The Executive Summary of the Northwest Advanced Renewables Alliance

Western Montana Corridor

NARA

Northwest Advanced Renewables Alliance

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BACK GROUND

The Northwest Advanced Renewables Alliance is one of seven Coordinated Agricultural Projects (CAPs) within the Sustainable Bioenergy challenge area funded by the USDA National Institute of Food and Agriculture (NIFA) in its Agriculture and Food Research Initiative (AFRI) program. CAPs in Sustainable Bioenergy are charged to:

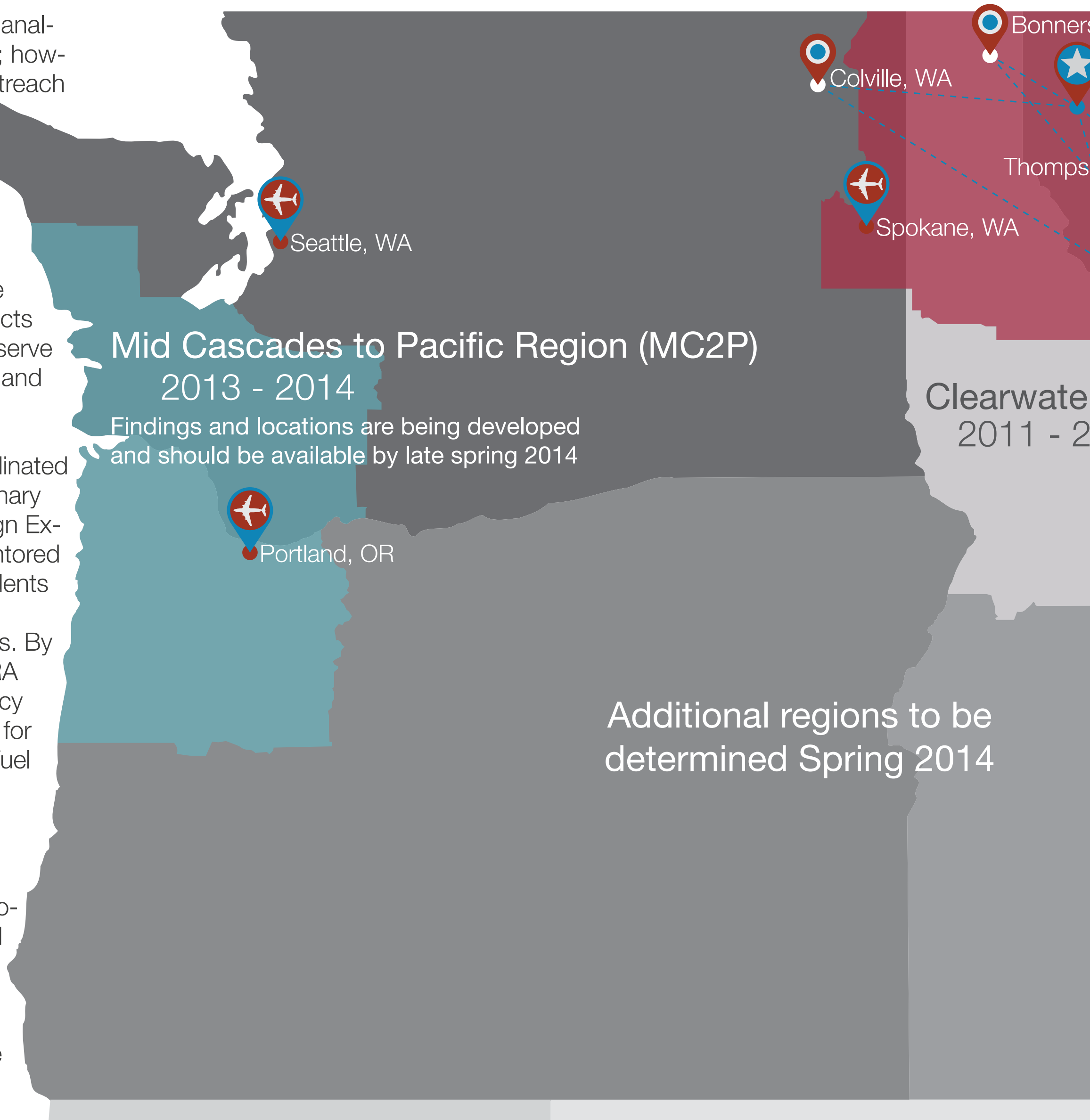
> **"…facilitate the establishment of regional systems for the sustainable production of bioenergy and biobased products that: contribute significantly to reducing the National dependence on foreign oil; have net positive social, environmental, and rural economic impacts; and are integrated with existing agricultural systems."**
>
> (USDA NIFA 2010)

For NARA, a key contribution to this charge is to envision and delineate supply chains within the NARA four-state region (Idaho, Montana, Oregon and Washington). The intent is to provide regional stakeholders with information useful to develop an industry that converts forest residuals into jet fuel and other co-products. The Western Montana Corridor (WMC) supply chain is one of several regionally distinct supply chains to be analyzed. Figure ES-1 shows the working boundaries of the WMC and additional supply chain study areas identified since January 2014.

Providing the WMC supply chain analysis engaged all NARA members; however, groups within the NARA Outreach and Education Teams have specific tasks dedicated to this goal. The NARA Outreach Team identified and consulted with key stakeholders in the region who provided access to information and local perspectives. In the WMC, the Montana Forest Products Retention Roundtable agreed to serve as our client to provide guidance and perspective.

The NARA Education Team coordinated the work. Through an interdisciplinary course titled IDX (Integrated Design Experience), NARA researchers mentored graduate and undergraduate students to produce much of the data and analysis reflected in these volumes. By involving university students, NARA is able to develop bioenergy literacy among students and a workforce for an emerging cellulosic-based biofuel and co-products industry.

The volumes contained on this website (http://nararenewables.org/westernmontanacorridor/) provide information that can be used to strategically build a supply chain that produces jet fuel and other co-products using forest residuals as feedstock. Listed are brief descriptions of the content found in each volume.



Vol. I

Overview

Contains additional information regarding NARA, IDX and the timeline for this analysis.

Vol. II

Regional Capacity

Describes the assets available in the WMC.

Vol. III

Site Selection & Supply Chain Analysis

Highlights case studies for conversion and depot sites and provides an analysis of the forest residual biomass available to each conversion site.

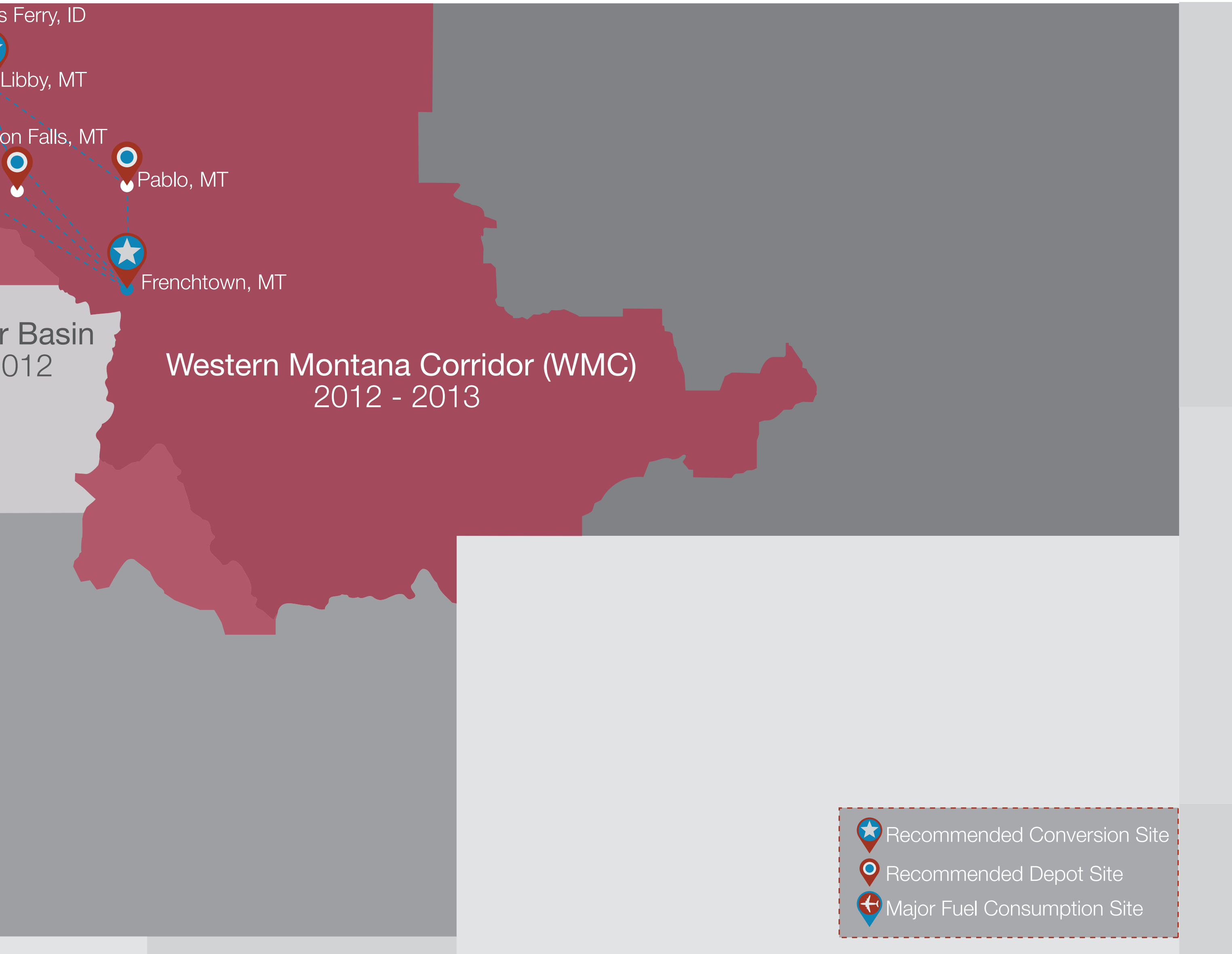


Figure ES-1. NARA's supply chain regional studies in ID, MT, OR, and WA as of January 2014

Vol. IV

Sustainability

Contains updates that describe the most recent analyses on the potential economic, social and environmental impacts realized from a forest residual to bio-jet fuel and co-products industry.

Vol. V

Supplemental Info

Contains information and updates concerning RINs (Renewable Identification Numbers); a report describing the availability if construction and demolition wood waste as a potential feedstock for conversion to jet fuel; and a report from Greenwood Resources regarding the use of softwood plantations in the WMC to supplement forest residual feedstocks.

The analyses found in these volumes are on-going and therefore subject to revisions and additions as NARA's work continues through the funding duration to be completed by summer, 2016.

VOLUME II

REGIONAL CAPACITY

Volume 2 assesses the resources available within the Western Montana Corridor (WMC) region that impact supply chain development for an industry that uses forest residual biomass to produce bio-jet fuel. The resources assessed are organized using a modified capitals framework (Emery, Fey and Flora 2006) and include:

NATURAL CAPITAL

Ecological stocks and flows that provide valuable goods and services (e.g., forests, water quality, biodiversity)

PHYSICAL CAPITAL

Material resources that can be used to produce a flow of future income (e.g., transportation infrastructure, utilities, mothballed mills)

ECONOMIC CAPITAL

Money and access to funding (e.g., tax burden/savings, state and federal tax revenues, grants, and contracts)

CIVIC CAPITAL

Assets of the community including human (leadership capabilities, knowledge, skills, abilities and information possessed by people in the region); social (interpersonal interactions, networks and customs that contribute to stronger community fabric including trust, cooperation, community cohesion, tolerance, compassion, patience); and cultural (shared experiences through traditions, norms, values, heritage, and history)

POLICY CAPITAL

Federal, state and local laws and regulations that create an environment conducive to regional goals (e.g., supportive legislation, incentives for new or existing businesses, regulatory exemptions)

Natural Capital

BIOMASS

To help understand the locations, amounts and availability of forest biomass in the WMC region, GIS maps were created that illustrate land ownership and the total volume, bone dry tons (BDT), of biomass (forest and mill residuals) by county within the WMC region. The maps illustrate that a majority of available residual and mill biomass exists in the northwestern portion of the WMC region and that much of the forested land is federally owned. A more in-depth description of forest residual and mill volumes are provided for Flathead, Lincoln and Missoula counties (Figures ES-2.1 and ES-2.2); here land ownership is delineated and the amount of forest and mill residues from private lands is compared to the total amount available. In these examples, at least half of the total forest residual and mill residues available come from private lands.

It is important to note that unlike forest residuals, a majority of mill residues produced are utilized for pulp, boards, pellets, mulch, and energy production. Under present demand and economic conditions, mill residue availability as a feedstock for bio-jet production is unlikely.

Figure ES-2 Forest residuals as biomass in the Western Montana Corridor

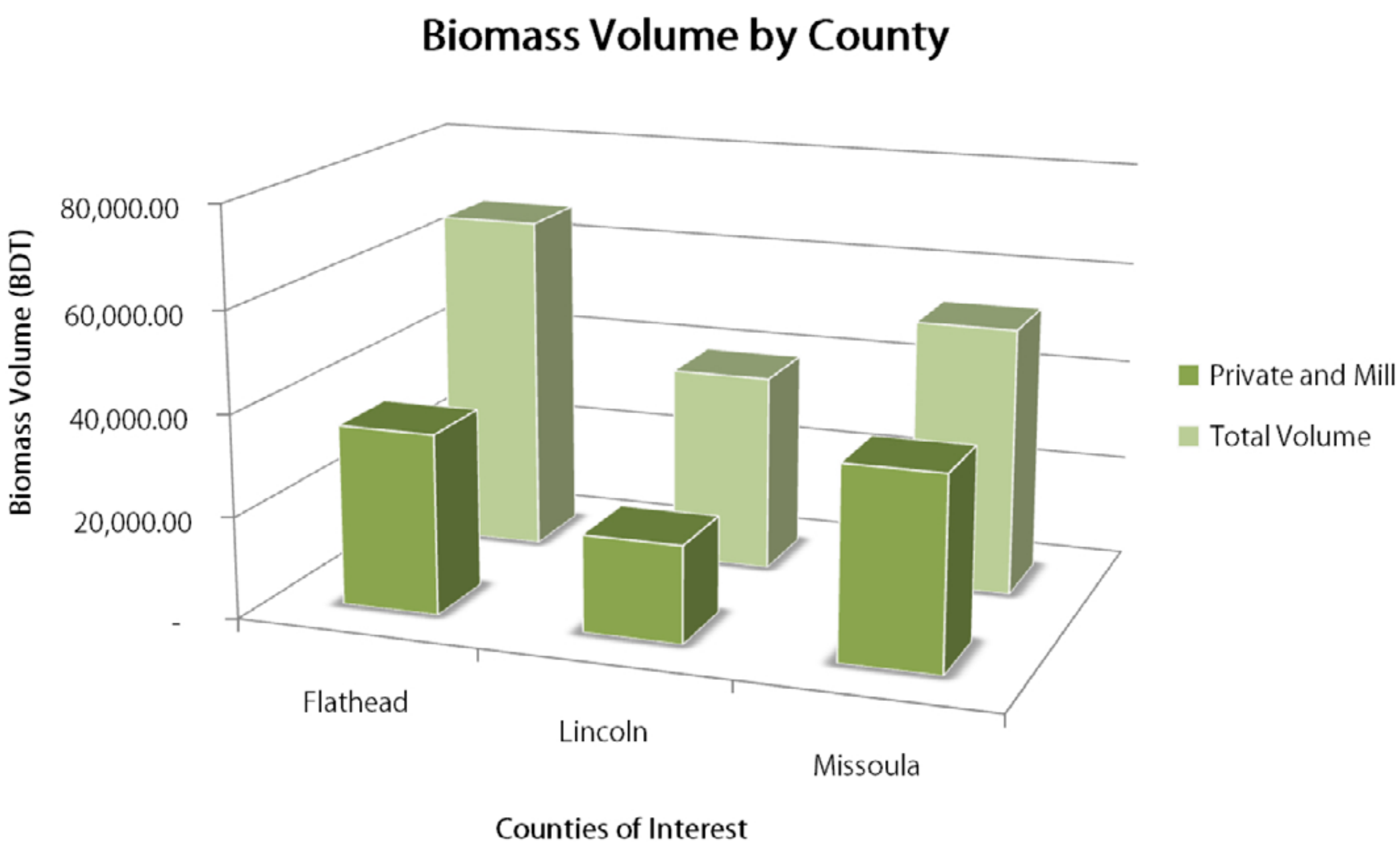
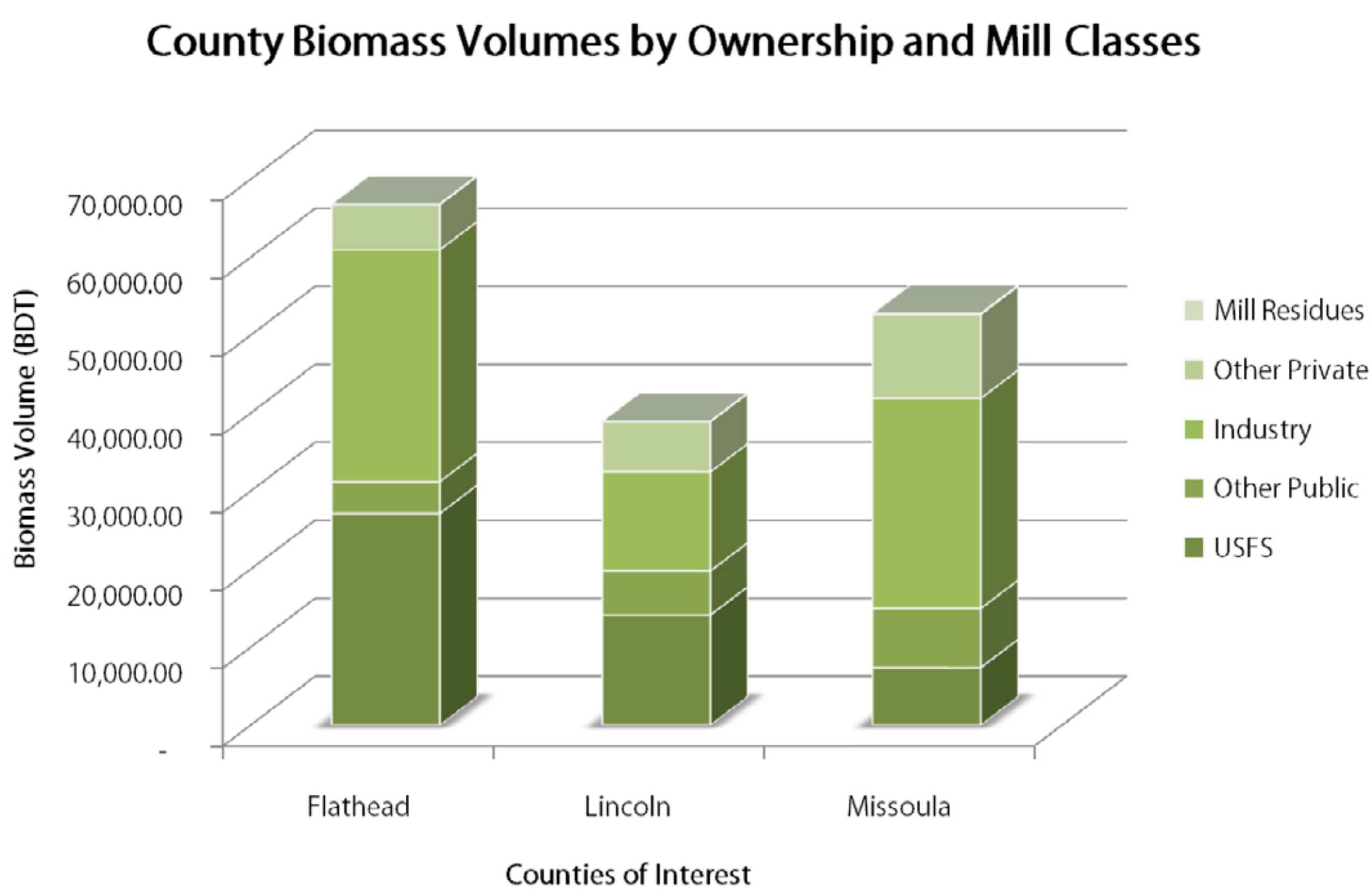


Figure ES-2.1. Bar graph comparing total biomass volumes to private and mill biomass volumes http://www.bber.umt.edu/pubs/forest/fidacs/MT2004.pdf



ES-2.2 Bar graph showing county biomass volumes divided into land classifications and mill residues http://www.bber.umt.edu/pubs/forest/fidacs/MT2004.pdf

Physical Capital

CONVERSION AND DEPOT SITES

Physical capital described in this study includes industrial sites that could be used as conversion or depot facilities, plus roads and railways— all within the WMC region. Potential conversion facilities in Libby, Frenchtown, and Olney, Montana are identified based on existing infrastructure available. A conversion facility would process forest residuals into simple sugars and then isobutanol, used to produce jet fuel and other value-added products. Fifteen potential depot sites, located in Montana and Idaho, are also described. A depot site may be used to collect, chip, and store biomass from smaller regions that would otherwise be cost-prohibitive to transport to the conversion site directly. Utilizing depot sites would expand the amount of residual biomass available to supply a conversion facility. Road and rail line networks are illustrated for the northwest region of the WMC.

Figure ES-2.3. Physical Capital site in the Western Montana Corridor

Economic Capital

EMPLOYMENT AND PRODUCTIVITY

Timber industry employment and productivity will affect an emerging industry using forest residuals to generate chemical products like biojet fuel. Timber harvest levels determine the amount of forest residuals available.

A vibrant timber industry with the supporting infrastructure, machinery and skilled work force complement the work force and infrastructure needs of a wood-biomass to biofuel industry.

As of 2010, timber related employment in the WMC region represented 1.25% of all private employment for the region. This percentage has decreased from 2.8% in 1998. Between 1998 and 2010, timber employment shrank by 6,461 jobs, whereas, non-timber employment grew by 82,484 jobs. The sector that experienced the most dramatic job loss was "sawmill and paper mill". Jobs in sectors "wood products manufacturing" and "growing and harvesting" experienced less of a decline. One example of paper mill job loss is given with the closure of the Smurfit-Stone mill in Frenchtown Montana. In 2009 the mill closed and an estimated 2,000 timber industry jobs were lost (Saboe 2010).

In the WMC region, the unemployment rate in 2012 was 6.5% with 50,216 persons unemployed from a labor force of 772,801. The unemployment rate in counties with relatively large amounts of forest residuals available (Lincoln, Shoshone and Sanders counties) exceeds 10%.

Though employment levels in the WMC have shown a steady decrease during the 1998-2010 period, the outlook for Idaho's forest product's industry appears to be improving. Surveys done by the University of Montana show that many of the major wood products manufacturers in Idaho were doing better financially in 2012 than in 2011. One survey shows that timber product sales and production increased by 58% in 2012 and profits increased by about 56% (Morgan et al 2013). In addition, lumber production in Montana increased 20% in 2010 over 2009 production levels. These increases are most likely due in part to a 40% increase in U.S. housing sales between 2009 and 2012.

COST OF DOING BUSINESS

Northwestern Energy and Avista supply electricity in the WMC. In 2011, the average price of electricity for industrial use in Montana was $0.051/kWh, Idaho $0.046/kWh and Washington $0.041/kWh. (Marketplace).

Property tax rates in Montana are calculated using property values and millage rates. Millage rates correlate with the level of services provided to the property. In 2010, Montana's average mill levies per county ranged from 380 to 720 with Lincoln, Lake and Sanders counties exercising the lowest mill levies. Each class of property has its own tax rate, expressed as a percentage that is used in taxable value calculations. In Montana, class 4,5,6,8,9,10,14,15, are most applicable to current and future forest product or woody biomass related industries. These class distinctions are described in the report.

Corporate income tax rates vary for each state in the WMC region. In 2010, Montana's tax rate was 6.75%, Idaho's was 7.6% and Washington did not levy a corporate tax although the state does assess a business and occupation tax. Between years 2004 and 2010, Montana corporate tax collection ranged from $65 million to $178 million.

	Average Cost for Electricity	Income Tax Rates
Montana	$0.051/kWh	6.75%
Idaho	$0.046/kWh	7.60%
Washington	$0.041/kWh	0.00%

REGIONAL DEVELOPMENT ASSISTANCE

Using forest residuals to produce bio-jet and co-products will require capitol investment for refineries, depots and other supporting business. Within the WMC region, there are many organizations and programs that provide economic and development assistance at both macro and micro levels. They should play a key role in developing a biomass to biofuels industry as many of these organizations offer support for new companies or those requiring revitalization efforts.

In Montana, the Certified Regional Development Corporations (CRDC) and the Montana Small Business Development Center (SBDC) serve to provide loans, business development and operational assistance. They both operate through Montana state agencies. In addition, business incubators operate throughout the WMC and provide multiple forms of assistance to start-up businesses.

Programs targeted to advance industrial use of woody biomass:

1 Development grants through the Montana Department of Natural Resources

This resource is designed to increase the use of forest products, create jobs, stimulate the economy, improve forest conditions and reduce the air pollution that results from open slash pile burning. Eligible organizations can apply for biomass utilization grants when engaged in activities such as market feasibility assessments, developing manufacturing processes, and purchasing equipment used to manufacture of woody biomass products.

2 Loans from the ShadeFund program

The ShadeFund program is administered through The Conservation Fund and functions to help companies, foundations and individuals develop green businesses nationwide. Entrepreneurs located within the United States engaged in activities such as sustainable forestry, organic farming, and biomass or energy efficiency projects are eligible.

3 Loans from the Montana Distressed Wood Products Industry Recovery and Stabilization (WPIRS) program

The WPIRS program is both federally (Economic Development Administration) and state (Montana Department of Commerce) funded and targets areas in Montana where timber jobs are most threatened, particularly in counties with lumber mills and similar facilities. Loans are made to individuals or small businesses and can be used to improve working capital, purchase/lease land or equipment, update infrastructure, or improve debt service.

REGIONAL COMPETITIVENESS

In order to measure which counties in the WMC would provide a competitive advantage and be most suited to accommodate woody biomass harvest operations, location quotient data was collected for all 37 counties in the WMC. Location quotients are useful because they can measure the degree of specialization in an industry within a given region compared to the base region. Specifically, location quotients measure the percent of employment in a given industry of specific regions against the percent of employment in that industry within the base area.

Location quotients (LQs) were determined for forestry and logging (NAICS code 113), forestry support services (NAICS code 115310), and wood products manufacturing (NAICS code 321) within the WMC. For forestry and logging, Lincoln, Granite, Pend Oreille, Benewah, Powell and Boundary counties had exceptionally high LQs. A high LQ suggests a number of things: 1) the goods produced can be exported; 2) there is a positive degree of specialization for the production of that good within the region; and 3) due to the presence of specialization, we can assume that the region holds a comparative advantage for the production of that good. For forestry support activities, Missoula, Lincoln and Shoshone counties showed high LQs. The LQ for wood products manufacturing was highest in Boundary, Benewah, Sanders and Granite counties.

It is important to understand that although LQs may indicate comparative advantage, they are not a measure of productivity. There may be 100 people employed in the timber industry in a county, but if there are only 200 people employed in all industries within the county, the numerator of the LQ equation will be very high, leading to a very high LQ in the county where there are actually very few employment opportunities. To enhance the LQ information, maps were generated that indicate the LQ for each county in the WMC and the active facilities for each sector measured. For instance, the map illustrating LQs for forest support activities also contains support activity locations. In this case, even though Missoula, Lincoln and Shoshone have high LQs, no support activities are actually listed in Shoshone County. The business clusters located in Missoula and Lincoln counties would make them most attractive in terms of competitive advantage.

Taken together, the business clusters and LQ data indicate some potential locations for biomass utilization. Based on these indicators, Lincoln, Flathead, Missoula and Ravalli counties in Montana, and Bonner in Idaho seems best suited for facilities engaged in biomass extraction and processing.

Civic Capital

The civic capital section looks at the human assets in the WMC region including population demographics and various key educational and employment attributes associated with that population. Each county's K-12 schools were assessed, as well as the opportunities that currently exist for further education through community colleges, four-year universities and vocational training. Employment trends and labor participation rates were gathered for each county, and these factors combined with the educational data were used to assess the readiness of the region to support the labor needs of a wood biomass conversion industry. In addition to the region's work force assets, this section also examines its social and cultural assets including regional collaborations and health considerations. Measuring civic capital reveals what the WMC region can do for a new biomass industry and what the industry can do for the region.

HUMAN ASSETS

Population trends can suggest whether a region is retaining its youth and if the existing population has the numbers to support a new wood-biomass conversion industry. There are a variety of population densities in the WMC region. In 2011, Spokane and Yellowstone counties contain the largest populations; 13 counties contain less than 8000 residents. The natural population change, the difference between births and deaths, showed growth in each county with the exception of Deer Lodge. Net migration in the region, the difference between how many people move out to those who move in, showed that negative and positive migration at the county level were equally mixed: 19 counties experienced population losses while 20 counties experienced gains. The trend from 2000 through 2011 indicates that gains in net migration have progressed over that time period. Glacier, Missoula and Gallatin counties contained the youngest median population (30-34), while nine counties showed the highest median (48-52).

A median age of 32 years is indicative of a community with a large percentage of young people that would be needed to sustain a new biomass industry. The trend from 2000 to 2011 indicated that the region is getting progressively older.

(Daniels, Thomas L. et al 2010)

Figure ES-2.4 PHOTO CREDIT: Gevo Lab Facility, Englewood, CO, USA. Reproduced with permission of Gevo, Inc.

In 2010, 11 counties distributed throughout the WMC region had poverty rates between 18.1% and 30%. The lowest poverty rates are found in counties located in the southeast portion of the WMC region. Between years 2000 to 2010, poverty rates in the WMC have increased. High poverty rates are considered a liability for areas of the supply chain that require advanced skill sets or could be seen as an opportunity for rural development.

WORK FORCE

2008 average income for Washington WMC counties Pend Oreille and Spokane was $38,939 and $48,269 respectively; in Idaho WMC counties, the average income ranged from 49,721 in Kootenai County to $36,423 in Lemhi County; and for Montana counties, average income ranged from $28,238 in Powell County to $56,650 in Jefferson County. Non-labor percent of total personal income, which is not directly earned income (e.g., dividends, interest, or retirement funds), is 41% in Montana compared to 35.2% in the United States. In Montana, the government employed 14.9% of the total workforce compared to 14.2% in the United States. Agriculture is the largest component of Montana's commodity sector and employs 3.1% of the available workforce. Mining is the smallest component of the job sector, employing 1.01% of the Montana total workforce. Accommodation and food represents the largest component of travel and tourism related employment in Montana and represents 13.5% of the total workforce.

EDUCATION

According to data published by the National Assessment of Educational Progress and the Annie E. Casey Foundation, Montana students generally score above the national average in the subjects tested (reading, writing, mathematics), which reflects a relatively high quality of public education in the state. Idaho and Washington generally score a bit lower than Montana, yet still above the national average.

Graduation rates throughout the region have been rising in recent years, along with the improvement in the economy.

Schools in the WMC shows trends that are common throughout the region: urban high schools have lower graduation rates than smaller rural schools and also have greater difficulty maintaining Adequate Yearly Progress (AYP).

In the Western Montana Corridor, rural high schools have shown consistent yearly improvement and improved student retention. The data illustrates that small school size can be an indicator of exceptional educational quality, and that rural counties' lack of population should not be taken as a lack of ability for skilled jobs.

(Montana Office of Public instruction, American Welding Society, Automotive Mechanic Schools and Training Center)

REGIONAL COLLABORATIONS

The WMC region has a significant number of collaborative organizations focused on forest management and restoration projects. These collaborative groups bring together diverse stakeholders from federal, state and local government agencies to environmental groups, private companies, private landowners and the interested public to share knowledge and resources to achieve desired outcomes for public lands and communities within statutory and regulatory frameworks (USDA BLM 2000). 23 collaborative groups are identified in the report with descriptions for:

MFRC

Montana Forest Restoration Committee

Advances restoration to accelerate the recovery of ecological processes and the enhancement of societal and economic wellbeing.

SCC

Southwestern Crown Collaborative

This group develops a comprehensive vision and management goals for the Southwestern Crown landscape that includes the lower elevation forests of the Blackfoot, Clearwater and Swan River Valleys.

IFRP

Idaho Forest Restoration Partnership

The partnership is comprised of seven separate working groups throughout Idaho who connect, inform, and support collaborative groups working to restore the resilience of Idaho's forests.

SOCIAL AND CULTURAL ASSETS

Social capital is the value added to the region's population through networks and collaboration that creates trust and shared values between individuals (Bypass 2011). Every organization that creates communication links and networks within a region is adding to this asset. Internally this capital is measured through the cultural values and trust that exists in the community. These valuable assets help to create the space that trade and outside organizations need to operate successfully (Bypass 2011).

Crime has long been studied in association with social capital. Lower crime rates in rural areas are seen to be an indicator of a high level of community trust and collaboration. In 2010, the highest crime rates in the WMC were in Spokane, Cascade, Silver Bow and Yellowstone counties.

> **The Economic Research Service of the United States Department of Agriculture theorizes that all towns need to attract a fraction of the creative population to be competitive in today's economy.**
>
> **(United States Department of Agriculture, 2012)**

The Creative Vitality Index (CVI) studies the impact that the arts have on the health of the region. The metrics used for this index are defined as all profit and nonprofit arts related to creative enterprises and the key support and service industries that sustain them (Herbert, Jim Irby 2010). Pend Oreille, Pondera, Meagher and Golden Valley counties showed the lowest CVI score in the WMC. This would indicate that these counties have fewer art related services and events that high scoring counties such as Bonner, Flathead, Missoula, Granite and Yellowstone.

HEALTH AND SUITABILITY

County health rankings rate Flathead, Gallatin, Madison, Missoula, Stillwater, Ravalli and Kootenai counties as having citizens with the best overall health. A suitability analysis measures median age, net migration, poverty rates, labor force participation, educational attainment, crime, and the CV Index to create an overall score suggesting areas that are highest in human capital. For this measurement, Gallatin County is ranked number one on both the health ranking and the suitability analysis. The suitability analysis also suggests that the counties of Lewis & Clark, Jefferson, Madison, Park, and Sweet Grass are also high in human capital. These are counties that could be good places to concentrate a biofuels industry, if human capital is an important variable to consider.

Policy Capital

Policy capital relevant to biomass extraction and processing consists of regulatory frameworks at all levels of government, incentives, programs, multi-jurisdictional agreements, and sources of technical assistance for forest businesses.

All biomass extraction and processing must follow the regulations and requirements set forth by federal and state laws. The use of woody biomass for bioenergy is strongly supported by the US federal and most state governments. Figure ES-2.5 shows the various federal and state laws and programs associated with the use of wood-biomass.

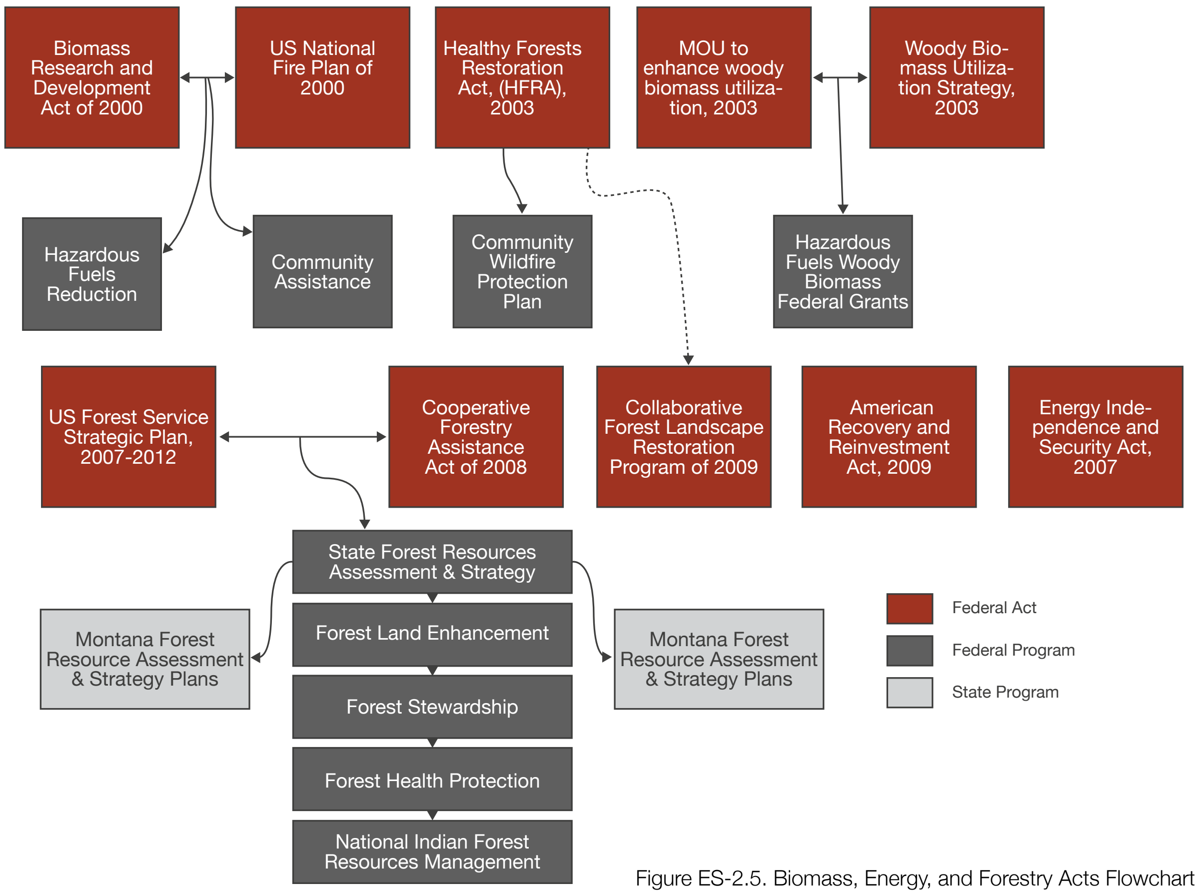


Figure ES-2.5. Biomass, Energy, and Forestry Acts Flowchart

FEDERAL EFFORTS

Federal legislation and programs impacting wood biomass use in the WMC includes:

Biomass Research and Development Act of 2000

Coordinates federal research and development activities relating to bio-based fuels, power, and products.

Cooperative Forestry Assistance Act of 1978

As amended in 2008 (CFAA) authorizes the Secretary of Agriculture to assist in the establishment of coordinated and cooperative Federal, State and privately owned forestland cooperatives to encourage the production of timber.

Fuels for Schools and Beyond

Promotes the reduction of hazardous fuels by using the woody- biomass locally for heat and power.

Cooperative Forestry Assistance Act of 1978

As amended in 2008 (CFAA) authorizes the Secretary of Agriculture to assist in the establishment of coordinated and cooperative Federal, State and privately owned forestland cooperatives to encourage the production of timber.

Fire Hazard Reduction Agreement

Requires private landowners to reduce debris to state standards, and for the purchaser of the forest product to ensure the seller has completed this work.

Healthy Forest Restoration Act

Speeds up hazardous fuel reduction and forest restoration projects on specific types of Federal land that are at risk of wildland fire and/or insect and disease epidemics.

STATE EFFORTS

State laws and programs in the WMC that potentially impact woody biomass utilization include:

Montana Environmental Policy Act of 1971

Requires state agencies to consider the environmental, social, cultural and economic impacts of proposals like mines, power plants, subdivisions, and timber sales, before the project is approved.

Idaho Environmental Protection and Health Act of 1972

Ensures clean air, water and land in the state, and protects Idaho citizens from the adverse health impacts of pollution.

Forest Action Plans

State plans used to improve forest health, productivity and benefits.

In addition to these efforts, state agreements with Canadian provinces and among neighbor states exist.

LOCAL EFFORTS

A review of the current county-level comprehensive plans demonstrates that a majority of the counties of the Western Montana Corridor region support state and local policies that are beneficial to biomass extraction.

Economic development districts, conservation districts, and tribal agencies provide resources that can benefit a wood biomass industry.

National Fire Plan

Develops a coordinated strategy to address the threats posed by wildland fire.

Energy Independence and Security Act of 2007

Requires an increase in the use of renewable fuels and sets a mandatory renewable fuel standard requiring fuel producers to use at least 36 billion gallons, of biofuels by 2022, with an increasing reliance on the use of "advanced biofuels", i.e. using non-food feedstocks.

Federal programs established that provide potential impact to wood-biomass use include:

Forest Stewardship Program

Forest Legacy Program

Collaborative Forest Landscape Restoration Program of 2009

Biomass Commercial Utilization Grant Program

In addition to these efforts, interagency agreements exists among federal agencies to encourage the use of woody biomass byproducts as sources of renewable energy.

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VOLUME III

SITE SELECTION & SUPPLY CHAIN ANALYSIS

NARA Supply Chain Defined

A supply chain is a system to move products or services from supplier to consumer and includes organizations, people, technology, activities, information and resources (Vitasek 2010). Activities along the supply chain transform raw materials into a finished product delivered to the end consumer. For the NARA process, forest residues must go through several processes to be converted into isobutanol and ultimately biojet fuel. These processes include chipping the woody biomass into a usable feedstock, chemically and biologically converting the feedstock into isobutanol, and refining into fuel and co-products. Companies and facilities that can perform these operations are needed throughout the supply chain and can exist in integrated or dispersed manufacturing scenarios while maximizing efficiency and minimizing costs. Supply chain analysis has been acknowledged as one of the vital assessments for stimulating renewable energy development (Council 2011).

A supply chain can be evaluated as regions, nodes and linkages. A biofuels supply chain initially requires a region rich in biomass. For NARA, the biomass of interest is forest residuals, however, construction and demolition debris (C&D waste) could potentially become and additional source of feedstock, especially in urban regions. Feedstock materials are refined from this raw biomass, at specific nodes that we call 'depots' and 'conversion' sites. These nodes may exist at a landing of a forest harvest operation or at a nearby facility such as a sawmill or chipping yard. At depot sites, the forest residuals are sorted, ground, and loaded for transport to other nodes, that is conversion facilities where the chips undergo mechanical, chemical, and biological treatments to produce isobutanol. Finally, linkages are transport systems that enable the transfer of materials between nodes (e.g., forest roadside pickup from slash piles, highway, rail and pipelines).

The NARA project treats isobutanol as the primary final product produced from a conversion facility. It is assumed, but not necessary, that the catalytic conversion of isobutanol to iso-paraffin kerosene (i.e. jet fuel) would be conducted at a petroleum refinery. It is important to know that alternative processing scenarios may evolve that could prove more cost effective.

For instance, specialized conversion facilities could be established that concentrate the carbohydrates from wood residuals, which could then be shipped to another facility for conversion to isobutanol and other products. In analyzing the Western Montana Corridor (WMC) supply chain, the starting point is considered to be where the forest residuals are generated. Here forest residuals are collected and either preprocessed at the landing or transported by truck to a pre-processing depot. The potential unit operations employed in the pre-conversion process include: sorting, size reduction (i.e. grinding, chipping, hammer milling, etc.), cleaning, and shipping. Conversion facilities will generally receive the preprocessed residuals in the form of chips, which are similar to but less refined than the feedstock provided in a typical pulping operation. At the conversion facility, the feedstock is then 'pretreated' so that the cellulose component of wood is accessible to enzymes, which convert the cellulose into its constituent simple sugars. The simple sugars are subsequently fermented into an alcohol (isobutanol), which is transported from the conversion facility via pipe, rail or truck to a petroleum refinery for final conversion into biojet fuel. Figure ES-3 illustrates the varied processing steps in the supply chain.

NARA
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SUPPLY CHAIN

FRP

FOREST RESIDUES PREPARATION

Primary feedstock targets include forest residues from logging and thinning operations. We are also considering mill residues and discarded woody material from construction and demolition, in regions where these materials are under utilized.

ONE BONE DRY **TON** WOODY BIOMASS +

T

TRANSPORTATION

Feedstocks are transported from the collection site to a conversion facility. Chipping can take place at the loading or in a preprocessing facility.

DIESEL +

PT

PRE-TREATMENT

Wood chips are treated to make the sugar polymers (polysaccharides) accessible to degrading enzymes. These processes allow the lignin to be available for separation.

HEAT, WATER, & CHEMICALS =

ENZYMATIC HYDROLYSIS

Specific enzymes are added to hydrolyze (cleave) the polysaccharides and generate simple sugars (monosaccharides).

FERMENTATION

Specialized yeast convert the monosaccharides into isobutanol.

BIOJET & CO-PRODUCTS

Aviation fuels can be generated from the platform molecules derived from wood sugars. Lignin can be used to generate co-products such as epoxies, structural materials and bio-based plastics. As an alternative, lignin can be burned to produce renewable energy.

= **~600** POUNDS LIGNIN AND **~59** GALLONS ISOBUTANOL OR **~45.6** GALLONS BIOJET

NARA is led by Washington State University and supported by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

Figure ES-3. Steps involved in the supply chain for conversion of wood residues to bio-jet fuel

Conversion Sites

A biomass conversion site can be divided into four key areas: a biomass feedstock yard, a chip yard, a pretreatment facility, and a hydrolysis and fermentation facility. The biomass feedstock yard may receive the raw biomass (i.e., slash) straight from harvest site landings or depot (biomass consolidation) sites, but to be economic, the harvesting must be within 20-30 miles of the facility. In addition to storage capacity, this portion of site operations also has sorting and grinding equipment that reduces the slash and removes bark and needles. The chip yard stores ground chips that are produced on site as well as those that are delivered. It is common for a biomass facility to keep a 30-day supply of feedstock and chips on site (EPA 2007). This sizable quantity can allow the plant to function through seasonal supply shortages and inclement weather conditions.

Our analysis determined that the feedstock yard would require 5 to 12 acres, and a chip yard would need 3 to 7 acres. The calculated range of values was based on the premise that biomass feedstock and wood chips can be stacked to a height ranging from 12 to 32 feet.

(EPA 2007; Garstang et. al. 2002)

Table ES-3. Conversion site requirements

Conversion Site: Space Requirements for Facilities and Activities	
General Assumptions	
1 million BDT/year 30 Green Tons/Truck Site operation 365 days/year 16 hour days (2 shifts) Receiving 4,128 tons of biomass material each day 30-day supply in feedstock and chip yards (123,840 tons)	1 ton = 2000 lb Raw biomass (slash pile) density = 40 pcf Loose wood chip density = 70 pcf Moisture Content = 50% Feedstock and chip yard material height = 12 to 32 ft Producing 56 million gallons of isobutanol/year
Feedstock Yard: Storage of slash pile and all other raw biomass materials	
Area Range: 4.5 to 11.8 acres (for 32 ft and 12 ft heights) Comparable: 3.5 to 9 football fields Facility Description: Uncovered space with concrete pad, truck tipper, and conveyor system	
Chip Yard: Storage of chipped biomass materials	
Area Range: 2.5 to 6.7 acres (for 32 ft and 12 ft heights) Comparable: 2 to 5 football fields Facility Description: Uncovered space with concrete pad, truck tipper, and conveyor system	
Pretreatment: Biomass materials are prepared for hydrolysis and fermentation	
Area: Currently unknown, use 10.3 acres modeling pretreatment as a similar process to hydrolysis and fermentation Facility Description: Covered structure with appropriate equipment inside	
Hydrolysis and Fermentation: Pretreated materials are converted into isobutanol	
Average Area: 10.3 acres Comparable: 8 football fields Facility Description: Covered and uncovered structures, tanks, pumps, lines and dispensers	

The buildings where pretreatment (preparing chips for the hydrolysis and fermentation process) and conversion (pretreated materials are converted to isobutanol) processes occur must also be considered in determining the minimum acreage necessary for locating a conversion facility. Because the biomass conversion process is similar to that of the ethanol conversion process, existing ethanol plants were used as models to determine the area required for pretreatment, hydrolysis and fermentation (Ethanol Producer Magazine 2013). Several sites for existing ethanol hydrolysis and fermentation plants were evaluated resulting in an average site area of 10 acres. From the ethanol facility studies, it is assumed that the pretreatment process will require about the same amount of space. Woody biomass conversion site assumptions are listed in table ES-3.

Based upon these assumptions and on the recommendations of regional stakeholders, two potential conversion sites were identified for the WMC region. One site is located in Libby, Montana and the other at the former Smurfit-Stone pulp and paper mill site near Frenchtown, Montana. These potential conversion site locations contain much of the existing infrastructure required such as utilities, transportation access, wastewater treatment facilities, permits and a large feedstock storage yard. The use of existing facilities was important to reduce the capital expenditure costs associated with new development.

FRENCHTOWN CONVERSION SITE CASE STUDY

The Frenchtown conversion site also has many physical attributes that make it suitable for development as a conversion facility. These include highway and rail access on site, river and streams needed for industrial effluent discharge, wetlands for natural water purification, and an on-site waste water treatment plant. In addition, the site is zoned for light and heavy industrial use and vegetation surrounding the river provides a natural buffer for excess runoff. It is located just a few miles from Interstate 90 and has rail access to many areas around the site. The remaining infrastructure includes offices, warehouses, truck dumps, a scale, a chipping facility, and a multi-fuel boiler, all which could be adapted to facilitate a forest residuals to chemical products conversion operation.

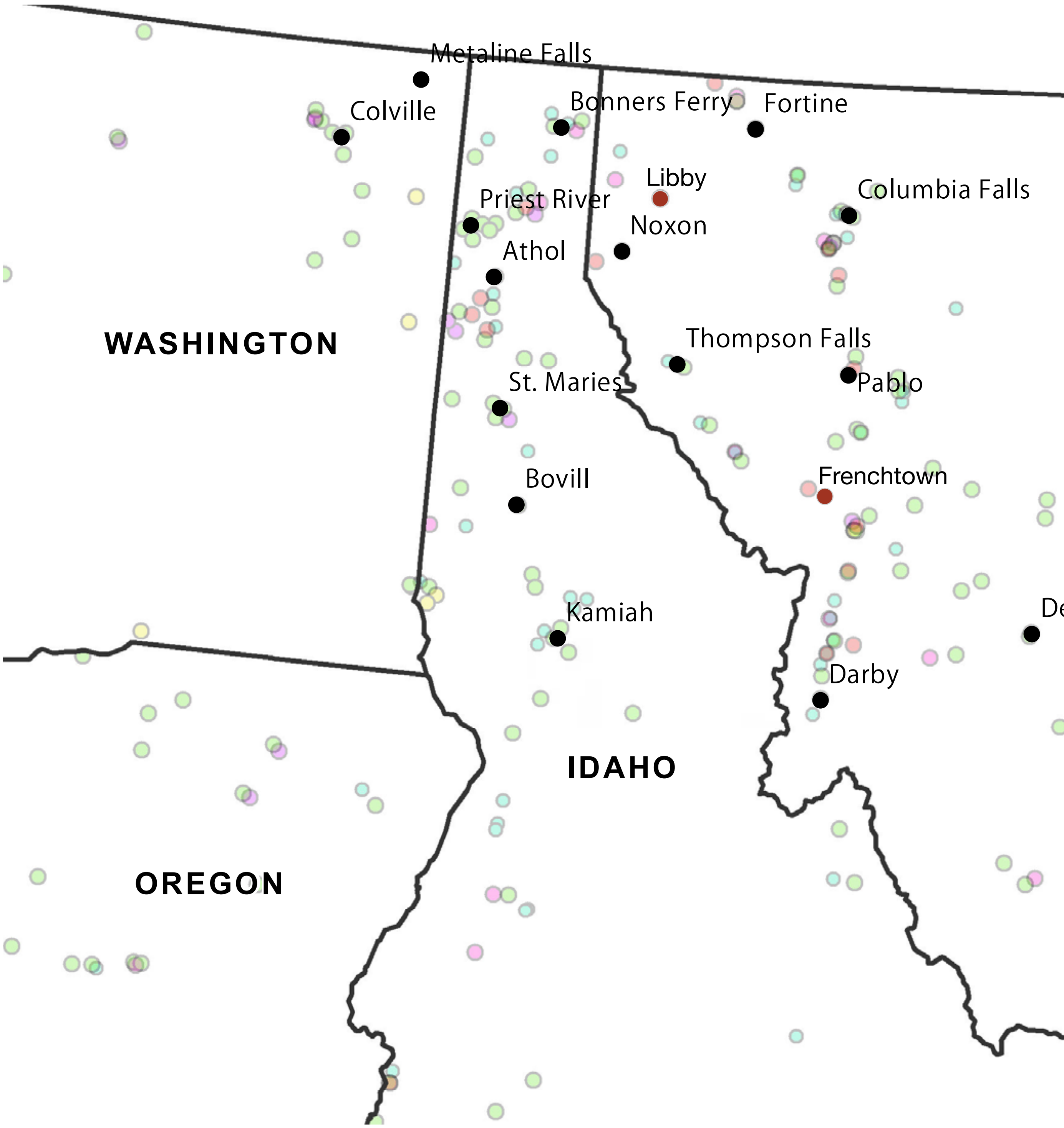
There are three wells on the property that draw water from the aquifer below the site; these aquifers have a production capacity of roughly 30 million gallons of water per day. The previous Smurfit-Stone operation had a National Pollution Discharge Elimination System (NPDES) permit that outlines the standards for storm water discharge from their industrial operation to the Clark Fork river. There are three discharge pipes on-site that could be repurposed. Pipes 1, 2, and 3 are covered under the existing NPDES permit that outlines acceptable effluent standards such as biological oxygen demand (BOD) and Total Suspended Solids (TSS). Existing permits may present an opportunity if they are in good standing and transferable to the new site operator with oversight and approval by the appropriate regional, state and federal regulatory agencies.

Some challenges facing the site include the possibility of flooding from the river and streams and potential pollution issues to the nearby river and wetlands. Furthermore, due to historic industrial operations, a portion of the site is under consideration by the US EPA as a Superfund site. The regional EPA headquarters in Denver is supportive of the new owners, who will not be responsible for the clean up costs of past activities. The cleanup is complicated by the size of the site and proximity to the river. Depending on which portions of the site actually get designated with ‘Superfund Status’ site, redevelopment into a conversion operation may be complicated. At a minimum, Superfund Status is likely to reduce the amount of available acreage for redevelopment related to biofuels production (i.e. biomass storage/chipping, etc.). Furthermore, it is likely that a Superfund assessment and cleanup could take several years to complete.

The site suitability analysis performed by the IDX team suggests that the area previously used for log storage and wood chipping should remain as the wood yard for the conversion facility. The wood yard will host processes such as unloading trucks, grinding biomass, and biomass storage. The area set aside for these processes is approximately 60 acres. From the wood yard, the biomass would move to pretreatment facilities located to the southeast in the previous hog fuel area. This area is approximately 40 acres. From the pretreatment facility, the biomass would move west to the fermentation and hydrolysis area where it would be converted to isobutanol. The area set aside for these processes is approximately 25 acres. It is important to note that both the wood yard and the fermentation and hydrolysis areas have road and rail access allowing for easy transportation of materials to and from the site by either mode.

LIBBY CONVERSION SITE CASE STUDY

There are several opportunities and constraints associated with the Libby conversion site. Opportunities include the existing concrete pads and wood-related equipment and industrial infrastructure (i.e. a truck scale, wastewater retention/settling/fire water ponds with active permits), a 25 megawatt (mw) electrical substation which is nearly complete, and an 11 million gallon per day (mgd) water plant with proximity to a large river and creek. The location of the site within the Kootenai Business Park, which has super-fund status, presents a possible constraint for the Libby site. The US Environmental Protection Agency (US EPA) has an ongoing cleanup operation for groundwater contamination associated with a closed and capped landfill within the park. The site suitability analysis performed by the IDX team suggests that site development and environmental restoration could be combined.



Depot Facility Sites

Depots are facilities where woody biomass feedstock is delivered from forested lands to undergo sorting and densification (e.g., chips or pellets). Through our work in the WMC region, we identified the role of biomass depots for increasing feedstock supply to potential conversion sites. The role of existing supply chain assets, including both functioning and dormant mill sites, is essential in decreasing capital expenditure requirements for an advanced biofuels process.

Due to the potential savings in capital costs from retrofitting, only existing and dormant mill sites in the WMC region were considered for analysis. To screen these sites further, additional factors were considered including total acreage, site classification, operating status, access, proximity to city limits, and proximity to the conversion facility. Based on these analyses, 15 potential depot sites were identified. Figure ES-3.1 shows the locations of the 15 depot sites and their proximity to the proposed Libby and Frenchtown conversion facilities. Each potential depot site was evaluated for site opportunities and constraints and master plan illustrations are provided.

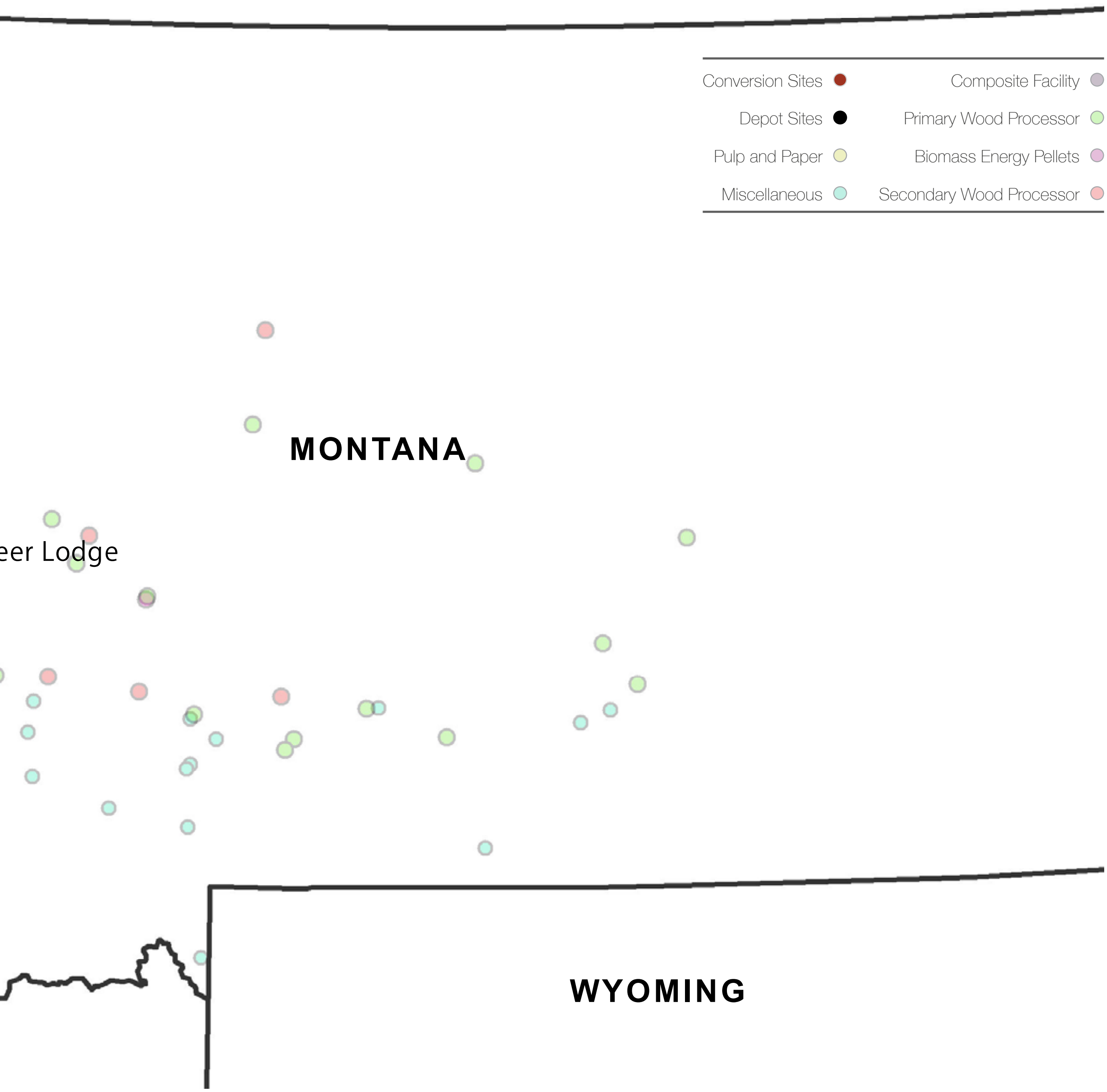


Figure ES-3.1 WMC potential depot site locations in relation to existing wood facilities and the two proposed conversion sites: Libby and Frenchtown

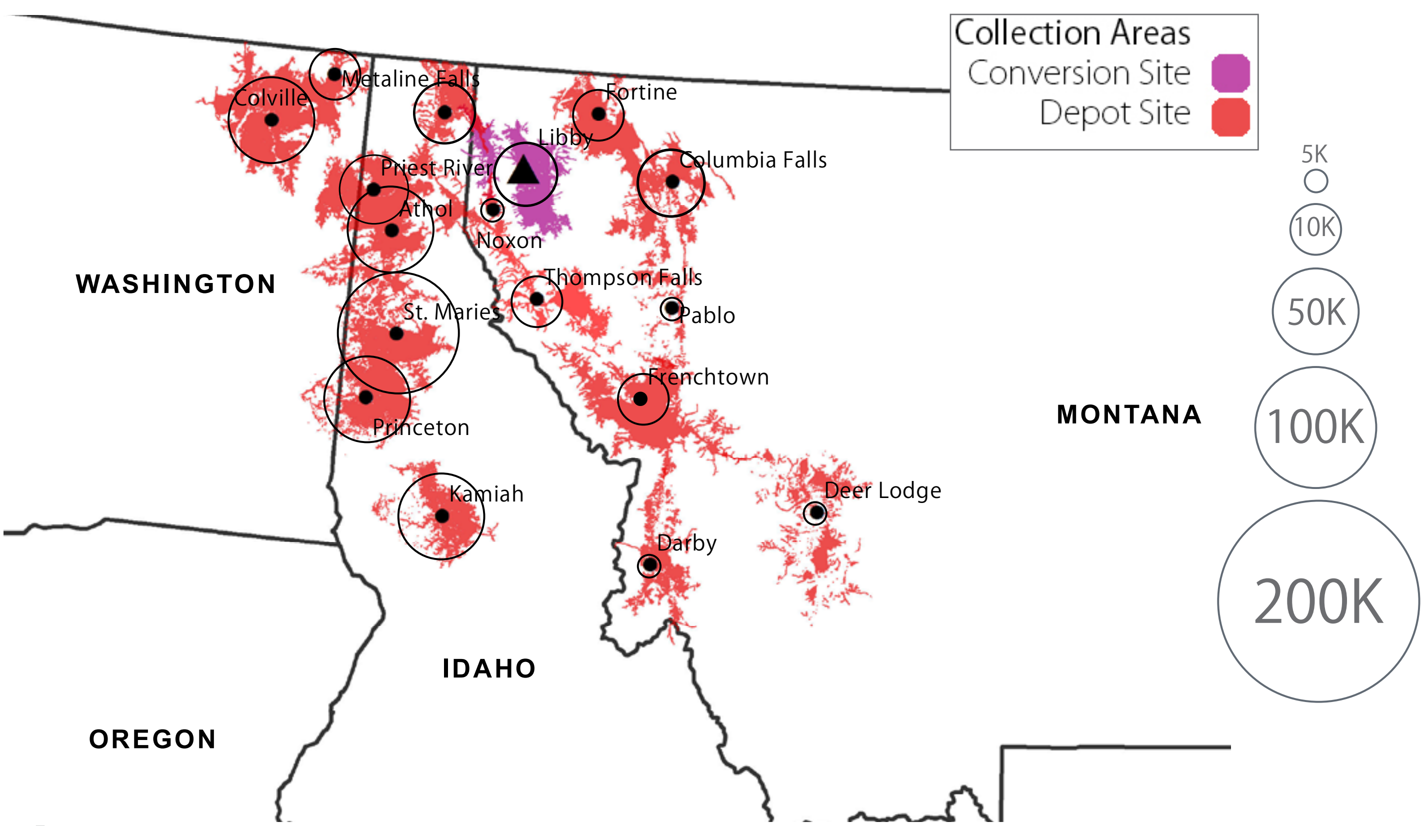
Supply Chain Analysis

Biomass supply curves were developed for each depot and conversion facility site. These supply curves show the amount of forest residual biomass available depending upon drive time. In addition, forest residual transport costs connected to rail and road transport were determined. This combined information was used to present a supply chain scenario for the Libby and Frenchtown conversion facilities based on a market case defined by the price for wood residuals delivered to a conversion facility at $40 per bone dry ton (BDT).

Based on the $40/BDT scenario, the annual amount of feedstock available by rail for a Libby and Frenchtown conversion facility is over 400,000 BDT for each facility (figures ES-3.2 and ES-3.3). The assumptions listed in Table ES-3 place an annual supply of forest residual feedstock at 1 million BDT per conversion facility. Conversion facility feedstock volume assumptions used in the NARA Techno-Economic Analysis (Volume 4, Chapter 1 of the WMC Supply Chain Study) place the minimum amount of feedstock at 770,000 BDT. The 770,000 figure was adopted from the feedstock assumptions used for a techno-economic analysis conducted by the National Renewable Energy Laboratory (NREL) for generating ethanol from cellulosic materials (Humbird et al 2011).

The $40 per bone-dry ton figure applies to transportation cost only and is used to define a "biomass availability" radius in which transport costs to the conversion facility would not exceed that amount.

Though the amount of available forest residuals for either the Libby or Frenchtown conversion facility sites is significantly lower that the 1 million or 770,000 annual BDT assumptions, a conversion facility processing ~400,000 BDT/year is not unrealistic. Current facilities built to convert cellulosic feedstocks to ethanol project ethanol output at a range of 25 to 50 million gallons per year (see table 3.3.5 in Volume 3 of the WMC Supply Chain Study). Based on NARA's conversion estimates listed in figure ES-3, 400,000 BDT of forest residuals will produce ~ 24 million gallons of isobutanol annually, which has a higher energy density than ethanol. 24 million gallons of



$40/BDT
(Transportation Cost Only)

405,000 BDT

Private: 294,737
Tribal: 68,648
State: 41,995

Figure ES-3.2. Libby Conversion Site $40/BDT Rail Scenario isobutanol translates to ~18 million gallons of iso-paraffinic kerosene (IPK). This amount of IPK will most likely be used with fossil fuels in blends up to 50%, which would supply up to 36 million gallons of jet fuel (USDA 2013).

In 2009, the Spokane Airport and Fairchild Air Force Base in Spokane consumed 13.1 million and 17 million gallons of jet fuel respectively. The amount of blended biojet fuel produced from a conversion facility processing 400,000 BDT of residuals annually would potentially supply 100% of the jet fuel needs for both of these airports based on 2009 levels.

(Sustainable Aviation Fuels Northwest 2011)

The supply chain analysis methods and assumptions used by the IDX group will continue to be refined in the coming years, including adding more detailed cost estimates to transportation and estimating policy impacts such as renewable identification numbers (RINs) attached to feedstocks. Currently, the IDX group is analyzing intermediate facilities that produce carbohydrates from wood in liquid solution. It may be, given further analysis, that the WMC could support one or more of these intermediate 'liquid' depots. The output from these facilities, which has much higher energy densities, could be transported at greatly reduced costs via rail or pipeline to receiving facilities outside of the region for conversion to isobutanol and other products.

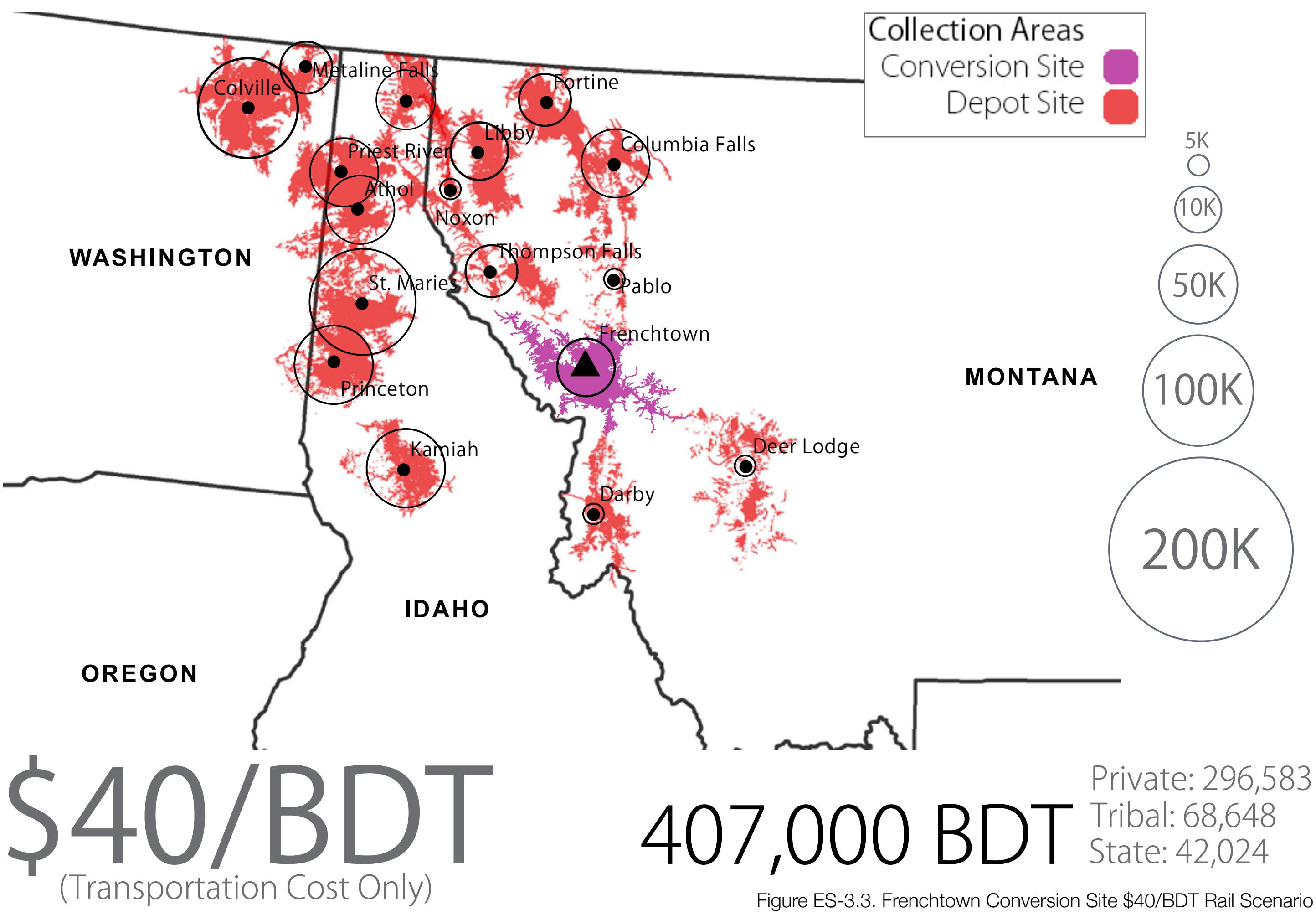


Figure ES-3.3. Frenchtown Conversion Site $40/BDT Rail Scenario

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VOLUME IV

SUSTAINABILITY

Sustainability Analyses

The USDA NIFA AFRI CAPs in Sustainable Bioenergy are charged to:

> **...facilitate the establishment of regional systems for the sustainable production of bioenergy and biobased products that: contribute significantly to reducing the National dependence on foreign oil; have net positive social, environmental, and rural economic impacts; and are integrated with existing agricultural systems.**
>
> (USDA NIFA 2010)

Within this charge, the term "sustainable" applies not only for production, but also to the environmental, social and economic conditions that accompany an emerging industry using forest residuals to produce biofuels and co-products. Introduced in this volume are assessments that address the sustainability of this emerging industry. These assessments are preliminary and present the reader with a snapshot of their development based on the information obtained through 2013 in the WMC. As NARA 's work continues, these assessments will be updated. Fully developed assessments for the entire NARA region will be available in 2016 when the NARA project is complete.

Below are the four chapters available in this volume:

TEA

Techno-Economic Analysis

The TEA provides an assessment for the overall economics of biofuels production from feedstock delivered to the mill gate through to biojet sale. The TEA models the capital requirement plus the fixed and variable operating costs for producing biojet from forest residuals.

LCA

Life Cycle Assessment

The LCA assesses the environmental impact of producing aviation biofuels from wood residuals and compares it to the petroleum products for which it will substitute. This assessment considers options associated with various harvesting and production steps suitable for specific regions in the Pacific Northwest.

CIA

Community Impact Analysis

The CIA applies economic models to measure the economic impacts on local communities from residual harvest activity, transportation, collection and storage of woody biomass materials, through processing into biojet fuels. Social accounting matrices will be constructed for counties in the WMC region and used to calculate multipliers that relate total dollars of input per dollar of output and the number of wage and salary employees per dollar of output.

E&O

Education and Outreach

The NARA Education and Outreach Teams conduct surveys used to gauge community attitudes and knowledge regarding an emerging industry that uses forest residuals to generate chemical products like bio-jet fuel. Preliminary survey results and a summary of education activities are provided in the WMC report.

Techno-Economic Analysis (TEA)

NARA is developing a techno-economic assessment that describes operational and capital costs related to converting forest residuals into biojet fuel and co-products. This TEA uses the analytical framework developed by the National Renewable Energy Laboratory (NREL), who published a TEA on producing cellulosic-based ethanol, while revising capital expenditures, operational expenditures, and fixed costs as appropriate (Humbird et al 2011).

A more detailed account of the NARA TEA is provided in Task SM-TEA-1: Techno-Economics Analysis of the 2013 NARA Cumulative Report.
http://nararenewables.org/2013-report/

Several scenarios were developed for operating a biofuels refinery. For purposes of brevity, the analysis in the NARA TEA focuses on the "Burn Lignin" scenario that includes:

Feedstock Preparation and Storage

Calcium Bisulfite Pretreatment

On-Site Enzyme Production

Standard Gevo Isobutanol (IBA) and Iso-Paraffinic Kerosene (IPK) Production

Multi-Fuel Boiler Burning all Production Residues with Natural Gas for Energy Balance

Assumptions in this analysis and production scenario are as follows:

Integrated Biorefinery 770,000 BDT/yr

Feedstock - Ground Slash Piles Composition from NARA FS-10

Greenfield Capital Expenditure (CapEx) Entire Facility

Commercial Feedstock Costs of $68/BDT delivered to mill gate

Burn Lignin and Screen Rejects

Assuming a complete greenfield construction of an integrated biorefinery and a 20% internal rate of return, the current cost estimate for producing biojet (IPK) from forest residuals will be 2 to 3 times the current spot market cost of petroleum jet fuel (Figure ES-4). With optimistic estimates for improved yields throughout the conversion process, this value might be lowered to 1.5 times the cost of the petroleum equivalent. The capital expenditure for a biorefinery built on a greenfield-site is projected at between $500 million to $1 billion depending on capacity. The operational expense of producing biojet fuel would represent 45% of the total cost of 1 gallon of biojet fuel. It should be noted that this initial model is a "worst case" scenario for costs and does not investigate other production scenarios currently under investigation.

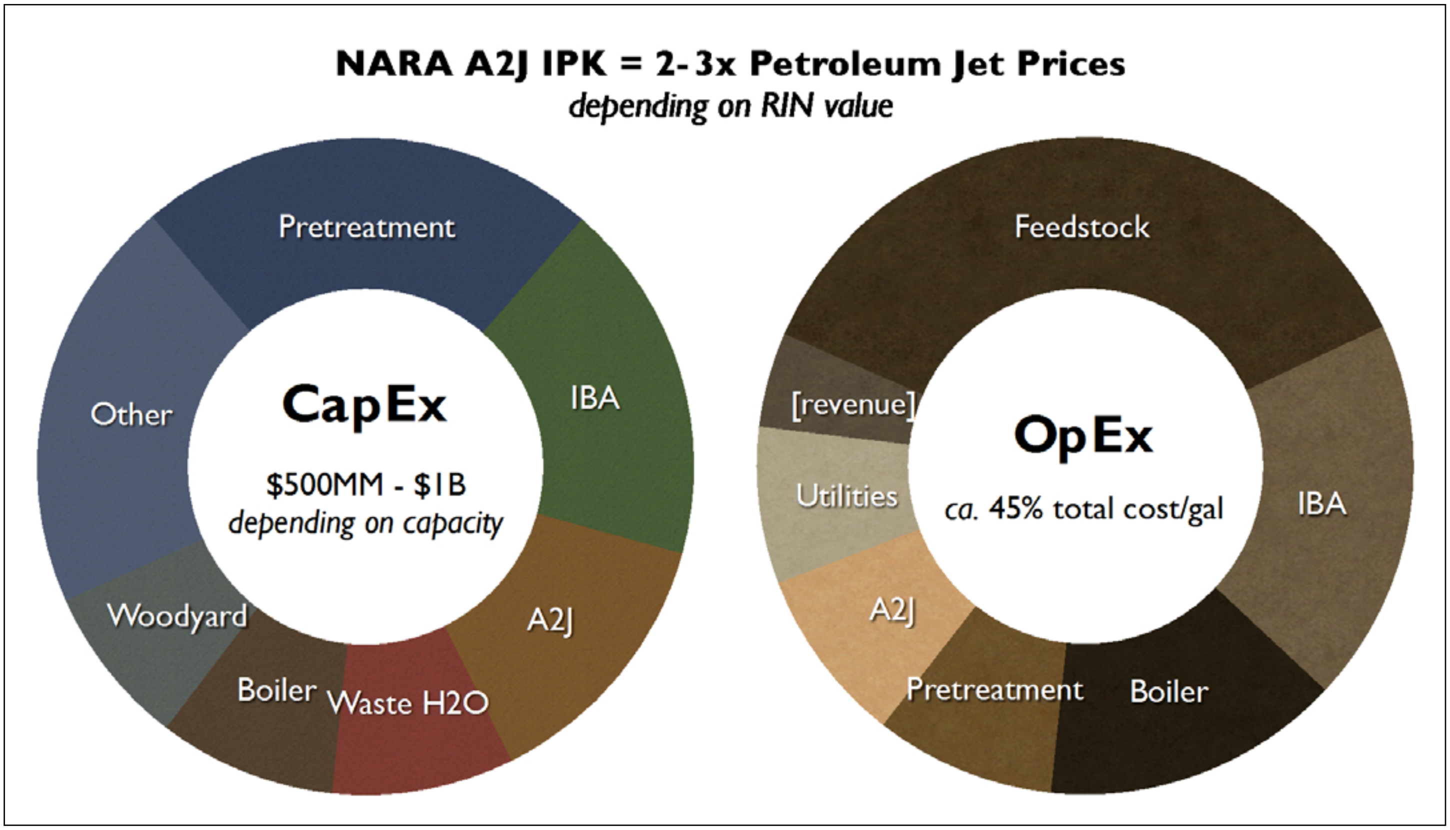

Figure ES-4. Current status of the techno-economic analysis

Interpretation of the analysis presents several highlights concerning the economic production of advanced biofuels

1

A high CapEx for a greenfield construction of an integrated biorefinery will likely impose financing barriers for large plants. NARA is identifying and making recommendations for existing facilities and brownfields that could be developed at a lower cost than greenfield development (See Volume 3).

2

The role of feedstock costs in the OpEx is critical. Even at relatively low mill gate costs for forest residuals, its role is dominant over every other cost center in the analysis. NARA is exploring methods to improve transport costs through more efficient processing and establishing solid and liquid depots.

3

Federal renewable fuel policies that influence financial incentives for production are crucial to successfully establishing an industry.

Life Cycle Assessment (LCA)

Life cycle assessment (LCA) identifies the environmental impacts of a product or activity over its entire life cycle. NARA performed a preliminary LCA of the WMC region to accurately estimate the environmental footprint of a woody biomass based biojet fuel supply chain in this region.

The results of the LCA will help forest managers and biofuel processing facilities evaluate biomass recovery options as they pertain to the environmental impacts of gathering and processing forest residuals after harvest and conversion into biojet fuel. The environmental impacts are measured utilizing protocols set up by the environmental management standard ISO 14044 (International Organization for Standards 2006a and 2006b).

The LCA results presented in Volume 4 assume an integrated model where the biomass preconversion, pretreatment and fuel conversion processes are all undertaken at the same location. It is important to note that various pretreatment and feedstock logistics options are currently being evaluated for their technical, economic and environmental feasibility, and that a final LCA will be presented once these variables are finalized.

PRELIMINARY RESULTS

Two sets of results are presented. The first compares the global warming, acidification, smog, and ozone depleting potentials of converting forest residuals into biofuels as opposed to burning the forest residuals. Forest residuals in the WMC region, which are typically left in the forest after harvest, are burned to avoid fuel accumulation on the forest floor. In this case, burdens associated with the "preconversion process" where forest residuals are collected, processed and transported to the conversion facility were compared to the burdens associated with slash pile burning. As Table ES-4 indicates, the avoided greenhouse gas (ghg) emissions from burning slash piles balances out the overall ghg emissions from woody feedstock collection and transportation.

Moreover, there is a net reduction in the environmental impact resulting from extraction of residuals for the biojet fuel project by avoiding slash pile burning for the following indicators: smog formation, acidification, and respiratory effects.

The second analysis compares the air emissions generated by jet fuel production from two feedstocks: fossil fuels and forest residuals. The use of fossil-fuel derived aviation fuels releases geologic carbon that has been stored for millions of years, and those emissions represent a net addition of CO_2 to the atmosphere. The NARA biojet fuel uses wood residue derived from timber harvest operations as the raw material to produce iso-paraffinic kerosene (IPK) jet fuel. Trees use atmospheric carbon dioxide to grow and burning biofuels simply releases this sequestered carbon dioxide back into the environment.

Table ES-4. Preliminary analysis comparing impacts related to forest residual processing and transport to forest residual burning.

Impact Category	Unit	System Impact	Avoided Impact	Total Impact
Global Warming	kg CO^2 eq	65.71	-65.7	0.006
Smog	kg O^3 eq	28.8	-89.5	-60.7
Acidification	mol H+ eq	52	-176	-124
Ozone Depletion	kg CFC-11 eq	2.7 IE-09	-3.26E-10	2.3E-09
Respiratory Effects	kg PM 1- eq	0	-11.1	-11.1

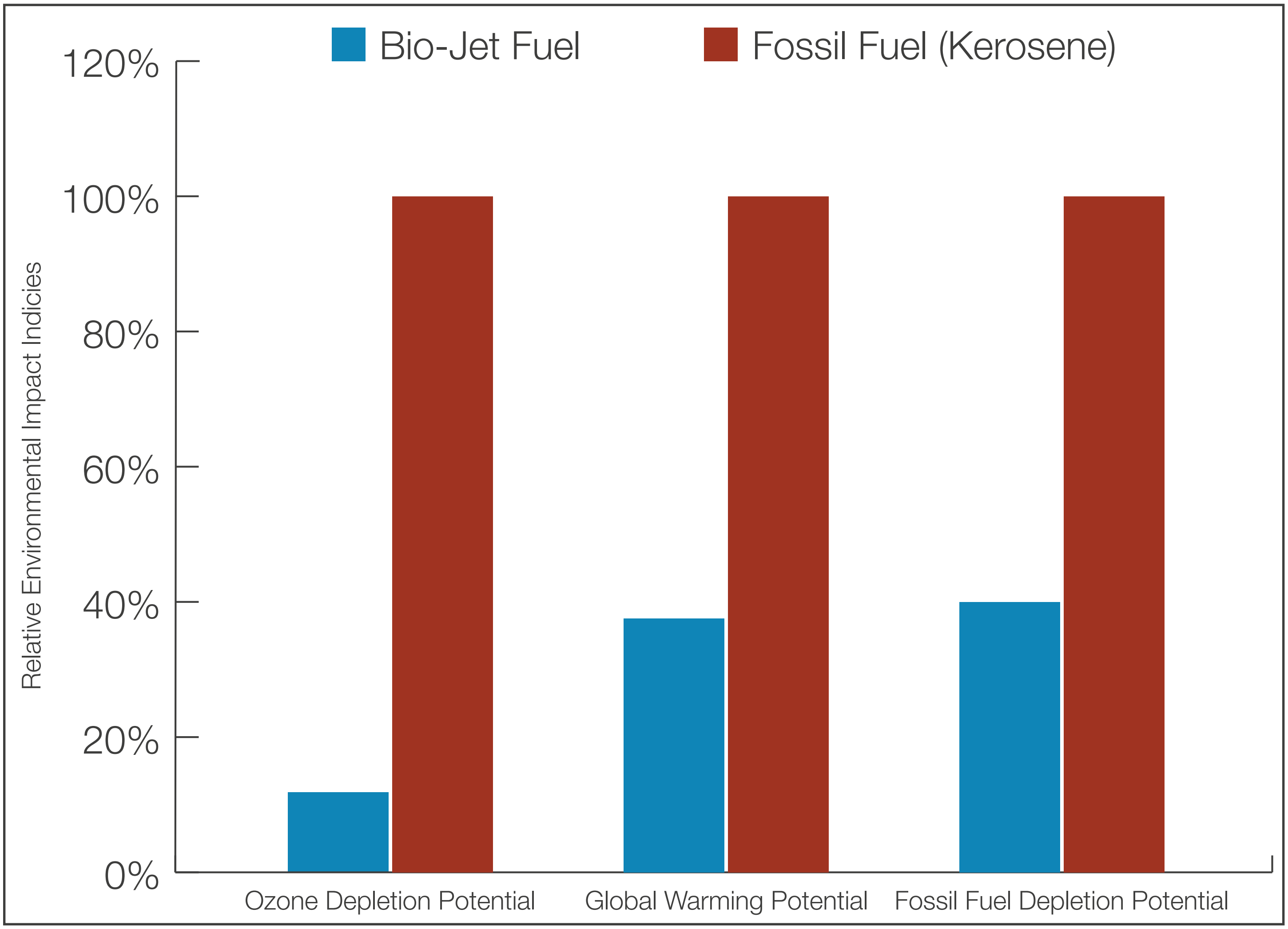

Figure ES-4.1 Preliminary analyses of the emissions reduction associated with biojet fuel used as a substitute for fossil based jet fuel in an intercontinental flight

As shown in Figure ES-4.1, the preliminary results of this comparison suggest that the overall global warming potential of the NARA biojet fuel, measured in kilograms of CO_2 emissions, is just 38.4% that of fossil fuel based jet fuel. In addition, the ozone depletion potential of the NARA biojet fuel is approximately 12% that of fossil fuel based jet fuel while the fossil fuel depletion potential is 39.1% of fossil based jet fuel. In other words, our preliminary analysis suggests that there is a 61.6% reduction in the global warming potential, an 88.1% reduction in the ozone depletion potential and a 60.7% reduction in fossil fuel depletion by substituting biojet fuel for fossil fuel based jet fuel. This preliminary result is significant in that it exceeds the mandated 60% emission reduction criterion specified in the US Energy Independence.

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Community Impact Analysis

An input-output model is created for the Western Montana Corridor (WMC) region and used to measure the impact on county-level economies from the production of biofuels using forest residues as the feedstock. This project is a first attempt to study and measure the importance of the production of biojet fuels using forest residue feedstock to the local economies and its impact on the livelihood and businesses within the WMC region.

The study utilizes three major data sources. County-level data for transactions were provided by the Minnesota IMPLAN Group. Forest residue data were provided by the University of Montana, Bureau of Business and Economic Research, who are contracted by the U.S. Forest Service to quantify all timber harvests and sales, and the flow of the wood products through processing plants and to the end users. Their data is summarized in a Timber Product Output report for each state that they monitor. This data was used to construct estimates of unutilized forest residues for the WMC. Expenditure data for the biojet fuel refinery were taken from a techno-economic analysis completed as part of the larger Northwest Advanced Renewables Alliance (NARA) study on biojet fuel production using forest residue feedstock.

RESULTS

The results reported are for the impacts of added economic activity due to additional forest residual harvests and their associated effect on the forestry and transportation sectors. We also report the results for the impact of a hypothetical biojet fuel plant with co-product production. The sum of these impacts constitutes the economic impact of new biorefinery production in the WMC.

As Table ES-4.1 indicates, an estimated $46 million (valued at $65/BDT delivered) spent by a hypothetical biojet fuel refinery on forest residue feedstock creates a direct and indirect economic impact of $74 million. Seven hundred thirty-six new jobs are created with nearly $36 million in value added, i.e., the induced effect. The sum of these direct, indirect and induced economic effects totals $110 million annually. This impact measures only the expenditure associated with feedstock purchases.

Table ES-4.1. Direct, indirect and induced effects from $46 MM additional spending on feedstocks

Sector	Impacts	Unit
SECTOR IMPACTS	$74.407	$MM
VALUE ADDED	$35.860	$MM
EMPLOYMENT	736	Persons
Value Added/Employee	$48,723	$/Person

An estimated $203 million annually spent by a hypothetical biofuel refinery on variable inputs, such as labor and materials, creates a direct and indirect economic impact of $459 million (Table ES-4.2). One thousand seven hundred fifty four new jobs are created with slightly over $143 million in value added (induced effect).

Table ES-4.2. Direct, indirect and induced effects from $203.6 MM additional spending on biorefinery operations

Sector	Impacts	Unit
SECTOR IMPACTS	$458.543	$MM
VALUE ADDED	$143.346	$MM
EMPLOYMENT	1754	Persons
Value Added/Employee	$81,725	$/Person

The combined effect of $249 million in expenses results in $533 million dollars in direct and indirect economic impact with nearly 2,500 new workers and $179 million in value added. The sum of these direct, indirect and induced economic effects totals $822 million annually.

These estimates are preliminary and the employment coefficients calculated from IMPLAN employment numbers seem high. We chose to use multipliers associated with chemical sector after a comparison between expenses associated with the hypothetical biorefinery and the chemical sector in the WMC region. The study method used chemical-sector multipliers subtracting the expenses associated with feedstock purchases, and used the forest and transportation sector multipliers to assess feedstock purchases. This is akin to saying that the biorefinery operations industry has a business separate that is in charge of purchasing feedstock and then passes it along to its "parent" business, without additional charge. While the procedure produces estimates of the economic impacts, there is room to improve upon the data associated with both expenses for feedstock and biorefinery operations.

New estimates of feedstock availability and improvements in expenditure data are being calculated by NARA members as the project progresses. We will use these estimates when made available to revisit the economic impacts on rural communities within the WMC and the broader NARA region.

The

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of

$249 million

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$533 million

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direct and indirect economic impact

with

nearly 2,500 new workers

and

$179 million in value added

The

sum of these

direct, indirect, and induced economic effects

totals

$822 million annually.

Education and Outreach

STAKEHOLDER ASSESSMENT

In recent years, there has been significant attention paid to the technology required for the creation of biofuels from various cellulosic feedstocks. In the Pacific Northwest region of the US, this focus has resulted in several alliances addressing numerous feedstocks relevant to the region (safnw.com; nararenewables.org; ahb-nw.com). This research addressed the impacts of social acceptance on biofuel project success. While scientific, infrastructure, and community physical asset development are significant and important to the success of this emerging industry, key questions must also be addressed regarding the perceptions, experiences and potential acceptance or rejection of this emerging industry by local stakeholders and communities.

The informed stakeholder assessment study examines informed stakeholder perceptions regarding the social factors which impact a biomass-to-biojet industry based on forest residues in the Western Montana Corridor (WMC). Key issues under investigation using a mixed-method approach include forest management practices, trust, communication, knowledge, experience, social acceptance, local community impact, and environmental concerns.

STAKEHOLDER ASSESSMENT FINDINGS

To date, preliminary analysis was conducted on 52 responses from the WMC; 41 surveys were completed over the internet, one via phone interview and 10 through in-person interviews. Figure ES-4.2 shows the location of respondents in the WMC by zip code.

Survey participants were categorized into three large stakeholder groups consisting of government, industry and environment (Figure ES-4.3). Within the government category, we included local, state and federal agencies, as well as elected officials; in the industry category we included all respondents associated with private industry ranging from forest operations to refineries; the environment category captured nonprofit organizations and regional collaborative organizations. To further understand survey participants, we asked them to provide their political preference. Figure ES-4.4 shows participants' self-described political preference.

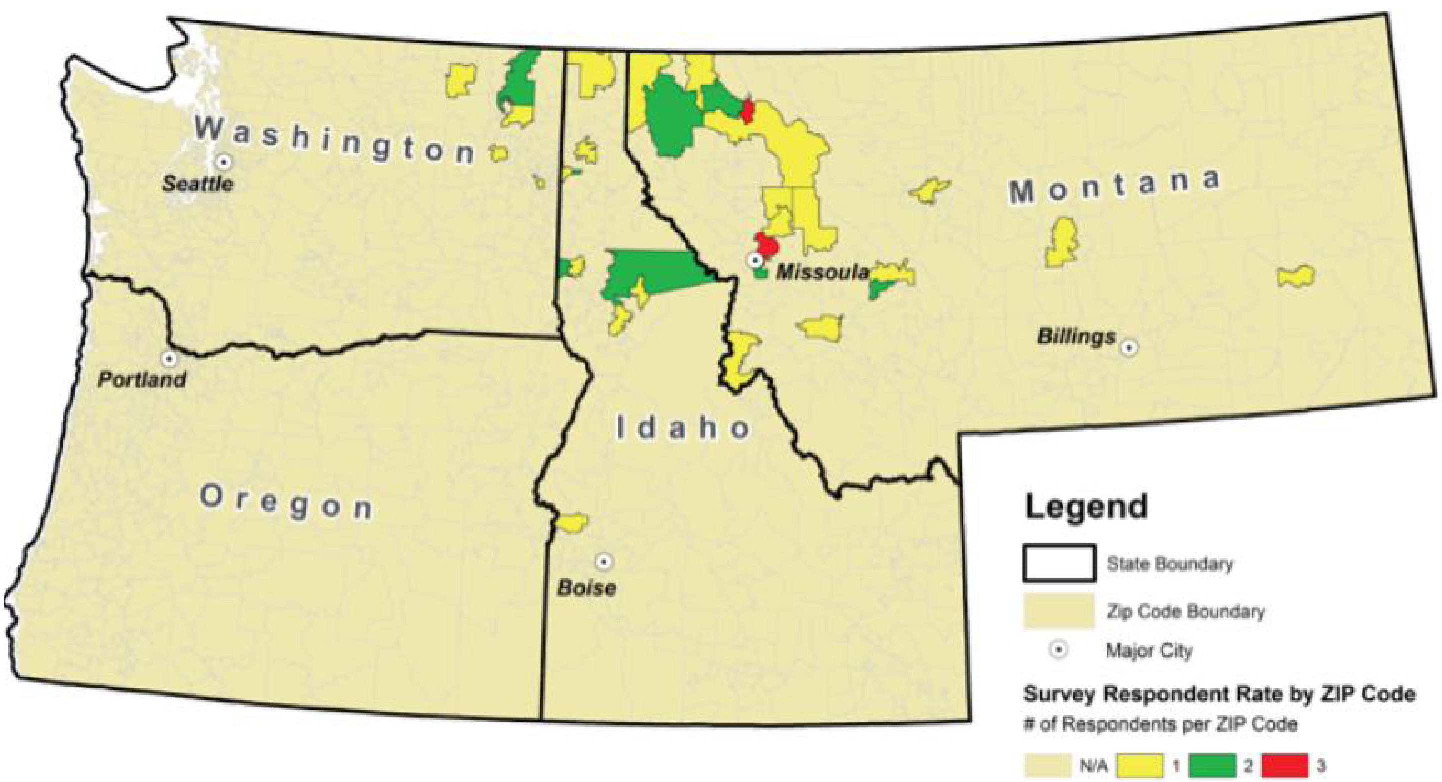

Figure ES-4.2. WMC Survey Participants by Zip Code

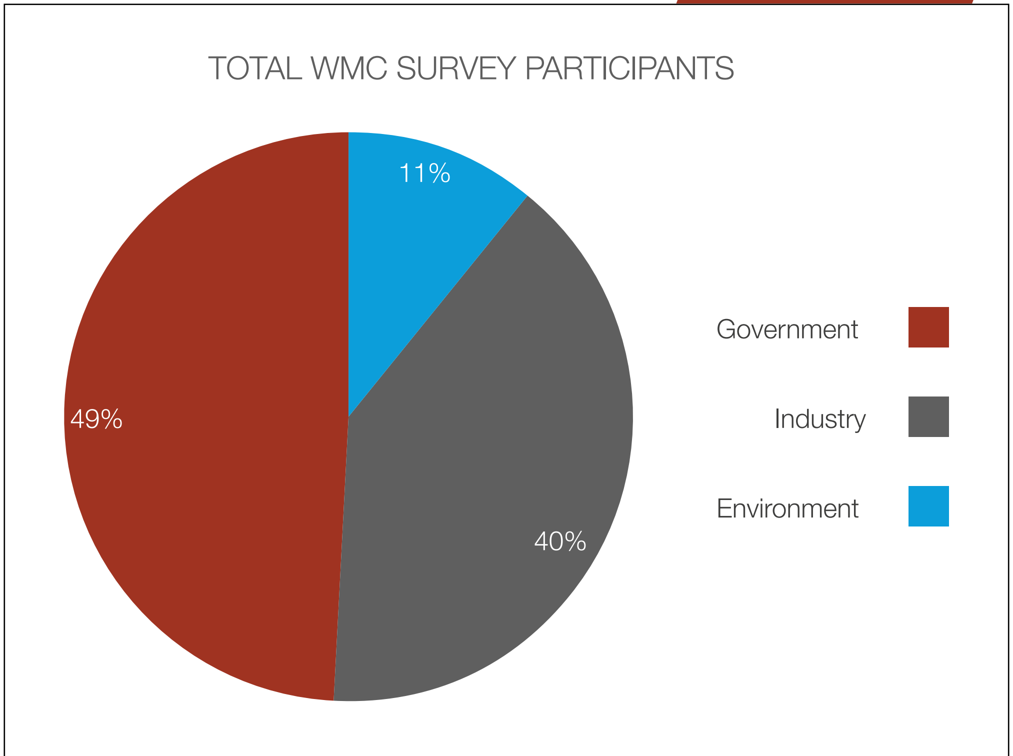

Figure ES-4.3. WMC Survey Participants by Stakeholder Category

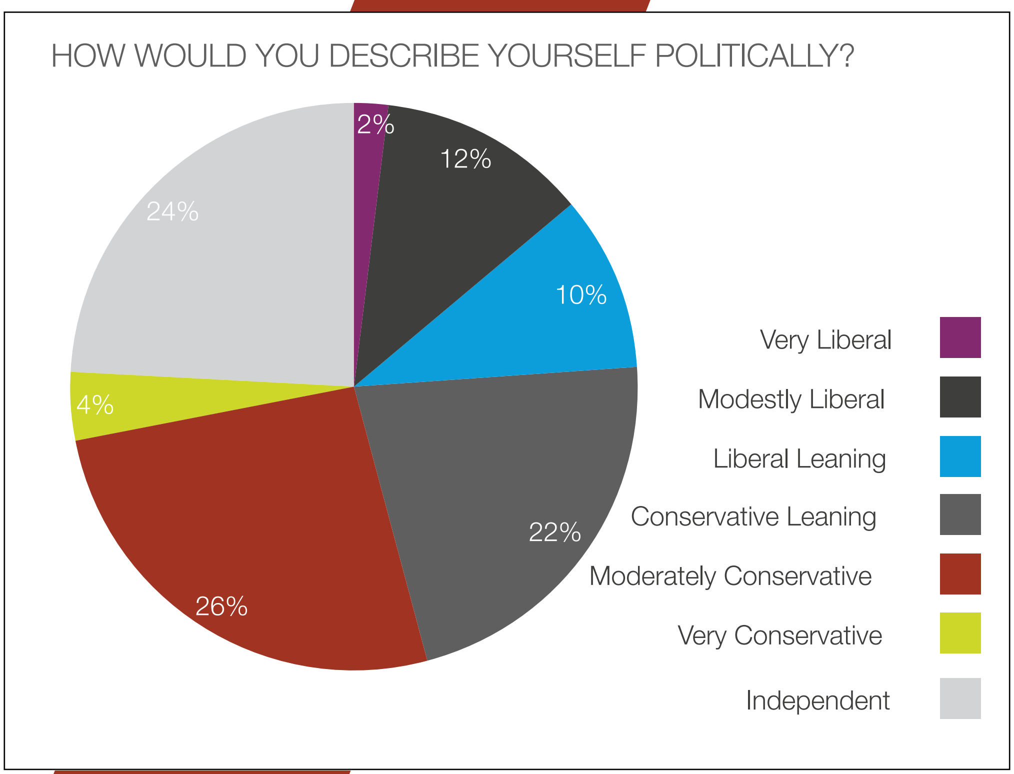

Figure ES-4.4. WMC Survey Participant's Self-Described Political Preference

Figure ES-4.5 shows the level of participants' support for a biofuels industry in the region. The graph shows that the majority of participants (86.2%) believe development of a biofuels industry in the Pacific Northwest would be good for the region, even though some (27.5%) had concerns.

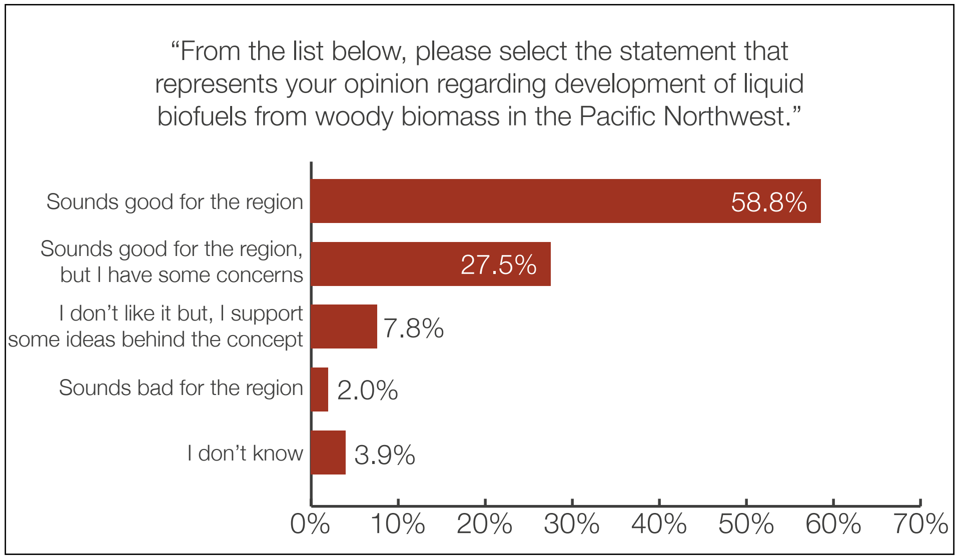

Figure ES-4.5. Participants' opinions regarding the development of liquid biofuels from woody biomass in the Pacific Northwest

Figure ES-4.6 shows participants' level of concern regarding multiple topics. From the items listed, the 'local economy' in their region, 'forest health in the Pacific Northwest,' and 'forest management practices on public lands in the Pacific Northwest' show the highest levels of concern.

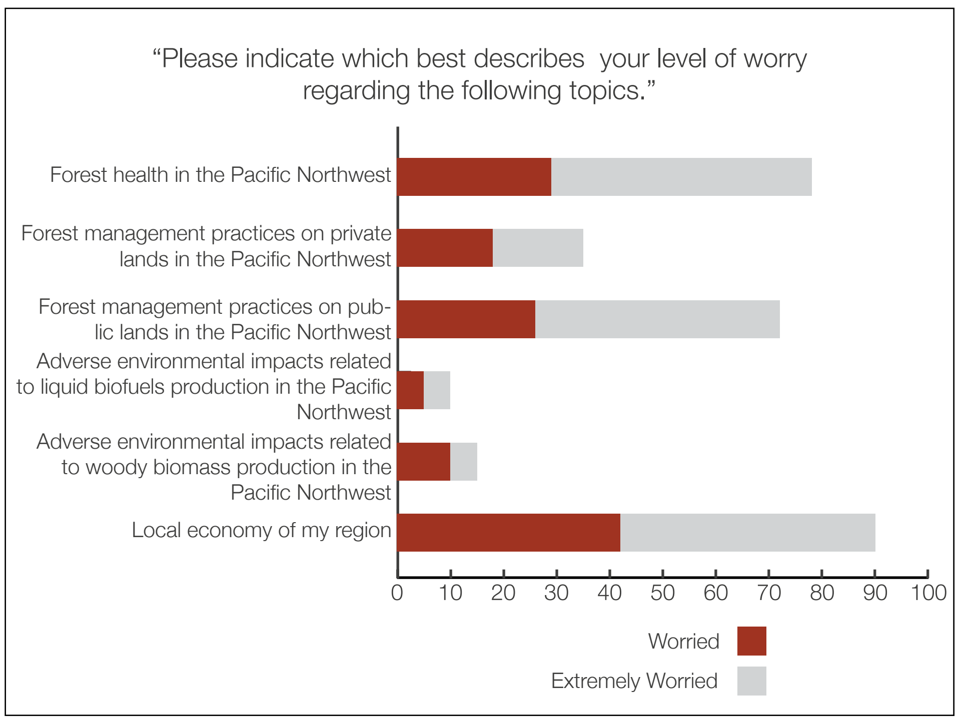

Figure ES-4.6. Participants' level of worry regarding several topics related to biofuels

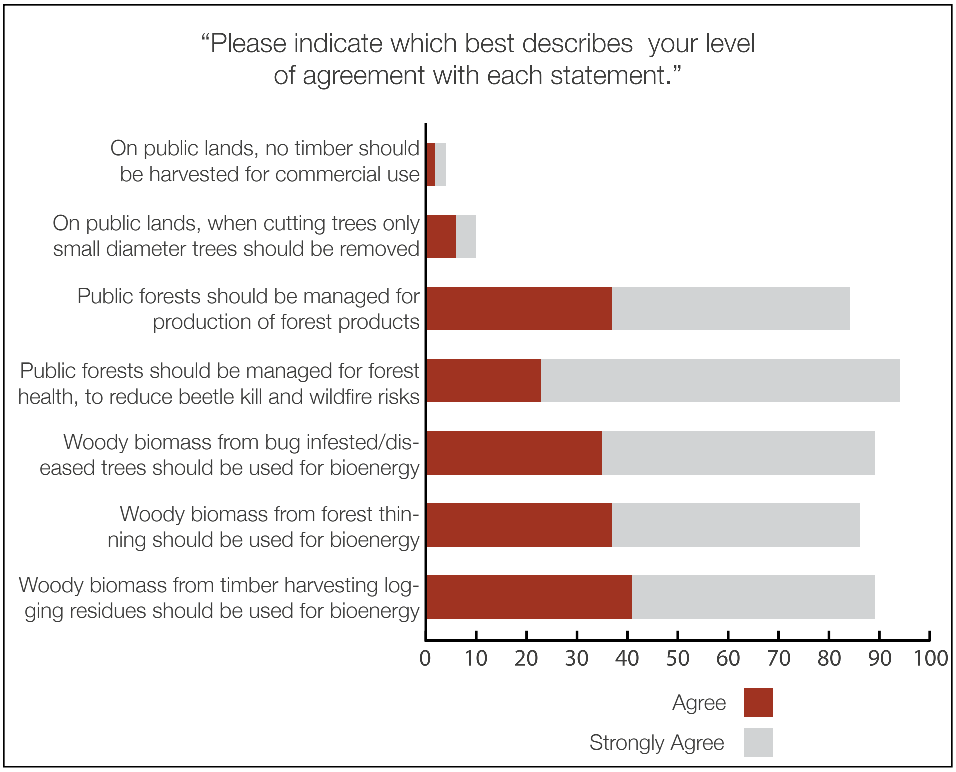

Figure ES.4.7 Participants' agreement with statements about sources of woody biomass

We asked participants to indicate how much they agree with or disagree with a number of potential sources of woody biomass (Figure ES-4.7). There was significant agreement among the majority of participants that woody biomass from multiple forest management activities should be collected and used to produce bioenergy. Their sentiments suggest that biomass from areas treated for insect disease, restoration thinning and from logging operations should be considered.

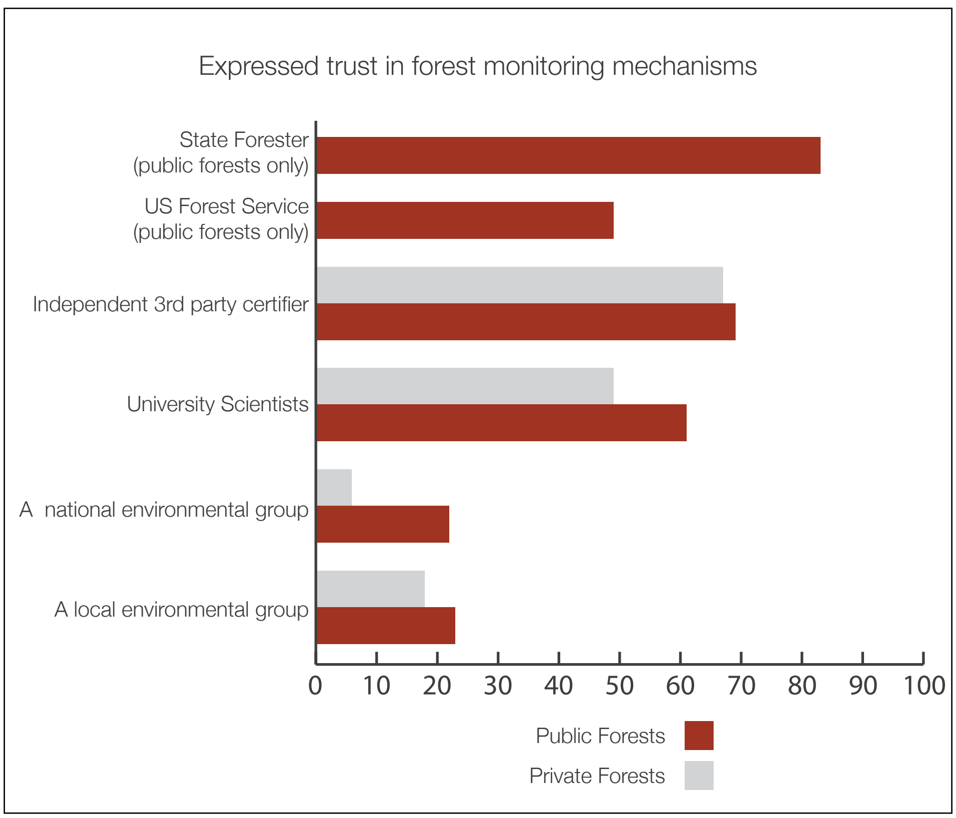

Figure ES-4.8. The expressed level of trust in groups of people potentially responsible for monitoring forests used as a potential source of woody biomass

Participants were also asked to select the entities they trust to monitor forest management activities, especially as it relates to bioenergy production. Figure ES-4.8 shows responses that indicate significant trust in state foresters, independent 3rd party certifiers, university scientists and the US Forest Service.


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