stronger projects.

In review, the Imagine Tomorrow competition was a great success. Of course, the students were excited about winning cash prizes, however, when students were asked what was the best part of their Imagine Tomorrow experience, they frequently brought up the interaction with judges. One teacher pointed out that her students were highly impacted when a judge provided them her business card. The ability for students to share their project with the "real world" seems to be a real motivator.

View a video about Imagine Tomorrow



Screenshot of the Western Montana Corridor Supply Chain webpage

Western Montana Corridor Work Available Online

NARA is tasked to provide a supply chain analysis for converting forest residuals to biojet fuel and lignin-based co-products within the northwestern United States defined within the Oregon, Washington, Idaho and Montana state borders. University students and their mentors, through the Integrated Design Experience (IDX) course, provide much of the work used to compile the analysis. Each year, this course focuses its efforts annually on a sub-region within the four-state region.

View the Western Montana Corridor Supply Chain website

Through 2012 to 2013, a sub-region titled the Western Montana Corridor was the focus of their work. This region covers areas in western Montana, northern Idaho and eastern Washington. The results of their work as well as other NARA researchers is now available online.

To read more about the work done by IDX and the NARA Outreach team, read here and here.

The site offers select volumes and chapters that cover the various analyses. The volumes and chapters listed are:

Volume 1: Overview

Volume 2: Regional Capacity

Volume 3: Site Selection and Supply Chain Analysis

Volume 4: Sustainability

- Chapter 1: Techno-Economic Analysis
- Chapter 2: Life Cycle Assessment
- Chapter 3: Community Impact
- Chapter 4: Education and Outreach

Volume 5: Supplemental Information

- Chapter 1: White Paper: RFS, RINS, and Implications
- Chapter 2: Municipal Solid Waste Analysis
- Chapter 3: Strategic Feedstock Production Analysis
- Chapter 4: Biomass Supply Estimates for the Confederated Salish and Kootenai Tribes

The website also provides an Executive Summary and links to the peer reviewed papers published through this effort.

The sub-region focus for 2013-2014 is titled the MC2P region. This region includes western Oregon and Washington. The deliverables from this analysis should be posted on a separate webpage by Fall 2014.

Read about work in the MC2P region

Energy Literacy						
Absent 1	Pre-Emerging 1.5	Emerging 2	Developing 3	Competent 4	Effective 5	Mastering 6
Students: - Do not identify issue - Do not summarize the issue - Do not consider stakeholders - Focus on their own perspective - Do not consider impact or context -Do not consider current information available on the issue			Students: - Begin to frame the issue, but gloss over key details - Discuss approaches to resolve issue - Discuss the impact in one or two contexts - May consider perspectives of some stakeholders -Mention available information		Students: -Frame professional challenge -Develop appropriate approaches to resolve the issue -Deeply examine impact -Seek and evaluate outside sources -Examine current information as it relates to their research -Understands various stakeholder views	

Biofuel Literacy						
Absent 1	Pre-Emerging 1.5	Emerging 2	Developing 3	Competent 4	Effective 5	Mastering 6
Students: -Do not address biofuels -Do not explain why alternative fuels are needed -Do not mention potential impacts of biofuels -Do not consider challenges associated with biofuels			Students: -Address a specific biofuel -Briefly state why they are needed -Discuss one or two possible impacts -Mention possible technology or market challenges		Students: -Address feedstock, processing, etc. of a particular biofuel -Explain with specific facts why they are needed -Explain specific future impacts associated with particular fuels -Explain potential challenges in terms of technology and market -Understands varying stakeholder views	

Rubric for evaluation of Imagine Tomorrow deliverables

Measuring Energy Literacy

NARA invests nearly a third of its total budget to improve the bioenergy literacy of students and professionals with the assumption that an improved level of bioenergy literacy will translate into a knowledgeable workforce and a more engaged and enlightened citizenry who can help shape and contribute to a bio-energy/bio-products economy.

A particular challenge facing NARA, and other institutions, is how to measure progress and success in programs designed to improve energy literacy. In a paper partially funded by NARA and published in the Journal of Professional Issues in Engineering Education, NARA researchers Quinn Langfitt, Liv Haselbach and Justin Hougham present a case study that describes a novel method used to gauge bioenergy literacy of high school student s participating at the Imagine Tomorrow competition.

Obtain the Artifact-Based Energy Literacy Assessment Utilizing Rubric Scoring here

Defining Energy Literacy

The US Department of Energy defines energy literacy as, "an understanding of the nature and role of energy in the universe and in our lives. Energy literacy is also the ability to apply this understanding to answer questions and solve problems." The authors of this paper describe bioenergy literacy as " … an extension of energy literacy that acknowledges biologically based feedstock for energy production and recognizes the role that biofuels stand to play in future markets".

Developing a tool to measure energy literacy from the Imagine Tomorrow competition

The Imagine Tomorrow competition challenges high school teams throughout the Northwest United States to seek new ways to support the transition to alternative energy sources. The event is partially funded by NARA and is held annually at Washington State University. The authors in this study designed a way to score the artifacts (abstracts and posters) generated by the high school teams that participate in the event. In doing so, they can measure the level of energy literacy change reflected in the artifacts presented during five consecutive years of the Imagine Tomorrow event (2008 through 2013).

Developing a scoring tool, or rubric, to measure energy literacy reflected in deliverables turns out to be a novel approach. When the authors searched for existing rubrics that measured energy literacy or biofuels, they found none available; however, many rubrics were available for topics such as energy, alternative energy and science literacy. So with little precedent available, they built a rubric adapted from an existing scoring tool used to assess senior design projects for civil engineering at Washington State University and from elements previously designed to evaluate science writing. The rubric measures elements in the abstracts or posters as either absent, pre-emerging, emerging, developing, competent, effective or mastering. Two versions were developed, one to measure energy literacy and the other to measure bioenergy literacy.

Evaluation Results

To measure energy literacy reflected in the abstracts, over 500 abstracts submitted for five consecutive Imagine Tomorrow competitions (2008-2013) were assessed using the developed rubric for energy literacy. In order to test the reliability of the rubric, two raters were used. One rater was a graduate student in civil and environmental engineering the other a faculty member with a PhD in education. A reliable rubric would produce similar scores from multiple raters.

The results show that energy literacy scores from abstracts improved in the last two years of competition compared to the first three years. The score increase in 2013 relative to 2012 may reflect the coaching and workshops delivered to high school teams by the University of Idaho's McCall Outdoor Science School (MOSS).

When abstracts were grouped into the individual competition categories (behavior, design, multidisciplinary, technology and biofuels), the biofuels category received the highest score. According to the authors, this result was not unexpected; abstracts for social sciences tend to provide more breath than depth; subjects such as biofuels and technology generally have a stronger focus on scientific energy

concepts. Interestingly, there was no difference in scoring between schools that had multiple teams or repeat teams present verses first time participating schools. The authors speculate that experienced presenters may have focused more on appealing to judging criteria, which is not entirely focused on energy literacy.

The scores presented by the two raters exhibited a low level of consensus, even though both sets of scores correlated on showing similar trends over the years. The authors point out that a calibration session, in which the two raters discuss the rubric beforehand and draw a consensus for scoring, was not conducted for this study due to time limitations. Calibration sessions have been shown to increase rubric scoring reliability.

Posters from the 2013 Imagine Tomorrow event were scored. Energy literacy scores for posters were higher than abstract scores. This was not surprising as the abstracts were similar to project proposals and did not contain the more descriptive content present in the posters. The results showed that a high abstract score generally correlated with a high poster score for the same team. A team with a higher average grade level scored higher than younger teams.

Further Refinement

Additional rubric refinements, the use of calibration sessions, and a larger sample size (as in the case of scoring the biofuel category) are needed to ensure that this approach to measure energy literacy is successful; however, this introductory look seems promising. When validated, this artifacts scoring tool could be used to test the effectiveness of teaching methods, curriculums and project types for increasing energy and bioenergy literacy.

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