NARA Goal Five

3RD Cumulative Report

April 2014 - March 2015

Bioenergy Literacy

Improve bioenergy literacy to develop a future energy workforce,
provide professional development, and enhance citizen understanding.

SUMMARY

The NARA project is designed to enable a new and technically complex industry in the Pacific Northwest. Elevating general knowledge around energy literacy serves an important role to ensure biofuels industry sustainability by: 1) educating and providing training to a future energy workforce; 2) providing timely information and resources to stakeholders and professionals in industries connected to the biofuels supply chain; and 3) enhancing citizen understanding to improve public support and participation in political decision making.

To secure an effective and sustainable workforce and generate future leaders who can move the biofuels industry forward, training and educational opportunities related to Science, Technology, Engineering and Mathematics (STEM) topics, and specific to the biofuels supply chain, need to be created and promoted. For this purpose, NARA provides opportunities tailored to engage students along the education pathway from K-12 students and educators; to undergraduate and graduate students; and finally to practicing professionals.

Danica Hendrickson, curriculum director at Facing the Future, introduces curriculum units to high school teachers. Photo courtesy of MOSS.

K-12 STUDENTS AND EDUCATORS

Programs targeted to K-12 students and teachers provide curriculum development and educational programs. The McCall Outdoor Science School (MOSS) provides over 2500 K-12 students courses to develop energy literacy. For this reporting period, members of the NARA Education and Outreach team developed and administered a middle school energy literacy assessment tool based on energy literacy tests given to students before and after their experience at MOSS. Initial results show that students who attend the MOSS training show a significant increase in energy literacy (Task E-2). To provide a portal to teachers for energy literacy resources, 160 assets were added to the NARA matrix (energyliteracyprinciples.org; Task O-9).

This reporting year, a webinar series and workshop were provided to middle and high school teachers who planned to mentor students for the Imagine Tomorrow Competition (Task E-2). Fifteen teachers are participating in the 2015 webinars, which include presentations from NARA researchers, and 17 teachers participated on site, plus 20 teachers participated in an online version, of a four-day workshop. Surveys report that both teachers and NARA presenters benefitted from the webinars and workshop.

The bioenergy lesson plan Fueling our Future was published during NARA Year-3. As of April 7, 2015, 319 copies of Fueling our Future (FOF) (176 middle school and 143 high school) have been distributed, and 225 free individual lessons (77 middle school and 148 high school) have been downloaded from FTF's website, reaching over 16,000 students. A considerable outreach effort to promote FOF continues with email marketing, workshops and professional conference attendance (Task E-2).

Again this year, NARA was a major sponsor for the Imagine Tomorrow (IT) program. This event engages high school students to develop creative solutions to society's energy challenges. The 2014 event showed an increase in total student teams (140 student teams in 2014 to 133 in 2013), with a total of 542 students participating. The assessments initiated in NARA Year-3 were further refined to reflect student interest in the Imagine Tomorrow competition and in STEM related careers. A very significant observation from the assessment is that males and females score equally (Task E-4).

UNDERGRADUATE AND GRADUATE STUDENTS

Programs targeted to undergraduate and graduate students provide research opportunities that contribute directly to NARA project outcomes. The Summer Undergraduate Research Experience in Biofuels (BF-SURE) is a summer (10 week) research experiences for undergraduate students that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bio-products research. In 2014, 52 students applied and five were selected. The number of applications increased by 36% over the second year (summer of 2013), indicating better recruitment efforts. The applicants for the third year were also very diverse. Demographics of 2014 applicants were 48% women, 52% men; and 6% Hispanic, 6% Native American, 31% Asian, 12% African American, 37% Caucasian. To date, over 90 applicants are available for 2015 SURE placements (Task E-5).

In NARA Year-4, additional undergraduate and graduate student training opportunities were provided through the IDX course (Task E-3), MOSS (Task E-2) and the Tribal Partnership Program (Task E-1).

PUBLIC BIOENERGY LITERACY

To promote bioenergy literacy opportunities to the public, portals and materials were provided to explain and disperse the project's outputs. During this annual reporting period, the NARA website reached 11,893 individual users throughout the world, of which, 57.6% were new users. Additional NARA webpages were maintained at Oregon State University, Montana State University, and PNW Research Station . NARA maintained an active blog, Facebook, Twitter, and You-Tube presence plus directed newsletter stories to 976 email subscribers. NARA's repository of unbiased scientific knowledge on wood-based biased biofuels and co-products (Knowledge Base) was converted to a stakeholder resource; over 950 users throughout the world have accessed the site since it was established in 2014 (Task O-1).

SIGNIFICANT INTERNAL OUTPUTS REPORTED THIS PERIOD FOR NARA TEAMS INVOLVED WITH PROMOTION ENERGY LITERACY

- Thirty-seven newsletter stories were distributed to 976 email subscribers with an average viewing percentage at 27.3 % (Task O-1).
- Seventeen videos describing NARA research were posted on the NARA YouTube channel (Task O-1).
- 77 NARA blog and 104 Facebook posts were placed (Task O-1).
- An infographic was developed to articulate the broad impacts provided by NARA Education and Outreach activities, and three fact sheets were developed to highlight the NARA's Tribal Partnership Program, NARA education programs and the supply chain flow and products derived from the production of biojet fuel from forest residuals (Task O-1).
- Four research briefs were generated and posted covering Oregon State University NARA research (Task O-4).
- A survey of logging contractors was conducted to assess attitudes and beliefs towards utilizing woody biomass as a biofuel (Task O-5).
- A Congressional Briefing Paper was prepared for the PNW Research Station Director to take to Washington, DC (April 2015) for meetings with Congressional members and staff and other stakeholders (Task O-6).
- Quarterly briefing papers aimed at informing 1,500+ policy-makers in Washington, Oregon, Idaho, Montana and Northern California about the project's progress were sent (Task O-7).
- A historical document concerning the PNW timber industry was created and posted (Task E-3).
- A peer-reviewed manuscript (Langfitt et al) was published titled "Artifact Based Energy Literacy Assessment Utilizing Rubric Scoring" doi:10.1061/(ASCE)EI.1943-5541.0000210 (Task E-4).
- A peer-reviewed manuscript (Langfitt et al) was published titled "Refinement of an Energy Literacy Rubric for Artifact Assessment and Application to the Imagine Tomorrow High School Energy Competition" ISSN: 2151-7452 (Task E-4).
- A peer-reviewed manuscript (Eitel et al) was published titled "Teacher Professional Development for Energy Literacy: A Comparison of Two Approaches" ISSN: 2151-7452 (Task O-8).
- A peer-reviewed manuscript (Hougham et al) was published titled "From the forest to the classroom: Energy literacy as a co-product of biofuels research" ISSN: 2151-7452 (Task E-2).
- A peer-reviewed manuscript (Hendrickson et al) was published titled "Global Sustainability: An Authentic Context for Energy Education." ISSN: 2151-7452 (Task E-2).
- A peer-reviewed manuscript (DeWaters et al) was published titled "Beyond Conservation: Reimagining the Purpose of Energy Education." Link (Task O-8).
- 2014 Imagine Tomorrow Competition: http://imagine.wsu.edu/past/2014/default.html
- Five webinars featuring NARA research were posted on MOSS website. Link

SIGNIFICANT OUTCOMES

- Due to the success of the Imagine Tomorrow (IT) with Biofuels, there is interest in using the format for other regional competitions in the U.S.. Currently, funding for launching IT nationally, with associated assessment and management, is being considered for the second regional site in Missouri (Task E-4).

TRAINING

Name	Affiliation	Role	Contribution
Aaron Boyles	UI	Graduate Student	Co-coordinator of webinar series
Ashlee Fliney	UI	Graduate Student	Co-coordinator of webinar series
Jim Casey	UI	Graduate Student	Energy literacy curriculum development
Will Stubblefield	UI	Graduate Student	Energy literacy assessment
Justin St. Onge	UI	Graduate Student	Energy literacy assessment
Jessica Beaver	WSU	Graduate Student	STEM Assessment Research Assistant
Quinn Langfitt	WSU	Graduate Student (PhD)	Energy Literacy Assessment Research Assistant
Brandon Werner	WSU	Undergraduate student	Energy Literacy Assessment Research Assistant
Cassandra Sanders	WSU-TC	SURE Student Undergraduate	Mechanistic kinetics study of biomass derived inhibitory compounds on cellulase hydrolysis of biomass substrate
Rodney Seals	Univ. Arkansas	SURE Student Undergraduate	Lignin residue as Wood Pellet Binder and Energy Enhancer for Energy Applications
Eric Sorensen	Humboldt State	SURE Student Undergraduate	Spatial Distribution of Grain Sizes in Sampling Heterogeneous Stream Beds
Preenaa Venugopal	Penn State	SURE Student Undergraduate	Potential Technological Pathways for the Production of Alternative Jet Fuel
Eileen Wu	U.C. Berkeley	SURE Student Undergraduate	Ball Milling: Effective Pretreatment Leading to A Clean Biomass to Cellulosic Sugar Conversion
Ike Nwaneshiudu	Univ of Washington	Post-Doc	LCA, Biomass technologies
Karl Oleson	Univ of Washington	Graduate Student (PhD)	Extractives and role in emissions from a sulfite sugar plant
Blake Hough	Univ of Washington	Graduate Student (PhD)	Forestry residues at CSKT, and pyrolysis modeling for value-added products
Burdette Birdinground (Crow)	Univ of Washington	Graduate Student (MS)	Federal forest residue volumes adjacent to CSKT
Katie Moore-Drougas (Crow)	Univ of Washington	MPA Student	Analysis of TFPA vs EISA: conflicts between federal policy to support tribal economies and ecosystems
Emile Delucca	Univ. of Montana	Summer Intern	Summer program 2014
Calvin Silas (Navajo)	New Mexico State Univ	Summer Intern	Withdrew from program, returned home due to death in immediate family.
Cody Sifford (Navajo)	Univ of Washington	Summer Intern	Grad student affiliated with NARA TPP
Clarence Smith (Blackfeet)	Univ of Washington	Summer Intern	Summer intern 2014
Shawn Defrance (CSKT)	Salish Kootenai College	Summer Intern	Summer intern, placed with John Bailey (NARA OSU) 2014
Breanna Gervais (Penobscot)	Portland State Univ	Summer Intern	Summer intern 2014, recent PSU Graduate 2015.

RESOURCE LEVERAGING

Resource Type	Resource Citation	Amount	Relationship or Importance to NARA
Perc H. Shelton and Gladys A. Pospisil Fund of the Idaho Community Foundation	Fizzell, G. 2014. Valley County Outreach Programs	$3,000.00	Support to deliver energy literacy curriculum to local McCall-Donnelly schools
Steven Leuthold Family Foundation	Fizzell, G. 2014. K-12 Residential Outdoor Science Program General Support	$10,000.00	General operating support to deliver energy literacy curriculum to MOSS audience.
Whittenberger Foundation	Fizzell, G. 2014. iSTEM Initiative	$4,000.00	Support to deliver energy literacy curriculum to Title I schools in Southwest Idaho.
EPSCoR National Science Foundation	Vierling, L., K Eitel, G. Fizzell and B. Miller. 2014. Support for MOSS K-12 Adventure Learning Programs	$70,000.00	
Donations			NARA partially supports the cost of the Imagine Tomorrow program, leveraging over $150,000 in other private donations and grants to run and assess the program.
WSU internal sources		$3,000	The program for presenting undergraduate work was sited with the existing summer undergraduate research poster session at WSU-Pullman on Aug. 1. The staffing and support for this event (on the order of $3000) is covered from WSU internal sources, and not charged to NARA.
State	Salary support, Schwartz	About $20,000 per year	Schwartz spends time on NARA, without taking salary the past two years.
State	TA Support, Hough	One quarter, about $11,000	Part of educational requirement to advance degree. Continued working on research.
State	TA Support, Oleson	One quarter, about $11,000	Part of educational requirement to advance degree. Continued working on research.

BIOENERGY LITERACY

EDUCATION TEAM

TASK E-1: BIOENERGY AND BIOPRODUCTS GRADUATE EDUCATION AND RESEARCH IN PARTNERSHIP WITH NORTHWEST TRIBES

Key Personnel
Daniel T. Schwartz

Affiliation
University of Washington

Task Description

The goal of this task is to educate next-generation scholars with unique skills for devising integrated resource management and technical designs that deliver bioenergy and bioproduct systems tailored to the resources, ecologic, and economic development needs of a community. To accomplish this, we work with tribes, tribal organizations, and each partner campus to offer up to 3 grad student tribal research projects. Specifically, student teams will work collaboratively with Northwest Native American tribes to provide integrative research on technical issues tied to feedstocks, their sustainable production and logistics, and conversion to value-added products. System metrics assess the overall performance of the integrated student design. Students benefit from outstanding training in interdisciplinary communications and research. Tribes benefit by collaborating to define, research, and assess a technical problem that is deemed a tribal priority for ecologic or economic development purposes. Each student team makes several trips to the partner tribe's reservation. We seek to complement the IDX team corridor-scale activities by incorporating detailed landscape scale information provided by major forested landholding tribes. To have maximum impact and credibility in Indian Country, this task has significant liaison activities with tribes, tribal organizations, and campus offices that coordinate with tribal student recruiting and retention programs.

Activities and Results

- Continued tribal research projects that support tribal interests in forest restoration, resilient forest management, air and water quality-related issues with biorefining, and new technologies to generate economic development from un-merchantable biomass residues.
- Continued direct outreach and support to Tribal Nations within the NARA region
- Established 2015 Summer Internship program. Recruited students at the American Indian Science & Engineering Society conference and have made 10 tribal student selections to date for the summer of 2015. Students will be participating in research at Western Washington University's Huxley School, Facing the Future, and on the University of Washington's campus and at two field sites.
- Douglas-fir biomass residues were acquired from the Muckleshoot Tribe and the Confederated Salish Kootenai Tribes to participate in the production of the 1,00 gallons of biojet fuel that NARA produces. Product were delivered to Lane Forest Products in Eugene, OR.
- Continue to collaborate with Tribal Nations via the Intertribal Timber Council.

Recommendations | Conclusions

We continue to provide research support to one of the largest Tribes in the Pacific Northwest, as an extension to the Western Montana Corridor (WMC) project. The Confederated Salish & Kootenai Tribes (CSKT) have requested and received a complete inventory of their available biomass residues for their next ten years of harvest management activities. We are investing forestry residue potential from existing tribal stewardship sites in adjacent federal lands, as well as the overall residue potential of a ten mile buffer around the reservation, which is nominally available to the tribe through the Tribal Forest Protection Act. We are also looking at the policy conflict between the Tribal Forest Protection Act and the prohibitions against using RIN credits to support biomass extraction form federal forests. Finally, we are investigating emissions from a sulfite-based sugar processing depot on the reservation, one of the potential options proposed for the western Montana corridor. The CSKT also contributed forest residues (in forest chipping with transfer to Oregon collection site) to NARA's 1,000 gallon goals. We've also been able to pull in one of the newest Tribal forest landowners in Indian Country with the addition of the Muckleshoot Indian Tribe (MIT) to the NARA Tribal Partnership projects. Muckleshoot also contributed forest residues (in-forest collection and transfer to chipping site, then delivered to Oregon collection site) via their current forest managers, Hancock Forest Management. Dr. John Sessions from NARA OSU assisted us in gaining tribal participation by providing a quick assessment and approval of their residues. NARA TPP provided the funding support to get Dr Sessions out to CSKT and MIT and to hire tribal contractors and trucking to deliver the residues. This is a major event for our tribal partners. Finally, Charles Burke and Vikram Yadama assisted this effort by capturing the residue collection on video at both the Montana and Washington sites. Video interviews were completed by: Jim Durglo (CSKT Forestry Department Head), Rod Couture (CSKT Forester), Louie Ungaro (MIT Tribal Councilman) and Lefi Tasauga (Hancock Forest Management representative). Student interviews were completed by Blake Hough (University of Washington) and Cody Sifford (University of Washington).

Table E-1.1. Students enrolled in the 2015 Tribal Partnership Projects (TPP) summer internship program.

Cody Sifford	University of Washington	2015 Summer Intern	Will continue work on air quality in relation to burning of slash piles – intended fall 2015 graduate.
Clarence Smith			Spring 2014 Graduate, will mentor new Tribal Partnership undergraduate in 2015 summer program.
Julia Wilson Peltier Turtle Mountain Chippewa)	Western Washington University	2015 Sumer Intern	Will work with Steve Hollenhorst as a TPP Summer Intern
Ryan Contreras (Yakama)	Bellevue Colelge	2015 Summer Intern	Will work with UW SEFS on biochar related research
Daylen Isaac (Yakama)	Heritage University	2015 Summer Intern	Will work with UW SEFS on biochar related research
Barb Wolfin (Pit River Nation)	Haskell Indian Nations University	2015 Summer Intern	Will work on NARA Tribal projects related research
Autumn Charley (Navajo)	University of Arizona	2015 Summer Intern	Will work on biomas conversion processes at UW SEFS
Nina Nez	University of Arizona	2015 Summer Intern	Will work on biomass conversion processes at UW SEFS
Charmayne Smith	Fort Lewis College	2015 Summer Intern	Will work on curriculum development with Facing the Future
Waynetta Dennison	University of New Mexico	2015 Summer Intern	Will work on current research in UW Engineering

In terms of where we are going, we've recently selected 10 students to participate in the Tribal Partnership Projects summer internship program for 2015. All 10 students are tribally enrolled and listed below in Table E-1.1.

Physical and Intellectual Outputs

- Two chip vans of biomass were collected from the Confederated Salish & Kootenai Tribes and transported to Oregon.
- One chip van of biomass was collected from the Muckleshoot Indian Tribe and transported to the Oregon collection site.
- Attempts were unsuccessful to collect forest residues at Yakama Nation (no chipping operation available), Warm Springs (resources unavailable), Nez Perce (currently not harvesting), and Spokane Tribe (only Ponderosa pine was available).
- Scheduled TPP participation by Blake Hough in Montana Roundtable, May 8, Missoula

REFEREED PUBLICATIONS

Co-authored Draft of Education at the Speed of Research: An Overview of the NARA approach to BioEnergy Literacy, Journal of Sustainability Education (theme issue for Energy Education)

Ikechuwku Nwaneshiudu and Daniel Schwartz, "Rational design of polymer-based absorbents: Application to the fermentation inhibitor furfural" Accepted, Biotech for Biofuels (2015).

Blake Hough, Tom Richards, Laurel James, Jim Durglo, and Daniel Schwartz, "Management of tribal timberlands for ecological and community goals can produce economic value streams comparable to industrial forestry in Western Montana USA" paper in preparation, draft on NARA website.

Karl Olson and Daniel Schwartz, "Process flows for extractive components of Douglas fir biomass residues during mild bisufite pretreatment and concentration", paper in preparation.

RESEARCH PRESENTATIONS

Blake R. Hough, Cody Sifford, Laurel James, Tom Richards, Jim Durglo and Daniel T. Schwartz. Biomass supply estimates for the Confederated Salish and Kootenai Tribes based on harvest planning and management goals. Poster presented at the 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Karl Olson and Daniel Schwartz. Tribal Communities Care about Effluents: Tracking Extractives, Inhibitors & Reaction Products in Bisulfite Processing. Poster presented at the 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Laurel James and Daniel Schwartz. NARA Education - Tribal Partnership Projects. Poster presented at the 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Cody Sifford, Indroneil Ganguly, Ernesto Alvarado and Ivan Eastin. Developing an Impact Assessment of Local Air Quality as a Result of Biomass Burns.

Poster presented at the 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

- 4 Presentations given at the NARA UW—WSU Presentation of Research, held at the UW School of Environmental and Forest Sciences July 29-30, 2014.
  - Emile Delucca
  - Cody Sifford
  - Clarence Smith
  - Burdette Birdinground

- 5 Presentations and posters given at the National Indian Timber Symposium, held at the Coeur d'Alene Resort Casino June 23-26, 2014.

Calvin Silas did not present a poster, as planned. He withdrew from the NARA Intenrship and the ITC conference due to a death in his immediate family. Aside from Calvin, the posters are the same as listed above for the Presentation of Research, except for the addition of Shawn Defrance – attached. Presentations available at website for Breanna Gervais and Burdette Birdinground: http://www.itcnet.org/resources/

OTHER PUBLICATIONS

- Contributed NARA newsletter article entitled NARA and Pacific Northwest Tribes

- Contributed to NARA one-page document sent to PNW policy makers

- NARA Graduate Fellow, Blake Hough had his final report for the Confederated Salish & Kootenai Tribe's biomass assessment published to the NARA website.

TRAININGS, EDUCATION AND OUTREACH MATERIALS

- Field days arranged and accommodations provided for Dr. John Sessions to review and approve biomass at CSKT & MIT. Dates of travel, March 14-16, 2015.

- Field day and media day arranged for Charles Burke, Vik Yadama, Cody Sifford and Laurel James at the Confederated Salish & Kootenai Tribes. Dates of Travel March 18-20, 2015.

- Field day and media day arranged for Charles Burke, Dan Schwartz, Blake Hough and Cody Sifford with the Muckleshoot Indian Tribe and Hancock Forest Management Group. Dates of Travel, March 26, 2015.

TASK E-2: GREENSTEM K-12 INITIATIVES

Key Personnel	Affiliation
Tammi Laninga	University of Idaho
Danica Hendrickson	Facing the Future

Task Description

The NARA Education Initiative, or GreenSTEM, includes an imaginative suite of programs that seamlessly link an array of educational and training programs with our university and commercial partners in order to meet the region's most compelling energy development needs. The overarching goal of GreenSTEM is to increase the capacity of the region for a transition to biofuels. This will be accomplished through four interrelated objectives:

1. Meet the workforce needs of the bio-energy/bio-products economy;
2. Develop the next generation of energy leaders for industry, government, and the civic sector;
3. Improve the biofuels literacy of teachers educating our future citizens; and
4. Strengthen overall science literacy of these same young citizens in areas particular to the biofuels debate.

The program develops energy and biofuel curricula, which are field-tested at University of Idaho's award winning McCall Outdoor Science School (MOSS), annually reaching 2,500 K-12 students and 150 teachers. This curricula will then be delivered via the web and social networking approach pioneered by Facing the Future (FTF), a Seattle-based non-profit renown for web-based sustainability curricula. K-12 teacher training will also be achieved through MOSS teacher institutes and FTF webinars and professional development workshops. Teachers and students will be impacted through this work and outcomes- through assessment and evaluation - will show that:

1. K-12 students are more knowledgeable about biofuels, biofuels research, and energy.
2. K12 students apply knowledge in energy literacy to successfully develop an approach to answering a problem-based energy issue.
3. K-12 teachers are more knowledgeable about biofuels, biofuels research, and energy.
4. K12 teachers apply knowledge in energy literacy to help their students successfully develop an approach to answering a problem-based energy issue.
5. Teachers participating in professional development programs will integrate problem-based learning and energy content in their home classrooms with increased confidence.

Task E-2.1. K-12 Students (MOSS)

The McCall Outdoor Science School delivers biofuel education programs to 2,500 middle and high school students annually both during the school year and during the summer. New biofuel lesson plans are created and field-tested in partnership with FTF. Select students will participate in conjunction with their teacher and MOSS graduate students as they prepare a problem-based project to compete in the Washington State University (WSU) Imagine Tomorrow (IT) Competition.

Task E-2.2. K-12 Teachers (MOSS)

The McCall Outdoor Science School delivers a summer workshop and an annual biofuel webinar series for 15 - 30 middle school to high school teachers. Teachers participating in the webinar series are supported as coaches for the Imagine Tomorrow (IT) competition while developing their own energy literacy through a series of lectures and discussions with NARA research scientists. An additional 40—50 teachers follow the IT competition preparation process via the web. Fifty teachers that accompany their 6th grade students to MOSS residential school programs participate by observing their students as they participate in biofuel focused education lessons. Teachers are also supported through a web-based "Energy Literacy Principle Matrix" (ELPM), designed to house and effectively organize educational materials covering a broad spectrum of subjects related to biofuels. Its design is flexible and adapts well to NARA activities while providing a single site where teachers or community members can effectively find information about biofuels.

Task E-2.3: Energy Curriculum Web Delivery (FTF)

Facing the Future creates interdisciplinary K–12 curriculum resources that equip and motivate students to develop critical thinking skills, build global awareness, and engage in positive solutions for a sustainable future. These resources use global sustainability as a framework to present engaging, real-world issues such as energy to K-12 students. Our resources reach 1.5 million students each year and are used in all 50 states and 135 countries through web-based delivery.

Facing the Future provides K-12 educators with high quality free and low-cost curriculum resources through the web that engage students in learning math, science, language arts and social studies through the context of real-world social, environmental, and economic issues such as energy. Our curriculum resources align with standards in all U.S. states. FTF's professional development services equip school districts, schools and educators with sustainability and global education frameworks and content, instructional strategies, and curriculum resources to help students excel academically. Facing the Future works with 12 peer educators from around the country who provide professional development to other educators based on FTF resources.

Activities and Results

MOSS graduate students teach K-12 energy literacy education to over 2500 students at MOSS with an emphasis on biofuels. Graduate students develop and implement new lessons every semester. All K-12 students take an Energy Literacy pretest upon arriving at MOSS, a posttest before leaving, and a one-month posttest after returning to their schools. Members of the Education and Outreach team developed a middle school energy literacy assessment tool. Spring 2015 activities include collecting data on at least 500 K-12 students to further examine the validity of the assessment instrument. Students showed a positive and statistically significant increase from assessment intervals Time 1 (mean 6.72) to Time 2 (mean 7.5) to Time 3 (mean 8.12).

MOSS delivered teacher professional development, through a monthly webinar series for teachers coaching teams for the Imagine Tomorrow Competition, and a four-day intensive summer workshop. Fifteen teachers are participating in the 2015 webinars that have included presentations from NARA researchers John Petrie, Scott Holub and Indroneil Ganguly. Seventeen teachers participated on site, and 20 teachers participated in an online version of a four-day workshop featuring presentations from NARA researchers Tammi Laninga and Jim Casey (NARA grad student working with Randy Brooks) and pre-recorded lectures and webinars from NARA researchers Michael Wolcott, Indroneil Ganguly, Carter Fox and Ian Dallemeyer. In addition to the videos from the NARA YouTube channel, we used seven different NARA newsletter articles, the NARA Knowledge Base, the Energy Literacy Matrix, two lessons from Facing the Future's Fueling our Future curriculum, four previously tested lessons designed by MOSS staff and grad students, and two new lessons designed for the workshop to support the workshop. Teachers reported gaining content for their classrooms, incorporating new pedagogical models and increasing their personal energy literacy. The NARA researchers reported gaining communication skills, developing more refined ideas, an opportunity to gain support from the public for their work.

Table E-2.1. Distribution of Fueling Our Future in the Pacific Northwest

STATE	Idaho	Montana	Oregon	Washington
Number of Teacher's Guides and Free Lessons	32	2	43	54
Potential Student Reach	960	60	1290	1620

FACING THE FUTURE (FTF) CURRICULUM DEVELOPMENT

As of April 7, 2015, 319 copies of Fueling our Future (FOF) (176 middle school and 143 high school) have been distributed, and 225 free individual lessons (77 middle school and 148 high school) have been downloaded from FTF's website, reaching over 16,000 students (Table E-2.1).

Elementary energy lessons (grades 3 through 5) are currently being copy-edited. The lessons are vertically aligned to the middle and high school versions of FOF and have been piloted and reviewed by teachers.

FTF PROFESSIONAL DEVELOPMENT

- 12 workshops for over 400 teachers have been conducted (see Physical and Intellectual Outputs).

FTF EVALUATION & OUTREACH

- Emails to 30,000 educators and 5,000 new teachers highlighting FOF.
- Planning for impact assessment of FOF on Energy Literacy (3 teachers currently committed)
- Creation of peer educator program focused on energy
- Attendance at national conference on Energy Education and Climate Change
- Conversations with United Nations about partnering to promote Lesson #5 from FOF, which is focused on the UN Sustainable Energy for All initiative.

Recommendations | Conclusions

We will continue to focus on sustainability issues in our teacher professional development and K-12 educational initiatives as we continue to have many questions from students and teachers about the overall sustainability of biomass residuals as a feedstock for jet fuel.

We will continue to incorporate emerging research into our webinars, workshops and curriculum. NARA-produced newsletters have been very helpful in this task.

Our educational efforts in the next year will focus on telling the story of the creation of 1000 gallons of biojet and the overall NARA process.

Physical and Intellectual Outputs

REFEREED PUBLICATIONS

Hougham, R.J., Eitel, K.B., Miller, B.G., (2015). Technology-enriched STEM Investigations of Place: Using Technology to Extend the Senses and Build Connections to and between Places in Science Education. Journal of Geoscience Education. (In press).

Eitel, K. B., Hougham, R. J., Laninga, T., Fizzell, G., Schon, J. & Hendrickson, D. (2015). Teacher Professional Development for Energy Literacy: A comparison of two approaches. Journal of Sustainability Education, 8(1).

Schon, J.A., Eitel, K.B., Hougham, R.J., Hendrickson, D. (2015). Creating a research to classroom pipeline: closing the gap between science research and educators. Journal of Sustainability Education, 8(1).

Hougham, R. J., Hollenhorst, S., Schon, J., Eitel, K., Hendrickson, D., Gotch, C., Laninga, T., James, L., Hough, B., Schwartz, D., Preslley, S., Olsen, K., Hasselbach, L., Langitt, Q., Moslemi, J. (2015). Education at the Speed of Research: an overview of the NARA approach to BioEnergy Literacy. Journal of Sustainability Education,8(1).

Hendrickson, D., Corrigan, K., Keefe, A., Shaw, D., Jacob, S., Skelton, L., Schon, J., Eitel, K.B., Hougham, R.J. (2015). Global Sustainability: An Authentic Context for Energy Education. Journal of Sustainability Education, 8(1).

RESEARCH PRESENTATIONS

Eitel, K., Schon, J., Vierling, L. and Fizzell, G. Developing STEM Identity through Place-based Field Science Inquiry. Idaho Conference on STEM Education Challenges and Innovative Solutions: Overcoming STEM Education Barriers in Rural States, Boise, ID, 28 May 2014

Hendrickson, D., D. Shaw, S. Jacob, A. Keefe and L. Skelton. Fueling our Future: Exploring Sustainable Energy Use – Middle and High School Interdisciplinary Energy Curricula. Poster presented at 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Schon, J., R.J. Hougham, K. Eitel, D. Hendrickson, T. Laninga, C. Gotch, S. Pressley, L. Haselbach and S. Hollenhorst. The Energy Literacy Feedstock. Poster presented at 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Eitel, K., T. Laninga, J. Schon, R.J. Hougham, D. Hendrickson and S. Hollenhorst. Teacher Professional Development: An Energy Literacy Supply Chain. Poster presented at 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

VIDEOS AND WEBINARS

MOSS (http://teachingadventurelearningatmoss.wordpress.com/media-archive/)

Webinar 1: Introduction to the NARA Project and the MOSS Imagines Tomorrow Webinar Series, Dr. Karla Eitel. December 10, 2014

Webinar 2: Coaching an Imagine Tomorrow Team, Dr. Andrew Morozov, January 28, 2015.

Webinar 3: How do residual biomass removals affect long-term forest productivity?:

Long-term Soil Productivity (LTSP) studies. Dr. Scott Holub, February 18, 2015.

Webinar 4: Rivers Channel Changes: Impacts of Forest Management, Dr. John Petrie, March 11, 2015.

Webinar 5: Environmental assessment of Woody biomass based bio-jet fuel, Dr. Indroneil Ganguly April 8, 2015.

TRAININGS, EDUCATION AND OUTREACH MATERIALS

K. Eitel, J. Schon, D. Hendrickson and R.J. Hougham, Adventures in Bioenergy. Workshop held at UI CNR McCall Outdoor Science School, June 16 – 20, 2014. McCall, Idaho.

D. Hendrickson, J. Hougham. Energy Education in the Classroom in Wisconsin Dells, Wisconsin, 8 teachers, Upham Woods Outdoor Learning Center) and the Wisconsin K-12 Energy Education Program (KEEP) from the University of Wisconsin-Stevens Point)

D. Hendrickson, Fueling Our Future at the WA Corrections Center for Women, 43 women in partnership with the Evergreen State College and Washington State Department of Corrections' Sustainability in Prisons Project

D. Hendrickons, Interdisciplinary & Interconnected: Social Studies Takes On Energy, 7 teachers, Washington State Council for the Social Studies in Chelan, WA

TASK E-4: IMAGINE TOMORROW WITH BIOFUELS

Key Personnel
Liv Haselbach

Affiliation
Washington State University

Task Description

The NARA Imagine Tomorrow (IT) program is designed to engage high school students in developing creative solutions to society's energy challenges. This project builds on the Imagine Tomorrow high school science competition at Washington State University. Now in its sixth year, the goal of Imagine Tomorrow is to unite educators, scholars, and industry leaders to teach students of all backgrounds and high school grade levels how to translate ideas into results. This energy-based competition program has been expanded to include a biofuel track, with the following objectives:

1. Engage future energy innovators. Students find ways to shift the public mindset, reshape governance and policy, reengineer technologies, and redesign communities toward a new energy future.
2. Foster collaboration. The competition shows students how collaborative actions make a difference in meeting the challenge of energy production and use in the 21st century.
3. Support educators. High school teachers inspire students to think bigger, gather information from diverse resources, and jointly develop new ideas.
4. Strengthen our community. Imagine Tomorrow creates connections among students, research faculty, and industry leaders. Students build confidence in their ability to make a positive difference in their communities.
5. Raise energy literacy. Imagine Tomorrow builds awareness of energy issues among students, educators, and the general population.

Activities and Results

During this period, the 2014 competition was held in May 2014. Forty-five schools attended sending 140 teams, with a total of 542 students participating. 138 judges participated. Post competition, additional assessment activities evaluated STEM perceptions and energy literacy, resulting in reports to the steering and executive committees. The perceptions are summarized in Figures E-4.1 and E-4.2.

The energy literacy work resulted in another journal paper and acceptance of a conference paper for June 2015, both papers on the modified energy literacy rubric as seen in Figure E-4.3. A very significant outcome of the assessment is seen in the analyses with respect to gender. These analyses showed similar scores between males and females. Not only has the format of the Imagine Tomorrow competition attracted both genders similarly, but it also affects similar learning, even if there are differences in the challenges entered by gender.

An additional output was the invitation for the winning team from the Biofuels challenge to attend the Biomass 2014 in July 2014 in Washington DC, as funded by the BETO office of the Department of Energy. Preparation for the 2015 competition has begun, with marketing and other material developed and distributed, and registration for the 2015 teams completed. The competition judging and award structure was slightly modified to encourage and award more diverse participation, including an additional specialty award for teamwork.

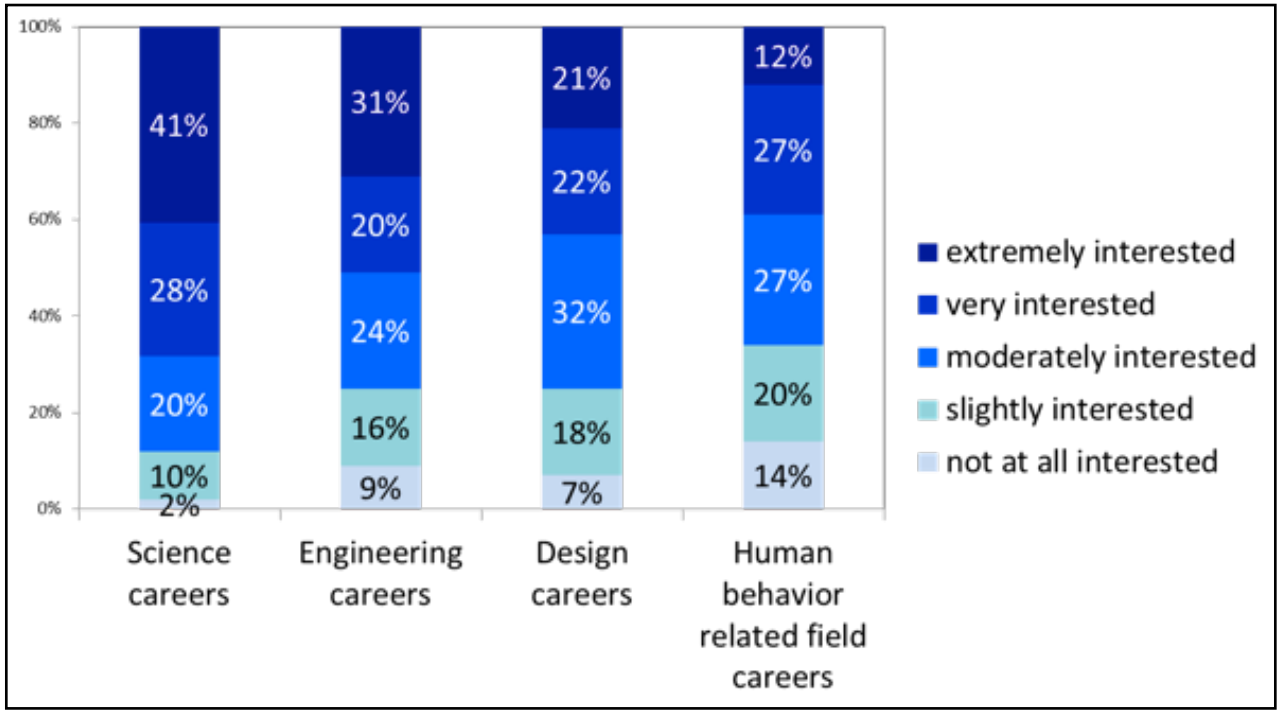


Figure E-4.1. Results of Imagine Tomorrow Student Survey in June 2014 on Careers (Beaver, J., Gotch, C. and French, B., Impact and Experiences of Imagine Tomorrow 2014, Submitted to the Executive Strategy Committee and the Internal WSU Imagine Tomorrow Steering Committee)

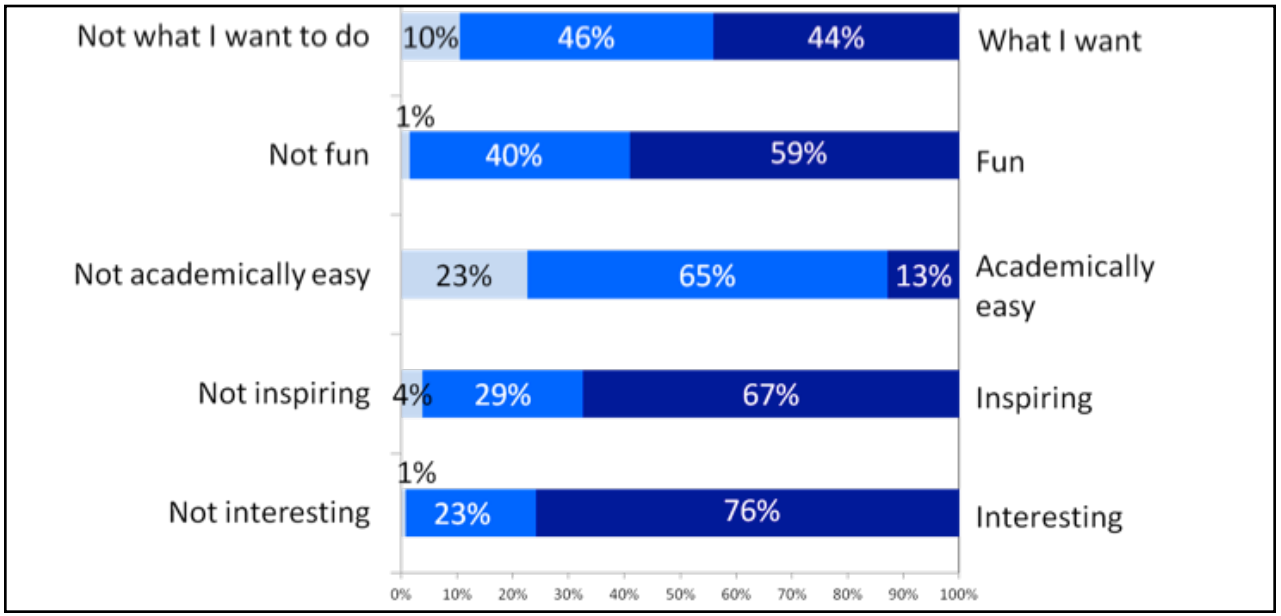


Figure E-4.2. Results of Imagine Tomorrow Student Survey in June 2014 on Competition Topic (Beaver, J., Gotch, C. and French, B., Impact and Experiences of Imagine Tomorrow 2014, Submitted to the Executive Strategy Committee and the Internal WSU Steering Committee).

	Points			
Topic	0	1	3	5
Issue	Not addressed	Identify the issue	Frame the issue	Professionally frame the issue
Solution	Not addressed	Identify solution to the issue	Discuss a solution	Develop appropriate solution
Impacts	Not addressed	Identify broader impacts	Discuss broader impacts	Examine broader impacts
Stakeholders	Not addressed	Identify stakeholders	Consider stakeholder perspectives	Understand and address stakeholder perspectives
Technical Concepts	Not addressed	Identify technical concepts	Discuss technical concepts	Examine technical concepts as they relate to the project
Literature	Not addressed	Identify that there is outside information	Use information from outside sources	Examine information as it relates to the project

Figure E-4.3. Modified Energy Literacy rubric used for assessing the 2014 competition projects (Langfitt, Q. and Haselbach, L. Imagine Tomorrow High School Energy Competition 2014 Energy Literacy and Biofuels Literacy Assessment of Abstracts and Posters, Submitted to the IT Steering Committee, September 2014).

Recommendations | Conclusions

Due to the success of the Imagine Tomorrow with Biofuels there is interest in perhaps using the format for other regional competitions nationally. Currently, funding for launching IT nationally with associated assessment and management is being considered, with interest for the second regional site in Missouri.

Physical and Intellectual Outputs

PHYSICAL

- 2014 Imagine Tomorrow High School Energy Competition in Pullman, WA May 30, 2014.

REFEREED PUBLICATIONS

Langfitt, Q., Haselbach, L., & Hougham, R.J. (2014) Artifact Based Energy Literacy Assessment Utilizing Rubric Scoring. J. Prof. Issues Eng. Educ. Pract. , 10.1061/(ASCE)EI.1943-5541.0000210 , C5014002.

Langfitt, Q., Haselbach, L. & Hougham, R.J. (2015) Refinement of an Energy Literacy Rubric for Artifact Assessment and Application to the Imagine Tomorrow High School Energy Competition, Journal of Sustainability Education, 8.

CONFERENCE PROCEEDINGS AND ABSTRACTS FROM PROFESSIONAL MEETINGS

Gotch, C., French, B., Langfitt, Q. and Haselbach, L. Determining Reliability of Scores from an Energy Literacy Rubric, accepted proceedings and presentation: American Society for Engineering Education, ASEE 2015 conference June 2015.

RESEARCH PRESENTATIONS

Langfitt, Q., L. Haselbach and R.J. Hougham. Artifact based energy literacy assessment utilizing

rubric scoring. Poster presented at 2014 NARA Annual Meeting, Seattle, WA, September 15-17, 2014.

Liv Haselbach was an invited presenter at Biomass 2014 on July 30th, 2014 in Washington DC. She participated in the panel discussion on: “Building Market Confidence and Understanding III: Engaging Key Audiences in Bioenergy”

VIDEOS AND WEBINARS

Langfitt, Q. and Haselbach, L., Imagine Tomorrow High School Energy Competition, The Department of Energy National Town Hall on Energy Literacy, August 5, 2014.

TRAININGS, EDUCATION AND OUTREACH MATERIALS

2014 Imagine Tomorrow competition website: http://imagine.wsu.edu/past/2014/default.html

TASK E-5: SUMMER UNDERGRADUATE RESEARCH EXPERIENCES (BF-SURE)

Key Personnel
Shelley Pressley

Affiliation
Washington State University

Task Description

BF-SURE is a summer immersion research experience for undergraduates aimed at giving them hands on skills in biofuels and bioproducts research, feeding the pipeline into energy research careers.

SURE participants participate in full time research experiences for a summer (ten week) program that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bioproducts research.

The SURE program goals are:

1. To excite undergraduate students about cutting edge research in the area of biofuels and bioproducts;
2. To develop skills needed for future biofuels and bioproducts research careers;
3. To increase the number of students participating in biofuels and bioproducts research in the northwest, including those from schools that do not have strong research efforts;
4. To integrate mentoring experiences for graduate students and post docs into a formalized training program.

Activities and Results

Recruit and Select SURE Students

The third year (summer of 2014) there were a total of 52 applicants resulting in 5 students that were selected for participation. Primary recruitment efforts included development of a NARA SURE website (http://www.nararenewables.org/ed) and individual faculty members in NARA contacted students at their schools. The number of applications increased by 36% over the second year (summer of 2013), indicating better recruitment efforts. The applicants for the third year were also very diverse. Demographics of 2014 applicants were 48% women, 52% men; and 6% Hispanic, 6% Native American, 31% Asian, 12% African American, 37% Caucasian and the rest did not identify with a specific ethnic group.

SURE Experience

Students were selected based on their applications and skills (relative to the proposed projects). Students were placed at three different NARA locations: WSU Pullman (3), WSU-TC (1), and Penn State (1). The students were paid a stipend of $5000 for the 9.5 week experience of conducting research full time, with additional costs for housing or tuition added for students depending on location and on–site needs. The students (Figure E-5.1) conducted research during this reporting period (May 29 – Aug 1, 2014) and all students participated in the poster session on August 1 in Pullman. The list of 2014 students and their associated research topic is provided in Table E-5.1. Additionally, all students participated in a meeting at University of WA in Seattle on July 30 to share their research results with UW students conducting NARA research. Presentations included poster presentations by the WSU-SURE students, and oral/power point presentations by the UW students. UW student presenters were Burdette Birdinground, Cody Sifford, Emile DeLuca and Clarence Smith. The nine students enjoyed meeting each other, sharing lunch together and hearing about each other's research.

Recruit and Select SURE Students

The fourth group of SURE students is currently being recruited and accepted for the summer 2015 program. The application pool is very strong with over 90 applications to date. Applications are currently being reviewed and students will be notified shortly about acceptance.

Additional recruiting efforts were continued during Fall 2014/Spring 2015. An informational flyer advertising NARA SURE was developed and distributed at the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) and the American Meteorological Society (AMS) Annual Meeting. In addition, a notice was posted on the Institute for Broadening Participation: Pathways to Science website (http://www.pathwaystoscience.org/).

Two additional recruitment efforts were done this reporting period. One at the American Indian Science and Engineering Society (AISES) Annual Conference which was held in Orlando, FL Nov 13-15. One of the NARA SURE students, Cody Sifford, placed 2nd in the Graduate Student poster category. Cody Sifford and Laurel James (UW) also recruited potential students for the 2015 SURE experience at a recruiting booth during the conference. The second was January 3-5, 2015 when Shelley Pressley recruited students during the American Meteorological Society (AMS) Annual Meeting in Phoenix, AZ.

Figure E-5.1. 2014 NARA Biofuels-SURE participants Left to right: Rodney Seals, Preenaa Venugopal, Cassandra Sanders, Eric Sorensen, and Eileen Wu

Recommendations | Conclusions

Recruitment of students is not a problem. This summer we received over 90 applications. So over the past four years application numbers have gone from 11 to 38 to 52 to 91. The pressing issue is finding mentors willing to work with students during the summer. Efforts were increased for the summer 2015 period, and there are some new mentors on board. However, efforts will need to be increased again for the summer of 2016.

Table E-5.1. 2013 NARA SURE students, their home institution, the title of their research, and their advisor

SURE student	Home Inst.	Research Title	Primary Advisor(s)
Cassandra Sanders	Washington State University - TC	Mechanistic kinetics study of biomass derived inhibitory compounds on cellulose hydrolysis of biomass substrate	Xiao Zhang
Rodney K. Seals	University of Arkansas	Testing lignin as an additive to wooden pellets	Jinwu Wang / Michael Wolcott
Eileen D. Wu	University of California, Berkeley	Ball Milling: Effective pretreatment leading to a clean biomass to cellulosic sugar conversion	Jinwu Wang / Michael Wolcott
Eric Sorensen	Humboldt State University	Spatial distribution of grain sizes in sampling heterogeneous stream beds	Jon Petrie
Preenaa Venugopal	The Pennsylvania State University	Potential technological pathways for the production of alternative jet fuel	Paul Smith

Physical and Intellectual Outputs

REFEREED PUBLICATIONS

Zhang, J., Laguna*, A., Clemons, C., Wolcott, M.P., Gleisner, R., Zhu, J.Y., & Zhang, X. (2015) Effect of hot-pressing temperature on the subsequent enzymatic saccharification and fermentation performance of SPORL pretreated forest biomass. Bioenerg. Res. 8:464-470

*indicates undergraduate researcher from the NARA SURE program

RESEARCH PRESENTATIONS

Pressley, S. and M. Wolcott. NARA SURE Summer Undergraduate Research Experience. Poster presentation at the NARA Annual Meeting. Seattle, WA. Sept 15-17, 2014.

NARA 2014 SURE Posters: http://www.nararenewables.org/features/posters#sure

OTHER PUBLICATIONS

WSU News Story "WSU Hosts Eight Summer Research Programs for Undergraduates" http://universitycollege.wsu.edu/units/undergraduateresearch/News-Events/headlines/summerresearchkickoff/

WSU News Story "WSU Poster Symposium Friday, Aug. 1, for 59 Undergraduate Researchers from 37 Universities" http://universitycollege.wsu.edu/units/undergraduateresearch/News-Events/headlines/2014PosterPreview/

TRAININGS, EDUCATION AND OUTREACH MATERIALS

Summer 2014 Undergraduate Research Poster Symposium at Washington State University – abstract book. http://universitycollege.wsu.edu/units/undergraduateresearch/photos-docs-pdfs/2014_REU_Abstract-Booklet_LowRes.pdf

TASK E-6: SUMMER UNDERGRADUATE RESEARCH EXPERIENCES (SURE-SKC)

Key Personnel	Affiliation
Adrian Leighton	Salish Kootenai College
Richard Everett	Salish Kootenai College

Task Description

Biofuels and bioproducts offer a high value use for woody biomass. Tribal forestry operations generate substantial quantities of woody biomass during fuels reduction aimed at forest health, timber harvest, and other activities. These forestry operations are keen to realize the environmental, economic, and social benefits of developing high value products from the forest. In order to help accelerate the development of high value-added uses of woody biomass among Northwest tribal communities, NARA is partnering with the forestry program at Salish Kootenai College (SKC), a tribal university, to provide research opportunities tied to biofuels and bioproducts from woody biomass. Annual summer internship awards will be made to SKC Forestry students so they can join a NARA research university for a summer research experience.

Summer Undergraduate Research Experiences (SURE) participants engage in a full time research experiences for a summer (ten week) program that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bioproducts research.

The SURE program goals are:

1. To excite undergraduate students about cutting edge research in the area of biofuels and bioproducts.
2. To develop skills needed for future biofuels and bioproducts research careers.
3. To increase the number of students participating in biofuels and bioproducts research in the northwest, including those from schools that do not have strong research efforts.
4. To integrate mentoring experiences for graduate students and post docs into a formalized training program.

Activities and Results

Task E-6.1. Recruit and Select SURE Students
Three SKC students completed internships funded by NARA during this time period: one on fire frequencies in mixed conifer stands (mentored by Everett), and two assessing tribal forest road networks and impacts in changes to hydrology due to climate change (mentored by Leighton). All three students successfully completed their internships, and one of them is currently analyzing results to be used in his Senior Thesis.

Recommendations | Conclusions

No recommendations at this time: internships continue to assist tribal forestry in answering important research questions while giving students meaningful research experience in NARA related fields.

BIOENERGY LITERACY

OUTREACH TEAM

TASK O-9: EDUCATION AT THE SPEED OF RESEARCH: NARA ASSESSMENT AND WEB-BASED RESOURCES

Key Personnel
R. Justin Hougham

Affiliation
University of Wisconsin

Task Description

Fundamentally, integrated approaches to energy literacy must be developed to effectively cross disciplines, include all stakeholders, and situate energy literacy into the consciousness of learners of all ages (Hougham et al. 2012). Meaningful approaches to this challenge address education at all levels—students, teachers, and public. The approaches found in the NARA project need to meaningfully address and align assessments as well as web-based content to communicate the exciting research in biofuels, while enriching the greater public understanding of energy literacy through media-enhanced curriculum. Addressing many entry points into the developing biomaterials economy of tomorrow while supporting an online collection of materials, supports learners and provides the infrastructure for education at the speed of research (Hougham et al. 2012). Assessing the outcomes and all education efforts is integral to the success of the NARA project's goal of enhancing energy literacy.

1. Lead Energy Literacy Assessment coordination efforts with support of Education and Outreach teams as well as stakeholders.

NARA Education and Outreach teams seek aligned assessment efforts to 1) internally align energy literacy assessment tools, and 2) create, vet, validate and deliver energy literacy assessments that communicate the impact of NARA energy literacy efforts, as well as contribute to the larger energy literacy landscape. The Learning Performance and Research Center (LPRC) at WSU will support development and refinement of energy literacy tools.

2. Lead Matrix web development efforts and coordinate population of relevant data into NARA web resources.

Development work for NARA Matrix, which includes the development of Literacy Assessment for Biofuels, can be delivered through energyliteracyprinciples.org. Additionally, the Energy Literacy Matrix and Web products will be developed and NARA project products will be organized into an online infrastructure. MagMag LLC will provide ongoing support of web-based tools, including refinement of energyliteracyprinciples.org

Activities and Results

Year 4 progress includes the completion of 2 energy literacy assessment tools, guest editor of Energy Education issue for Journal of Sustainability Education (featuring a collection of NARA articles), continued enhancement of NARA Matrix (676 assets to date, including 160 added this year), and wide dissemination of NARA efforts in stakeholder venues.

Recommendations | Conclusions

Year 5 will see finalized stakeholder literacy tool, coordination of summit in April 2016 featuring NARA education, support for 1000 gallon storyboard development and dissemination, continued enhancement of NARA Matrix, support for woodtobiofuel site, supporting workshops for teachers, and leveraging energy literacy assets into further work.

Physical and Intellectual Outputs

REFEREED PUBLICATIONS

Langfitt, Q., Haselbach, L., & Hougham, R.J. (2014). Artifact Based Energy Literacy Assessment Utilizing Rubric Scoring. Journal of Professional Issues in Engineering Education and Practice (2014).

Langfitt, Quinn, Liv Hasselbach, and Justin R Hougham. (2015) Refinement of an Energy Literacy Rubric for Artifact Assessment and Application to the Imagine Tomorrow High School Energy Competition. Journal of Sustainability Education (8) 2015.

Hougham, R. Justin, Steve Hollenhorst, Jennifer A Schon, Karla B Eitel, Danica Hendrickson, Chad Gotch, Tammi Laninga, Laurel James, Blake Hough, Dan Schwartz, Shelley Preslley, Karl Olsen, Liv Haselbach, Quinn Langfitt, and Jennifer Moslemi. From the forest to the classroom: Energy literacy as a co-product of biofuels research. Journal of Sustainability Education (8) 2015.

Schon, A. Jennifer, Karla B Eitel, R Justin Hougham, and Danica Hendrickson. Creating a research to classroom pipeline: closing the gap between science research and educators. Journal of Sustainability Education (8) 2015.

Eitel Karla, Justin Hougham, Tammi Laninga, Greg Fizzell, Jenny Schon, and Danica Hendrickson. Teacher Professional Development for Energy Literacy: A Comparison of Two Approaches. Journal of Sustainability Education (8) 2015.

Hendrickson, Danica, Kimberly Corrigan, Alicia Keefe, Danielle Shaw, Sheeba Jacob, Laura Skelton,

Jennifer Schon, Karla Bradley Eitel and Justin Hougham. Global Sustainability: An Authentic Context for Energy Education. Journal of Sustainability Education (8) 2015.

DeWaters, Jan, Justin Hougham, Clare Hintz and Larry Frolich. Beyond Conservation: Reimagining the Purpose of Energy Education. Journal of Sustainability Education (8) 2015.

RESEARCH PRESENTATIONS

Hougham, R. Justin (2015) Education at the Speed of Research: An Overview of the NARA Approach to BioEnergy Literacy. 2015 National Extension Educator Summit, Seattle, WA, April 7th.

Schon, Jenny, Karla Eitel, R Justin Hougham, Jim Casey and Mike Wang-Belt. Engaging Energy in an Outdoor Learning Center. Poster Abstract. National Extension Energy Summit, Seattle WA, April 7 2015.

Hougham, R. Justin, Jenny Schon, Karla Eitel, William Stubblefield, and Justin St. Onge. Assessing Energy Literacy in an Outdoor Learning Center. Poster Abstract. National Extension Energy Summit, Seattle WA, April 7 2015.

Eitel, Karla, R. Justin Hougham, Jenny Schon, Aaron Boyles, and Ashlee Fliney. Professional Development for Energy Literacy. Poster Abstract. National Extension Energy Summit, Seattle WA, April 7 2015.

O'Brien, Kevin and Hougham, R.J. (2015) Value of a Tree. 2015 Wisconsin Society of Science Teachers Annual Meeting, Wisconsin Dells, WI March 6th.

Hougham, R. Justin, Jenny Schon, Karla Eitel, Danica Hendrickson, Tammi Laninga, Chad Gotch, Shelley Pressley, Liv Haselbach and Steven Hollenhorst. (2014) Education at the Speed of Research: An Overview of the NARA Approach to BioEnergy Literacy (Poster). 2014 NARA Annual Meeting, Seattle, WA, September 15-17.

Hougham, R. Justin, et al. (2014) Education at the Speed of Research: BioEnergy Literacy. North American Association for Environmental Education, Ottawa ON.

Hougham, R. Justin (2014) Exploring Energy Literacy: Wood based biofuels and co-products. Wisconsin Association for Environmental Education, Stevens Point, WI.

Hougham, R. Justin. (2014). Education at the Speed of Research: Bio-Energy Literacy Northwest Wood-Based Biofuels + Co-Products Conference, Seattle WA, April 2014

VIDEOS AND WEBINARS

"NARA BioEnergy Literacy" Department of Energy Webinar Series, Energy 101

"Nara BioEnergy Literacy and energyliteracyprinciples.org" Department of Energy Webinar Series, Energy Town Hall

TRAININGS, EDUCATION AND OUTREACH MATERIALS

NARA Matrix, which includes the development of Literacy Assessment for Biofuels, can be delivered through energyliteracyprinciples.org.

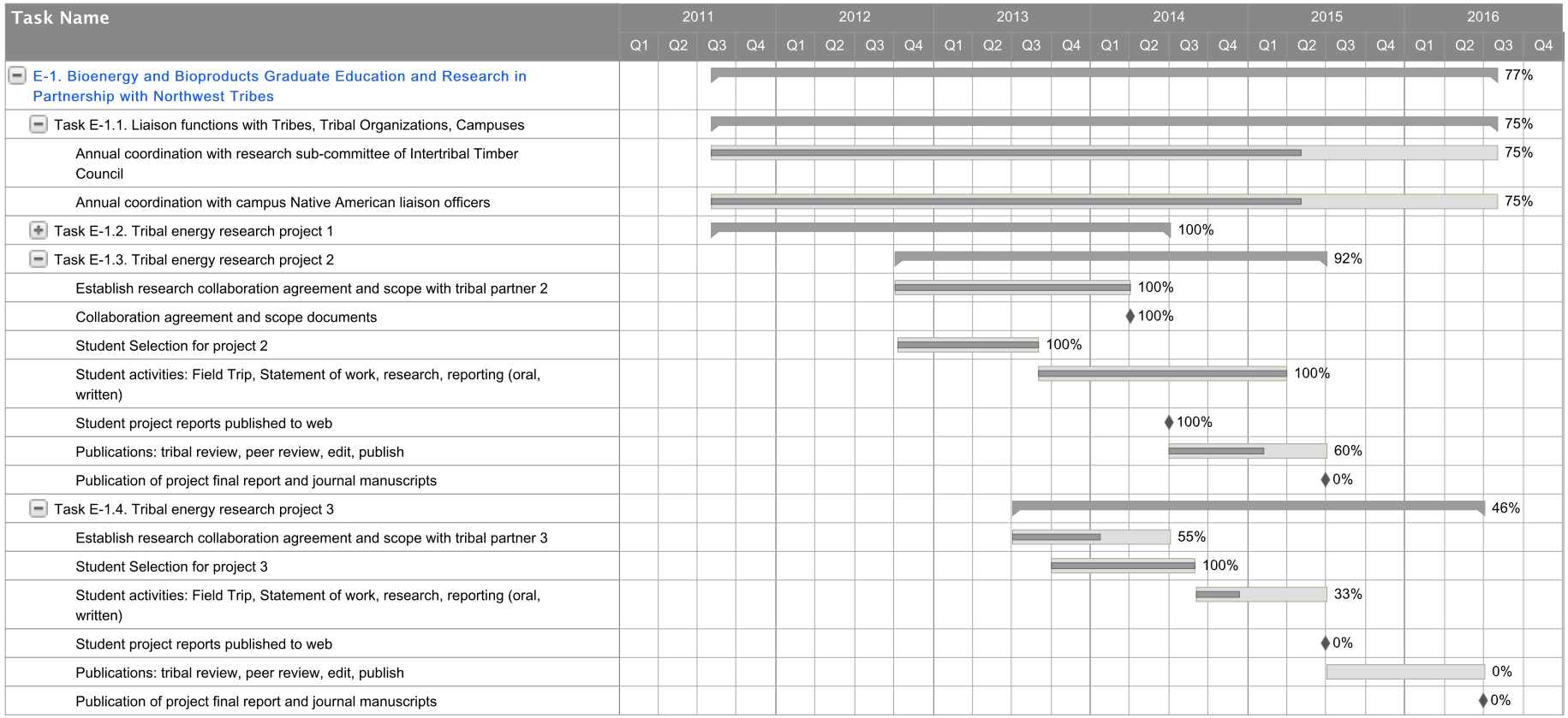
11/8-9/2014 Energy Workshop, Value of a Tree with K-12 Energy Education Project and Facing the Future.

NARA information table, 3 days, Midwest Renewable Energy Association "BioEnergy Literacy" Midwest Renewable Energy Association

"BioEnergy Literacy" Wisconsin Association for Environmental Education

Education_Schwartz

NARA



	Task Name	2011				2012				2013				2014				2015				2016			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	E-1. Bioenergy and Bioproducts Graduate Education and Research in Partnership with Northwest Tribes																							77%	
2	Task E-1.1. Liaison functions with Tribes, Tribal Organizations, Campuses																							75%	
3	Annual coordination with research sub-committee of Intertribal Timber Council																							75%	
4	Annual coordination with campus Native American liaison officers																							75%	
5	Task E-1.2. Tribal energy research project 1																								
13	Task E-1.3. Tribal energy research project 2																								
14	Establish research collaboration agreement and scope with tribal partner 2																								
15	Collaboration agreement and scope documents																								
16	Student Selection for project 2																								
17	Student activities: Field Trip, Statement of work, research, reporting (oral, written)																								
18	Student project reports published to web																								
19	Publications: tribal review, peer review, edit, publish																								
20	Publication of project final report and journal manuscripts																								
21	Task E-1.4. Tribal energy research project 3																								
22	Establish research collaboration agreement and scope with tribal partner 3																								
23	Student Selection for project 3																								
24	Student activities: Field Trip, Statement of work, research, reporting (oral, written)																								
25	Student project reports published to web																								
26	Publications: tribal review, peer review, edit, publish																								
27	Publication of project final report and journal manuscripts																								

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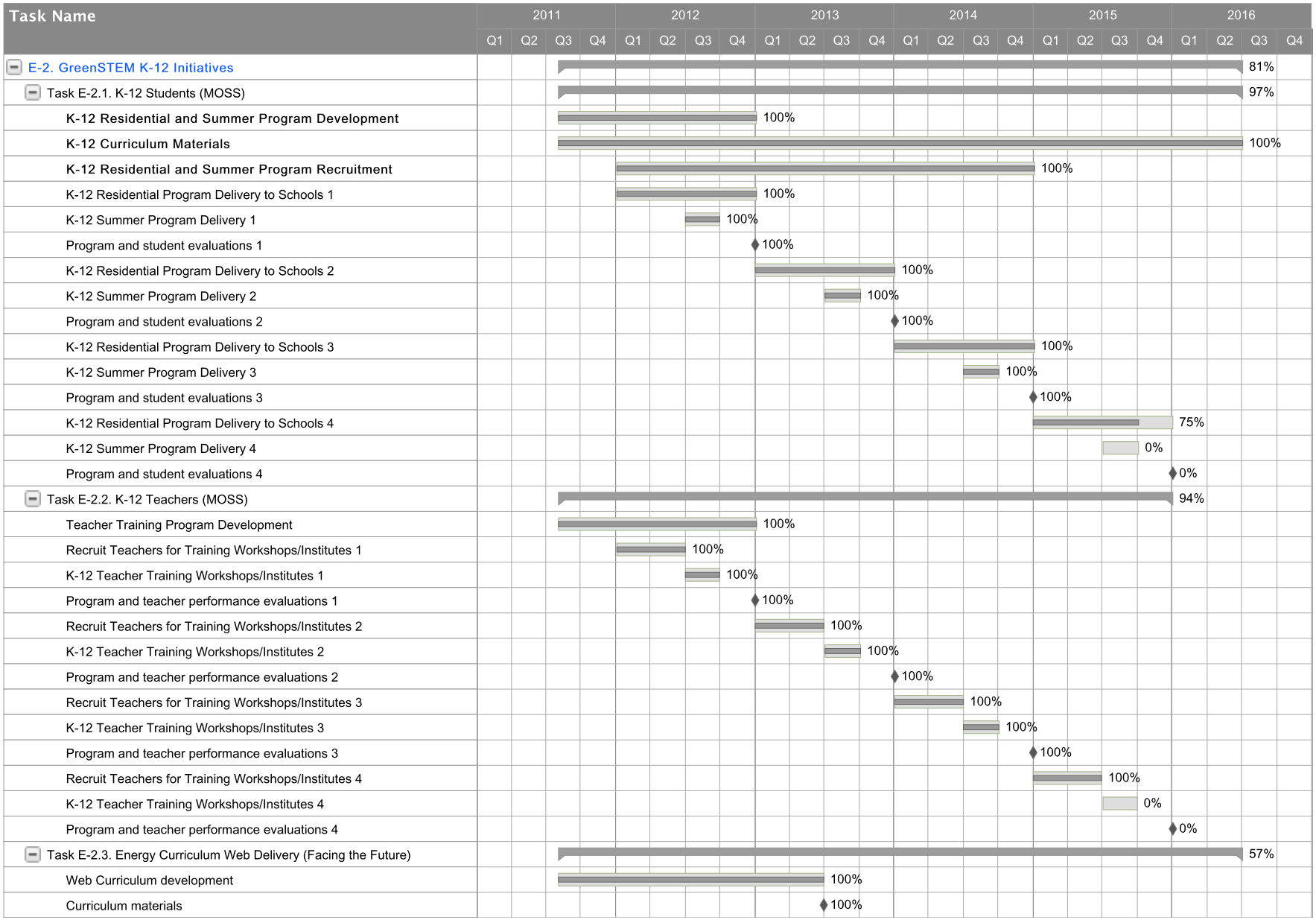

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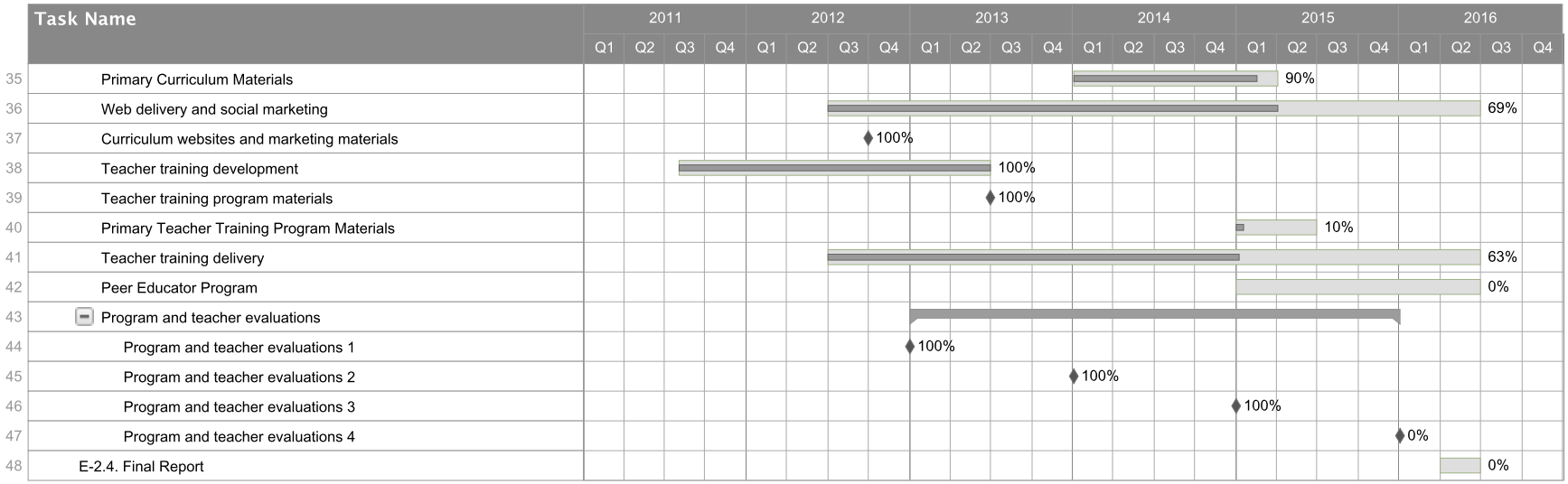

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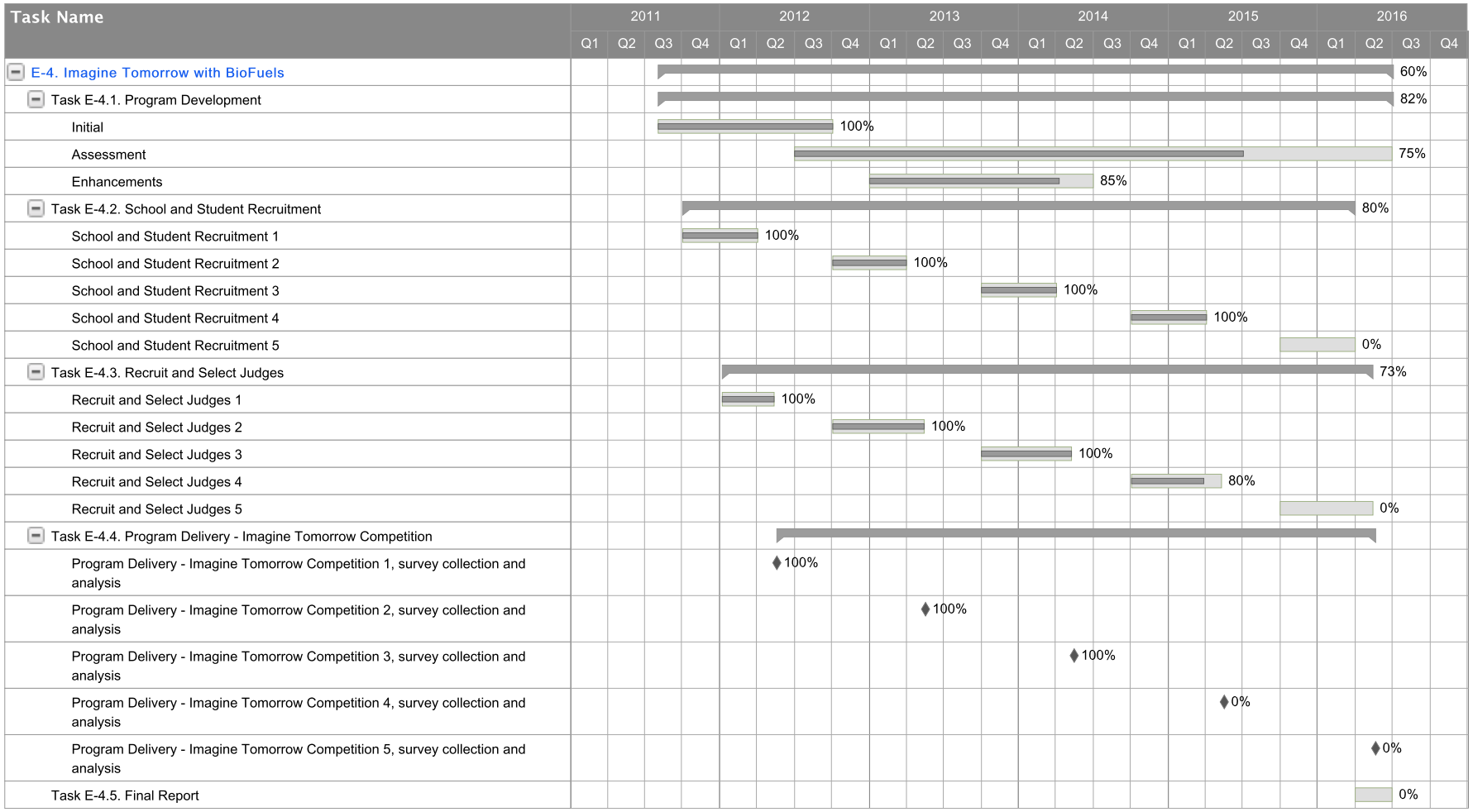
NARA



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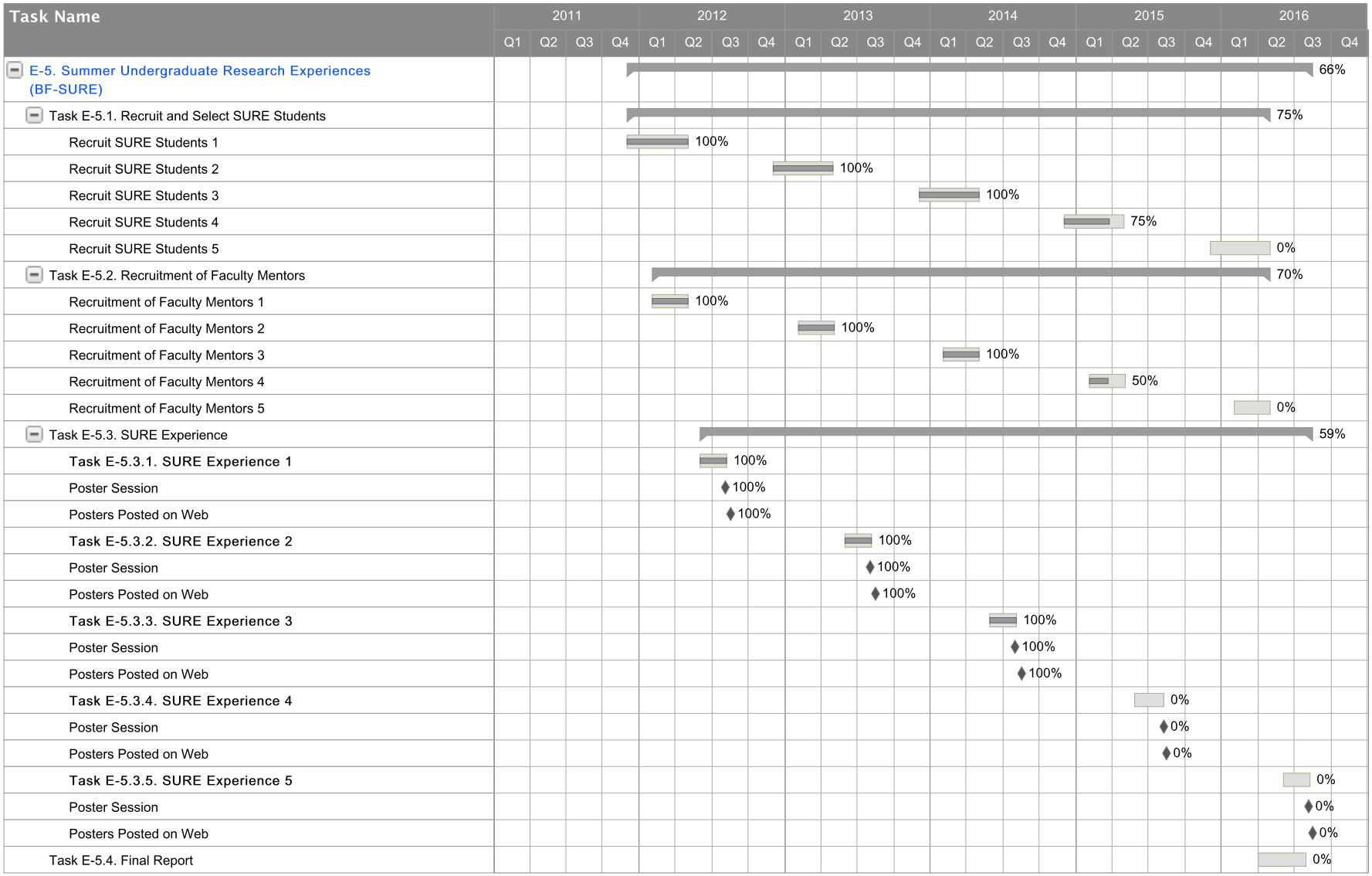
NARA



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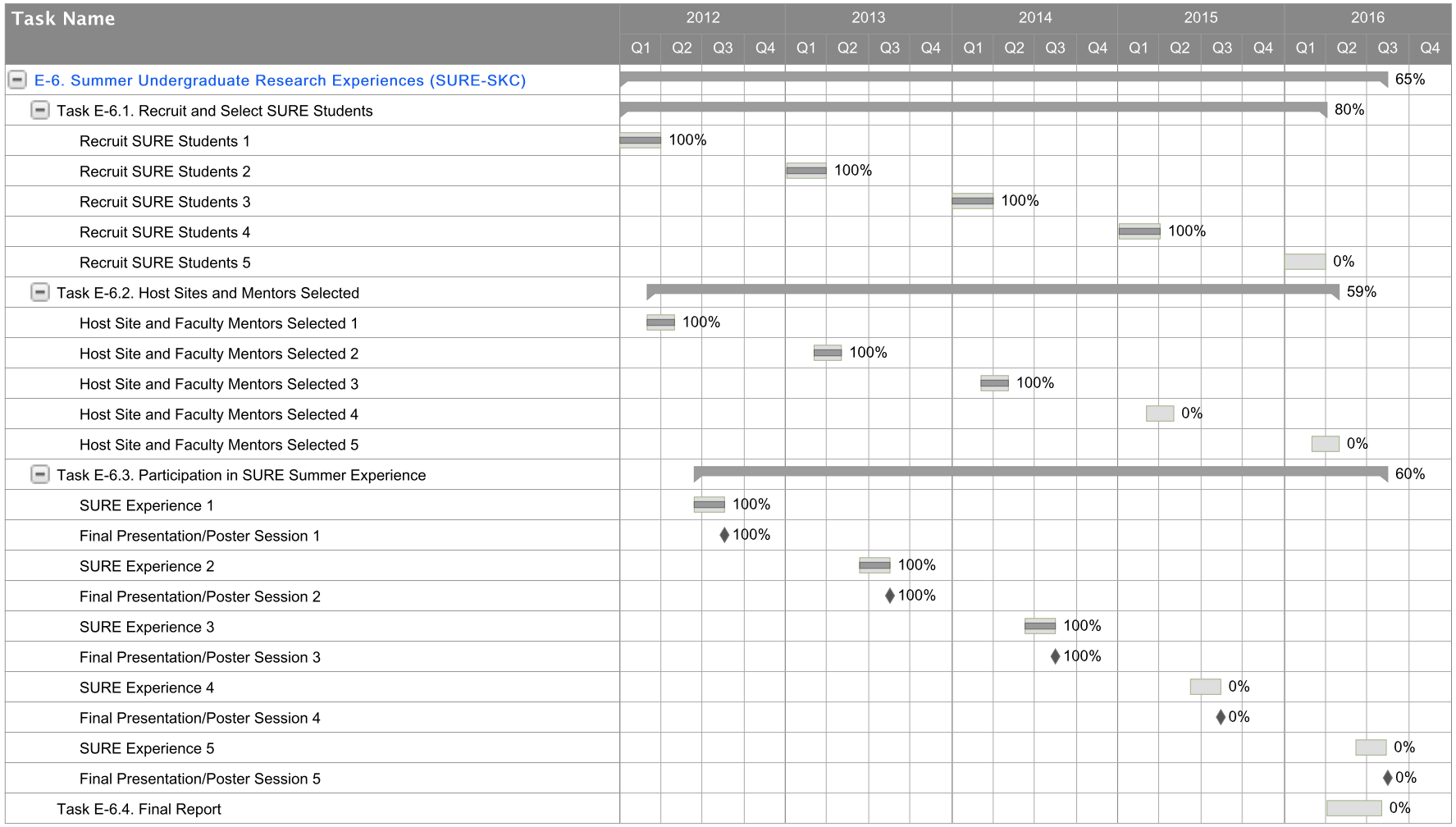

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Outreach_Hougham

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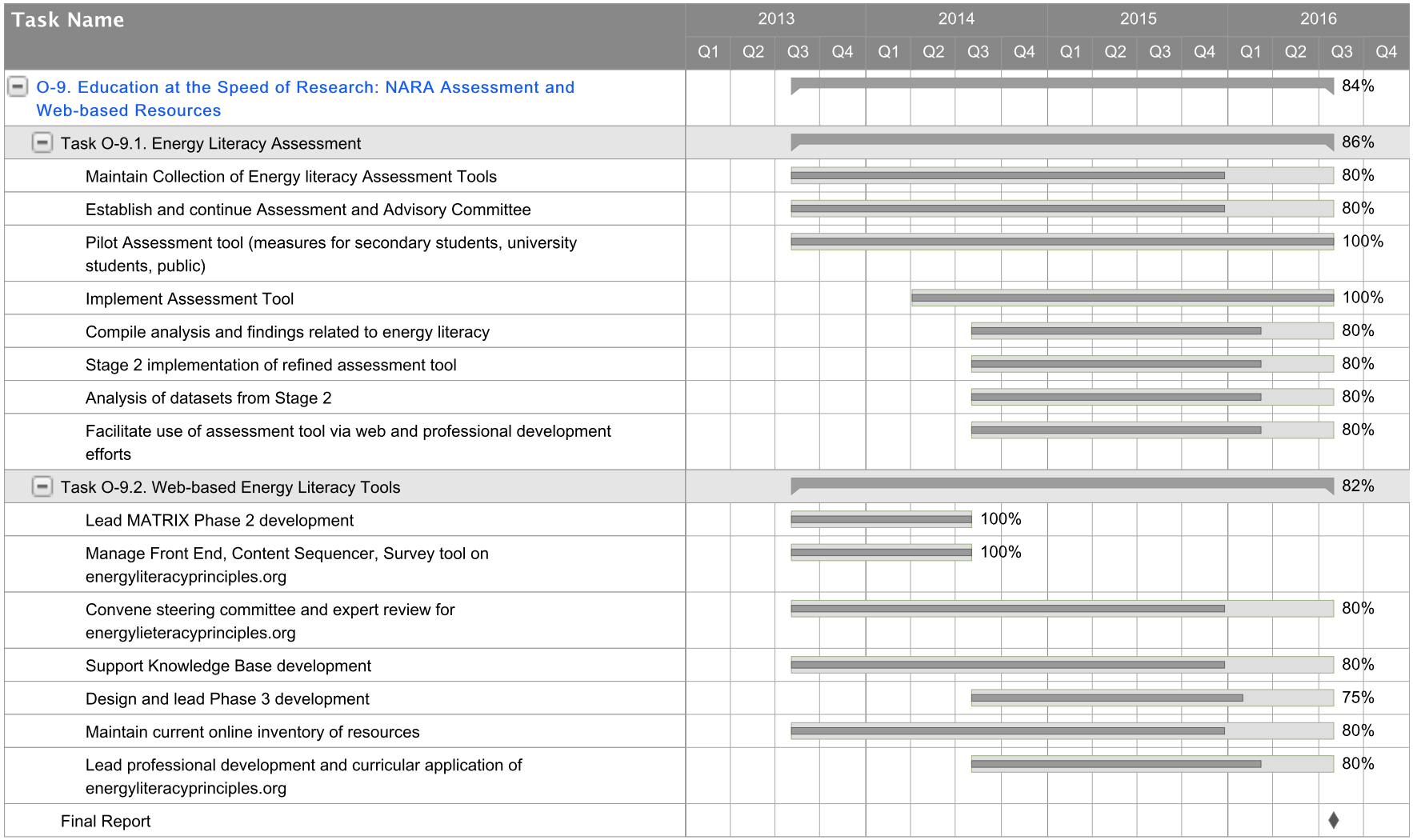

	Task Name	2013				2014				2015				2016			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	O-9. Education at the Speed of Research: NARA Assessment and Web-based Resources																84%
2	Task O-9.1. Energy Literacy Assessment																86%
3	Maintain Collection of Energy literacy Assessment Tools																80%
4	Establish and continue Assessment and Advisory Committee																80%
5	Pilot Assessment tool (measures for secondary students, university students, public)																100%
6	Implement Assessment Tool																100%
7	Compile analysis and findings related to energy literacy																80%
8	Stage 2 implementation of refined assessment tool																80%
9	Analysis of datasets from Stage 2																80%
10	Facilitate use of assessment tool via web and professional development efforts																80%
11	Task O-9.2. Web-based Energy Literacy Tools																82%
12	Lead MATRIX Phase 2 development																
13	Manage Front End, Content Sequencer, Survey tool on energyliteracyprinciples.org																
14	Convene steering committee and expert review for energylieteracyprinciples.org																80%
15	Support Knowledge Base development																80%
16	Design and lead Phase 3 development																75%
17	Maintain current online inventory of resources																80%
18	Lead professional development and curricular application of energyliteracyprinciples.org																80%
19	Final Report																