

DRAFT

FOR PARTICIPANT COMMENT

WESTERN REGIONAL ROADMAP WORKSHOP SUMMARY

August 8-9, 2006
Sacramento, California

Roadmap Chair: Ralph Cavalieri

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Purpose

EPAct 2005 requires the Vision and Roadmap documents developed by the Biomass R&D Technical Advisory Committee be updated. A Vision workshop was held in November 2005 and Vision goals were updated. In 2006, three roadmap workshops were held to highlight the regional differences in the United States with respect to biomass barriers, R&D, and policies related to biomass technologies. Over 100 experts from industry, academia, and government participated in the three regional Roadmap Workshops. The structure of the original Roadmap was kept intact and the discussions focused on key barriers to the biomass sector, R&D to address those barriers, and policies to help facilitate the R&D were discussed.

In the following sections, the results of the Western Regional Roadmap Workshop are highlighted. The summary is organized based on the major categories discussed during the workshop: Feedstocks, Infrastructure, Processing and Conversion, End Use, and Cross Cut. Policy discussions are woven into the main categories which also include barriers to meeting Vision goals and R&D needed to overcome those barriers. A list of attendees for the Western Regional Biomass Roadmap Workshop can be found in Appendix B.

This document contains:

- *A summary of the discussion of the Western Regional Roadmap Workshop. Workshop participants are asked to provide comments on the document.*
- *For reference purposes, Appendix A provides a compilation of participant inputs posted during the workshop. Numbers in parentheses indicate number of votes received during prioritization process. Appendix B is a list of the Western Regional Roadmap Workshop participants.*

Following completion of each of the three regional roadmap workshops, combined results will be used to develop a draft Roadmap. All workshop participants will be provided the opportunity to comment on the Roadmap.

1. FEEDSTOCKS

Plant Science and Genetics and Feedstock Production are important to the biomass industry. Major areas of focus were identified including: Decentralization; Ecosystem Services, Crop Yield, Resource Sustainability and Farm Profitability. Each of these areas is extremely important if progress in feedstocks is to be made towards achieving the Vision goals for a biobased economy in the future.

Technical Challenges

A number of technical challenges face the biomass industries in plant science, genetics, and feedstock production for conversion to energy and products. Many of these challenges are specific to the western region of the United States.

The western region is comprised of states from Washington to California to Texas to North Dakota and includes Alaska and Hawaii. Management of these diverse and dispersed feedstocks is technically challenging across the vast areas of collection and in the management of dedicated growing areas of biomass for energy and products. Although there is a large portion of public land in the west available for biomass feedstocks there is a lack of access to biomass resources and sustainability of those resources due to water scarcity and multiple uses. In addition, due to the diversity of the terrain from arid deserts to Rocky Mountains, the amount of arable land that could be dedicated to biomass feedstocks is limited due to the higher value of biomass for food and cash crops in many of the western states. There is a high cost of wildfire suppression related to forestry residues in the vast tracts of forest land. There is a misguided perception that there are no bio-resources in the west which must be overcome to achieve the Vision goals and to provide a working base of biomass resources for biobased energy and products.

High priority barriers identified in the western region are:

- Financial return to farmers
- Equipment development/ cost sustainability
- Farm subsidies. Paying farmers not to grow. Level the playing field on biofuel subsidies
- Year round supply
- High R&D focus on a few crops
- Sustainability
- Competing uses for crops

Additional research needs include:

- Consumer acceptance of GMO crops
- Use and application of remote sensing, GPS and GIS for inventories and on farm use
- Carbon harvesting trade offs with soil quality and arid soils
- Limits on using CRP lands while preserving conservation values

Research Needs for Achieving the Vision Goals

R&D needs for the Western region of the United States were discussed with respect to the barriers identified for deployment of biomass technologies. Workshop participants developed R&D strategies for each phase of biomass development and outlined a timeframe to achieve the Vision goals for biobased fuels, power, and products. Additionally, high priority R&D needs were identified.

The highest priority as well as the first step needed to accomplish biomass R&D in the west is an assessment of biomass with respect to sustainability, ecological potential of the region. Specific R&D by final product is outlined below. They are organized by priority within each product group.

Biofuels and Coproducts

Near Term R&D

- Existing crops: Quantify biomass potential in west (all sources)

Mid Term R&D

- R&D in feeds (yield increases, harvesting, reducing inputs, densification)
- R&D biofuel options with low water demand
- Implement research agenda for Office of Science into FACA roadmap (begin now for M/L)

Long Term R&D

- Algae feedstocks (cross-cut fuels and products)

Bioproducts

Near Term R&D

- Biochemistry: long term sustainability of feedstock production (soil health, residual removal) utilization of animal waste

Mid Term R&D

- Investigate plants with improved oil characteristics/yields
- Modify carbohydrate composition of plants for improved utilization

Biopower and Co-products

Near Term R&D

- R&D to build waste water treatment plants as better biogas / bioenergy producers; R&D landfill design to facilitate biogas production and harvest
- Natural vegetation

Mid Term R&D

- Co-product streams to bioenergy
- Feedstock with low Silicon
- Phytoremediation and energy crop co-production

Public Policy Needs for Achieving the Vision Goals

A number of policies are needed to help promote the biomass industries in plant science, genetics, and feedstock production for conversion to energy and products. Many of these challenges are specific to the western region of the United States.

Incentives are needed to change plantings on CRP lands, which should be opened for biomass production for biofuels & bioenergy. There should be incentives for water reduction in crop production or low-water intensive crops and residues. Working landscape and natural resources should be retained. Aggressive policies are needed for forest health & sustainability to result in economic sources of fuel for energy supplies. Policies should foster change in farm subsidies to reflect energy crop values; agriculture policies/programs to encourage energy crops. Legislatures need to think regionally in order to support biofuels requirements and rationalize policies regarding utilities and infrastructure access.

High priority policies identified in the western region for biomass are:

- Biomass products commodity exchange; potential for cooperatives to grow and process feedstocks that would be traded through a national exchange; create a system similar to lumber futures contract mechanisms
- Support policies for lignocellulosic market entry; including incentives for optimizing yield per acre; policies to support proof of concept; tax incentives
- Investment tax credits for productive lands and/or carbon credits
- provide farmer incentive to have farm energy independence; credit for use not disposal; policies to protect biomass generators (farmers) from risks & transitions; examine capital gains tax policy

Additional policy needs include:

- State reduction of property tax. Farmers to preserve land use for agriculture
- detailed analysis of farm subsidy programs; forestry & farm crops are agriculture, policies should apply to both; when analyzing farm subsidies, be cognizant of world trade talks (Doha round) and impact of subsidies on world trade agreements
- Personal property tax reduction to incentivize agriculture/biofuels
- Consider feedstock supply from international perspective
- Implement long term contracts (feedstock, power, etc., i.e. 10 years)
- Sunset subsidy based on commercial success

2. INFRASTRUCTURE

Transportation and Distribution Systems make up the biomass infrastructure for this workshop. Within those systems: Harvesting, Transportation, and Storage are key areas in which biomass R&D can be applied to achieve the Vision goals of increased utilization of biobased fuels, power, and products.

Technical Challenges

A number of technical challenges face the biomass industry infrastructure in harvesting, transportation, and storage. Many of these challenges are specific to the western region of the United States.

The western region is comprised of states from Washington to California to Texas to North Dakota and includes Alaska and Hawaii. Infrastructure for the biomass industry faces technical challenges due to the vast areas of collection that is comprised of rugged landscape containing forest, cities, and agricultural residues. The diversity of the terrain from arid deserts to the Rocky Mountains; the challenges for harvesting, transporting and storing biomass for processing is enormous. Supply and demand disconnect in the western region is another barrier (i.e., the demand for energy is more than the supply). There is also a lack of transmission and interconnect. Current infrastructure is not compatible with the large distances biomass must be transported, creating economic challenges.

High priority barriers identified in the western regional biomass are:

- Year round supply
- Feedstock density
- Collection, storage, and transportation economics

Additional barriers identified are:

- Collection, storage, and transportation economics
- Lack of biomass collection infrastructure "no biomass collection or BFI"
- Sorting

Research Needs for Achieving the Vision Goals

R&D needs for the Western region of the United States were discussed with respect to the barriers identified for deployment of biomass technologies. Workshop participants developed R&D strategies for each phase of biomass development and outlined a timeframe to achieve the Vision goals for biobased fuels, power, and products. Additionally, high priority R&D needs were identified.

Harvesting subcategories:

Waste

- Near Term: Develop technology to sort & convert MSW animal & plant (1)
- Near/Mid Term: Research more efficient methods of gathering & collecting municipal green waste

Woody

- Near Term: Further R&D on biomass harvest solutions for variety of ag & forest residues

Herbaceous

- Near/Mid Term: What is best harvest solution/s for crop residues that work over wide variety of feedstocks

Transportation subcategories:

Conventional

- Near to Mid Term: Research reduced transportation costs, more tons transported per unit of energy

Advanced (Near to Mid Term)

- Biofuel pipeline R&D "test loop" (3)
- Explore transport of biomass as slurry/R&D of slurry movement of feedstocks & water Mid term (2)

In Appendix A, Exhibits 2 through 4 illustrate the near and mid term biomass R&D needs to achieve the Vision goals. Harvesting, Transportation, and Storage are key elements of the biomass industrial infrastructure which need more R&D to develop more cost efficient industrial processes.

Storage subcategories:

Wet

Near Term

- Solicitation of equipment R&D for material handling
- Improve processing technology to increase density, extend storage life/wet/dry storage issues

Mid Term: Densification

Oil

Mid Term: Integration/densification (bulk energy) /characterization /purification /separation/scalability

Public Policy Needs for Achieving the Vision Goals

A number of policies are needed to help promote infrastructure in the biomass industry. One of these challenges specific to the western region of the United States is that rational policies regarding utilities and infrastructure access need to be developed in order to promote bioenergy.

Additional policies identified were to create tax incentives for infrastructure development and to increase truck weight limits for biomass. Both of these policy recommendations relate to the large size of the western region of the United States. Money needs to be pumped into infrastructure development to cover these large areas. In addition, truckload weight increases will help collection of the dispersed feedstocks and transport over large areas.

3. PROCESSING AND CONVERSION

Pre-Processing, Conversion face numerous technical challenges. These challenges vary from: Analysis of Processes Found in Nature; Increased Yield; Oils, Sugars, and Protein Platforms; to New Approaches to Separations. A number of technical challenges face the biomass industry in

pre-processing and conversion. Many of these challenges are specific to the western regional of the United States.

Technical Challenges

The western region is comprise of states from Washington to California to Texas to North Dakota and includes Alaska and Hawaii. Infrastructure for processing and conversion for the biomass industry faces technical challenges due to the vast areas of collection and the diversity of feedstocks.. Current processing and conversion infrastructure is not compatible with the large distances biomass must be transported and its diversity creating economic challenges.

High priority barriers identified in the western region biomass workshop are:

Research Needs for Achieving the Vision Goals

R&D needs for the Western region of the United States were discussed with respect to the barriers identified for deployment of biomass technologies. Workshop participants developed R&D strategies for each phase of biomass development and outlined a timeframe to achieve the Vision goals for biobased fuels, power, and products. Additionally, high priority R&D needs were identified.

Conversion activities:

Near Term:

- Conversion processes that accept diverse feedstocks
- Assess thermochemical limitations & energy balances / research efforts focused on thermochemical conversion methods
- Develop low NOx process fuel & energy production
-

Mid Term:

- Develop green diesel product options (green gasoline too)
- Developing and using value-added co-products (e.g. CO₂, germ oil, biochemicals)

Long Term:

- Continue enzyme research for cellulose hydrolysis and fermentation (simultaneous)

Public Policy Needs for Achieving the Vision Goals

A number of policies are needed to help develop biomass technologies related to preprocessing, processing, and conversion.

Preprocessing and Conversion

- Flexibility the in environmental permitting to implement emerging conversion tech/facilities
- Incentives for capital investment in biofuels, e.g. accelerated opportunity
- Policy to support development of supplier base for building plants - economic development policy

- Consolidate & coordinate permitting process; remove complexity, reduce amount of time required

Transportation and Storage

- Tax incentives for infrastructure development
- Increase truck weight limits for biomass

4. END USE/X-Cut

End Use and Distribution of biomass finished products such as biopower, biofuels, and bioproducts encompasses a vast area of the biomass industry. Expanding product uses and applications as well as certification and product specification are high priority areas in which R&D efforts must be focused. Other areas which have been highlighted as priority are:

- Education
- Public Outreach
- Financing
- Incentives
- Environmental Measures
- Regulatory Environmental Systems Integration

Technical Challenges

The western region is comprised of states from Washington to California to Texas to North Dakota and includes Alaska and Hawaii. Infrastructure for the biomass industry faces technical challenges through the vast areas of collection comprising of rugged landscape containing forest and agricultural residues. The diversity of the terrain from arid deserts to the Rocky Mountains and the challenges for harvesting, transporting and storing biomass for processing is enormous. Current infrastructure is not compatible with the large distances biomass must be transported, creating economic challenges.

Research Needs for Achieving the Vision Goals

R&D needs for the Western region of the United States were discussed with respect to the barriers identified for deployment of biomass technologies. Workshop participants developed R&D strategies for each phase of biomass development and outlined a timeframe to achieve the Vision goals for biobased fuels, power, and products. Additionally, high priority R&D needs were identified.

Standards, Codes, and Certification

- Methodology and analytical techniques for development of standards and specifications
- Natural compatibility guide for biofuel application
- Independent and government testing and certification labs (including sustainability)

Research Infrastructure and Scope

- National effort on R&D rather than individual... (how do we do this?)
- Extension for R&D, existing and new programs

Systems Analysis (LCS, Markets, Optimization)

- Systems analysis optimization and efficiency of bioenergy systems
- Assess national and international impacts of feedstock competition of food, feed, fiber, energy,(land use, policy)
- Market analysis for highest use of biomass (business)

Education, Training, Outreach and Information

- Increase integration of national labs with universities on R&D
- Develop curriculum for K-12, university and technicians

Data Development Dissemination

- Feedstock characteristics (Properties)
- Environmental and permitting database
- Data for economic analysis

Public Policy Needs for Achieving the Vision Goals

A number of policies are needed for end use of biomass technologies. In addition, there are many crosscutting policy recommendations that were identified as high priority in the western region of the United States.

Western Region Recommendations

- Aggressive policies for forest health & sustainability resulting in economic fuel treatment for energy supply (west)
- Rationalize policies regarding utilities and infrastructure access (west)
- Legislatures need to think regionally in order to support biofuels requirements. (west)
- Aggressive policies for forest health & sustainability resulting in economic fuel treatment for energy supply (west)
- Change farm subsidies to reflect energy crop values; agriculture policies/programs to encourage energy crops (west)
- Rationalization of national regional, and local environmental regulation with bioenergy policy

End Use policy Recommendations:

- Establish policy that provides incentives for all biofuels equally on an energy content basis
- Tax incentives: Reduction in personal property tax in order to purchase flex fuel vehicles; to increase market entry; for bioproducts, biogas and bioheat; develop a just and equitable tax structure for biofuels - consider factors such as volumes, GGE, emissions.
- Biomass products commodity exchange; potential for cooperatives to grow and process feedstocks that would be traded through a national exchange; create a system similar to lumber futures contract mechanisms
- Support policies for lignocellulosic market entry; including incentives for optimizing yield per acre; policies to support proof of concept; tax incentives
- Rationalize standards for product performance; harmonize fuel specifications; create flexible and open policies to promote innovation and uniform application of standards

- Create a tax credit for the general public to promote fueling vehicles with E85; require submission of receipts as a monitoring process

Crosscutting Policy Recommendations for Biomass technologies

- Require best practices, development as industry grows; best practices should relate to codes and standards and require data collections
- Expand graduate training fellowships and expand funding for university and trade programs for biofuels and bioproducts; this should be similar to national defense education act, focus on security issues and reducing dependence on imported fuels and chemicals; attract a combination (multidisciplinary approach) of environmental scientists, agronomists, engineers, and business students - should include university programs and trade schools.
- No child left behind for biofuels engineering and science curricula; need for a long-term commitment for R&D and education; blue ribbon panel to develop core undergraduate and graduate curriculum; leverage programs such as NSF/ATE and NSF/PFI to address training/trades
- Renewable fuels standards and renewable portfolio standards should reflect 25 x 25 goals
- Funding for multi-year multi-agency R&D initiative with well defined goals and milestones for next generation technologies “Moon shot program” it should include examining strategic needs for fuels and chemicals and determine if biomass can meet shortfalls. It should also include an analysis of the need for an international policy to recognize for LCA and food vs. fuel; existing assets; what are the trade-offs on using edible oils food vs. fuel from and international perspective.
- Consistent policies for fuels mandates/incentives - federal/state, state/state regional, and regionally. There needs to be a rational framework
- Loan guarantees; cost share by government state/fed combined incentives
- R&D strategy and funding needs to be more aggressive. Increase the number of competitive research grants and reduce earmarks
- Establish regulation and policy for carbon management
- Policies to deal with environmental trade-offs
- Federal funds for complete and accurate systems analysis
- Adopt a strong deployment program both near and long term
- Internalize benefits

APPENDIX A: West Roadmap Inputs Matrix

DOCUMENTATION OF CARDS POSTED DURING CENTRAL
REGIONAL ROADMAP WORKSHOP SESSIONS

DRAFT

**WESTERN REGIONAL
BIOMASS ROADMAP WORKSHOPS**

**UNEDITED DOCUMENTATION OF
RECOMMENDATIONS PROVIDED
BY WORKSHOP PARTICIPANTS ON:
BARRIERS TO ACHIEVING VISION GOALS
AND
POLICY AND RD&D RECOMMENDATIONS TO
OVERCOME THOSE BARRIERS**

WESTERN BARRIERS															
Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Barriers To Achieving Vision Goals															
Consumer acceptance of GMO crops	3		x												
Equipment development/ cost sustainability	10			x											
High R&D focus on a few crops	6			x											
Use and application of remote sensing, GPS and GIS for inventories and on farm use	2			x											
Carbon harvesting trade offs with soil quality and arid soils	2			x											
Farm subsidies. Paying farmers not to grow. Level the playing field on biofuel subsidies	8			x											
Better monitoring inventories of fertilizer and pesticide use goes to LCA				x											
High cost of wildfire suppression - forestry residue. Alternative fate of residue. Non-market cost. Off-set costs.		x													
Financial return to farmers	11														
Sustainability	6			x	x										
Declining working and landscapes		x		x											
Lack of high quality data for economic analysis of varied feedstocks				x											
Water	5	x		x											
Impact on primary product				x											
Amount of arable land	1	x		x											
Management of dispersed feedstocks	7	x		x											
Competing uses for crops	5			x											
Lack of access to biomass resources and sustainable ways; feedstock sufficiency; large portion of public land in the west	4	x		x											
Limits on using CRP lands while preserving conservation values	1			x											

WESTERN BARRIERS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Barriers To Achieving Vision Goals															
Perception of no bio-resource in the west.		x		x											
feedstock density	7				x										
Lack of biomass collection infrastructure "no biomass collection or BFI"	2				x										
Sorting					x										
Capital stock conversion and agriculture;	3				x										
Technology to deal with rugged landscape agriculture and forest residues.	3	x			x										
Year round supply	8			x			x								
Collection, storage, and transportation economics	4				x	x	x								
Uniformity and diversity of feedstock; integration of diverse feedstocks into large plants.	7							x							
Enzyme cost	4							x							
Biomass/energy zones or energy sheds	1							x							
Scalability	11								x						
Complex permitting process; time consuming	5								x						
Water	5	x							x						
Conversion efficiency	3								x						
Limited two to four year scale up to operate biofuels plants	1								x					x	
Refining capacity	1								x					x	
Hydrolysis of cellulose	1								x						
Focus on one at a time feedstocks; need flexible conversion technology	1								x						
Public perception of biopower	3								x				x		
Distribution infrastructure	4									x					
Inefficient channels to market distribution										x				x	
Pipeline distribution of ethanol										x				x	
Supply demand disconnect in the west		x								x				x	

WESTERN BARRIERS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Barriers To Achieving Vision Goals															
Lack of transmission and interconnection	8	x								x			x		
Biopower purchase programs										x			x		
Compatibility with existing fuels - distribution	3										x			x	
Lack of markets driving development	2										x				
Cost vs. Value; conversion costs for changing over to biobased intermediates											x				X
Competing in the market; ensuring product quality; standards and quality of products, remove impurities; product functionality/quality/safety	4										x			x	X
Competing uses of fuel vs. power											x		x	x	
Vehicle technology e.g. E85 hybrid fuel specifications	1										x			x	
Consumer acceptance of fuels/infrastructure; vehicle power trains											x			x	
Concerns about criteria air pollutants of transportation fuels; increases in hydrocarbon and NOx and VOC.											x			x	
Conflicts with environmental policy	1										x				
Availability of cheap coal											x		x		
Long term consistent national commitment to R&D; eliminate conflicting regulations; don't repeat past mistakes in policy development - ensure that energy policies are long term and consistent; create a sustained will among the public	15											x			
Capital cost; scale of technology	12											x			
Risk management	6											x			
Higher capital for new technology	1											x			
Regulatory consistency, level playing field. Regulatory/policy cost competitiveness	2											x			
Lack of environmental performance data-lca												x			
Environmental regulation	1											x			

WESTERN BARRIERS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Barriers To Achieving Vision Goals															
Lack of R&D funding for technology advances in the west		x										x			
Attracting students; lack of educational R&D funds	x											x			
Inadequate systems analysis and information	3											x			
Public perception/consumer education	9										x	x			
Lack of best management practices	1											x			
Low energy density (densification)											x				
Database of current processes i.e., efficiencies yields, etc.	1										x	x			
National means to cheaply assess new technologies; energy balance												x			
Naming biofuel too early i.e., ethanol											x			x	

WESTERN POLICY RECOMMENDATIONS															
Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Recommended Policy Measures for Achieving Vision Goals															
Funding for multi-year multi-agency R&D initiative with well defined goals and milestones for next generation technologies (Moonshot program) it should include examining strategic needs for fuels and chemicals and determine if biomass can meet shortfalls. It should also include an analysis of the need for an international policy to recognize for LCA and food vs. fuel; existing assets; what are the trade-offs on using edible oils food vs. fuel from and international perspective.	5											x			
Rationalization of national regional, and local environmental regulation with bioenergy policy	2	x										x			
Leadership - establishing a champion												x			
Energy supply security												x			
International oil use and reuse policy												x			
Certification of sustainable practice including international markets and supply (don't export environmental degradation and environmental justice NIMBY)												x			
Internalize benefits	3											x			
Consistent policies for fuels mandates/incentives - federal/state, state/state regional, and regionally. There needs to be a rational framework	8											x		x	
Renewable fuels standards and renewable portfolio standards should reflect 25 x 25 goals	5											x	x	x	
(No child left behind) for biofuels engineering and science curricula; need for a long-term commitment for R&D and education; blue ribbon panel to develop core undergraduate and graduate curriculum; leverage programs such as NSF/ATE and NSF/PFI to address training/trades	6											x			
Buy green for general public												x			

WESTERN POLICY RECOMMENDATIONS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Recommended Policy Measures for Achieving Vision Goals															
Link legislatures and state research and development institutions needs												x			
Increase transportation funds to states that convert to biofuels and support standards and education	1											x		x	
Need a more universal definition of biomass for considerations under the RFS and RECs	1											x			
Policies to take advantage of US technologies												x			
Loan guarantees; cost share by gov't; state/fed combined incentives	4											x			
R&D strategy and funding needs to be more aggressive. Increase the number of competitive research grants and reduce earmarks	4											x			
Expand graduate training fellowships and expand funding for university and trade programs for biofuels and bioproducts; this should be similar to national defense education act, focus on security issues and reducing dependence on imported fuels and chemicals; attract a combination (multidisciplinary approach) of environmental scientists, agronomists, engineers, and business students - should include university programs and trade schools.	8											x			
Establish enterprise zones and partnerships												x			
Require best practices, development as industry grows; best practices should relate to codes and standards and require data collections	10											x			
Establish regulation and policy for carbon management	3											x			
Policies to deal with environmental trade-offs	1											x			
Federal funds for complete and accurate systems analysis	1											x			
Adopt a strong deployment program both near and long term	2											x			
On all incentives develop a means for tracking and auditing and conducting due diligence												x			
Biomass products commodity exchange; potential for cooperatives to grow and process feedstocks that would be traded through a national exchange; create a system similar to lumber futures contract mechanisms	4			x							x				

WESTERN POLICY RECOMMENDATIONS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Recommended Policy Measures for Achieving Vision Goals															
Support policies for lignocellulosic market entry; including incentives for optimizing yield per acre; policies to support proof of concept; tax incentives	4			x					x		x			x	
Require all cars to be flex fuel											x			x	
Legislatures need to think regionally in order to support biofuels requirements.		x									x	x		x	
Improve efficiency i.e., CAFÉ standards											x			x	
Establish carbon content standards for motor fuels	1										x			x	
Establish energy conservation policies for all energy uses											x				
Develop product labeling that reflects the carbon footprint and the embodied energy e.g., Energy Star Program											x				x
More aggressive RFS that credits all biofuels on a GGE basis											x			x	
Tax transportation fuels in order to develop and improve and use tax revenues to improve public transportation											x			x	
Create a tax credit for the general public to promote fueling vehicles with E85; require submission of receipts as a monitoring process	3										x			x	
Establish policy that provides incentives to all biofuels equally on an energy content basis	6										x			x	
Extension of CAFÉ credits or other incentives to vehicle manufacturers for production of flex fuel vehicles.											x			x	
Rationalize standards for product performance; harmonize fuel specifications; create flexible and open policies to promote innovation and uniform application of standards	2										x				
Renewable fuel impacts on emission standards of technology											x			x	
Tax incentives: Reduction in personal property tax in order to purchase flex fuel vehicles; to increase market entry; for bioproducts, biogas and bioheat; develop a just and equitable tax structure for biofuels - consider factors such as volumes, GGE, emissions.	5										x				

WESTERN POLICY RECOMMENDATIONS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Recommended Policy Measures for Achieving Vision Goals															
Procurement - minimal purchase of biofuels by the federal government; all educational institutions that accept federal dollars should convert to biofuels; all fed/state/local govts should use biofuels.											x			x	
Rationalize policies regarding utilities and infrastructure access		x								x	x		x		
Aggressive policies for forest health & sustainability to resulting economic fuel treatment for energy supply	3	x	x	x	x										
Change farm subsidies to reflect energy crop values; ag policies/programs to encourage energy crops	3	x		x											
Investment tax credits for productive lands and/or carbon credits	1			x											
Monetize CO2 emissions & sequestration	13			x											
State reduction of property tax. Farmers to preserve land use for agriculture				x											
detailed analysis of farm subsidy programs; forestry & farm crops are agriculture, policies should apply to both; when analyzing farm subsidies, be cognizant of world trade talks (Doha round) and impact of subsidies on world trade agreements				x											
personal property tax reduction to incentivize ag/biofuels				x										x	
consider feedstock supply from international perspective				x											
provide farmer incentive to have farm energy independence; credit for use not disposal; policies to protect biomass generators (farmers) from risks & transitions; examine capital gains tax policy	1			x											
implement long term contracts (feedstock, power, etc., i.e. 10 years)				x											
incentives shift to production (away from non-production): CRP land; open CRP lands for biofuels & bioenergy; CRP land used for feedstock R&D (west)	11	x		x											
incentives for water reduction in crop production or low-h2o crops or residues (west)	4	x		x											
retain working landscape/natural resources	4	x		x											

WESTERN POLICY RECOMMENDATIONS

Category	Votes Received	Western Specific	Plant Science/ Genetics	Feedstock Production	Harvesting	Transportation	Storage	Pre-Processing	Conversion	Distribution	End Use	X-Cut	Biopower	Biofuels	Bioproducts
Recommended Policy Measures for Achieving Vision Goals															
sunset subsidy based on commercial success				x											
tax incentives for infrastructure development	5				x	x	x								
increase truck weight limits for biomass	1					x									
flexibility in environmental permitting to implement emerging conversion tech/facilities	1							x	x						
incentives for capital investment in biofuels, e.g. accelerated opportunity	10								x					x	
policy to support development of supplier base for building plants - economic development policy	3								x						
consolidate & coordinate permitting process; remove complexity, reduce amount of time required	11	x							x						
create floor price for fossil fuels/energy	4									x					
require/incentivize gas stations to offer E85;property tax credit/reduction for biofuel station owner (infrastructure offset)	1	x									x			x	

**WESTERN BIOMASS REGIONAL ROADMAP WORKSHOP
RD&D RECOMMENDATIONS FOR ACHIEVING VISION GOALS**

Exhibit 1: Plant Sciences & Feedstock Production			
First Steps	Quantify biomass potential in west (all sources) 7 Regionally specific: <ul style="list-style-type: none"> - natural vegetation - Waste Water Treatment Plant (WWTP) - CRP model - animal - marine Identify large reliable consistent sources of biomass or intermediates for western region 1 What is a realistic biomass production level from current CRP lands 1 Characterize bioenergy potential from forest/grassland residue		
Timeframe Subcategory	NEAR	MEDIUM	LONG
Biofuels and co-products	Existing crops <ul style="list-style-type: none"> - year-round feedstock; R&D to stagger harvest windows for different regions in the west - sugar/grain ethanol and biodiesel - residuals (ag, forest, urban) - develop western oil seed cop agronomy by rainfall and climate zone - R&D on feedstocks for Western states that minimize water and fertilizer inputs; biomass crops systems R&D for multiple conditions unique to the west; modification of feedstocks to reduce environmental impacts of product; develop western energy crops ; What changes are needed in existing CRP program to produce needed amount of biomass; develop improve western specific feedstocks/crops that are saline and drought tolerant; R&D to dramatically increase yields and reduce fossil energy inputs - Evaluate competitive water uses and competing water/energy crops 	Economics / Cellulosic Ethanol and Green Diesel <ul style="list-style-type: none"> - research production of cheaper carbohydrates - research silviculture and to maximize value added per acre; silvicultural R&D for soil productivity and low and no-water environment dramatic improvement needed in water use efficiency impacts of soil nutritive and productivity as a function of take-off (data) standards and challenges in using new feedstock species (if invasive species and pest issues) Crop adaptation breeding and genetics <ul style="list-style-type: none"> - improve the utility of crop residues (1) - R&D in feeds (yield increases, harvesting, reducing inputs, densification) (6) 	Hydrogen Potential for importing feedstocks Investigate plants that contain cellulases (xcut fuels and products) Algae feedstocks (xcut fuels and products) (4)

	<ul style="list-style-type: none"> - Ensure western biomass assessments (sustainability, eco potential) (16) <p>Agronomy</p> <ul style="list-style-type: none"> - Use of GIS and remote sensing for land use planning inventory and monitoring and enforcement - Gray water / water treatment - Research on yield – pest-water of polycultures versus genomics of monoculture 	<ul style="list-style-type: none"> - New crops - R&D biofuel options with low water demand (2) - Implement research agenda for Office of Science into FACA roadmap (begin now for M/L) (3) 	
<p>Bioproducts</p>	<p>Biochemistry</p> <ul style="list-style-type: none"> - forestall oils / residues - wood fiber products <p>animal rendering / oils</p> <ul style="list-style-type: none"> - utilization of fish/ coastal production waste - utilization of animal waste (4) - long term sustainability of feedstock production (soil health, residual removal) (6) 	<p>Investigate plants with improve oil characteristics/yields (2)</p> <p>Modify carbohydrate composition of plants for improved utilization (2)</p> <p>Research mechanisms to transfer water value to watersheds for bio growth and integration</p> <p>GMO Use: study how to control and optimize use of GMO crops, bugs, public perception</p>	<p>Optimize soil chemistry by adding c-60 carbon (1)</p> <p>Develop multi-trait crops suitable for bioenergy and bioproducts</p> <p>Develop plants that are suitable for dual uses (grain and cellulose availability (M/L)</p>
<p>Biopower and co-products</p>	<p>Wood and biogas</p> <p>R&D to build waste water treatment plants as better biogas / bioenergy producers; R&D landfill design to facilitate biogas production and harvest (2)</p> <p>Natural vegetation (1)</p>	<p>Co-product streams to bioenergy (2)</p> <p>Low Si feedstock (1)</p> <p>Phytoremediation and energy crop co-production (1)</p>	

Exhibit 2: Harvesting	
Subcategory	Near-term and N/M-term R&D
Waste	Develop technology to sort & convert MSW animal & plant (Near Term) (1) Research more efficient methods of gathering & collecting municipal green waste (N/M-term) (1) transfer stations / central landfill/recycling
Woody	Further R&D on biomass harvest solutions for variety of ag & forest residues (Near Term) (8) Develop improved harvest systems for small diameter wood (N/M-term) (2) Develop logging-level densification technologies (1) Whole tree vs. terrain cut to length chaparral
Herbaceous	What is best harvest solution/s for crop residues that work over wide variety of feedstocks (N/M-term) (2) Grain - one step residue/material sizing & processing (1)

Exhibit 3: Transportation	
Conventional (Near to Mid Term)	Study methods to improve rail throughput Mid - term (1) Rail barge truck: logistics & equipment
Advanced (Near to Mid Term)	Biofuel pipeline R&D "test loop" (3) Explore transport of biomass as slurry/R&D of slurry movement of feedstocks & water Mid term (2) Studies (LCA) equipment development integration

Exhibit 4: Storage		
Subcategory	Near Term	Mid Term
Wet	<p>Integration/densification (bulk, energy)/characterization/purification/separation/scalability</p> <p>solicitation of equipment R&D for material handling N (3)</p> <p>Improve processing technology to increase density, extend storage life/ wet/dry storage issues (3)</p>	<p>densification (2)</p> <p>stability/methods of quality assurance/water treatment/integration</p> <p>/ understand better how to do distributed mfg and transportation / develop technology to convert biomass to easily transportable form / how to handle collection, transport, and storage for a diversity of feedstocks / feedstock pretreatment to utilize diverse feedstocks</p>
Dry	<p>integration/densification(bulk, energy) characterization/purification/separation scalability</p> <p>stability/Quality Assurance/integration/equipment for reclamation/densification</p> <p>granularization of feedstocks for optimum performance</p>	
Oil		<p>integration/densification(bulk energy)/characterization/purification/separation/scalability (1)</p> <p>develop portable pyrolysis for bio-oils/ classification of feeds by "processibility" or conversion type / separation of lignin and cellulose or hemi-cellulose / forestry & agricultural residues portable conversion systems for field use to higher density feeds / compatibility of feedstock blends to optimize economics / year-round feed: R&D to understand process robustness for different feeds biochemical conversion</p>

Exhibit 5: Conversion				
DEVELOP NEW OR EMERGING TECHNOLOGIES TO FEED INTO NEAR TERM RESEARCH FOR 2006 – 2010	2006 – 2010	2010 – 2015	2015 – 2020	2020+
<p>Biochemistry:</p> <ul style="list-style-type: none"> - robust ethanol; - low cost hydrolysis <p>Thermochemical (gasification)</p> <ul style="list-style-type: none"> - gas cleanup - Gas to fuel and products at appropriate scale - Complete integration and pinpointing / defining the opportunities <p>Pyrolysis Research</p> <ul style="list-style-type: none"> - improve qualities of biofuels - separations by or after pyrolysis - maximize development of anaerobic digestion for fuels and biopower <p>Power Heat</p> <ul style="list-style-type: none"> - Vision goals unlikely <p>DG & CHP</p> <ul style="list-style-type: none"> - environmental compliance - mass production - Resource matching / location - Thermal industrial uses that replace energy demands from fossil fuel based energy production - CHP / Biopower; investigation of Biorefinery residues for CHP (corn Ethanol, cellulosic Ethanol,) contribute to biopower goals 	<p>Use existing infrastructure for:</p> <ul style="list-style-type: none"> - co-processing of biomass streams in petroleum refineries (triglycerides, bio-oil, deployment and development) - co-processing (add products) to pulp and paper mills - corn mills - Ethanol from food wastes 	<p>Cost competitive cellulosic ethanol is proven</p> <p>Achieve economy of scale on GTL</p> <p>Deploying the technologies that utilize existing infrastructure</p> <p>Demonstration of emerging / new technologies as stand alone R&D of advanced technologies</p>	<p>Deployment of emerging new technologies demonstration of advanced technology</p>	<p>Hydrogen??</p> <p>Deployment of advanced technology in high cost feedstocks</p> <p>Integrate processes to use bio and thermochemical conversion for multiple feedstocks</p>

NOTE: IN SUMMARY, MESH ABOVE TABLE ON CONVERSION RD&D TIMELINE WITH SPECIFIC RD&D ACTIVITIES LISTED IN TABLE BELOW

Exhibit 6: CONVERSION R&D ACTIVITIES		
Near	Mid	Long/Far
<p>Go Regional: feedstocks type, processes type, products type, infrastructure, west/central/east / what is the best conversion approach for the western region? Given diversity of feedstocks (2)</p> <p>demonstrate biomass to liquids using western feedstocks (2)</p> <p>conversion processes that accept diverse feedstocks (12)</p> <p>demonstrate advanced biorefinery under western conditions (1)</p> <p>better use of natural western vegetation / R&D on conversion technology to use mixed biomass</p> <p>develop scalable technology for diverse western feedstocks (4)</p> <p>thermochemical modeling feedstock specific (rice straw) small scale</p> <p>further develop forest products mill tech to build biorefineries</p> <p>assess thermochemical limitations & energy balances / research efforts focused on thermochemical conversion methods (5)</p> <p>improve & demonstrate CHP, DG - meeting environmental performance goals (see card) (3)</p> <p>need pilot biorefinery R&D facility in west (4)</p> <p>demonstrate BIGCC using Western Feedstock - thermochemical biorefineries (1)</p> <p>development of new sensors/controls for process (3)</p> <p>inexpensive cleaning of bio-gas - biomethane (3)</p> <p>manage emissions compliance/mitigation for bioenergy facilities (1)</p> <p>develop low NOx process fuel & energy production (4)</p> <p>sustainability: Solid, liquid, air emissions minimized / "clean bio-process" development</p> <p>platform that targets many R&D pathways (multiple products)</p>	<p>R&D strategies for cost-effective biorefinery scalability (1)</p> <p>increase overall conversion efficiency higher energy content of biofuels (3)</p> <p>develop more efficient pre-treatment enzymes (1)</p> <p>polymer liners for pipes, tanks, valves for biochemical and thermochemical appropriate (2)</p> <p>develop green diesel product options (green gasoline too) (7)</p> <p>develop more efficient pre-treatment enzymes</p> <p>co-processing with fossil fuels/fund integrated biorefineries - targeted feedstocks forest, crops residue, urban wastes/ H2 production systems (3)</p> <p>production of H2 from fermentation (2)</p> <p>developing and using value-added co-products (e.g. CO2, germ oil, biochemicals) (6)</p> <p>research into alternative uses for co-products</p>	<p>continue enzyme research for cellulose hydrolysis and fermentation (simultaneous) (4)</p> <p>nano-scale characterization for more efficient conversion self assembly (cell wall characterization) (2)</p> <p>microorganisms capable of defending feedstocks</p> <p>develop two uses of biomass in one process</p>

Exhibit 7: Crosscutting RD&D				
STANDARDS AND CODES AND CERTIFICATION	RESEARCH INFRASTRUCTURE AND SCOPE	SYSTEMS ANALYSIS (LCA, MARKETS OPTIMIZATION)	EDUCATION, TRAINING, OUTREACH	DATA DEVELOPMENT/ DISSEMINATION
<p>Methodology and analytical techniques for development of standards and specifications (2)</p> <p>Natural compatibility guide for biofuel application (2)</p> <p>Independent and government testing and certification labs (including sustainability) (2)</p> <p>Gap filling for regulation and standards (1)</p> <p>Safety and performance data for plant use and storage of biofuels (1)</p>	<p>Assessment of progress to achieving roadmap goals</p> <p>National effort on R&D rather than individual.... (how do we do this) (1)</p> <p>Extension for R&D, existing and new programs (1)</p> <p>Use existing basic science regional and industry roadmaps where appropriate, for example GTL</p> <p>Equipment, loan access programs from national labs</p> <p>Broaden span of federal and state research in bioenergy and bioproducts i.e. don't limit to cellulose</p> <p>International collaborations for example Europe, Asia, Canada</p> <p>Increase number of forest and agricultural products labs</p> <p>Regional bioenergy infrastructure compatible with U.S. and global markets</p>	<p>Development of models / modeling techniques (including integrated and assessment network models); improve eco-system analysis (2)</p> <p>Systems analysis optimization and efficiency of bioenergy systems (7)</p> <p>Assess national and international impacts of feedstock competition of food, feed, fiber, energy,(land use, policy) (5)</p> <p>Market analysis for highest use of biomass (business) (3)</p> <p>Farming system analysis (2)</p> <p>Harmonization of R&D policy and approach h with other policy areas for example trade, tax, environment (2)</p> <p>LCA –improve metrics (2)</p> <p>Relative carbon reduction benefits of competing uses of biomass (2)</p> <p>Policy impact analysis; Risk analysis</p> <p>Investigation of infrastructure access for portability</p> <p>Systems analysis of barriers and incentives for market access, for example interconnection / transmission</p> <p>Economic feasibility of competing technologies and uses (technical and product viability)</p> <p>Should transportation infrastructure and availability of adequate water and feedstocks drive decisions on conversion facility locations (citing optimization)</p>	<p>Facilitate researcher collaboration through conferences, workshops, dedicated journals/publications</p> <p>National R&D database (info exchange)</p> <p>Professional interactions, visiting scholar programs, internships, etc. (1)</p> <p>Increase integration of national labs with universities on R&D (11)</p> <p>Develop curriculum for K-12, university and technicians (4)</p> <p>X-prize for plant to meet desired product output (1)</p> <p>Policy database virtual library, DSIRE database</p> <p>Develop information and educational programs at informal educational centers for example science museums, discovery centers</p>	<p>Feedstock characteristics (Properties) (3)</p> <p>Technology database, terminology (glossary)</p> <p>Environmental and permitting database (2)</p> <p>Data for economic analysis (2)</p> <p>Data for environmental analysis</p>

APPENDIX B: Participants in the West Roadmap Workshop

First Name	Last Name	Affiliation
Arthur	Blazer	New Mexico State Forestry
Dan	Burica	ThermoChem Recovery International
Ralph	Cavalieri	Washington State University
Carl	Hansen	Utah State University
Doug	Hawkins	Rhom and Haas
Denny	Hunter	Weyerhaeuser
Kelly	Ibsen	National Renewable Energy Laboratory
Jeffrey	Jacobs	Chevron Technology Ventures, LLC
Terry	Jaffoni	Clean Transportation Fuels
Charles	Kinoshita	University of Hawaii at Manoa
Jim	Martin	Omni Tech International, LTD
Steve	Miller	Chevron Technology Ventures, LLC
Mike	Pacheco	National Renewable Energy Laboratory
William Lee	Pan	Washington State University
Lori A.	Perine	Agenda 2020
David W	Sjoding	Washington State University
Don	Stevens	Pacific Northwest National Laboratory
Candace S.	Wheeler	GM Research & Development Center
Randy	Lewis	Brigham Young University
Val	Tiangco	California Energy Commission
Gary	Banowitz	USDA/ARS
Ann	Bordetsky	Natural Resources Defense Council
Bill	Hagy	USDA, Rural Development
John	Hickman	John Deere
Michael	Kazz	Zelen Environmental, Tucson AZ
Tad	Mason	TSS Consultants
Marcia	Patton-Mallory	US Forest Service
Bentham	Paulos	Energy Foundation
Neil	Rossmeissl	U.S. Department of Energy, Biomass Program
Steve	Shaffer	California Department of Food and Agriculture
John	Shears	The Center for Energy Efficiency and Renewable Technologies
Luke	Tonachel	Natural Resources Defense Council
Doug	Wickizer	California Department of Forestry and Fire Protection
Rick	Zalesky	Chevron Technology Ventures, LLC;