NARA
Northwest Advanced Renewables Alliance

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2012 - NARA First Annual Meeting group photo in Missoula, MT

NARA 2012 annual meeting: One year stronger and ahead to year two

NARA capped off its first year with an annual meeting held in Missoula Montana September 13th and 14th, 2012. This event convened over 100 NARA contributors from our affiliate institutions across the country. In addition, over 50 individuals, representing varied interest groups, came to meet NARA members and participate in the meeting.

The meeting format offered panel presentations and discussions covering NARA's progress and future directions arranged within NARA's five goals: sustainable biojet from wood residuals, valuable lignin co-products, pilot supply chain coalitions, rural economic development, and energy literacy.

Thursday evening's poster session hosted over 50 posters showcasing NARA related work completed in the first year. Press coverage was provided by Rob Chaney with the Missoulian and Dennis Bragg at kpax.

Ralph Cavalieri, NARA Executive Director, provided the opening and concluding remarks. Members of the NARA executive committee and NARA team leaders provided project overviews covering project management (Linda Beltz), the biojet technical pathway (Tom Spink) and the western Montana Corridor supply chain project (Michael Wolcott). Guest speakers included Bill Goldner, National Program Leader of Sustainable Bioenergy of the Institute of Bioenergy, Climate and Environment, in USDA's National Institute of Food and Agriculture (NIFA); Gordy Sanders, Resource Manager with Pyramid Mountain Lumber and co-chair of the Montana Forest Restoration Committee; John Engen, Mayor for the City of Missoula; and Montana U.S. Senator Jon Tester provided a video greeting. Representatives from two other biofuel projects involving woody feedstock reviewed their programs. Rick Gustafson described the Advanced Hardwood Biofuels Northwest (AHB-NW)project and Tim Rials described the Southeast Partnership for Integrated Biomass Supply Systems (IBSS). Like NARA, these two programs are supported by Agriculture and Food Research Initiative Competitive grants from the USDA National Institute of Food and Agriculture.

2012 Annual Meeting agenda

The western Montana region has received focused attention as an important supply chain for the NARA project. Two previous meetings were held in this area, and much scoping work has been done to identify regional assets (see the August NARA newsletter). Consequently, NARA has received input from many regional business leaders and non-profit and government organizations, and further input was provided at the meeting. After all the presentations were given, regional stakeholders were invited to gather together as a group and outline concerns, impressions and suggestions regarding the NARA project. Their output was recorded and shared with the NARA group. Some of the comments voiced by this group were:

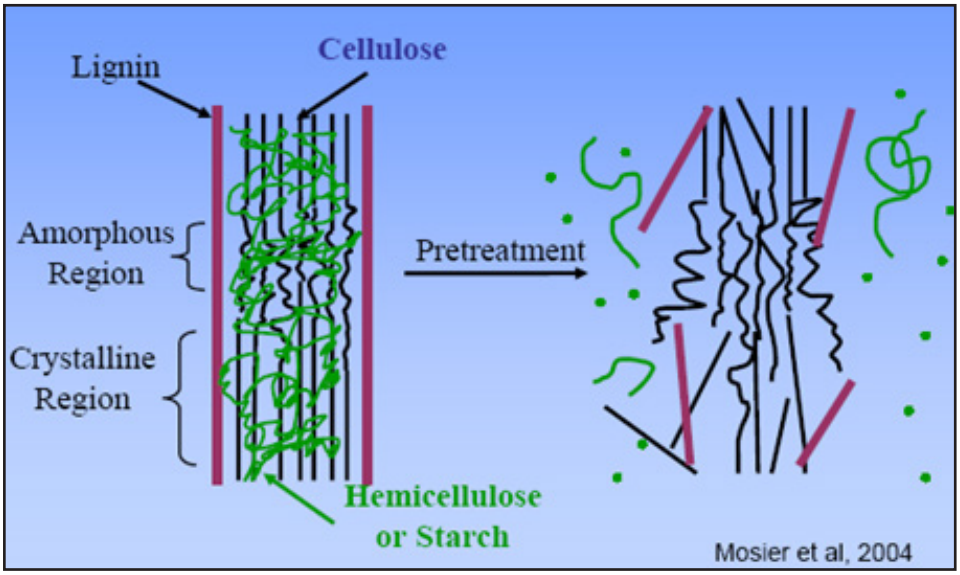
1) If NARA is dedicated to work with stakeholders, then make sure the stakeholders are engaged and information is transparent. Also try to include all stakeholders and groups, even those with limited capacity.
2) In the process of developing this industry, all efforts should be made to utilize the region's existing capital (infrastructure, people, political).
3) Western Montana urgently needs a re-

vitalized wood products industry and a means to reduce fuel loads. Consider smaller facilities covering a radius of less than 50 miles.

The annual meeting provided a useful forum to report NARA's progress not only to NARA members and stakeholders, but also to NARA's Advisory Board members and to the USDA-NIFA representative Bill Goldner. The Advisory Board noted that NARA is a high quality project with potential to create public and environmental benefit in the Pacific Northwest. Their suggestions for improving the project were:

1) Define success and the real targets of the project.
2) Provide a more comprehensive economic analysis covering each step of the feedstock to biojet and co-products process. Also identify the costs of commercial investments needed to manage this industry.
3) Include transparent information to policy makers and conservation organizations.
4) Review and complement the efforts of other organizations that may overlap NARA's efforts.

The opportunity to interact with other NARA members and the public proved both stimulating and informative. Based on the progress demonstrated at the meeting and with the guidance and support of the many stakeholders, the advisory board and USDA-NIFA, NARA is well positioned to implement plans and accomplish tasks that will advance the project into the next year.



Pretreatment: the first chemical treatment in the wood to biojet/co-product conversion

One of NARA's goals is to promote bioenergy literacy. Describing the conversion of wood into biojet fuel and other co-products can involve technical language and concepts that, without further detail, can be tough to follow. This description of pretreatment processes contains numerous links intended to provide more indepth explanations. An additional source of information being developed to cover all aspects of the NARA project, including pretreatment, can be accessed at our knowledge database.

The molecules in wood tissue used to make liquid biofuels are sugars. These sugars are linked together in complexes known as cellulose and hemicelluloses and together can represent up to 75% of dried wood weight.

Getting access to these sugar complexes is not easy. Surrounding the cellulose and hemicelluloses is lignin which serves as the glue and protects the polysaccharides from enzyme and microbial deconstruction. The lignin, cellulose and hemicellulose form strong bonds and their combined structure is named lignocellulose. The natural protection to the sugar complexes provided by the lignin presents a significant challenge to NARA chemists. Their goal is to break up the lignocellulose so that hydrolysing enzymes can be introduced to release the individual sugars (monosaccharides) from the polysaccharides. Those monosaccharides released serve as the feedstock to produce downstream molecules such as ethanol and isobutanol used for biofuel production.

The process to overcome lignocellulosic recalcitrance and expose the cellulose and hemicellulose so that individual sugars can be released is called pretreatment. Choosing the most effective pretreatment strategy involves a number of considerations including:

The amount of energy required

Energy costs are a concern and the pretreatment procedures described below require heat and in some cases, mechanical milling.

The amount and quality of sugars released

We want to insure that the sugars are not degraded so that they can be properly converted into fuel.

The chemical effects on lignin

The leftover lignin will be processed into valuable products. Like the sugars, we want to ensure that the lignin structure is not degraded.

The chemical waste disposal

To ensure a sustainable process, we need to ensure that the chemicals used are recycled or disposed of in an economically and environmentally sound manner.

The byproducts generated that could inhibit the downstream fermentation process

Heat and chemicals could generate compounds that obstruct or inhibit processes

used to convert the sugars into fuel molecules.

The scalability for industrial bioprocessing

A pretreatment procedure demonstrated in the laboratory must be suitable for large scale production

The ability to effectively treat a variety of woody residuals feedstocks

Wood residuals vary greatly depending on species and harvest method. A pretreatment protocol should be able to process a wide variety of feedstocks.

Economics

The costs and efficiency of the pretreatment process will significantly impact the fuel and co-product production costs.

NARA researchers are currently modifying and testing some of the most promising pretreatment technologies for woody biomass to ensure that they address these considerations. Listed are three pretreatments strategies currently undergoing NARA consideration.

Sulfite Pretreatment

Sulfite pulping is a process used by the paper and pulp industry for years to separate lignin from cellulose and hemicellulose. Aspects of this technology are incorporated into two sulfite pretreatment processes. NARA researcher Junyong Zhu, scientific team leader at the USDA Forest Service, Forest Products Laboratory (FPL), Madison WI developed the SPORL (sulfite pretreatment to overcome recalcitrance of lignocellulose) process; NARA affiliate Catchlight Energy uses a modified version of the SPORL process.

Sulfite pretreatment involves two fundamental steps. The first step mixes woodchips with an acidic aqueous sulfite solution. The mixture is then heated. This process separates most of the hemicelluloses from the lignocellulose and partially separates lignin. The second step employs a mill to grind the pretreated solid cellulose/lignin rich material into fibers or fiber bundles. The remaining solids can easily be enzymatically digested to glucose. The separated lignin fraction can be purified and incorporated into valuable co-products.

According to Dr. Zhu, the SPORL process is relatively versatile. Varying the temperature, time, pH or the amount of chemicals can accommodate a variety of woody feedstock streams. Because this pretreatment method was built on existing technologies used for decades, scaling to an industrial level should be relatively straightforward.

Wet Oxidation

In 2004, NARA researcher Birgitte Ahring, Battelle Distinguished Professor; Director, WSU Center for Bioproducts and Bioenergy (BSEL) at WSU Tri-Cities, patented the wet oxidation process. With wet oxidation, no external chemicals are added except water and moderate concentrations of oxygen. Under high pressure and heat, oxygen reacts with lignin altering its structure and forcing it to detach from the hemicelluloses and cellulose. The high pressure, coupled with a quick pressure release, helps break the crystalline cellulose structure making it accessible to enzymatic hydrolysis.

The wet oxidation process is suitable to both hardwoods and softwoods. No harsh chemicals are used which limits environmental costs. Another advantage to this process is that no mechanical milling is required and the remaining lignin is chemically unaffected.

Dilute Acid

The dilute acid pretreatment process is similar to sulfite pretreatment except sulfite is omitted. NARA researcher Xiao Zhang will use this technology to rapidly compare and evaluate various woody species and cultivars to determine their susceptibility to pretreatment.

Specifications And Scale-Up

NARA researchers working on a pretreatment strategy must consult regularly with other NARA teams. Any chosen pretreatment protocol will have to deliver biomass material that is compatible with the fermentation (microbial digestion) process handled by NARA affiliates Gevo and the BSEL team at WSU Tri-Cities. Additionally, it will have to accommodate variable biomass feedstocks. Specifications will be required for both the inputs and outputs of any pretreatment strategy. Once a pretreatment strategy is set, it will need to be scaled to a level suitable for industrial processing.

Summer undergraduates = hot research + workforce development

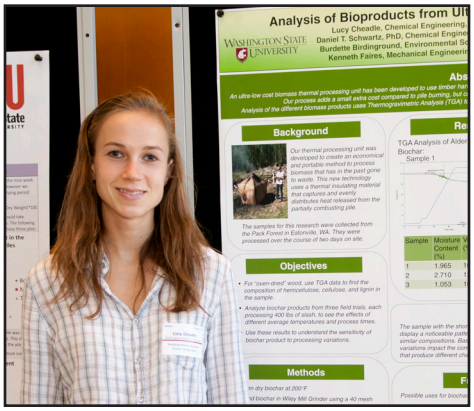
This summer, eight undergraduate students were placed at four different NARA locations, Washington State University (WSU) Pullman, WSU-Tri Cities, Oregon State University and University of Washington, to join NARA mentors in conducting full time research in the broad area of biofuels and bioproducts.

This opportunity was made possible through the NARA biofuels SURE (Summer Undergraduate Research Experience) program — a nine-week summer program targeted to ensure workforce security in the new biofuels and bioproducts industry by getting undergraduate students involved with NARA-related research. Last spring, 11 applicants from eight colleges were recruited into the program. Developing a diverse future workforce is a major goal for NARA, and in this area, NARA SURE students represented a variety of ethnicities (Hispanic, Native American, Asian and Caucasian), as well as a strong distribution across the genders. Of the 11 applicants, eight were placed on NARA-specific projects and received NARA funding. Students were provided a $5000 stipend in addition to housing, travel and tuition costs.

On August 3rd, these students showcased their work at the Undergraduate

Research Poster Symposium held at Washington State University. This annual symposium featured the work of over 50 students representing a wide range of majors and projects.

For some of the students, this was their first research and poster symposium experience. Based on the quality of their poster content, enthusiasm and subject mastery, one might think they were graduate students.



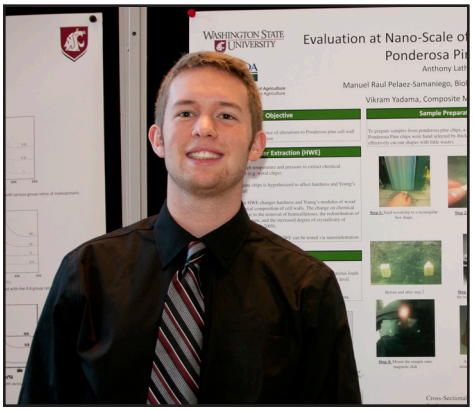
Lucy Cheadle

Analysis of Bioproducts from Ultra-Low Cost Biomass Processing

Poster | Abstract

NARA mentor: Daniel Schwartz, University of Washington

Lucy is a sophomore at Washington University in St. Louis. This was her first research experience. When asked about the positive aspects of the experience.



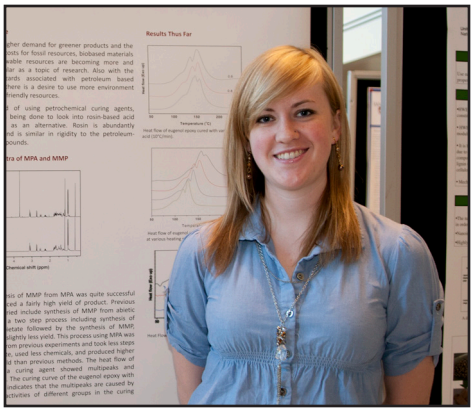
Anthony Lathrop

Evaluation at Nano-Scale of Hot-Water Extracted Ponderosa Pine Chips

Poster | Abstract

NARA mentor: Vikram Yadama, Washington State University

Anthony is a junior studying physics at Washington State University. He is a recipient of a Boeing Scholars Award. Anthony plans to continue the research in his senior year and says that the experience motivated him to seek additional research experience.



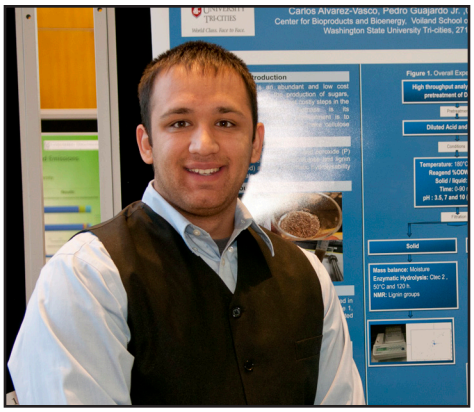
Ellen Simonsen

Biobased Curing Agent for Epoxy

Poster | Abstract

NARA mentor: Jinwen Zhang, Washington State University

Ellen is a senior studying civil engineering and chemistry at Washington State University. This is her first research experience. She remarked that it was a satisfying experience to connect her work to the broader body of work represented by NARA.



Pedro Guajardo Jr.

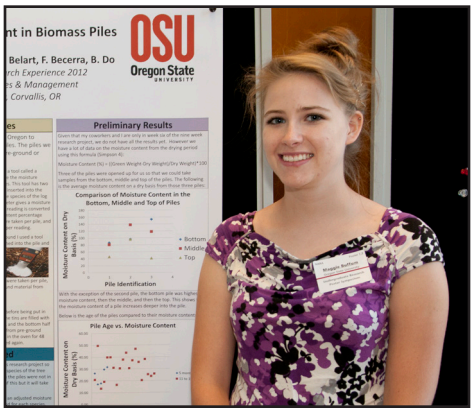
Diluted Acid and Peroxide Pretreatments of Douglas Fir

Poster | Abstract

NARA mentor: Xiao Zhang, Washington State University

Pedro studies electrical engineering at Washington State University-Tri Cities. He valued the biochemical research and identified how his electrical engineering training provided a unique perspective.

Pedro Guajardo was accepted for the Auvil Undergraduate Scholars Fellowship. The award was based on his statement of research interests and a faculty mentor's letter of recommendation. The Auvil Scholars program provides $1,000 support for both the school year and summer research. Congratulations Pedro and job well done!



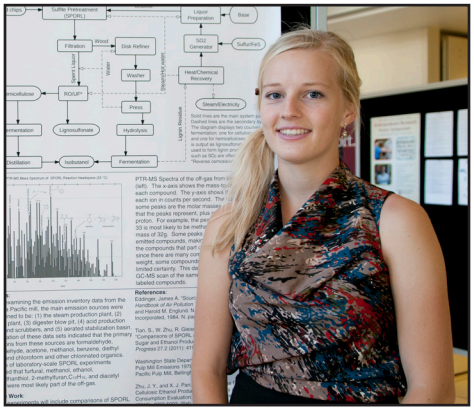
Maggie Buffum

Assessing Moisture Content in Biomass Piles

Poster | Abstract

NARA mentor: Glen Murphy, Oregon State Univercity

Maggie just finished her sophomore year studying Forest Engineering at Oregon State University. Maggie learned that being outdoors while performing research suited her well.



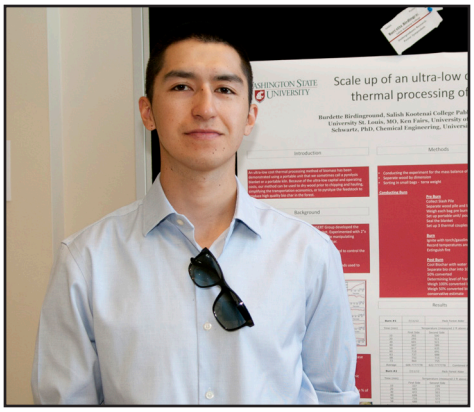
Madeline Fuchs

Nara Biofuels Production Emissions

Poster | Abstract

NARA mentor: Michael Wolcott, Washington State University

Madeline is a senior studying chemistry at Montana State University. Madeline appreciated how this project provided real life practical solutions.



Burdette Birdinground

Scale Up of an Ultra-Low Cost In-Forest Thermal Processing Of Biomass
Poster | Abstract
NARA mentor: Daniel Schwartz, University of Washington

Burdett studies environmental science at Salish Kootenai College. He found the research experience to be a great complement to his plans to study environmental law when he graduates.

Brady Do

Assessing Risks of Arson in Biomass Piles
Poster | Abstract
NARA mentor: Glen Murphy, Oregon State University

Brady is a senior in the Forest Research, Resources and Management Department at Oregon State University.

Congratulations students, and a job well done. Next year we would like to increase the number of applicants. For more information regarding NARA biofuels SURE opportunities for Summer 2013 contact:

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