WESTERN REGIONAL CENTER
Oregon State University

Western Biomass Energy Feedstock Partnership
Workshop Discussion
Executive Summary

August 27-29, 2007
DoubleTree Hotel at the Lloyd Center
Portland, Oregon

Partnership Goal

The availability of biomass feedstocks for energy production varies regionally because of differences in production and marketing factors such as soil type, climate, and competing uses. A consistent and reliable supply of biomass feedstocks is critical to energy production. The goal of the Western Regional Biomass Energy Feedstock partnership is to facilitate the development, evaluation, and delivery of existing and emerging biomass feedstocks in an economically feasible and environmentally sustainable manner.

Partnership Collaborators

- Western Sun Grant Regional Center
- Oregon State University
- US Departments of Agriculture, Energy and Transportation
- Oregon Departments of Agriculture and Energy
- Western Governors' Association
- Western Sustainable Agricultural Research and Extension
- Pacific Northwest, Idaho and Oak Ridge National Laboratories

Workshop Goal

The overall objective for the workshop was to examine the opportunities for implementing a biobased economy in the West. The workshop also provided an opportunity to establish dialog and working partnerships among the entities and individuals participating in the workshop. The individual working groups convened at the workshop had more specific objectives for their discussions.

Working Groups and Their Leaders

1. Agricultural energy crops – Russ Karow and Steve Petrie, Oregon State University
2. Agricultural residues – Gary Banowetz, USDA-Agricultural Research Service
3. Woody energy crops – Mike Cloughesy, Oregon Forest Resources Institute
4. Woody residues, wastewoods, and invasives – Scott Leavengood, Oregon State University and Mark Kendall, Oregon Department of Energy

5. Other biowaste resources – Hong Liu and Mike Gamroth, Oregon State University
6. Biochemical conversion – Christine Kelly, Mike Penner and Alan Bakalinsky, Oregon State University
7. Thermochemical conversion – Dennis Stiles, Pacific Northwest National Laboratory
8. Other conversion technologies – John Bolte, Oregon State University
9. Economics and Policy – Jon Yoder and Phil Wandschneider, Washington State University
10. Business Planning – Dennis Stiles, Pacific Northwest National Laboratory
11. Environment – Catherine Clark and Yao Yin, Oregon State University
12. Communications and Outreach – Peg Herring, Oregon State University

Biomass Groups (Agriculture, Woody, and Other)
Objective: To examine biomass availability, location, abundance, characteristics and quality in the region.

The biomass groups met to better understand the ability of the Western region to deliver biomass for biofuels and other bioproducts. In addition, they identified criteria to determine sustainability of these resources for the West and its communities, such as concerns, opportunities and needs. They also asked what are assumptions commonly made; what drives our assumptions, biases, values, directions; and are there new paths to consider?

Technology Groups (Biochemical, Thermochemical, And Other)
Objective: To explore new or refine existing conversion technologies for existing or new feedstock streams.

Each technology group examined the constraints and opportunities for their suite of technologies and considered the top 2-4 interdisciplinary, multi-institutional, intersectoral frameworks or projects that would suit and enhance the opportunities in the Western region.

Cross-Cutting Groups (Environmental, Economic, Business and Communications/Outreach)
Objective: To examine major areas of impact from delivering feedstocks for bioproduct production

Each cross-cutting group examined the strengths, weaknesses, opportunities and threats for delivery of feedstocks from their particular perspective.

Summary of Workshop Outcomes

Biomass Feedstock Supply

Agricultural Feedstocks: Crops identified with the greatest potential for additional work in the western region are safflower, canola, camelina, mustards, and grain residues in dryland, and camelina, canola, sweet sorghum and switchgrass on irrigated acreages (ideas for specific crops are available in the working group summary). The group felt that an agroecozone approach to identify representative locations for initial "high risk of failure" trial work would be most productive. Investments need to be made in two areas - on high risk crops such as camelina and

on developed crops such as canola in which there is still a "flaw." Given the high value of crops grown on available arable lands and limited water availability in the West, focus must be on crops that can be grown under deficit irrigation and on marginal irrigated and dryland ground. Double cropping needs to be considered in irrigated areas. Research is needed to investigate dual purpose crop use and to develop a standard energy lifecycle analysis system for use in assessing crops, waste use, etc.

Agricultural Residues: Rational placement of conversion facilities is dependent upon knowledge of regional and local feedstock availability, including agricultural residues. Major issues in the use of residues as biofuel feedstock are the impact of their removal on environmental sustainability as well as temporal and spatial supply, and storage characteristics. Synthesis of information on residue requirements for maintenance of soil quality, standard metrics for defining soil quality, and the impact of residue removal is needed. Additionally, compositional differences in crop residues impact their suitability as feedstock for conversion processes. In some cases, there is opportunity to improve their suitability through plant breeding but more knowledge is needed about basic plant physiology, decomposition characteristics, and characterization of non-straw residues (i.e., oil crop residues, orchard trimmings, fruit crops, etc.). Other important points included the recognition that potential feedstock has benefit as a soil amendment that needs to be included in valuation of feedstock; the potential for use of Conservation Reserve Program biomass as feedstock, and decomposition that impacts feedstock value during storage. Partnerships will be critical in addressing the multiple objectives of utilization as feedstock, environmental sustainability, economic analyses, and ultimate commercialization of new technologies. There is a need to quantify and understand how competing uses, changing policy, and market conditions impact residue supply and feedstock supply "uncertainty." Research is needed to optimize the use of residues, to investigate dual purpose crop use, and to develop a standard energy lifecycle analysis system for use in assessing crops, waste use, etc.

Woody Biomass and Residues: Discussion covered woody feedstocks from energy crops, forest biomass, and urban wood waste. Participants examined availability, level of detail/resolution for inventories, return on investment, social implications (especially on public lands, which is a high percentage in the West) and ecosystem services, and research needs. The group talked about building a "matrix" that would essentially be a hierarch of tables containing information about feedstocks and attributes outlined in the group report. The major categories of woody biomass are: forest restoration thinnings (for fire, habitat, scenic, etc.), logging slash, hazardous fuel reduction, rangeland restoration (e.g., juniper harvesting & utilization), urban wood waste (mixed wood and urban wastes, wood waste), orchard, vineyard, nursery, and Christmas tree residues, energy crops (such as poplar and eucalyptus), mill residues, and lumber (e.g., low-grade lumber chipped for pulp).

Animal Production and Industrial Waste Streams: The biowaste sources discussed in this group included municipal solid waste (MSW), sewage sludge, animal waste and manure, and organic materials in industrial waste streams. Information about the volume, distribution, quality, and characteristics of these materials is spotty but some states have inventories with varying degrees of completeness and level of evaluation. The current uses are varied, from the use of algae to remove nutrients to the use of manure and fish waste solids in place of peat. Most are

underutilized but barriers to their use, including the lack of policies, are numerous. Inconsistent focus on these biomass sources can lead to duplication or overlap in research efforts, which a coordination scheme could mitigate. A few governmental incentives are available but integration and cooperatives between animal and food wastes are needed to make use economical. Additionally, environmentally friendly and high efficacy technologies are needed including the development of carbon sequestration techniques for long-term storage of carbon from bio-wastes.

BIOMASS SUMMARY:

The focus of agricultural feedstocks must be on crops that can be grown under deficit irrigation and on marginal irrigated and dryland ground. Double cropping needs to be considered in irrigated areas. Research is needed to optimize the use of residues, to investigate dual purpose crop use, and to develop a standard energy lifecycle analysis system for use in assessing crops, waste use, etc.

Forestry/Woody feedstocks have several constraints to overcome. The primary one is that making fuel out of cellulose is not yet economical and there are a number of technological hurdles related to using mixed feedstocks. What products can be made from mixed feedstocks and can we manage the biomass stream to aim it to highest and best end use? Therefore, what policy incentives will encourage woody biomass use, including the use of slash and thinnings? There is also the fact that much of the forest resources are in public rather than private ownership and far removed from processing facilities.

There remain many obstacles to the use of wastestreams other than those of agricultural and forestry/woody production, which can be summarized as the lack of accurate inventories, technology, incentives, and policies.

Technologies

Biochemical Conversion: Three major conclusions resulted regarding the development and improvement of biochemical conversion technologies: to develop improved fractionation methods (for example, lower cost separation of ethanol from fermentation broth), to develop a set of standard pretreatments, and to develop strategies for handling inhibitory compounds in fermentation platforms. With regards to fractionation, the Western Region has a large variety of biomass feedstocks and thus pretreatments designed for a homogeneous feedstock supply are not expected to be directly applicable to this region.

Relative to the Midwest, the Western Region has a large variety of potential feedstocks for which pretreatments cannot be individually optimized due to significant cost; a set of standard pretreatments (along with a corresponding set of rapid assays to help choose the most appropriate pretreatment for a given feedstock or mix of feedstocks and that would accommodate the variety of feedstocks) would be a practical alternative. Finally, the diversity of feedstocks in the Western Region means that sugar platforms produced from biomass saccharification are likely to be unique with respect to nonsugar, inhibitory, components. There is a extreme need to develop useful ways of disposing of the lignin-rich residual, thus there is a need for more research focused on lignin chemistry. It is clear that developing methods for handling such inhibitors will be important. This effort should include inhibitor characterization, development of detoxification processes, and development of robust microorganisms able to

tolerate such inhibitors. Overall, efforts should be multidisciplinary, include life-cycle and economic analyses, have high technical merit, and state the degree to which the project facilitates commercial implementation. A minimum value option is to recover the heat value from lignocellulosic material without having to dry it first, but ideally research could identify ways to get higher value uses from that material, thereby improving the overall economics of the fermentation-centered biorefinery.

Thermochemical Conversion: The potential benefits of technologies such as gasification and pyrolysis are that they accommodate a wide range and quality of feedstocks and afford many more product options, including alcohols but also hydrocarbon fuels. These technologies could be more readily adapted to the biomass resources available in the west (e.g., wood) than the biological conversion options and could fit well with the existing refining and fuel distribution infrastructure as well. There are a number of ongoing research programs and operating demonstration projects in the West that could be used to accelerate that adaptation and to facilitate deployment in the West. However, many challenges or barriers were noted for the current generation of gasification and pyrolysis processes and thermochemical technology in general. The group concluded that:

- Thermochemical systems do handle a multiplicity of feedstock and the systems can be quite flexible, but there is a need for some significant simplification of the systems and standardization of the products.
- Standardization of product is particularly important for pyrolysis.
- Capital costs of these gasification systems must be cut by 30-50% to get into a capital expenditure range acceptable to investors.
- There are a number of start-up (and a few established) companies that are making some very bold claims for their systems, but there are no operating facilities and only limited laboratory data to back these claims. There needs to be some means to validate these claims before investors will commit -- a regional validation center was suggested as one means to to accomplish that.

Priority research and development topics suggested included:

- Development of small-scale (e.g., farm scale) gasification systems and the accompanying small-scale synthesis gas chemistry & reactor systems to enable distributed gasification and fuel synthesis. Microtechnology could be a key enabling element of reducing the size and cost of the synthesis reactors.
- Thorough exploration of all of the potential bio-oil upgrading strategies and demonstration of the most promising chemistries. This would open the door for more pyrolysis projects.
- Development of higher-yield synthesis gas chemistry processes, particularly for Fischer-Tropsch and mixed alcohol syntheses.
- Development of improved gas clean-up systems
- Development of alternative thermochemical processes better suited to the specific carbon/hydrogen/oxygen composition of biomass.
- New systems for O_2 separation in oxygen blown gasifiers (would really cut the capital cost)
- New systems to improve the heat transfer performance in indirectly heated gasifiers
- Capture & immobilization of pollutants in synthetic gas stream (e.g., mercury, chlorine, etc.)

Other Conversion Technologies: This group identified other and emerging technologies for biomass conversion, particularly for mixed biomass in the West. Of critical concern were technologies for pretreatment, conversion, extraction, and coproduction.

- Pretreatment/fermentation technologies for lignin defractionation along with lignin recovery technology for petrochemical and other uses – systems integration was a key aspect, as were enzymes and other systems for co-processing multiple feedstocks and continuous flow transesterification technology with closed product capture. Information system needs included sensor systems for classification of mixed biomass, harvesting equipment, and other processing steps; steam explosion technology for lignin defractionation; ability to transfer LIDAR data into farm/forest biomass density determination.
- Microbial fuel cells and anaerobic digesters technologies
- Harvesting and extraction technologies for producing oil from algae and biohydrogen
- Coproduct management discussion also included on-farm nutrient management
- There was also discussion about the need for less expensive ASTM certification process, particularly for on-farm biodiesel, alternatives for transesterification for biodiesel, biogas engines, improved or new on-farm equipment for handling biocrops, mobile conversion technologies (e.g., forest residue gasification/liquefaction), and storage/handling of mixed feedstocks.

Cross-Cutting Issues

Economics and Policy: The key points for the Economics and Policy group were defining parameters for setting policy goals for the West and identifying three major policy areas. Investments in research, development and infrastructure were recommended to facilitate biofuel market emergence. Distinguishing between the roles and targets for public versus private investment is a needed step. Three major components for investigation were explored in detail.

- Infrastructure development issues
- Biofuel content standards
- Carbon index versus fuel based incentives

Business Planning: Current consumer interest in biofuels creates a unique timing for investment and funding. In the West, the market is growing. Proximity to major consumer markets is a key differentiator, especially when markets integrate well with existing infrastructure such as rail and barge, and power grids. In California and Washington, there are unique market opportunities; but distributed processing technology may limit growth unless the products could be branded.

The business challenges are numerous: technology uncertainty with a long time to maturity, siting complexity, high capital requirements, a fuels commodity market where margins are low, difficult resource sourcing and pricing, and geographic distances, to name a few. Technology may or may not be the key enabler.

Some lessons learned from business models. are: maximize the value of the resource; pursue products that have value and can be value priced; optimize siting and scale; evaluate local production, carefully select technology that avoids large capital outlays and reduce risk.

One of the common needs noted in the resource sessions and in this session was the role that the Land Grants could play in helping business understand the following:

- where the resource is within the region
- how much of that resource can be removed sustainably (particularly true for straw).
- what business model makes sense to acquire that resource (e.g., contracts with 500 individual farmers vs. a "biomass exchange" where prices could be set). The whole problem of pricing/sourcing was a BIG uncertainty for the business guys in the session. Seems like a good topic for ag or natural resource economists to me.

Environmental Sustainability: In the West, the top environmental dimensions surrounding the growth, development, transportation, conversion, and use of biomass feedstocks and bioenergy were soil, water, forest health, and atmosphere/climate. Emerging issues included infrastructure building and maintenance, energy for irrigation, genetically modified organisms, carbon sequestration, bioplastics as a significant industry product, greenhouse gas mitigation, and related social issues. The group identified critical information that was needed to make decisions about biomass energy and proposed mitigation strategies and/or policy changes for the sustainable development of biomass energy in the West.

Communications and Outreach: This group expressed the need for broader public education about issues and basic topics related to biomass production and biofuel development. A "Frequently Asked Questions" system was proposed. A set of questions about conversion and biofuel technologies was developed. However, it was noted that the scope and depth of content for any particular question varied from feedstock to feedstock. Some feedstocks, such as agricultural ones, will need more information about location and conversion. Other feedstocks will require more answers about removal of impediments or defining potential benefits. The initial list of questions proposed for the system included the following:

- How much is being produced and potentially available?
- Where is the field going?
- What are the currently available conversion technologies?
- What are the potential conversion technologies?
- What impeded developing new conversion technologies?
- How can those impediments be reduced?
- What are the potential benefits?
- What are the potential risks?
- Are there opportunities for technical support for
    - new industries
    - small-scale entrepreneurs
    - back-yard enthusiasts
- What more information is needed?
- How does this affect me?

Responses will be developed during the first half of 2008. It is expected that a webpage will be developed for the Western Center.

Rappateur

John Ferrell, US Department of Energy, EERE (Energy Efficiency and Renewable Energy)

Key points noted:

- Biomass Resource Assessment
  - – Diverse, Mixed Feedstocks
  - – Widely Distributed Feedstocks
  - – Best fit with small-scale applications
  - – Federal level – ARS and FS oriented to “Farm-scale”
  - – “Sub-regions” should be further investigated

- Biomass Resource Development
  - – Inventory existing plots from replicated field trials of dedicated energy crop and CRP lands
  - – Propose experimental design for replicated field trials of dedicated energy crops and CRP lands
  - – Agricultural residue removal tool (led by ARS/INL)
    - Corn stover FY08 focus (immediacy of problem)
    - Small grain straws sustainability
  - – DOT/SGI field trails in Spring/Summer 2008

- Education & Outreach
  - – Continued development/population of BIOWEB as an accessible information source on the Internet
  - – Outreach activities
    - SARE (Sustainability)
    - Experiment Stations
    - Extension

- Optimizing the location of biorefineries in the Western United States using Geographical Information Systems (GIS) and Linear Programming (LP) – Peter Tittmann, University of California at Davis
  - – The infrastructural layer for a GIS system is critical for further development of this biomass partnership effort

Workshop Participant List

Ag Feedstocks (Biomass Working Group)		
Jack	Breen	OSU
Jeff	Canaan	Washington Agriculture
Hal	Collins	USDA/ARS
Neil	Conklin	USDA/ERS
Nikola	Davidson	NW Biofuels Assoc
Thayne	Dutson	OSU
David	Hannaway	OSU
Peg	Herring	OSU
Ding	Johnson	U of Idaho
Stephen	Machado	OSU
Partick	Mazza	Climate Solutions
Michael	Neff	WSU
Steve	Norberg	OSU
Brian	Orlopp	Hawaii BioEnergy
Mark	Riley	U of Arizona
Dennis	Roe	WSU
Brent	Searle	ODOA
Ryan	Siegel	OSU
Woody Feedstocks (Biomass Working Group)		
Alan	Bakalinsky	OSU
Mike	Cloughesy	OFRI
Peter	Crimp	AK Energy
Terry	Fairbanks	BLM
Mark	Fuchs	WA Department of Ecology
Richard	Hess	INL
Jon	Johnson	WSU
Marcus	Kauffman	U of Oregon
Christine	Kelly	OSU
Mark	Kendall	ODOE
Mark	Lyman	
Gareth	Mayhead	UC, Berkeley
Daniel	McElligott	Cascade Grain
Mike	McKenzie-Bahr	Lane County
Joe	Misek	ODF
Blair	Moody	BLM
Ron	Saranich	USDA FS
Peter	Tittmann	UC, Davis
Ken	Williamson	OSU
Other Feddstocks (Biomass Working Group)		
John	Bolte	OSU
Catherine	Clark	OSU
Erik	Coats	U of Idaho
Kulinda	Davis	Pacific Ethanol
Conly	Hansen	USU
Charles	Kinoshita	U of Hawaii
Mari	Maratani	U of Guam
Keith	Miller	Linn Co Business Development

Mawae	Morton	Hawaii BioEnergy
Peter	Moulton	Climate Solutions
Grant	Pease	Trillium FiberFuels
Warren	Shoemaker	Pacific Ethanol
Dave	Sjoding	WSU
Tamra	Thomas	Terre-Source
Priscilla	Thompson	State of Hawaii
Anthony	Turhollow	ORNL
Yao	Yin	OSU
Yanyun	Zhao	OSU
Biochemcal (Conversion Technology Working Group)		
Jan	Auyong	Sun Grant Western Regional Center
Alan	Bakalinsky	OSU
Christopher	Beatty	Trillium FiberFuels Inc.
Jack	Breen III	OSU
Dennis	Burke	Environmental Energy & Engineering Co.
Bill	Chandler	Northwest Agrifuel
Mike	Cloughesy	Oregon Forest Resources Institute
Erik	Coats	U of Idaho
Harold	Collins	USDA-ARS
Neilson	Conklin	USDA/ERS/MTED
Nikola	Davidson	NW Biofuels Association
Kulinda	Davis	Pacific Ethanol Inc.
Chad	Davis	Sustainable Northwest
Tammy	Dennee	Oregon Wheat Growers League
Thayne	Dutson	OSU
Terry	Fairbanks	US BLM
Craig	Frear	WSU
Mike	Gamroth	OSU
Ragen	Garrison	Andritz-Sprout
Alison	Goss Eng	US DOE
David	Hammer	US EPA
David	Handaly	Imerjent LLC
Conly	Hansen	USU Biofuels Program
Michael	Harrington	WAAESD
Peg	Herring	OSU
Richard	Hess	Idaho National Laboratory
Raymond	Huhnke	Oklahoma State University
Jeff	James	U.S. Department of Energy, GFO
James	Johnson	University of Idaho
Jon	Johnson	WSU
Marcus	Kauffman	Resource Innovations
Christine	Kelly	OSU
Mark	Kendall	Oregon Department of Energy
Charles	Kinoshita	CTAHR/University of Hawaii
Chad	Kruger	WSU CSANR
Scott	Leavengood	OSU
Carol	Lewis	University of Alaska, Fairbanks

Stephen	Machado	OSU CBARC
Mari	Marutani	University of Guam
Patrick	Mazza	Climate Solutions
Jeff	Mehlschau	Weyerhaeuser
Keith	Miller	Linn County Business Development Center
Joe	Misek	Oregon Department of Forestry
Mawae	Morton	Kamehameha Schools
Peter	Moulton	Climate Solutions
Michael	Neff	WSU
Richard	Nelson	Kansas State University
Terry	Nipp	Sun Grant Association
Steve	Norberg	OSU
Dave	Panco	Weyerhaeuser Company
Steven	Petrie	OSU
Mark	Riley	University of Arizona
Dennis	Roe	WSU
Ron	Saranich	USDA Forest Service
Alex	Schroeder	Western Governors' Association
Brent	Searle	Oregon Department of Agriculture
David	Shintani	University of Nevada
Ryan	Siegel	OSU
Brent	Steel	OSU
Tamara	Thomas	Terre-Source LLC
Larry	Thompson	Western SARE
Steve	Van Mouwerik	Anderson Hay & Grain Co., Inc.
Philip	Wandschneider	WSU
Clarence	Watson	Oklahoma State University
Malcolm	Weaver	Energenetics
Yao	Yin	OSU
Jonathan	Yoder	WSU
Thermochemical (Conversion Technology Working Group)		
Stefanie	Aschmann	USDA NRCS
William	Chernicoff	USDOT
Peter	Crimp	AK Energy
Jim	Doolittle	NC Sun Grant
Mark	Fuchs	Washington Department of Ecology
Richard	Hess	INL
Ray	Hunke	SC Sun Grant
Russ	Karow	OSU
Charles	Kinoshita	U of Hawaii
Daniel	McElligott	Cascade Grain
Tom	Miles	TR Miles
Keith	Miller	Linn Co Business Development
Manae	Morton	Hawaii BioEnergy
Steve	Petrie	OSU
Ron	Saranich	USDA FS
Warren	Shoemaker	Pacific Ethanol
Dave	Sjoding	WSU
Jonathan	Yoder	WSU

Other Technologies (Conversion Technology Working Groups)		
Thayne	Dutson	OSU
Mark	Kendall	ODOE
Chad	Krueger	WSU
Dennis	Roe	WSU
Anthony	Turnhollow	ORNL
Environmental/Sustainability (Cross-Cutting Working Group)		
Stefanie	Aschmann	USDA-NRCS
Jan	Auyong	OSU
Alan	Bakalinsky	OSU
Jack	Breen	OSU
William	Chernicoff	USDOT-RITA
Catherine	Clark	OSU
Erik	Coats	U of Idaho
John	Ferrell	US DOE
Alison	Goss Eng	US DOE
David	Hannaway	OSU
Richard	Hess	INL
Ding	Johnson	U of Idaho
Jon	Johnson	WSU
Joe	Misek	Oregon Department of Forestry
Blair	Moody	US BLM
Phil	Rasmussen	Western SARE
Greg	Rorrer	OSU
Brent	Steel	OSU
Priscilla	Thompson	State of Hawaii
Yao	Yin	OSU
Economics/Policy (Cross-Cutting Working Group)		
Jack	Breen	OSU
Bill	Chandler	Northwest Agrifuel
Nikola	Davidson	NW Biofuels Association
Kulinda	Davis	Pacific Ethanol Inc.
Tammy	Dennee	Oregon Wheat Growers League
Mark	Downing	Oak Ridge National Laboratory
Thayne	Dutson	OSU
Michael	Harrington	WAAESD
Christine	Kelly	OSU
Mark	Kendall	Oregon Department of Energy
Dan	Ledoux	Teaford Canada
Carol	Lewis	University of Alaska, Fairbanks
Daniel	McElligott	Cascade Grain Products
Mike	McKenzie-Bahr	Lane County
Keith	Miller	Linn County Business Development Center
Blair	Moody	US BLM
Mawae	Morton	Kamehameha Schools
Terry	Nipp	Sun Grant Association
Brian	Orlopp	Hawaii BioEnergy, LLC
Grant	Pease	Trillium FiberFuels Inc.
Ron	Saranich	USDA Forest Service
Ryan	Siegel	OSU

Dave	Sjoding	WSU Extension Energy Program
Tamara	Thomas	Terre-Source LLC
Anthony	Turhollow	Oak Ridge National Laboratory
Philip	Wandschneider	WSU
Malcolm	Weaver	Energenetics
Kenneth	Williamson	OSU
Jonathan	Yoder	Washington State University
Communications & Education (Cross-Cutting Working Group)		
Mike	Cloughesy	Oregon Forest Resources Institute
Craig	Frear	WSU
Mike	Gamroth	OSU
Peg	Herring	OSU
Russ	Karow	OSU
Marcus	Kauffman	Resource Innovations
Gareth	Mayhead	UC Berkeley
Michael	Neff	WSU