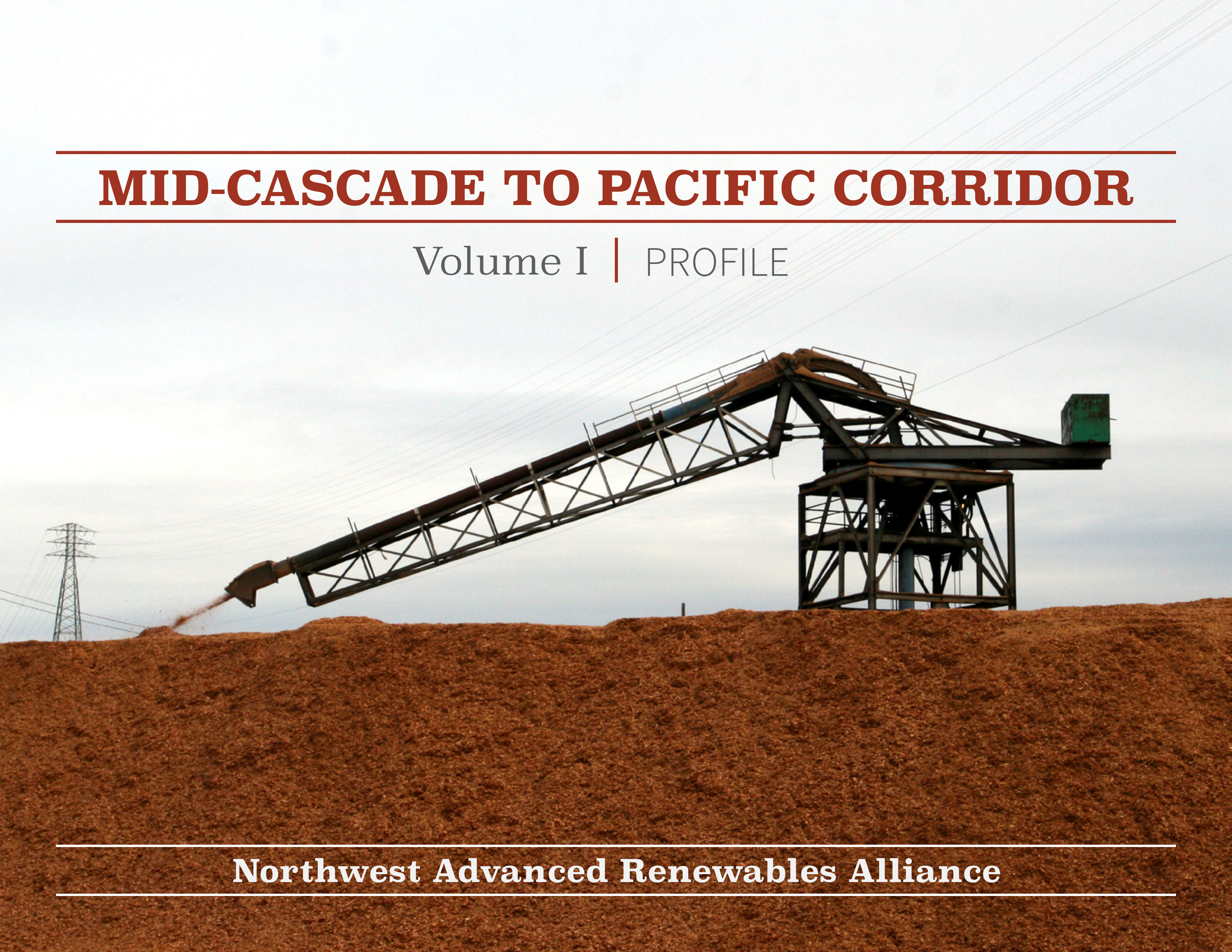
MID-CASCADE TO PACIFIC CORRIDOR

Volume I | PROFILE



Northwest Advanced Renewables Alliance

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ABBREVIATIONS

AFRI	Agriculture and Food Research Initiative program
AHB	Advanced Hardwood Biofuels Northwest
BDT	Bone Dry Tons
Brownfield	Abandoned or underutilized site with real or perceived contamination
CAPS	Coordinated Agricultural Projects
CAAM	Community Asset Assessment Model
C&D	Construction and Demolition Debris
CIA	Community Impact Analysis
CY	Cubic Yard
Greyfield	Vacant or underutilized site with no contamination
IDX	Integrated Design Experience
IO	Input-Output Analysis
LCA	Life Cycle Assessment
MRF	Material Recycling Facility
MSW	Municipal Solid Waste
N&E	New and emerging
NARA	Northwest Advanced Renewables Alliance
NIFA	USDA National Institute of Food and Agriculture
OSU	Oregon State University
RFA	Resource Flow Analysis
RWW	Recycled Wood Waste
SLA	Site Location Analysis
TEA	Techno-Economic Analysis
UI	University of Idaho
USFS	United States Forest Service
MC2P	Mid-Cascades to Pacific Corridor
WSU	Washington State University

AUTHORS

Tamara Laninga

Karl Olsen

Michele Vachon

Michael Wolcott

EDITORS

Charles Burke

Tamara Laninga

Jacob Smith

Michele Vachon

LAYOUT & DESIGN

Jacob Smith

Michele Vachon

Northwest Advanced Renewables Alliance

Mid-Cascade to Pacific Corridor

1.0.0 EXECUTIVE SUMMARY

NARA
Northwest Advanced Renewables Alliance

The Northwest Advanced Renewables Alliance (NARA) is examining the wood-based biofuels supply chain in the Pacific Northwest (MC2P), specifically in Oregon, Washington, Idaho and Montana during 2014/2015. The four-state region is shown in Figure 1.0.1. This Profile document provides an overview of NARA, outlines roles for NARA teams and stakeholders, describes the methods used to analyze the regional wood to biofuels supply chain, and provides an initial compilation of regional assets that will be verified and refined.

Background: NARA was initiated in 2011. It is one of six regional bioenergy 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).

This charge is being addressed through collaborative research, education and workforce development, as well as technology transfer through outreach. Our goal is to integrate research-based findings, knowledge of regional resources, and direction from regional partners to support the development of a sustainable biofuels industry in the Pacific Northwest.

GOALS AND OBJECTIVES

NARA' s primary challenge is to envision and facilitate an environmentally, economically, and socially sustainable wood-based biofuels and co-products industry in the Pacific Northwest. NARA's basic task is to develop, with regional stakeholders, a viable integrated pathway for commercially producing a bio-based aviation fuel (biojet).

Towards this end, NARA's five specific goals include:

1) CREATING sustainable biojet from forest residuals and construction and demolition waste
2) PRODUCING value-added polymer and carbon products from lignin to aid in the economic viability of a biorefinery
3) DEVELOPING regional supply chain coalitions to facilitate biorefinery infrastructure
4) PROMOTING rural economic development
5) ENHANCING bioenergy literacy for citizens and professionals

In cooperation with NARA members from private industry (e.g. Weyerhaeuser, Gevo and Catchlight), the project has produced an initial techno-economic analysis (TEA) that outlines an integrated biorefinery (IBR) operation producing isobutanol and biojet from forest residuals and construction and demolition waste (C&D). Assuming the construction of a 770,000 bone dry ton (BDT)/yr biorefinery from scratch (an approach known as greenfield development), the estimated cost for producing biojet from forest residuals is currently about two to three times the current market price of petroleum jet fuel. The biojet price will improve with overall process refinements as research progresses. In addition, increases in the price of petroleum will make the biojet price more favorable. Still, to achieve economic viability, we must also focus on refining supply chain efficiencies to achieve affordable feedstock and to trim costs by utilizing existing industrial assets for production.

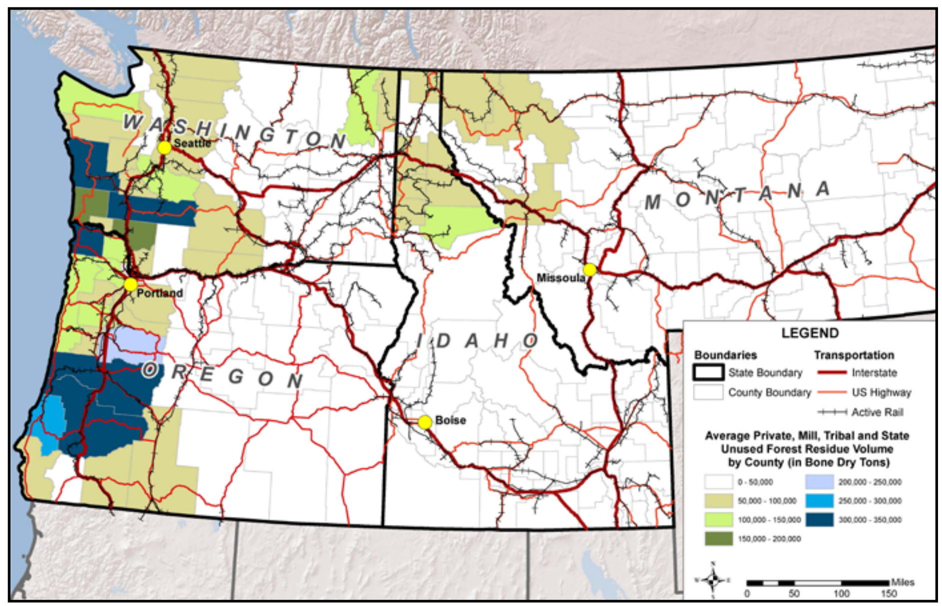


Figure 1.0.1. NARA Pacific Northwest Four-State Region

CHALLENGE

The overall goal of the MC2P supply chain study is to characterize, describe and understand the elements of the supply chain and evaluate supply chain performance in various regions of the MC2P. A framework will be designed to understand the linkages among producers, processors, suppliers, distributors, and markets. We will identify activities, linkages, barriers, and constraints that exist along the supply chain. This analysis will refine and build from the three supply chain studies conducted in the Clearwater Basin of Idaho, the Western Montana Corridor, and the Mid-Cascade to Pacific (Oregon and Washington) regions. Furthermore, it will take into consideration technological breakthroughs identified by NARA researchers including the preferred pre-conversion method of wood milling and the pretreatment method using a mild-bisulfite protocol.

The specific objectives of the MC2P supply chain study include the following:

- Determining regional market demand in various regions across the MC2P to set feedstock demand for conversion/IBR facilities.
- Identifying and ranking viable processing sites (e.g., solids and liquids depots, conversion and IBR facilities) in each market region in the MC2P for converting forest residuals to isobutanol and/or biojet fuel.
- Providing a techno-economic analysis for each top ranked site in each market area.

The study will assess strategies that consider regional assets and identify gaps to be filled that aid supply chain efficiencies and result in significant cost reductions. These assets include regions with high biomass production; active or idle industrial facilities that could host biomass depots, pretreatment processes, fermentation, or biorefining; and access to markets for biojet fuel.

NARA considers two models for a wood-based supply chain. Two models are considered because often the raw feedstock (biomass) is typically concentrated in a remote area whereas processing infrastructure and demand for the final product are concentrated in another area. For our study, one model is built around a large centralized integrated biorefinery, a high-capacity plant that takes biomass from slash or other woody residuals all the way to biojet fuel. The second model is a distributed production approach, where depots could produce intermediate products (i.e. refined and sorted biomass, wood-based sugar-rich liquids, isobutanol). These distributed operations could help maintain economies of scale for other core processes, such as fermentation and conversion of alcohol to biojet fuel. Permitting and related costs might also be reduced if integrated biorefineries and/or depots are located on previously industrialized sites.

Stakeholder Roles: Regional stakeholders play an important role in NARA's efforts to envision and analyze regional supply chains. In particular, stakeholder understanding of local assets can highlight unique opportunities that will make financing attractive, as well as offset capital and operating costs. These assets include transportation networks (rail and road), existing or idle industrial sites, workforce skills, financial incentives and policies, and existing markets for co-products.

The Pacific Northwest Profile document: This document serves several purposes, it: outlines our supply chain analysis approach and methodology; establishes the roles and expected outcomes for NARA members and participating regional stakeholders; provides a functional baseline of assets currently available for supply chain development within the four-state region (see Appendices); and serves as a guide for how stakeholders can assist and contribute to NARA's supply chain development in the Pacific Northwest.

SECTION 1 introduces the NARA project in more detail, explaining its goals and team structure, as well as defining the MC2P study region.

SECTION 2 outlines the structure of NARA's supply chain study, including description and roles of various collaborators ranging from regional stakeholders to the NARA Education and Outreach teams, as well as other relevant partners.

SECTION 3 identifies the analysis and design methods being used to examine the biofuels supply chain in the MC2P. It offers a brief list of inputs required for such analyses, with examples and current data sets listed in the appendices. The regional assets provide the basis for conducting analyses of the MC2P biomass to biofuels supply chain. NARA fully recognizes that the quality of its analyses depends on the quality of the input data. As the project evolves, NARA will rely on regional stakeholders to provide accurate and meaningful feedback as well as additional, updated data that may become available to them. A web portal has been established for stakeholders to supply data to NARA researchers at http://goo.gl/ChBLr3.

SECTIONS 4 through 10 are document references and appendices. The appendices list the assets, grouped by community capitals, collected from local, regional, state and federal sources.

RELATED DOCUMENTS: The MC2P Profile document is the first of three documents. The second document, the MC2P Analysis, will include site location selection, resource flow, and site analysis examining regional assets. This document is anticipated to be complete in early 2015. The third document, MC2P Design, will include a refined supply chain analysis and case studies of specific sites in the region including master plans and building and infrastructure designs.

To find out more about NARA and other regional supply chain analyses in the Clearwater Basin, Western Montana Corridor, and the Mid-Cascade to Pacific, please visit www.nararenewables.org. To sign up for NARA updates and newsletters, please go to http://nararenewables.org/org.

1.0.1 NARA PROJECT INTRODUCTION

The Northwest Advanced Renewables Alliance (NARA) is a Coordinated Agricultural Project (CAP) funded under the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA) Sustainable Bioenergy Program (Award 2011-68005-30416). NARA is examining the environmental, economic and social feasibility of a regional system for sustainable production of biofuels and biobased products from woody biomass, specifically softwood forest residuals, in Washington, Oregon, Idaho and Montana. The USDA defines woody biomass as the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the byproducts of forest management (USDA 2008). In addition to focusing on post-harvest forest residuals, NARA is also examining construction and demolition (C&D) wood waste (indifferent to species) as a potential feedstock. In this document the term woody biomass refers to softwood forest residuals and C&D wood waste.

NARA'S GOALS ARE TO DEVELOP:

1) SUSTAINABLE BIOJET: Develop a framework for a sustainable biojet fuel industry in the Pacific Northwest that uses residual woody biomass as feedstock
2) VALUE-ADDED POLYMER AND CARBON PRODUCTS FROM LIGNIN: Create valuable co-products made from lignin, an industrial byproduct of the woody biomass-to-biojet process
3) RURAL ECONOMIC DEVELOPMENT: Sustain and enhance rural economic development
4) REGIONAL SUPPLY CHAIN COALITIONS: Facilitate and promote supply chain coalitions within the NARA region for wood-to-biofuel supply chain analysis
5) BIOENERGY LITERACY: Improve bioenergy literacy to develop a future workforce and enhance stakeholder engagement, participation, and understanding

NARA IS ORGANIZED INTO FIVE TEAMS (FIGURE 1.0.2):

1) THE FEEDSTOCK TEAM takes a multi-pronged approach to the development and sustainable production, efficient accumulation and transportation of feedstocks from wood materials, including forest residuals and wood debris from construction and demolition.
2) THE CONVERSION TEAM works to provide a wood-derived replacement for aviation biofuel and other petroleum-derived chemicals that is economically and technologically feasible. The goal is to collect low-market-value materials and convert them to high-value products in order to overcome the relatively high cost of densifying and transporting biomass.
3) THE SUSTAINABILITY MEASUREMENTS TEAM evaluates and assesses environmental, social, and economic viability of the wood-to-biofuels supply chain. The life cycle assessment (LCA), community impact analysis (CIA), and technoeconomic analysis (TEA) groups are conducting most of these analyses.
4) THE OUTREACH TEAM transfers research-based science and the technology of converting woody biomass into biofuels and co-products to stakeholders and works to facilitate regional coalitions to foster the emerging wood-based biofuels industry in the Pacific Northwest.
5) THE EDUCATION TEAM engages citizens, focusing on K-adults, meets future workforce needs, enhances science literacy in biofuels, and helps people envision their role in the new energy economy. The Integrated Design Experience (IDX) group, with assistance from the Outreach team, conducts the regional supply chain analysis. Section 2.2.2 provides a detailed description of IDX.

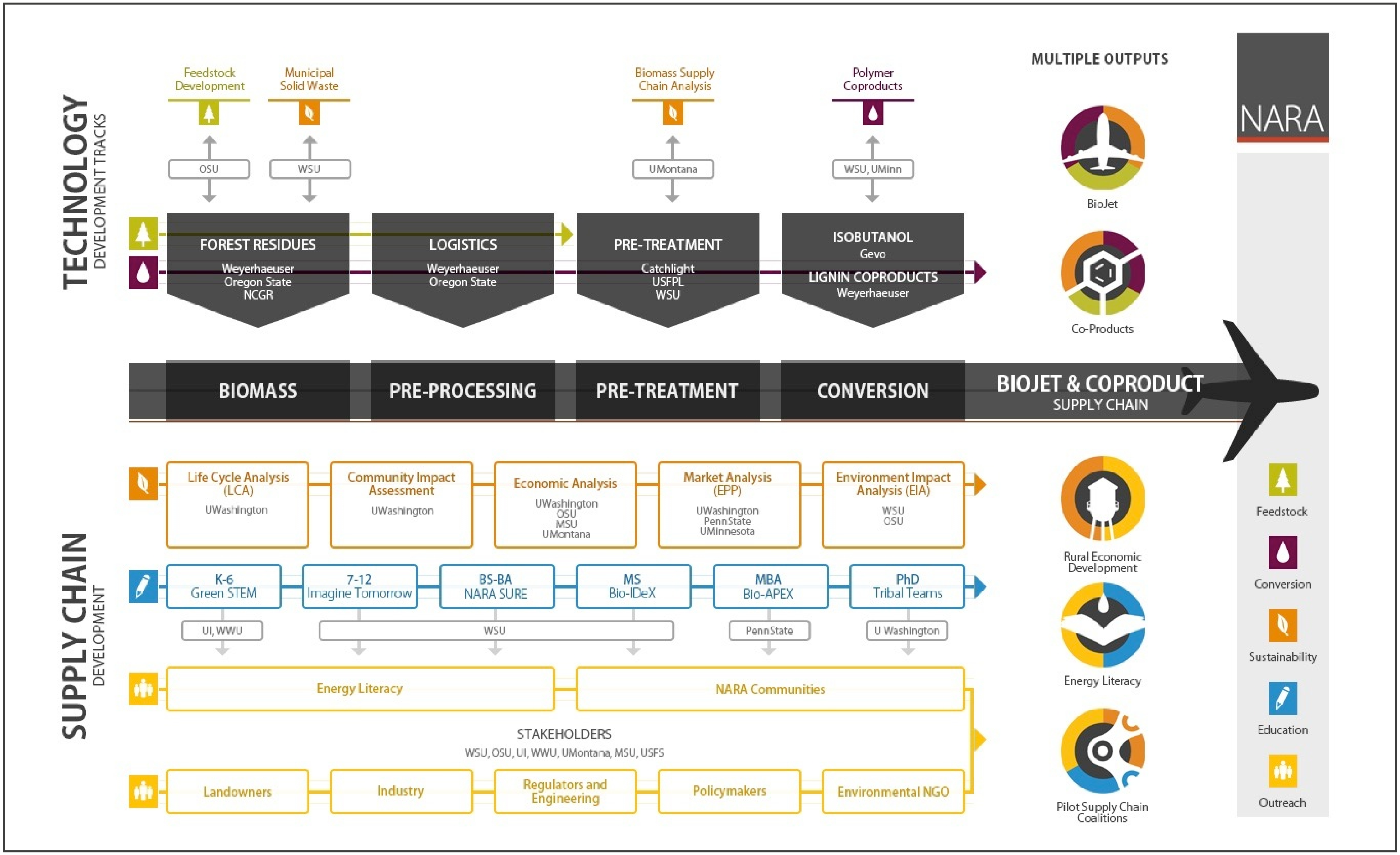


Figure 1.0.2. NARA Team Structure and Goals

1.1.0 INTRODUCTION

As stated above, one of the primary goals of the NARA project is to envision and delineate pilot supply chains within the NARA region that produce biojet and co-products from forest-based residuals and C&D waste. To this effect, the Outreach and Education teams work with Integrated Design Experience (IDX) students to develop a roadmap for industry to develop a viable supply chain. Involving stakeholders in the roadmap development, research process, and using their input to shape the supply chain analysis is an integral part of the pathway to a wood-to-biofuels/co-products infrastructure. Outreach Team members identify, inform, and engage stakeholders and existing organizations and working groups in the supply chain region. The Education Team partners with stakeholders and facilitates student teams who analyze and design regional supply chains for potential biofuels production. This two-pronged alliance both engages stakeholders in the research process and develops the regional knowledge and interest to carry the industry forward. Additionally, the diverse student teams researching the supply chains develop into the trained workforce of the future.

1.1.1 SUPPLY CHAIN ANALYSIS

A supply chain is a system developed to move products or services from supplier to consumer; it is composed of organizations, people, technology, activities, information, and resources. Activities along the supply chain transform natural resources, raw materials and components into finished products delivered to the end consumers. Supply chain analysis has been acknowledged as one of the required assessments for stimulating renewable energy development (IEDCl 2011). Supply chain management involves designing, planning, executing, controlling, and monitoring supply chain activities with the goal of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance.

Supply chain management for woody biomass to biofuels conversion involves activities from harvesting of the feedstock to transportation by one or several modes, pre-conversion (mechanical size reduction and densification), pretreatment, con-

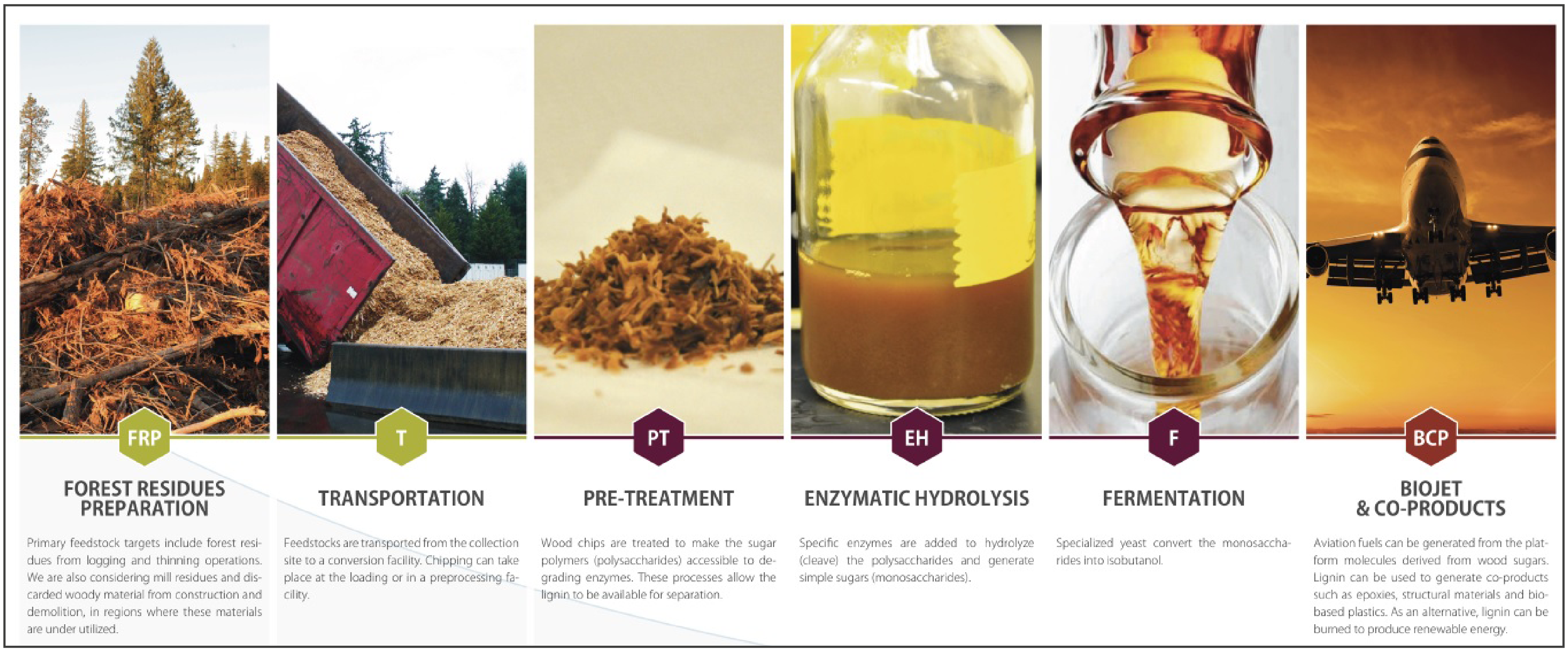


Figure 1.1.1. Overview of NARA Supply Chain

version, refining, and final biofuels delivery to consumers. In this project, the woody biomass to biofuels and co-products supply chain is shown in Figure 1.1.1.

The supply chain starts with harvesting feedstock (e.g,. collecting of softwood forest residuals and C&D waste). This may entail cutting and collecting biomass in the woods and transferring it at the landing to trucks for hauling to a pre-conversion facility or depot, where woody biomass is appropriately processed for downstream conversion into biofuels and co-products. Processes occurring at a depot site could include sorting, chipping, pelletizing, and/or conversion to sugar-rich liquids. To visualize the supply chain, it is useful to first understand a sequence of operations, keeping in mind that the feedstock must go through a series of processes. The operations might be sited at a variety of locations, depending on the particular supply branch of a given production arrangement, or centralized at an integrated biorefinery.

Some examples of supply chain operations are:

HARVEST OR COLLECTION: This activity occurs in the woods concurrent with, or shortly after, logging or forest thinning operations, or it could be collection of residual or waste biomass at sawmills or material recycling facilities. As a starting point, woody materials of interest currently have a zero or even negative market price, including residual slash piles that must otherwise be burned, and thinning that could provide non-commercial societal benefits, such as mitigating forest fires and maintaining healthy forests. It is expected that such biomass would still be at the low end of the price scale. Other uses of sawmill residues or pulpwood chips already have a positive market price, and competition for that material would only drive prices higher. NARA's initial estimates are based on available harvest and forest productivity data, along with data on collection methods, to estimate sustainable yields of the most plausible streams of forest biomass for energy uses.

TRANSPORT: High transportation costs are a key driver of total system cost for biomass. Biomass will typically go through several transport stages between the woods and the market, with the material's energy and mass density increasing along the way, and with the transport mode becoming more efficient in dollars per ton-mile or per gallon-mile equivalent. At one extreme, loose or baled logging slash could be hauled in slow, off-highway dump trucks. The cost per ton-mile (or per gallon-mile equivalent) for this step would be very high. At the other extreme, the final liquid product would likely flow to market in a pipeline. Energy density will be at its highest level and pipelines are the most efficient mode of bulk transportation, so the cost per gallon-mile will be the lowest possible. Reducing transport costs provides an incentive to locate processing stages closer to the feedstock and potential markets. At the same time, some of the processing (particularly conversion) is subject to economies of scale that motivates locating these processes in large, central biorefineries. Balancing these opposing technical/economic forces to minimize overall unit costs is the central challenge of designing an environmentally sustainable yet profitable biofuels supply chain.

PRE-CONVERSION: This term refers to mechanical sorting, cleaning, size reduction, and densification of the feedstock. Mechanical pre-conversion outputs could include wood chips or pellets. NARA is also looking into wood milling, which produces a fine wood flour. While wood milling is energy intensive, the advantages of this pre-conversion technique is that it reduces the amount of time and chemicals required in the pre-treatment stage. Pre-conversion activities may occur at solids depot. Although it is not really a "stage," seasonal storage is most likely to occur along with pre-conversion. The primary operation here, in terms of capital, energy, and labor costs, is likely to be electric-powered wood chipping, milling, and/or pelletizing of biomass at a depot site or adjacent to the conversion plant. Alternatively, for a long enough haul distance from the forest, relatively high-cost diesel chipping at harvest sites could pay for itself in reduced ton-mile transport costs.

PRE-TREATMENT: This is the process of deconstruction and loosening of the wood chemical structure so that enzymes can access and release the simple sugars in wood. NARA's pre-treatment pathway is a mild-bisulfite (MBS) protocol that uses sulfur dioxide to initiate the chemical breakdown of the wood structure at relatively low temperatures and pressures for separation of lignin and release of sugars from wood. This is similar in many ways to chemical pulping. Pre-treatment processes, which could occur at a liquids depot, will result in several product streams including lignin, 4- and 6-carbon sugars, as well as other byproducts.

CONVERSION: The conversion process converts the sugars to isobutanol at a conversion plant. The basic fermentation using bacteria or yeast has been in commercial operation for more than a century, but recently developed methods promise to increase the yield and produce a more cleanly separated alcohol. Isobutanol has several advantages over ethanol, including higher energy density, simpler final conversion to the long-chain liquid fuel (isoparaffinic kerosene a/k/a IPK) used for jet aviation, and being marketable as is.

REFINING: The final chemical process converts isobutanol into jet fuel. This might occur at a biorefinery or a conventional petroleum refinery that purchases the isobutanol. Biojet fuel from isobutanol can then be blended with petroleum-based jet fuel at the refinery to help meet refiners' renewable fuel obligations.

NARA considers two models to facilitate a complete wood-based biojet fuel supply chain. One model is built around a large centralized integrated biorefinery (IBR), a high-capacity plant that takes biomass from raw slash or other woody residuals, including C&D wastewood, all the way to biojet fuel. The second model is a distributed production approach, where depots could produce intermediate products (i.e. refined and sorted biomass, wood-based sugar-rich liquids, isobutanol). These distributed operations could help maintain economies of scale for other core processes, such as fermentation and conversion of alcohol to biojet fuel. Three facility types are being analyzed. They are described below and illustrated in Figure 1.1.2.

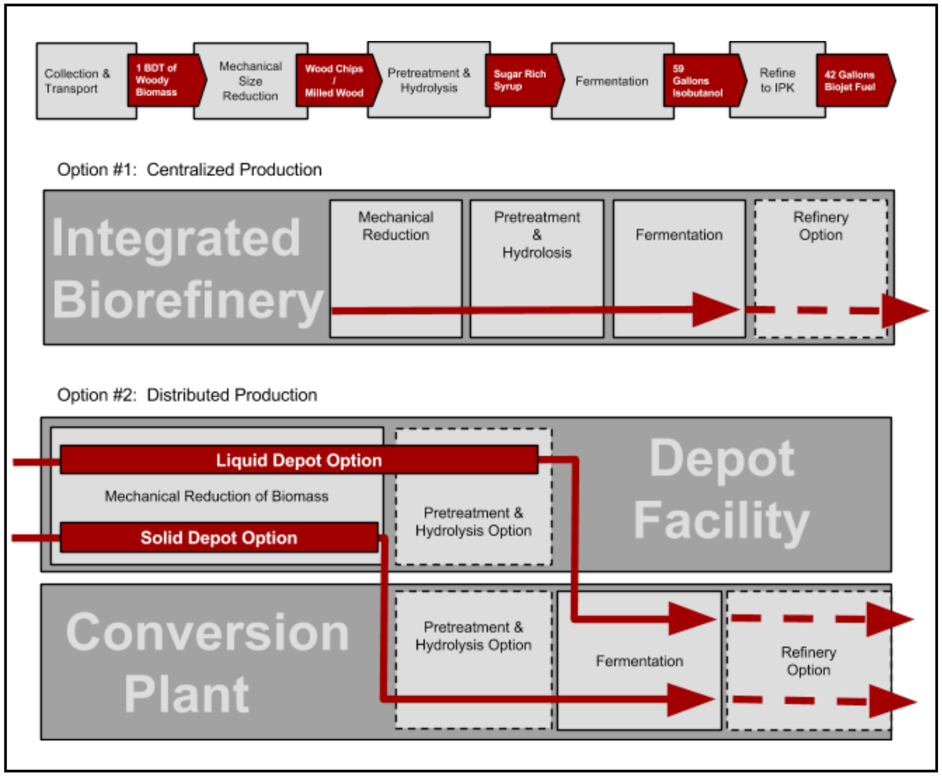


Figure 1.1.2. Wood to Biofuels supply chain pathway options

1) DEPOT FACILITY: A pretreatment facility that prepares the biomass for processing in a conversion facility. Two depot options are investigated and are detailed as follows:

Solids Depot: a pre-conversion facility that receives post-harvest forest residuals, forest thinnings, and/or C&D waste biomass. Mechanically processed materials could be shipped by rail or highway truck to a receiving liquids depot, conversion plant, IBR or other potential end user (e.g., fuel pellet manufacturer).

Liquids Depot: a pre-treatment facility that receives raw and mechanically processed woody residuals directly from nearby forests, or chips from a solids depot. A liquids depot produces a concentrated sugar-rich syrup that would be transported for conversion to isobutanol at an IBR for further refining into biojet fuel or other chemical conversion facilities.

2) CONVERSION PLANT: A high-capacity plant that takes in chips from a solids depot or liquid sugars from a liquids depot and produces isobutanol.

3) INTEGRATED BIOREFINERY (IBR): A high-capacity plant that converts biomass from raw slash or other woody residuals all the way to biojet fuel.

The centralized and distributed production models each aim to produce biojet fuel as the final product. The MC2P region has diversified supply chain assets across a vast geography and both models are being evaluated to identify the most efficient supply chain scenario. For the NARA project, the expected final consumers of biojet fuel include the U.S. Air Force and commercial carriers such as Alaska, Delta, and United Airlines. The U.S. military, Boeing, and several airlines have already conducted research on 50/50 blends of biojet with petroleum-based fuel (Enright 2011; Carbon War Room 2013). Key markets in the MC2P include commercial airports: Seattle-Tacoma International Airport (WA), Portland International Airport (OR), and Spokane International Airport (WA); and military bases: McChord Air Force Base (Tacoma, WA), Naval Air Station (Whidbey Island, WA), and Fairchild Air Force Base (Spokane, WA). Additionally, other potential consumers along the supply chain could also exist depending on the co-products developed from lignin and other byproducts of the process, such as sugars and wood fuel pellets.

Initial supply chain analyses are based on an assumption used by the techno-economic analysis team that a full-scale IBR would require 770,000 bone dry tons (BDT) of woody biomass annually. This quantity of feedstock would produce about 32 million gallons of biojet annually.

Since 2011, NARA has analyzed regional supply chains in three areas:

- Clearwater Basin in North Central Idaho, 2011/2012
- Western Montana Corridor (WMC), 2012/2013
- Mid-Cascade to Pacific (MC2P), 2013/2014

1.1.2 PRIOR SUPPLY CHAIN ANALYSIS STUDIES

Clearwater Basin Summary

Our analysis in the Clearwater Basin started by identifying supply chain assets and the region's resources (biomass availability), key nodes (potential sites for solids depots and conversion sites), and linkages - transportation (highways, railroads, and ports). Forest biomass estimates in the seven counties of the Clearwater Basin ranged from 679,000 BDT at $25/BDT to 738,000 BDT at $40/BDT.

Based on the regional assessment, specific sites were identified for further development. These sites are a solids depot at the former Jaype Plywood Mill near Pierce, ID; a conversion facility at the Lewiston, ID pulp and paper mill; and a transportation hub at the Port of Wilma in Whitman County WA (Figure 1.1.3). Using a 50-mile radius, and accounting for land ownership (specifically federal forests), the biomass availability for the Jaype site was estimated to be about 175,000 BDT. Site assessments and schematic site designs were completed for each site. Plans were developed for a chipping and pelletizing facility at the Jaype site; a retrofit of the Lewiston pulp and paper mill as a conversion facility; and a reorganization of the Port of Wilma site as a multi-modal transportation hub.

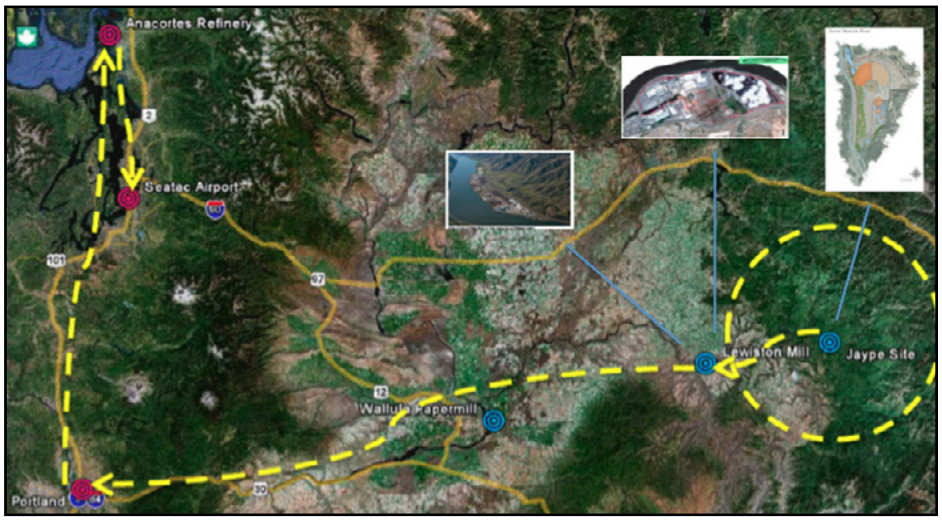


Figure 1.1.3. Clearwater Basin, Idaho, Yellow-dotted line represents the pilot supply chain

Western Montana Corridor (WMC) Summary

The WMC analysis collected regional asset data including natural, physical, civic, financial, and policy resources necessary for analyzing a wood-based biofuels supply chain. Biofuel supply chains, with conversion facilities at Libby and Frenchtown, MT, were analyzed in detail (Figure 1.1.4). In the WMC, analysis of forest residuals found biomass to be dispersed, making it harder to direct haul the requisite 770,000 BDT of feedstock to a conversion facility. A distributed depot model was developed, where solid depots were identified throughout the WMC to increase feedstock supply to potential conversion sites. The role of existing supply chain assets, including both functioning and idle mill sites, is essential in decreasing capital expenditure requirements for an advanced biofuels process.

Identified depot sites were classified into three categories: 1) active mills with a co-located depot; 2) idle mills with infrastructure; and 3) decommissioned mills with little or no infrastructure. These were further classified into brownfields and greyfields, which are abandoned or underutilized industrial and commercial facilities available for reuse. However, use of brownfields may be complicated by environmental contamination. Other factors considered included location within or outside of city boundaries and proximity to conversion sites. At each site, assets were inventoried, opportunities and constraints identified, and site master plans developed. The sites included: conversion plants in Libby and Frenchtown, and four depot sites located near Colville, WA (active/greyfield); Bonners Ferry, ID (idle/greyfield); Thompson Falls, MT (decommissioned/greyfield); and Pablo, MT (idle/brownfield). Assuming a $40/BDT hauling cost for biomass, two scenarios are shown for a proposed conversion facility at Libby, MT. Figure 1.1.5 shows the road-only scenario. In this case, only 71,000 BDT is accessible for a conversion site at Libby, with 65,000 BDT coming from private lands, and 6,000 from state lands. Figure 1.1.6 shows the rail scenario, where 405,000 BDT was accessible to the conversion facility, with almost 300,000 BDT coming from private lands; 70,000 BDT from tribal lands and the rest from state. Neither scenario is able to reach the goal of 770,000 BDT per year at the transportation cost of $40/BDT. Furthermore, if additional costs were included, such as removal, rehandling and chipping, the cost estimate is closer to $65/BDT. The analysis shows the necessity of a distributed depot/conversion model, relying on mixed transportation modes. However, it was found that in the WMC, even relying on depots, it is difficult to reach the 770,000 BDT of feedstock for a conversion facility at Libby. A similar analysis was conducted for a proposed conversion facility at Frenchtown, MT, and a similar conclusion was made.

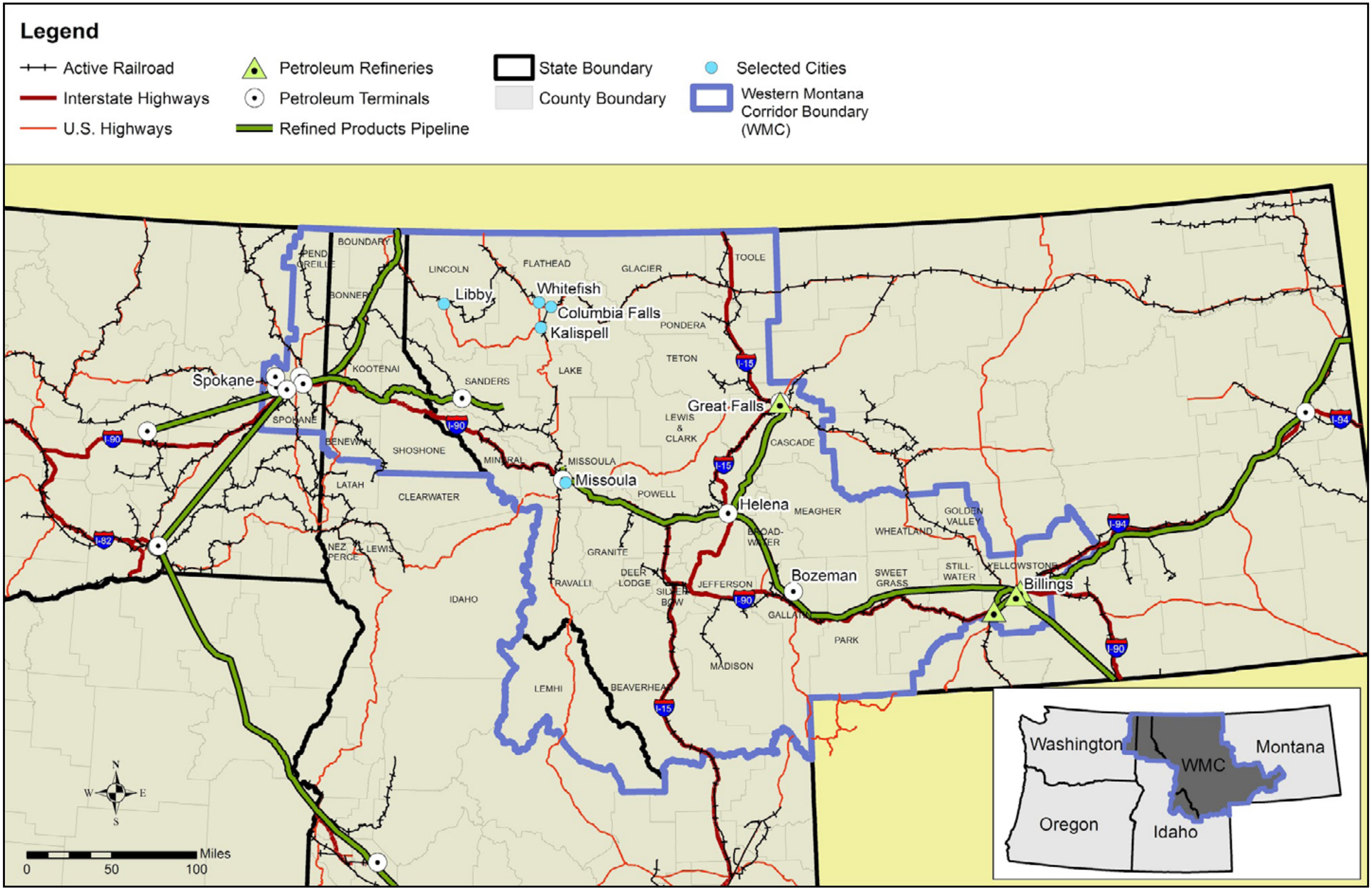


Figure 1.1.4. Western Montana Corridor (Northeast WA, Northern ID, and Western MT)

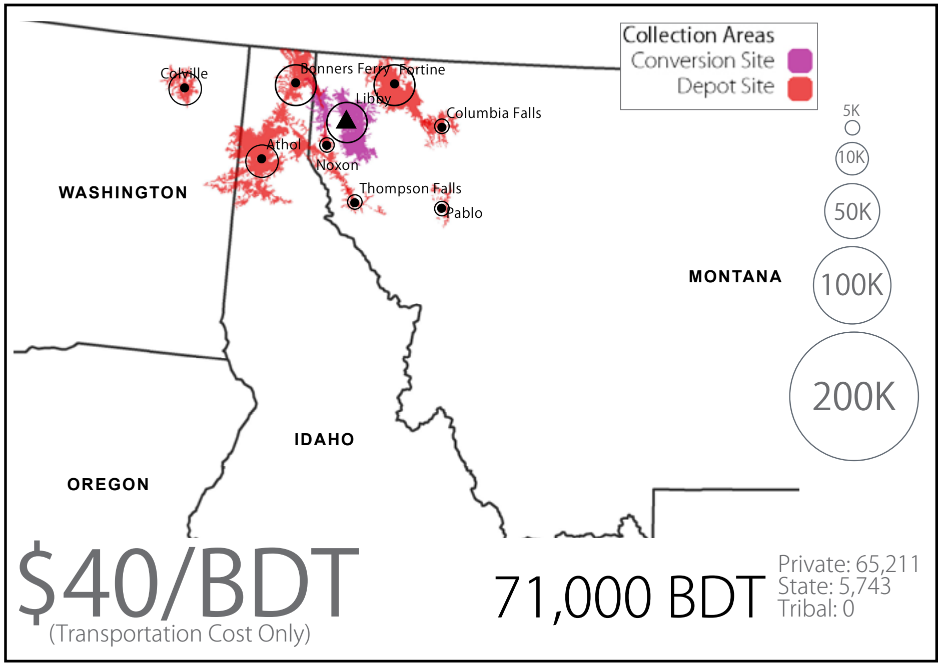


Figure 1.1.5. Libby conversion facility and depot sites using road network, $40/BDT

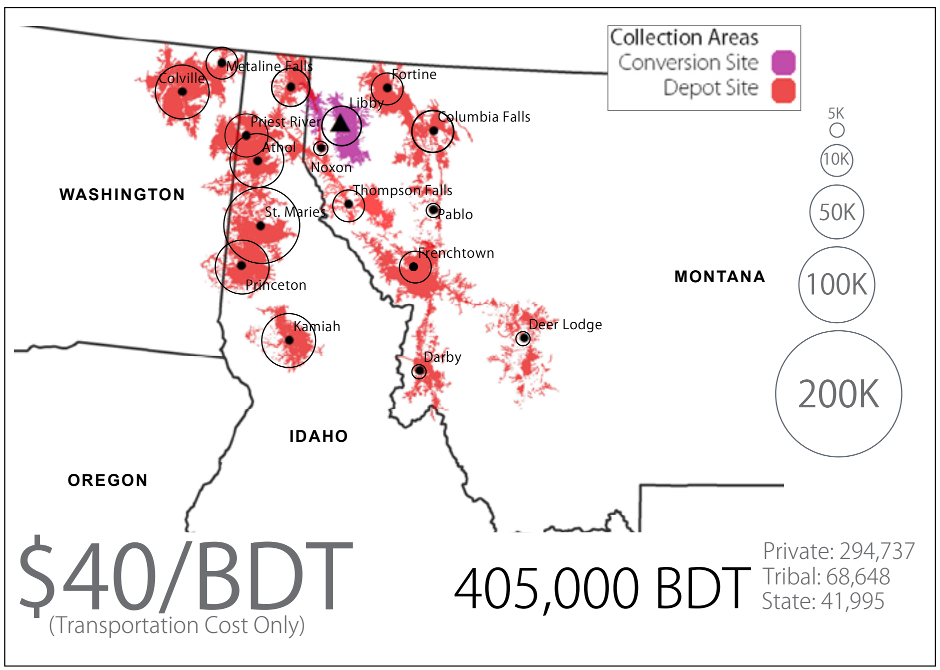


Figure 1.1.6. Libby conversion facility and depot sites using rail network, $40/BDT

Mid Cascades to Pacific (MC2P) Supply Chain

The MC2P region consists of several counties in southwest Washington and northwest Oregon. The focal area is highlighted in Figure 1.1.7. Due to large land area and availability of biomass, existing infrastructure and stakeholder interest, the initial analysis included the 20 counties inside the dark gray boundary, the MC2P region.

The MC2P region, with high concentrations of woody residuals, has enough biomass feedstock to support more than one integrated biorefinery (IBR) processing 770,000 BDT year. Current analysis shows that one IBR, operating in southwest Washington could receive, via direct haul, upwards of 825,000 BDT of feedstock within a 90 minute drive time radius at $42/BDT, accounting for transportation costs only. This is in contrast to the WMC, where a centrally located conversion facility in either Libby or Frenchtown, MT required feedstock inputs from remote depots. However, in the MC2P region the depot model was examined. It was found that this type of arrangement could help to ensure steady supplies for the IBR, where feedstock can be pre-processed and stored off-site and supplied when needed. This reduces the on-site pre-processing and storage needs on the IBR site. Figure 1.1.8 shows a proposed IBR at Cosmo Speciality Fibers in Cosmopolis, WA, supported by remote solids depots.

The site selection analysis in the MC2P region focused on solids depots, liquids depots and IBRs. To begin the site selection process in the MC2P region, assets and site characteristics necessary for facility types (e.g., proximity to harvested forests, site acreage, transportation access, etc.) were identified. The assets and characteristics were weighted according to their relative importance for each facility type. Sites were compared using a matrix, and an overall score for each facility was calculated based on the individual weights assigned to each facility's assets or characteristics. For example, close proximity to regularly harvested forest areas is a higher

Table 1.1.1. Proposed facilities for supply chain activities in the MC2P region

Solids Depot	Liquids Depot	Integrated Biorefinery
Sierra Pacific Industries, Aberdeen, WA Co-located Solid Depot	Kapstone Pulp & Packaging, Longview, WA Co-located Liquid Depot	Cosmo Specialty Fibers, Cosmopolis, WA Option 1: Co-located IBR with existing operations
Former Bradley-Woodward Lumber Company Bradwood, OR Solid Depot on greyfield	Weyerhaeuser Bay City Log Yard, Aberdeen, WA Liquid Depot on greyfield	Cosmo Specialty Fibers, Cosmopolis, WA Option 2: Transition of existing operations to IBR

priority for a solids depot than for an IBR, while an industrial site with large acreage is likely critical for an integrated biorefinery or a liquids depot, and less important for a solids depot. Table 1.1.1 shows the sites selected for detailed inventories and site designs.

Figure 1.1.7. MC2P Region

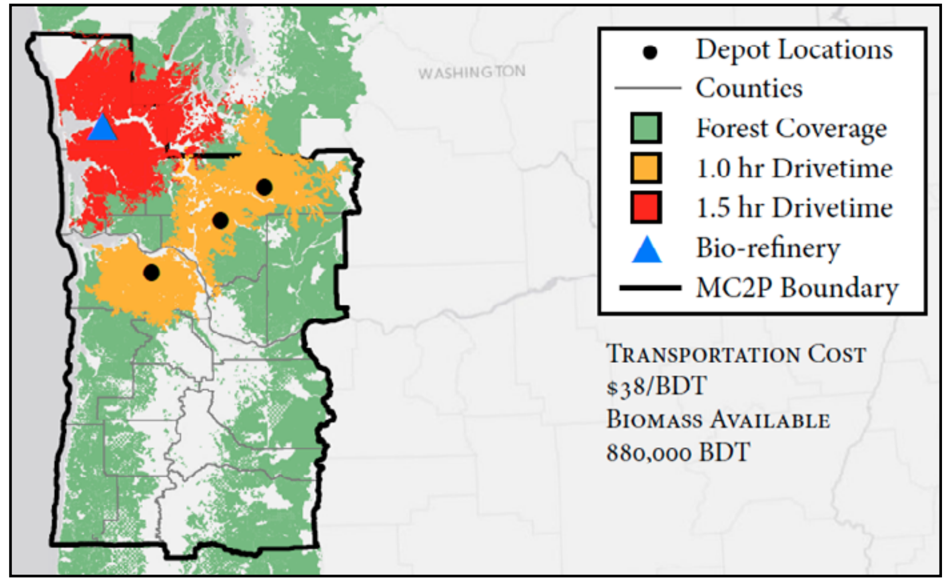


Figure 1.1.8. Proposed IBR in MC2P region supported by depots

Reports for the first three supply chain studies are available at the NARA website: www.nararenewables.org.

In summary, the three previous supply chain analyses were examined with the assumption that an IBR/conversion facility needed a feedstock supply of 770,000 BDT/year. This estimate was based on the initial techno-economic analysis conducted by the NARA team. Furthermore, the initial supply chain analyses focused primarily on the front end of the supply chain - getting forest residuals from the wood to the conversion/IBR facility gate. With the BDT estimate in mind, it became apparent in the WMC region that the requisite amount of feedstock needed would not be available under a direct haul scenario. Thus, a distributed depot model was analyzed, where remote sites, which collect and densify forest residuals, supply a conversion/IBR facility. In addition to examining the distributed depot model and the IBR model in the MC2P study, intermediate liquids depots were included, based on the assumption that the sugar product produced at these depots could be marketed to a biorefinery, or to other consumers interested in wood-based sugars (e.g., chemical manufacturer, polymer manufactures, and/or the bioplastics industry - PHB [polyhydroxybutyrate & polylactic acids], such as Renmatix in Philadelphia, PA Blue Marble Biomaterials in Missoula, MT).

1.1.3 MID-CASCADES TO PACIFIC (MC2P) SUPPLY CHAIN ANALYSIS GOALS AND OBJECTIVES

In Year 4, a number of modifications will be made to the supply chain analysis. For one, the optimal feedstock quantity will be determined by the fuel demand at regional airports, rather than assuming a conversion/IBR facility receiving 770,000 BDT of woody biomass. For example, in 2009, Spokane International Airport used 13.1 million gallons of jet fuel a year (SAFN 2011). A conversion/IBR facility taking in 156,000 BDT of feedstock a year would produce 6.6 million gallons of biojet a year. Blending this at 50 percent with petroleum jet fuel would supply the annual needs of Spokane International. A second modification in our analysis includes taking into consideration technological constraints based on research results from NARA scientists in the last three years. For example, the project has selected a mild-bi-sulfite pre-treatment protocol, which has implications for the types of pulp mills that might be identified for conversion/IBR facilities. More details about the year 4 supply chain analysis are provided below.

The economic viability of producing biofuels and value-added co-products from low-value and underutilized woody biomass is heavily dependent upon a reliable, cost-effective supply chain network. Preliminary techno-economic analysis (TEA) conducted by NARA emphasizes the need for exploring various logistical, financial, and technological strategies for reducing capital and operational expenditures to produce biofuel from woody biomass at a competitive price. The overall goal for Year 4 is to characterize, describe and understand the transportation linkages and evaluate the supply chain performance in various market regions of the MC2P. A framework will be developed that enables an understanding of the linkages among producers, processors, suppliers, distributors, and markets. Furthermore, activities, linkages, opportunities, and constraints will be identified. This analysis will examine drivers of the value chain and their contributions to the performance of the supply chain. Supply chains vary from region to region based on available assets, therefore NARA is evaluating assets, identifying gaps, engaging stakeholders, and evaluating metrics associated with the social, economic and environmental sustainability of wood-based biofuels in each market region.

In particular, the objectives of the MC2P Study include:

- Determining regional market demand in various regions across the MC2P to set feedstock requirements for conversion/IBR facilities.
- Identifying and ranking viable processing sites (e.g., solids and liquids depots, conversion and IBR facilities) in each market region in the MC2P for converting forest residuals to isobutanol and/or biojet fuel.
- Providing a techno-economic analysis for each top ranked site in each market region.

The NARA team will partner with stakeholders in the MC2P to vet and refine the list of regional assets, identify gaps, and assess progress on the supply chain objectives.

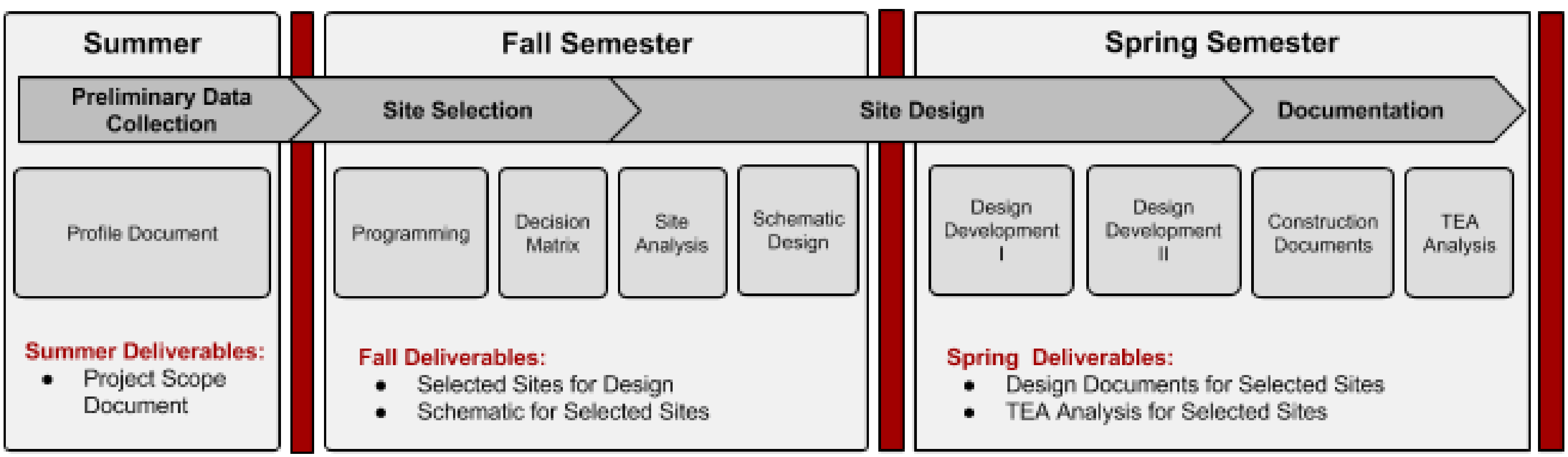


Figure 1.1.9. IDX structure and MC2P supply chain stages

1.1.4 STRUCTURE OF MID-CASCADES TO PACIFIC (MC2P) STUDY

As described in the earlier sections, the supply chain studies conducted in the first three years focused on specific subregions selected for the resources they offered, including biomass availability, physical assets, and human capital. In Year 4, the supply chain analysis will be conducted over the entire four-state MC2P region. The analysis methods used in the previous studies will be refined based on milestones met by other NARA research teams over the last three years.

Following are the key research and technology findings in the first three years of the NARA project that will drive the analysis of the Year 4 supply chain analysis in the MC2P region:

WOOD MILLING, which involves chipping, chip size reduction, and drying chips to approximately 10% moisture content, was found to significantly reduce energy and chemical consumption and improve sugar conversion yield. Techno-economic analysis (TEA) indicated that milling for production of clean sugar and lignin fuel pellets becomes economical only under certain energy consumption and sugar conversion yields. Relatively low electricity costs in the MC2P are attractive to evaluate milling as an integrated operation within the pretreatment protocol to produce bio-jet fuel and co-products.

- Wood milling as a pre-conversion process will be incorporated into the Year 4 supply chain analysis consideration in a distributed depot production model and an IBR model. For this analysis, it is critical to understand availability and distribution of biomass in the region as well as the presence of existing sawmills and wood processing facilities. Analysis conducted in the first three years of the project will be further refined and updated as necessary. Strategies devised by the feedstock team regarding feedstock preparation (biomass size, collection systems, processing equipment and moisture content), which demonstrated pathways resulting in ~$30/BDT savings, will be integrated into Year 4 supply chain analysis.

MILD BISULFITE (MBS) pretreatment, based on technical performance, economics, co-product opportunities, and commercialization potential was selected to move forward in Years 4 and 5. The MBS pretreatment protocol requires a reduced sulfur dioxide load applied to wood (from 12% to 6%) and a reduced cook temperature from 165°C to 145°C. Another advantage of MBS is that pretreatment efficiencies can be achieved without significant wood-chip size reduction. Other benefits include improved energy efficiency during pre-conversion and pretreatment, reduced chemical cost, and generation of fewer inhibitors to the fermentation process developed by Gevo.

- In Year 4, the supply chain analysis will assess the viability of retrofitting operational and idle pulp mill facilities as viable conversion/IBR sites.

THE TEA IN YEAR 3 also focused on the impact of potential revenue streams from lignin co-products to offset the bio-jet fuel production costs, and estimated relative contributions of individual revenues from these co-products (Figure). Two commercially viable lignin-based co-products have been identified: 1) lignosulfonates used for concrete additives and 2) activated carbon to be used for mercury adsorption in coal fired power plants.

- In Year 4, the supply chain analysis will consider where co-products from the biofuels production process can be produced along with co-products and marketed.

1.2.0 STRUCTURE AND COLLABORATION

To study the wood-to-biofuels supply chain in the MC2P, the NARA team has divided its tasks into three stages, outlined in Figure 1.1.9. Stage one identifies assets integral to developing regional supply chains. This Profile document outlines known and identified assets in the four-state region. The intent of this Profile document is to outline the scope of the supply chain study, define roles of collaborators, establish a methodology, and identify known assets. This is not a comprehensive list of assets, but an initial collection that can assist in NARA's analysis of regional supply chains. The appendices list assets currently collected for the MC2P.

In stage two, the supply chain is analyzed through site selection, resource flow, site analysis, and economic analyses. The previous supply chain studies emphasized depot and IBR proximity to biomass as well as other regional assets for identifying sites. Figure 2.1.1 shows biomass availability in the four-state region.

The MC2P study, while taking biomass availability into account, will also consider jet fuel usage at regional airports to help determine the optimal size and scale of conversion/IBR facilities that may supply biojet to MC2P airports. Additionally, technological requirements such as relying on wood milling for pre-conversion and MBS protocols for pre-treatment will inform the types of facilities considered for depots and conversion/IBR facilities. For example, wood milling is energy intensive. Identifying sites near power substations could be important. Likewise, the metallurgy of a pulp mill is important for ensuring compatibility with the MBS pretreatment protocol. These constraints will help to refine the supply chain analysis in Year 4. Figure 1.2.2 shows airports in the region, along with forest coverage and major roadways. The size of the icon is scaled to coincide with 2009 fuel consumption rates. The outcome of the MC2P supply chain analysis will be two-fold: 1) a list of potential solids and liquids depots and conversion/IBR sites in the MC2P; and 2) a summary of subregional supply chains based on availability of biomass feedstock and fuel demand at regional airports, refined by technological requirements. The results of the analysis stage will be documented in the MC2P Analysis report.

The third stage involves designs for potential solids and liquids depots and IBRs in each market region. This information will be used to develop a TEA that can be distributed to stakeholders to provide an analysis of the necessary cost to retrofit a pulp and paper facility to a conversion facility. The design work and TEA estimations will be presented in the MC2P Design report. More details on the supply chain methodology appear in Section 3 of this document.

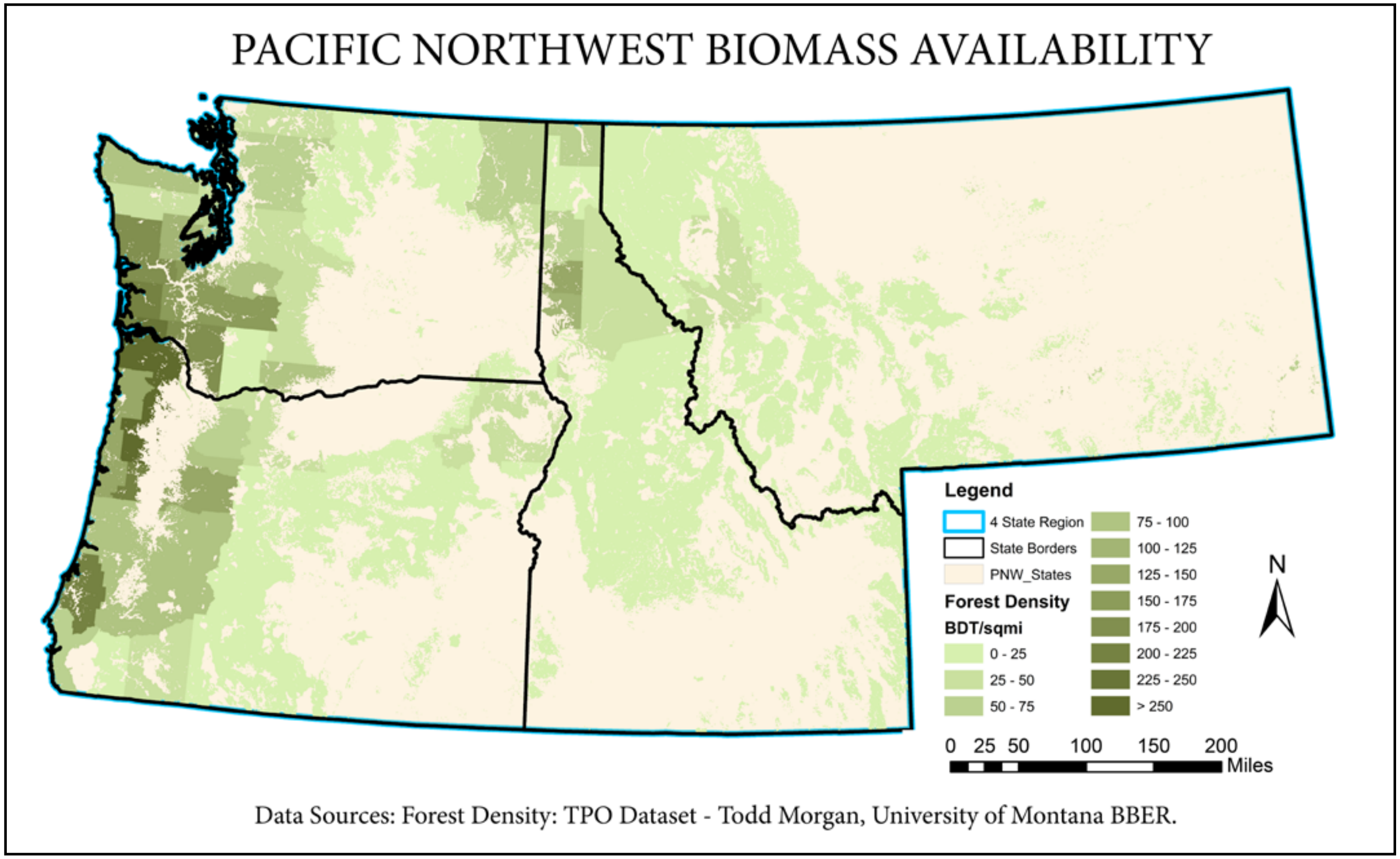
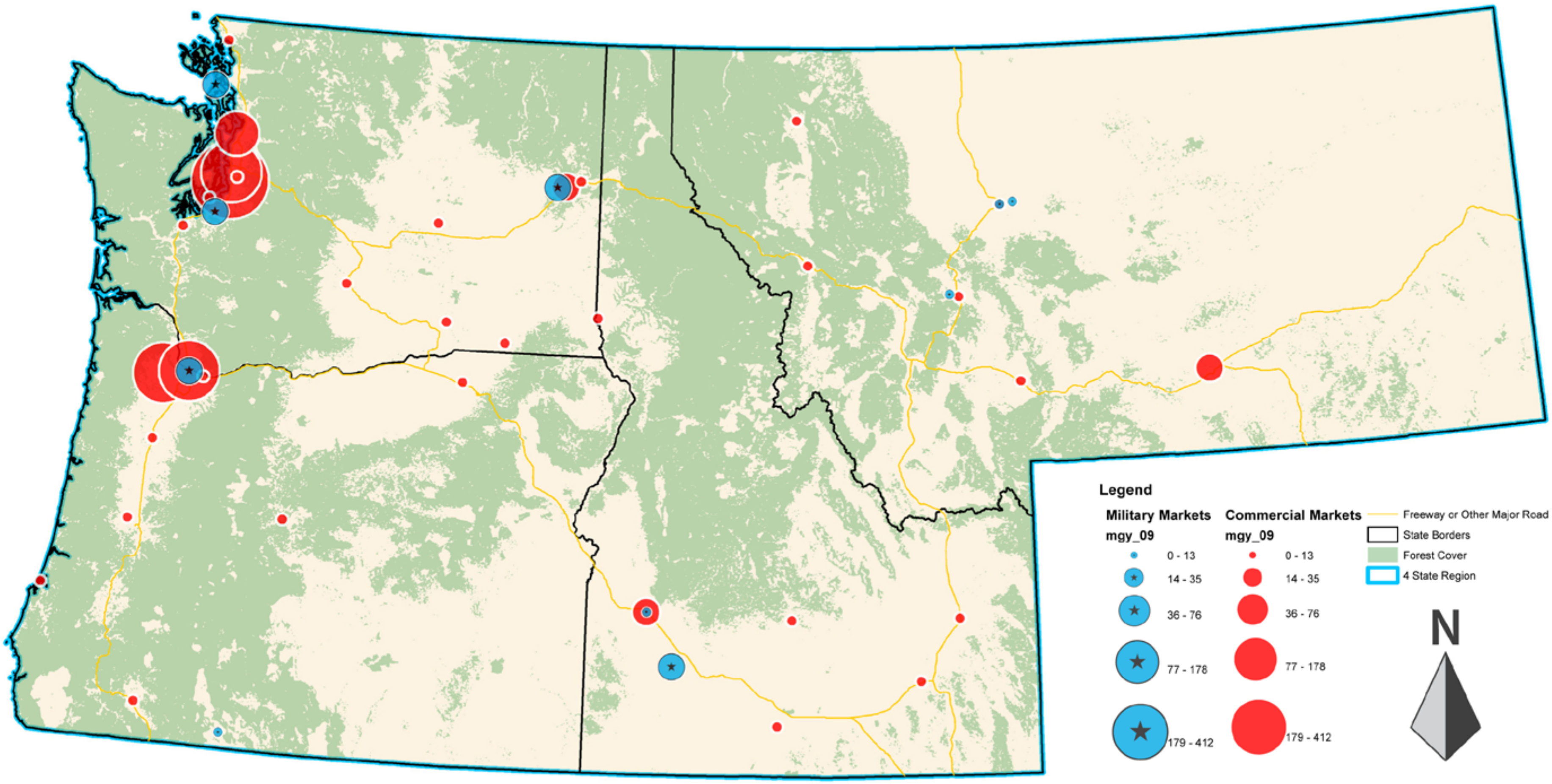


Figure 1.2.1. MC2P biomass availability

Pacific Northwest Potential Biojet Fuel Markets



Data Sources : U.S. Dept of Transportation. Federal Aviation Administration. Air Traffic Activity System: Airport Opps CY2009.
Sustainable Aviation Fuels Northwest 2011 Report. Current Regional Demand. 2009 Fuel Consumption.

Figure 1.2.2. MC2P biojet fuel markets

1.2.1 OVERVIEW

NARA involves more than 150 individuals representing research universities, state and federal agencies, and industry. Understanding the viability of establishing a wood-based biojet industry in the Pacific Northwest requires supply chain analysis of the four-state region. Numerous elements are required to conduct this analysis; including data, input about methods and assumptions, and fact-checking. In this section, we discuss various parties who contribute to NARA and the development of wood to biofuels supply chains in the MC2P.

1.2.2 REGIONAL PARTNERS

Regions that have been revitalized by building a healthy, sustainable community with steady economic development have recognized the importance of identifying their community assets (we describe such assets as a set of "capitals"), interactions among these capitals, and gaps that need to be filled (Flora et al. 2005). This information is not only necessary to generate data for a meaningful analysis, but also to identify key partners within the communities, their roles, and the interactions among partners for infrastructure development. Successful biojet fuel supply chain requires more than just an adequate supply of biomass, but also communities with assets and capitals to assist in the development of this new and emerging industry. Identification and compilation of pre-existing conditions and structures is vital before taking action and making investments to establish a wood to biofuels and co-products supply chain in a region. The economic viability of producing biofuels and value-added co-products from low-value and underutilized woody biomass is heavily dependent upon a reliable, cost-effective supply chain network. An inventory of supply chain assets and the transfer of appropriate technology will assist in retooling underutilized facilities or declining industries in favour of renewable industries.

Communities and their citizens play a vital role in identifying regional assets and recognizing the synergistic interactions among these assets. NARA recognizes that the role of community stakeholders is essential in developing a meaningful regional supply chain analysis. These stakeholders represent a diverse group of individuals and organizations across the wood to biofuels and co-products supply chain. They include forestland owners and managers, contractors and harvesters, transporters, biomass processors, existing wood-products industries, biofuel producers, business coalitions, regulatory bodies, distributors, buyers and sellers, consumers, local and national policymakers, and environmental, economic development, and other non-profit organizations.

To reach this diverse group of stakeholders, the NARA Education and Outreach teams work closely, for guidance and direct stakeholder engagement, with interested partners in the four-state region. Partners, with diverse memberships who reach out to diverse stakeholder groups, include the Montana Forest Product Retention Roundtable, the Washington State Forest Biomass Coordination Group and the Oregon Forest Biomass Working Group. These partners provide feedback and support to NARA team members completing analyses relevant to potential establishment of a wood-based biofuel and co-products infrastructure in the Pacific Northwest. The overall communication mechanism between NARA teams and stakeholders is described in Figure 1.2.3. The following sections outline the roles and responsibilities, potential opportunities, and general agreement among all partners.

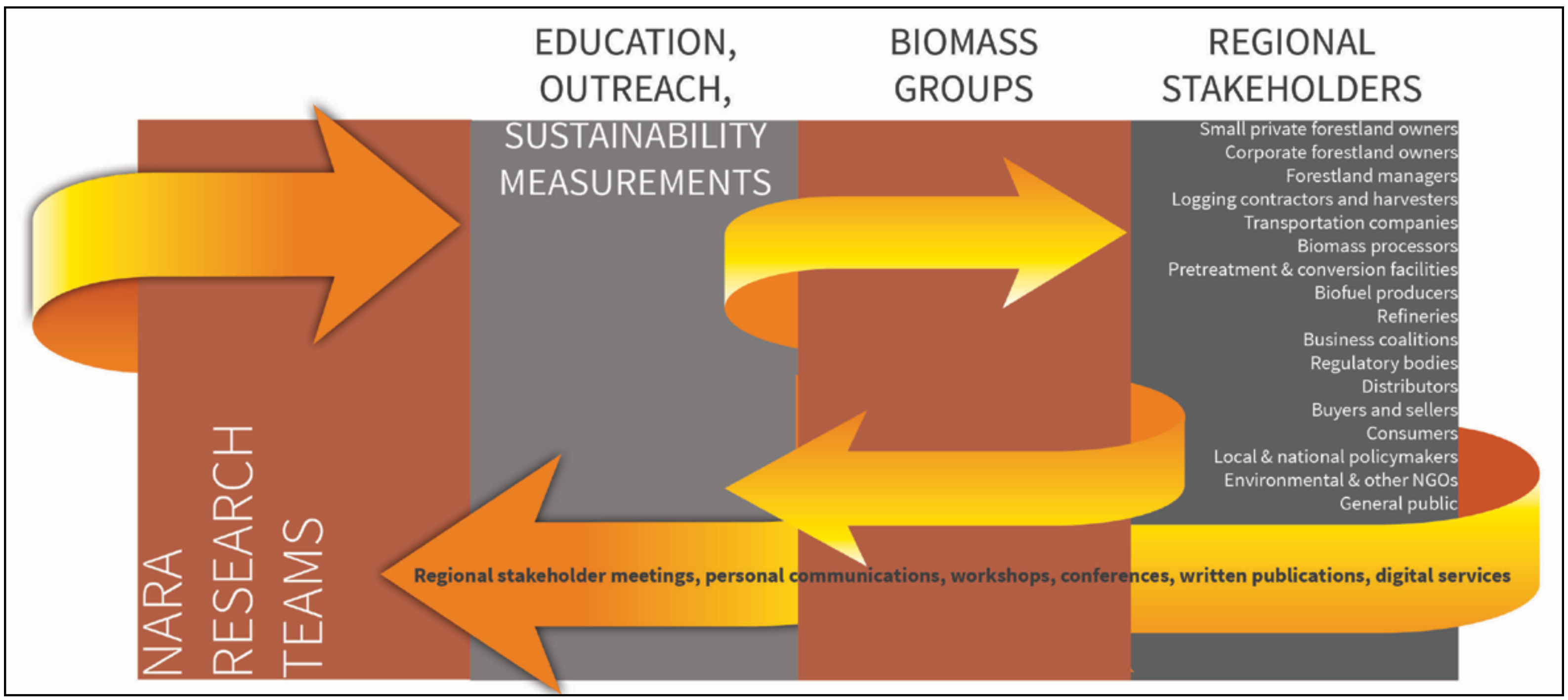


Figure 1.2.3. Communication mechanisms between NARA members and regional stakeholders

1.2.3 STAKEHOLDER ROLES AND RESPONSIBILITIES

NARA has developed a number of partnerships with working groups and stakeholders in the MC2P over the last three years. Project teams value input and feedback from partners and stakeholders. The following outline provides suggested partner and stakeholder roles and responsibilities.

1) COLLABORATE with the NARA teams to guide analyses to ensure alignment with regional goals and long-term plans
2) PROVIDE mentorship, feedback, resources, and appropriate data/information to NARA teams
3) PARTICIPATE in periodically organized evaluation processes on interim supply chain analysis deliverables
4) ASSIST NARA teams in identifying key stakeholders for conducting studies to assist regional perceptions, support, and interest in the utilization of woody biomass for an emerging biofuels industry
5) IDENTIFY regional assets including underutilized mills, brownfields, and potential conversion and biorefinery sites
6) ASSIST with field trips to active forest operations, construction and demolition (C&D) waste facilities, or operational and mothballed mills

Data and data sources for the assets in the region can be forwarded to any of the NARA Education and Outreach team members. Alternatively, they can also be submitted electronically at http://goo.gl/ChBLr3. Examples of data assets needed in the community capital categories are provided in Table 1.2.1.

As partners in this collaboration, stakeholders and NARA members will collaborate on supply chain analyses to stimulate development of a woody biomass to biofuels and co-products infrastructure. To analyze the supply chain, NARA members will identify technology suitable for such an infrastructure, and will provide analytical tools and knowledge necessary to conduct the study. Stakeholders will provide their experience, contacts, and knowledge, and they will be active members of the analytical and decision-making processes. NARA will strive to identify a diverse group of stakeholders in the region because collaboration across the supply chain is key for stimulating renewable energy development. Stakeholders will be involved in:

- Compiling inventories of supply chain assets
- Discussing potential strategies for regional supply chains based on biomass availability, transportation and proximity to markets
- Assisting with strategies for retooling existing facilities, if any, for renewable industries
- Reviewing the concepts and progress presented NARA teams

NARA members will strive to disseminate knowledge generated by the research teams and engage stakeholders for their input in the designing, planning, and evaluation processes. Dissemination mechanisms include webinars, monthly newsletters, presentations at regional conferences and association meetings, and the NARA website.

Table 1.2.1. Data needs by community capitals for the MC2P region

Community Capital	Data Needs
Natural	Biomass availability; Water resources (aquifer, rivers, etc.); Watersheds; Topography; Digital elevation models (DEMs)
Physical	Operational and idle/decommissioned mills sites including: primary wood processors (e.g., sawmills), chip yards, material recycling facilities, pulp and paper mills, ethanol/biofuels facilities, and refineries; Road networks; Rail networks; Forest road networks; Ports; Pipeline networks; Electric Power Grid; Transmission lines
Civic	Demographics; Labor force; Education attainment; Poverty rates; Certification programs
Financial	State grants, incentives and subsidies; Loans; Cost of doing business (state/county tax rates)
Policy	National energy policy (RIN, RFS, other); State biomass/biofuels legislation; County comprehensive plans; County land use ordinances; City comprehensive plans; City land use ordinances Economic development districts; Comprehensive economic development strategies; Land use and land ownership

1.2.4 SUPPLY CHAIN COALITION OPPORTUNITIES

Production of biofuels and co-products from woody biomass is heavily reliant upon strong supply chain linkages, which is especially true for economic viability. Initial calculations by NARA's techno-economic analysis group have shown that the cost of producing aviation jet fuel, per current estimates, will be two to three times that of petroleum-based jet prices based on the following assumptions (Wolcott and Cavalieri 2013):

- Integrated biorefinery plant with annual feedstock consumption of 770,000 BDT
- Feedstock considered is milled slash piles as defined by NARA FS-10
- Capital expenditures are for a greenfield facility
- Commercial feedstock costs of $68 per BDT delivered to mill gate
- Burn lignin and screen rejects

The techno-economic analysis (TEA) approach was based on the National Renewable Energy Lab's TEA of biochemical conversion of lignocellulosic biomass to ethanol (Humbird et al. 2011).

For biojet fuel to be produced from forest residuals and construction and demolition (C&D) wood waste, it is imperative that various value-added co-products are produced along the supply chain and efficient processes are implemented to reduce overall project costs. To conduct an analysis that considers a variety of scenarios to arrive at cost-effective strategies for material flow and co-products extraction with minimal environmental impact, it is necessary to understand the available assets and linkages among them. Reliable and realistic information, provided by partners and collected from government and private entities, will assist in exploring strategies to reduce the capital expenditures (CapEx) and operational expenditures (OpEx) for production of biofuels from woody biomass (Figure 1.2.4). A2J in the figure refers to alcohol to jet fuel and IBA refers to isobutanol. Revenue is included in the operational expenditure to consider potential revenue streams due to enforcement of the Renewable Fuel Standard via Renewable Identification Numbers (RINs).

NARA's Education and Outreach teams are working with partners and regional stakeholders to examine potential sites across the supply chain where new industries or retooling of existing facilities can occur. Through this engagement, NARA members will become more aware of regional needs, available assets, and existing gaps. This will enable meaningful involvement of appropriate NARA research teams for technology transfer and discussion of potential opportunities and challenges with regional stakeholders. Reliable inputs for analysis of feedstock logistic processes including harvesting, storing, pre-processing, and transportation can only be obtained through partnerships with regional stakeholders.

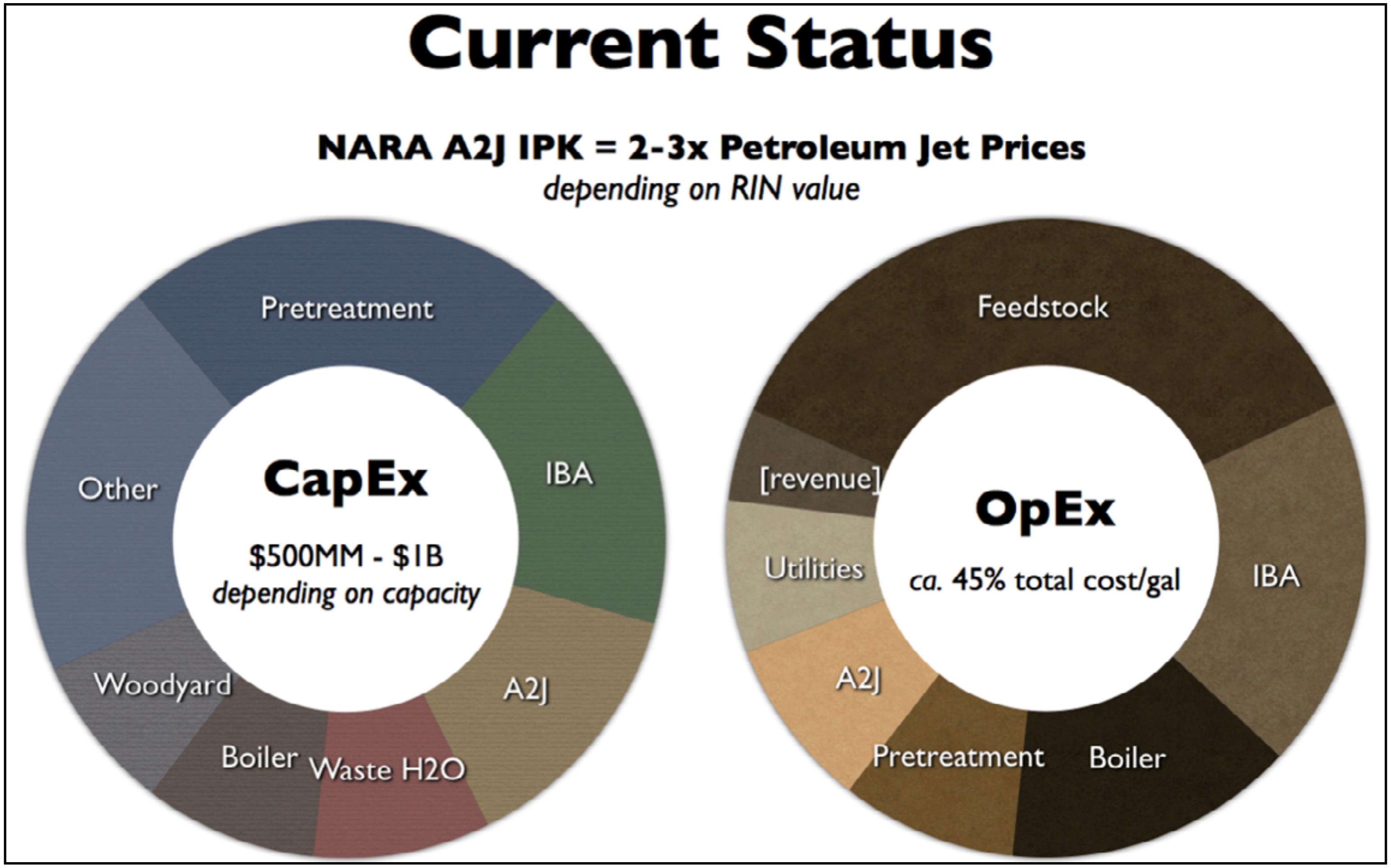


Figure 1.2.4. Techno-Economic Analysis

1.2.5 NARA TEAMS

The NARA Outreach and Education teams play a significant role in coordinating activities with partners and regional stakeholders. Other NARA teams and industry partners conduct specific analyses to understand the environmental and economic impacts of the project in the region.

OUTREACH TEAM

NARA researchers, university extension personnel and industry members work in tandem with stakeholders to plan and implement the changes needed to build, develop, and sustain a wood-based biorefinery infrastructure in the MC2P. The goal of the NARA Outreach team is to promote stakeholder bioenergy literacy and to build regional supply chain coalitions for facilitating development of a biofuel and co-products industry from woody biomass. Outcomes include promoting sustainable production of bio-jet fuel and co-products and rural economic development. The following are the two broad objectives of the Outreach team:

1) INCREASE Bioenergy Literacy by: disseminating research-based information on technology and markets to our industrial stakeholders and understanding the technical challenges regarding implementation at industrial scale; relating the feedstock development and logistics information to our resource-based stakeholders (local communities, forest landowners, forest managers) and hearing their concerns regarding the type of information that will assist them in keeping their costs low and marketable value high; and engaging the organizations and partnerships in connecting with public-interest groups and policymakers. These activities are being carried out via a variety of communication mechanisms, including social media, newsletters, briefing papers, extension publications, workshops/seminars, conferences, field trips, and stakeholder meetings.

2) BUILD Supply Chain Coalitions via stakeholder identification and engagement by forming stakeholder groups consisting of forestland owners and managers, environmental NGOs, businesses, regulatory facilitators, and others to interact with and inform policy makers at regional, state, and federal levels. Coalitions will be supported through interactions with NARA teams and through regional meetings.

EDUCATION TEAM

The NARA Education team works with students from K-12 through graduate school, including working with instructors and teachers serving these students.

The K-12 GreenSTEM Education group serves educators and students through 3-4 teacher professional development workshops per year, online curriculum hosted at http://energyliteracyprinciples.org/, field experiences provided by the McCall Outdoor Science School, interactive websites http://teachingadventurelearningatmoss.wordpress.com/, onsite instruction reaching 2,500 students annually and support for teams competing in the annual Imagine Tomorrow competition is hosted by WSU.

The Imagine Tomorrow (IT) program is designed to engage high school students from the Pacific Northwest in developing creative solutions to society's energy challenges, culminating in the annual IT Competition at Washington State University. IT's goal is to unite educators, scholars, and industry leaders to teach students of all backgrounds and high school grade levels how to translate ideas into results. Of note is the inclusiveness of the competition, reaching out to students and teachers beyond the typical science class, having four tracks: design, behavior, technology and biofuels.

Bioenergy literacy is being enhanced through curriculum developed by the McCall Outdoor Science School (MOSS) and Facing the Future (FtF). MOSS reaches 2,500 students a year through its residential science education program. This program is facilitated in part by 16-18 graduate students per year that take environmental education courses concurrently with their time as field instructors. Some of these graduate students work on materials and research projects that directly enhance energy literacy curriculum. FtF is an environmental education non-profit that develops curriculum, publishes resources, and provides teacher workshops focused on environmental issues including bioenergy. FtF has published Fueling Our Future middle school and high school sustainable energy curriculum, which is available for purchase on their website: http://www.facingthefuture.org/.

The Integrated Design Experience (IDX) group, a for-credit course, brings university students and faculty together with NARA stakeholders to contribute to the NARA goal of developing supply chain coalitions throughout the Pacific Northwest by providing knowledge, skills and assistance to communities interested in participating in the emerging wood-based biofuels economy.

IDX goals include:

1) GIVING students skills in collaborative research, problem-solving, and design methods to utilize in their academic and professional work
2) TRAINING a workforce ready to participate in the renewable energy and biofuels industry
3) PROVIDING technical assistance to communities interested in participating in the emerging biofuels economy.

IDX draws on undergraduate and graduate students from Washington State University and the University of Idaho who are interested in identifying innovative solutions to complex, contemporary, real-world challenges. Faculty with expertise in engineering, design, planning, and economics facilitate IDX, which attracts students seeking degrees in engineering (civil, mechanical, environmental), architecture, landscape architecture, bioregional planning and community design, law, business, environmental science, renewable materials and other disciplines.

IDX works with regional partners on identifying community assets, conducting site selection, and resource flow and supply chain economic analyses, as well as site specific designs for solids and liquids depots and integrated biorefineries.

Faculty provide students with resources, data, project background and context for understanding the region and NARA goals. Lectures and training in relevant tools include GIS, Adobe Illustrator and InDesign. Faculty bring in guest speakers who contribute to student understanding of the project, as well as organize site visits and interactions with regional partners.

Students work throughout an academic year in multidisciplinary groups to conduct supply chain analyses for NARA regions. In the fall semester, students identify regional supply chain assets and conduct site selection analyses. During the spring semester students conduct site assessments and develop site specific and structural designs and plans for specific locations in the supply chain. Additionally, site-specific techno-economic analyses are conducted for selected sites. Section 3 of this document provides more details on the supply chain analysis methodology used.

IDX faculty have developed an extensive GIS database for students to use in conducting their analyses of the wood-to-biofuels supply chain in the MC2P. If students require additional and more site specific information from regional partners, faculty will locate the data or initiate contact for students with relevant stakeholders.

Every year, IDX produces key outputs: a regional Analysis report that focuses on providing analyses of the supply chain, a Design portfolio that showcases innovative concepts and designs for selected production sites and linkages within the supply chain, and initial techno-economic analyses of selected sites. Students present their work to stakeholders in webinars, and also present their findings at the NARA Annual Conference.

OTHER NARA TEAMS & INDUSTRY PARTNERS

The Outreach and Education Teams work closely with other NARA research teams and industry partners to ensure that the supply chain analysis considers the most recent technology decisions, feedstock logistics research, and other relevant information.

Data from the supply chain analysis is used by other NARA team members, specifically the feedstock logistics team; the sustainability measurements team, particularly those examining life cycle assessment and community impact analysis; and the techno-economic analysis group. See Figure 1.1, NARA Team Structure and Goals, for information on other NARA research teams and industrial partners and their project roles.

1.3.0 PROJECT METHODS

PROCESS OVERVIEW

The MC2P wood-based biofuels supply chain study will provide analysis and designs for specific sites in the supply chain. The analysis and design techniques to be used include the following:

- Site Selection (Programming, Site Selection Methods)
- Design Process (Site Analysis, Schematic Design, Design Development)
- Documentation (Construction Documents, TEA Analysis)

1.3.1 SITE SELECTION

Site selection methodology will be used to identify potential sites for pre-conversion depots (Solid or Liquid), conversion plants and integrated biorefineries (IBR) in the MC2P for the NARA supply chain. Refer to Figure 1.3.1 for an illustration of the supply chain facility types and wood-to-biofuels pathway options. A literature review will be performed to research programming (e.g., activities that occur on site and required equipment) for depot and conversion facilities, which will include understanding site operations and resource flows. A decision matrix will then be developed to rank potential sites for each facility. Upon completion of site selection a potential IBR for each market region will be identified as well as potential depot facilities to meet biomass demand.

PROGRAMMING

The programming phase is a critical component of the project because it defines the activities and equipment needs for site design. Depending on the wood-to-biofuels pathway selected (e.g., distributed depot model or centralized IBR), specific operations will occur at different types of sites. The purpose of the program phase is to further clarify the scope of work, on-site operations, facility needs, and cost estimates for a general site. Resource flows will be used to provide a framework to identify the programming for each site type.

Resource flow analysis (RFA) identifies resource flows at specific depots and IBRs in the MC2P region. Outcomes of the RFA will assist in identifying site adaptations and redevelopment opportunities based on existing site attributes and resource availabilities.

A resource flow analysis aims to quantify the flow of resources, measured in mass, within a defined geographical area or industry sector over a set period of time. The generic model shown in Figure 1.3.2 illustrates the main flows of resources through a defined boundary. A resource flow analysis can point to opportunities for understanding and managing materials consumption and minimization.

A general resource flow analysis, targeting 770,000 BDT will be performed for each step in the supply chain, including pre-conversion, pretreatment, fermentation, and refining. The individual resource flows can then be combined to analyze various depot, conversion and IBR options in the site selection analysis.

SITE SELECTION METHODS

Site selection compares the programming needs of a new facility with the assets in a given region. These methods will be used to evaluate potential depot, conversion, or IBR sites in the supply chain. Specifically, GIS analysis and decision matrices will be used to identify, assess and rank potential sites. GIS will be used to analyze potential sites by geospatial evaluation of pertinent assets at a given site.

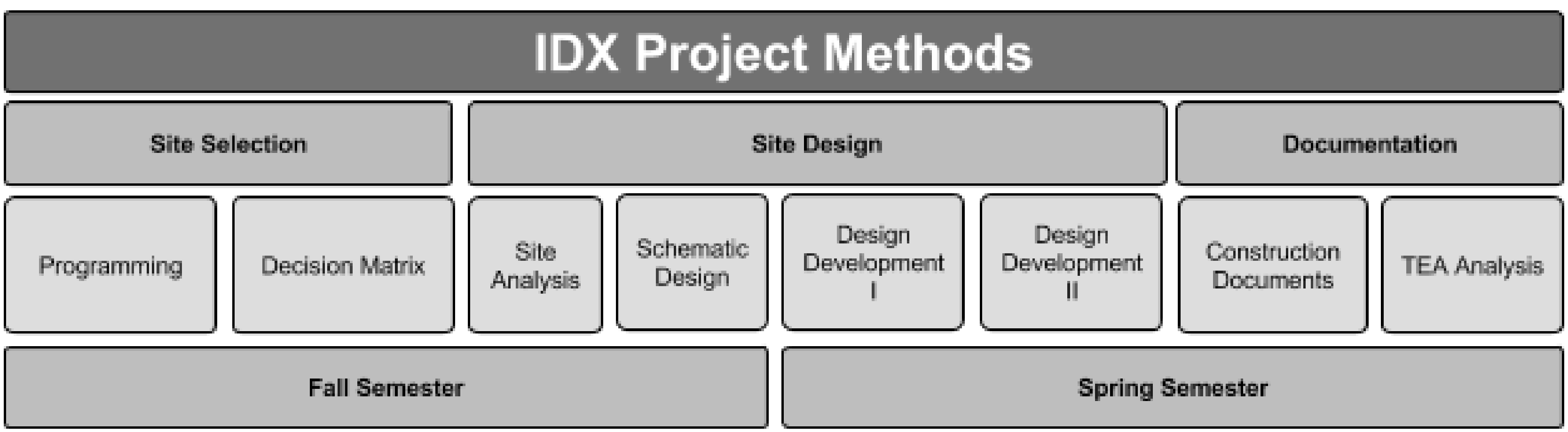


Figure 1.3.1. MC2P supply chain analysis and design techniques

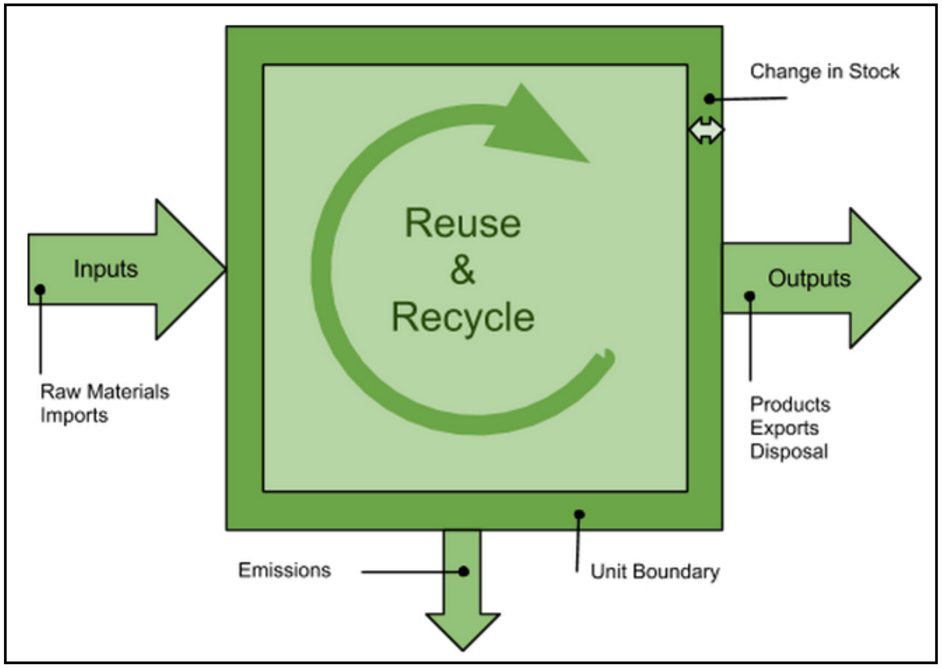


Figure 1.3.2. Flow of mass through geography or economic unit (Linstead and Ekins 2001)

The capitals framework will be used to categorize the down into the following categories:

NATURAL CAPITAL: Assets that abide in a location, including resources, amenities and wildlife.

PHYSICAL CAPITAL: Infrastructure that supports the community, such as telecommunications, industrial parks, water and sewer systems, roads, rail, etc.

CIVIC CAPITAL: Skills and abilities of people, as well as the ability to access outside resources and bodies of knowledge in order to increase understanding and to identify promising practices. Civic capital could include non-governmental organizations, economic development districts, and community-based organizations.

ECONOMIC CAPITAL: The cost of doing business in a particular county based on tax and utility rates, as well as incentives for locating a business in a community. Economic capital can also include resources available to invest in community capacity building, to underwrite businesses development, to support civic and social entrepreneurship, and to accumulate wealth for future community development.

POLICY CAPITAL: Ability to influence standards, rules, regulations and their enforcement. It reflects access to power and power brokers, such as access to a local office of a member of Congress, access to local, county, state, or tribal government officials, or leverage with a regional company.

Preliminary asset data that has been compiled for the MC2P supply chain study is presented in the appendices of this document. This data will be further vetted and augmented during the duration of the study.

Decision matrices will be used to rank the potential sites based on providing a valuation of multiple applicable assets. The matrices provide a mechanism for ranking/weighting asset data based on their level of importance for selecting a depot or conversion facility site. The weighted algorithm evaluates the value of each asset on a site and provides a ranking of each site.

Together the layering and decision matrices exercises will narrow down specific site locations in the MC2P where depots, conversion sites, and IBRs could be located. After these site locations have been identified, more specific analysis will be undertaken for each site. To see an example of this methodology, see the Mid Cascades to Pacific work at: http://www.nararenewables.org/midcascadestopacific/

1.3.2 SITE DESIGN PROCESS

SITE ANALYSIS

To further analyze the sites, a site analysis will be conducted to identify site opportunities and constraints for development of the site as a depot or IBR. The opportunities and constraints will be based on outputs of the resource flow analysis. Furthermore, the sites will be analyzed for development suitability. Development suitability shows where on a site, based on the RFA and site inventory, different activities should occur, buildings be located, and on-site circulation laid out.

SCHEMATIC DESIGN

The primary objective of Schematic Design Phase is to arrive at a clearly defined, feasible concept and to present it in a form that achieves client understanding and acceptance. Although the design is not entirely represented, the schematic drawings can demonstrate basic spaces, scale and relationship of components. The secondary objective is to clarify the project program, explore the most promising alternative design solutions, and provide a reliable basis for analyzing the cost of the project. Multiple schematic design options will be presented for each site, each including the sizing of buildings and processing areas and the flow of the site.

DESIGN DEVELOPMENT

The Design Development Phase focuses on the technical aspects of materials and infrastructure systems. Although this phase allows the designer to further refine space and function, the primary goal is to enable the site owner to understand how the project will function as well as give more detail about what the design will look like. Design development is an iterative process as designs are reviewed by the client and other stakeholders.

1.3.3 DOCUMENTATION

CONSTRUCTION DOCUMENTS

Construction documents include all building and site plans, specifications, and supporting documents used during the completion of a construction project. The documents translate the needs to the owner or developer into a buildable format that can be universally understood within the construction industry. The target completion for the construction documents on the NARA project is 50%. This should provide all major design decisions for site layout, new or modified buildings, space delineation in buildings, layout of all processing equipment including supporting calculations.

TECHNO-ECONOMIC ANALYSIS

A techno-economic analysis (TEA) will produce an analysis of estimated site costs. The TEA will focus on the capital costs necessary to implement the site design and the operational costs to run the facility on an annual basis. The aim of this analysis is to help refine the initial TEA conducted in years 2 and 3 of the project, which assumed a greenfield development.

1.3.4 SUMMARY

The supply chain analysis in the MC2P will produce a number of deliverables, which will inform both NARA researchers and stakeholders interested in developing a wood-to-biofuels industry. In particular, the outputs will include:

- A determination of market demand in various regions across the MC2P to set feedstock requirements for a centralized integrated biorefinery (IBR) in defined subregions.
- Identification and ranking of viable processing sites (e.g., depots and conversion sites) in each market region for converting forest residuals to biojet fuel.
- Production of a TEA for each top ranked site in the defined market regions.

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1.5.0 APPENDICES

The following Appendices describe the regional assets identified thus far in the MC2P supply chain region, which consists of several counties in Oregon and Washington. Table 1.5.1 shows the counties in both Oregon and Washington that are included in the MC2P. In some cases, data may have been collected for one state, but not the other. With further asset data collection, these discrepancies will be addressed. The community capitals framework is used to identify assets and conduct supply chain analysis. This framework provides a holistic perspective on all the assets that exist in a region and could contribute to understanding the MC2P supply chain. The assets are divided into the following capital categories: Natural Capital (1.6.0), Physical Capital (1.7.0), Civic Capital (1.8.0), Financial Capital (1.9.0), and Policy Capital (1.10.0).

Table 1.5.1. Oregon and Washington Counties included in the MC2P Supply Chain Study Region

Oregon MC2P Counties			
Benton	Clackamas	Clatsop	Columbia
Lincoln	Linn	Marion	Polk
Tillamook	Washington	Yamhill	Multnomah
Washington MC2P Counties			
Clark	Cowlitz	Gray's Harbor	Lewis
Pacific	Skamania	Thurston	Wahkiakum

1.6.0 APPENDIX A1: NATURAL CAPITAL

Natural capital is comprised of the natural resources and processes required for an organization to produce a product or deliver a service (Forum for the Future 2002). The most commonly utilized natural capitals include sinks, resources, and processes. A natural sink provides a non-invasive way to accumulate and store unwanted compounds such as carbon for an indefinite period of time. Natural resources consist of any raw material found in nature that is of value to a company or that can be made valuable by a company. Lastly, a natural process is an already-in-place environmental system that can be utilized by an organization as a service (e.g. air or water purification). For the purpose of the NARA project, it is necessary to consider all potential natural assets and how they will be affected by the woody biomass to biojet process. More importantly, researching these natural assets will set the groundwork to create a product life-cycle that is sustainable and operates within the limits of our natural environment.

Currently we have information on biomass availability from forest residues and recycled wood waste. Additional natural assets to be collected and analyzed include air, water, threatened and endangered species and other relevant assets.

1.6.1 BIOMASS AVAILABILITY

Based on initial analysis, the biomass processing plants for pretreatment and conversion are estimated to need between 0.5 and 1.0 Million bone dry tons (BDT s) per year of woody biomass (feedstock). In order to understand the availability of biomass, its characteristics, and distribution, NARA must determine the number of plants necessary for processing and their best locations within the pilot supply chain region. The following sections will outline the biomass data, from forest residues and recycled wood waste, that are currently available in the MC2P region. This data, and more refined data that we locate, will be used in the site location and supply chain analyses for understanding the regional biomass availability.

FOREST BIOMASS

The Washington State Biomass Calculator was developed as part of the Washington Department of Natural Resources' (DNR) Forest Biomass Supply Assessment project (Washington DNR 2012a). The calculated results of westside counties in Washington are presented in Figure 1.6.2. Three different forest biomass categories are summarized, including scattered biomass, roadside biomass and market biomass. Scattered biomass is residual harvested biomass, the volume that is left scattered in the woods as by-product of having been broken off, or tops and limbs cut when commercial logs were yarded to the landing. Roadside biomass is residual market biomass plus residual potential market biomass. Market biomass is the volume that is available to be brought to the market.

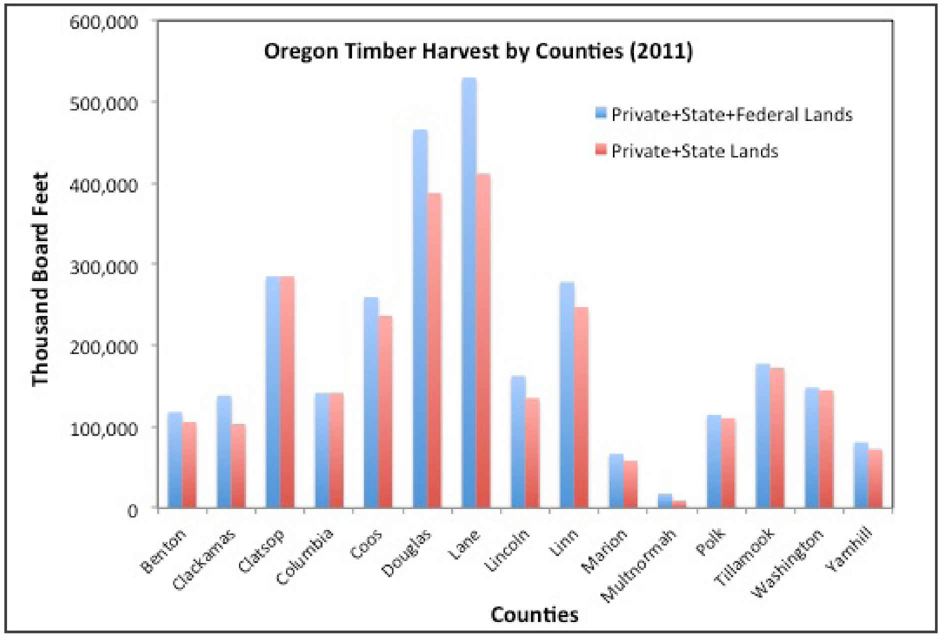

Figure 1.6.1. Oregon Timber Harvest by Westside Counties (2011) (Oregon Department of Forestry 2010)

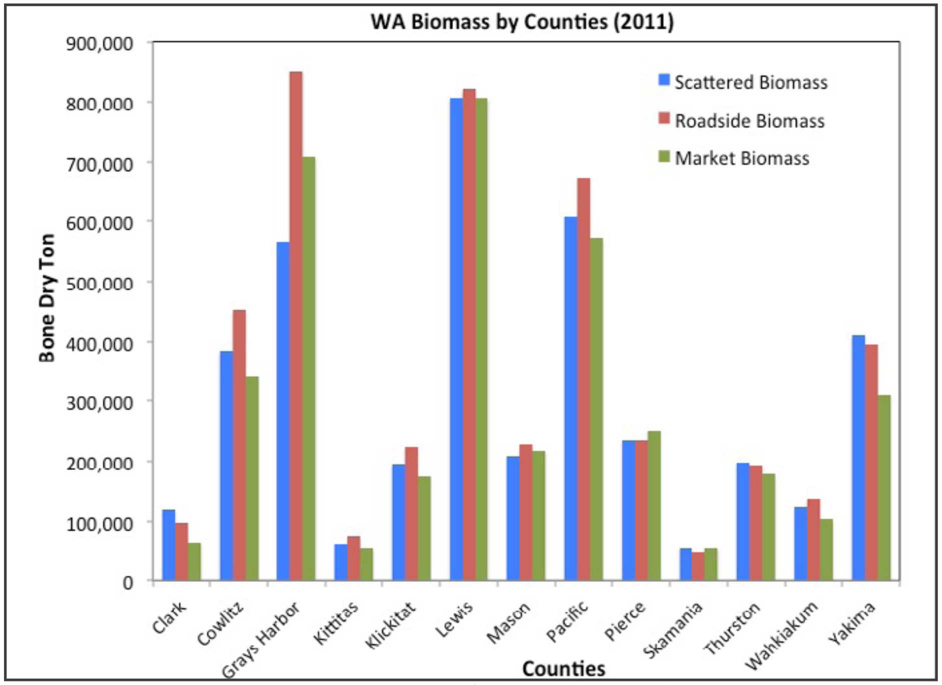

Figure 1.6.2. Calculated Biomass of MC2P Counties in WA (source: Washington DNR 2012)

For Oregon and Washington, timber harvest data is also available at the county level from the University of Montana Bureau of Business and Economic Research (BBER). This group has been contracted by the United States Department of Agriculture (USDA) Forest Inventory and Analysis (FIA) program to track harvest volumes and timber sales in each state and county within the Pacific Northwest on a bi-decadal rotation. The data provided by the BBER is considered to be accurate, making up a conservative estimate of the actual volumes of timber harvested within each county.

The area of forest types and grasslands are shown for western Oregon in Figure 1.6.3 (Oregon Department of Forestry 2013).

Area of forestlands in Washington by forest type groups and species are shown in Figure 1.6.4 (Campbell et al. 2010). According to FIA protocol, about 86 percent of Washington's forests are softwood conifer forest type. Within these types are four primary forest groups (i.e., combination of forest types that share closely associated species or productivity requirements). These are Douglas-fir, fir/spruce/mountain hemlock, western hemlock/Sitka spruce, and ponderosa pine.

As shown in Table 1.6.1, Douglas-fir has been the dominant species harvested in western Washington, accounting for ~48.8% of total volume (thousand board feet) harvested in 2011. Also, most timber is harvested on private forestlands (~75.8%).

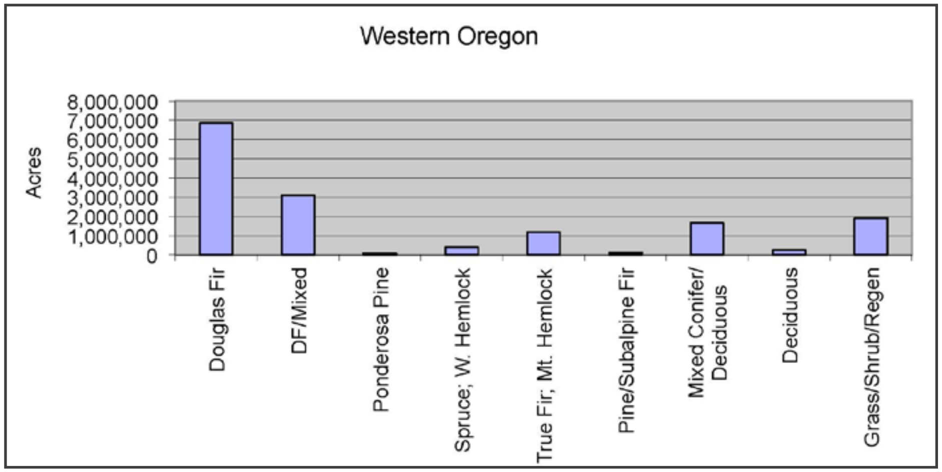

Figure 1.6.3. Western Oregon Tree Species, by acreage (source: Oregon Department of Forestry 2013)

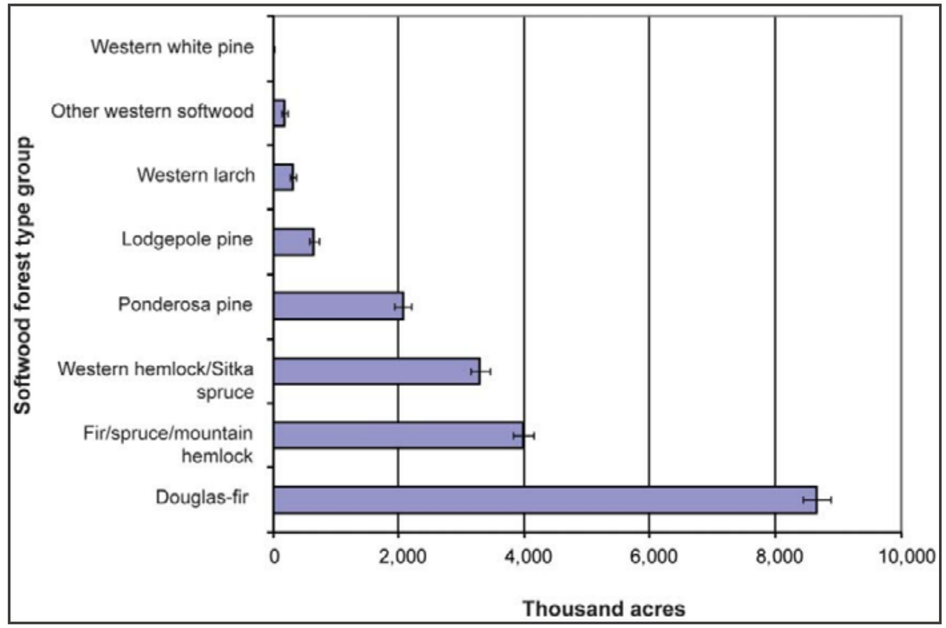

Figure 1.6.4. Area of forestlands in Washington by forest type groups and species, 2002-2006 (source: Campbell et al 2010)

Table 1.6.1. Timber harvest by ownerships and species in west side of Washington, 2011

OWNERSHIP	DOUGLAS FIR	WESTERN HEMLOCK	CEDARS	PONDEROSA PINE	OTHER PINE	OTHER CONIFER	RED ALDER	OTHER HARDWOODS	TOTAL VOLUME
Private Industrial	372,171	219,892	4,859	0	0	102,015	16,71	2,167	717,818
Private Lareg	365,400	167,125	14,253	3	65	111,906	22,457	2,429	683,638
Private Small	74,120	52,031	9,606	0	0	145,084	5,622	36,312	322,775
Private Unknown	48,130	117,043	1,934	0	0	47,355	4,519	101	219,082
Total Private	859,821	556,091	30,652	3	65	406,360	49,312	41,009	1,943,313
State	359,424	118,730	17,502	5	5	13,689	40,568	4,913	554,836
Federal	23,319	6,813	54	0	0	1,560	145	1,088	32,979
Other Public	8,113	16,920	2,154	0	0	3,363	623	0	31,173
Total Public	390,856	142,463	19,710	5	5	18,612	41,336	6,001	618,988
Total All Owners	1,250,677	698,554	50,362	8	70	424,972	90,648	47,010	2,562,301

Currently, all DNR-managed forest state trust lands (2.1 million acres) in Washington are certified under the Sustainable Forestry Initiative (SFI) standard. About 166,000 acres of forest state trust lands are certified under the Forest Stewardship Council (FSC) Pacific Coast Regional Standard (Washington DNR 2013).

RECYCLED WOOD WASTE

In addition to forest residues, NARA is studying recycled wood waste (RWW) as a potential resource. There are three general sources of urban wood waste: municipal solid waste (MSW), industrial waste, and construction and demolition (C&D) debris (Wiltsee 1998). General sources of MSW include residential, commercial, and institutional wastes (US Environmental Protection Agency 2011). Industrial wood waste includes residue from various industries such as pallet and woodworking companies (Wiltsee 1998). C&D debris derives from construction and demolition processes, and can occasionally include land-clearing debris (Wiltsee 1998). Although these are generally the accepted classifications of waste streams, there are many exceptions and alterations that can be found at the state or local level.

Table 1.6.2. Recycled Wood Waste per County

STATE	COUNTY/WASTE-SHED	RWW (TONS)
Oregon		
	Benton	1,355
	Clatsop	3,482
	Columbia	1,814
	Lincoln	5,939
	Linn	13,085
	Marion	30,392
	Metro	213,083
	Polk	1,493
	Yamhill	5,757
Washington		
	Clark	131,713
	Cowlitz	12,316
	Grays Harbor	5,723
	Lewis	15,806
	Pacific	1,300
	Skamania	7,800
	Thurston	24,328
	Tillamook	1,352
	Wahkiakum	685
	TOTAL	477,423

Figure 1.6.5 represents RWW quantities per county, waste-shed, and Material Recycling Facility (MRF) within the MC2P Region. A waste-shed is a populated region that contributes waste to a landfill; the concept is borrowed from the idea of a watershed.

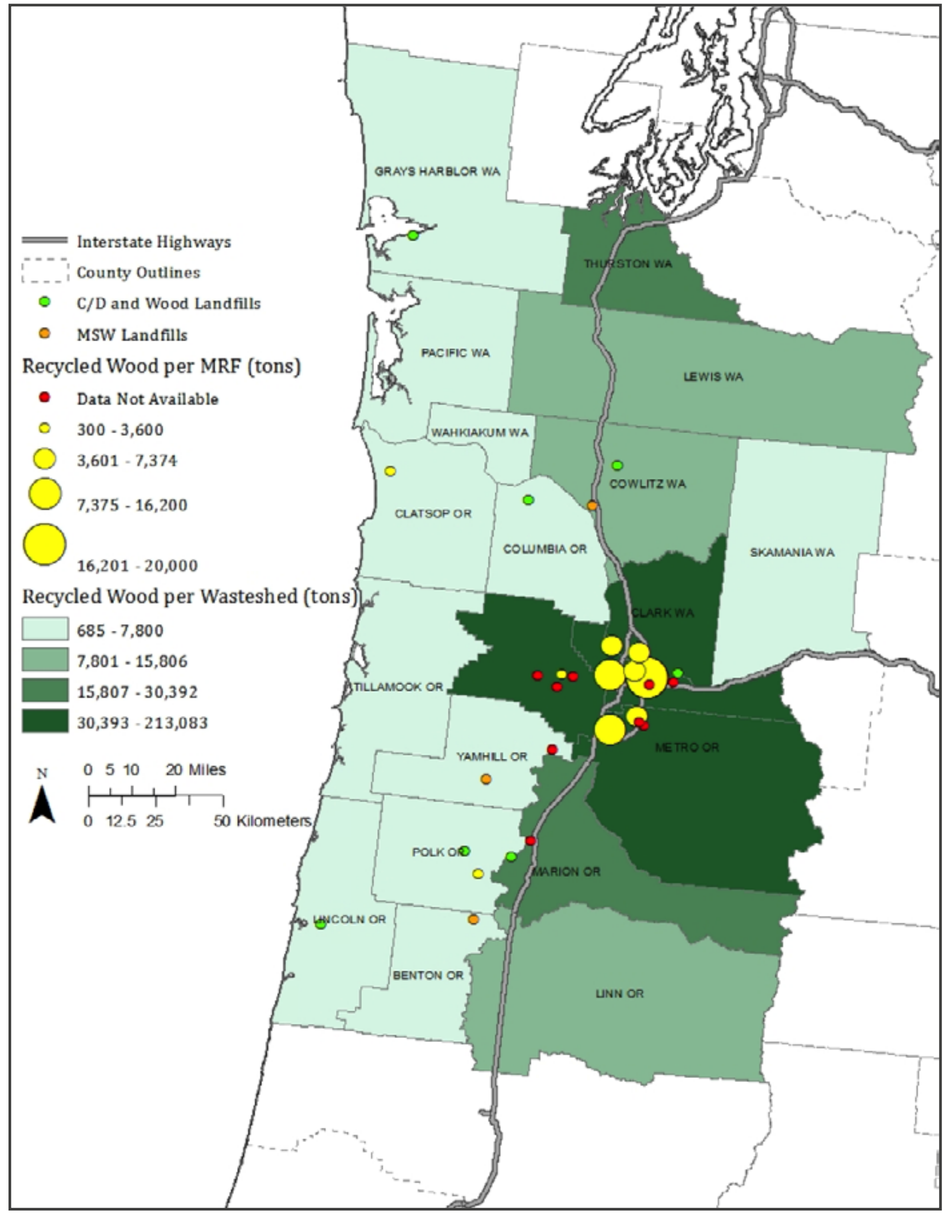

Figure 1.6.5. Recycled Wood Waste by County (Newman 2013; Spendelow 2013) As shown in Table 1.6.2, there were 477,423 tons of RWW recorded by counties and waste-sheds within the MC2P Region in 2011. Quantities per county and waste-shed were provided by the Oregon Department of Environmental Quality and the Washington Department of Ecology.

Table 1.6.3 lists 20 Material Recycling Facilities (MRFs) located in the MC2P, in which RWW quantities were collected from 11 of the facilities, totalling 97,603 known RWW tons.

Table 1.6.4 represents 11 landfills within the MC2P Region, with a total of 10,843 disposed tons of wood.

Table 1.6.4. Landfills within the Region

Landfill	Location	Disposed Wood (tons)	C&D (tons)	MSW (tons)
Brown's Island Demolition Landfill	Salem, OR	NA	15,793	NA
Buck Hollow Landfill	Dallas, OR	2,592	NA	NA
Coffin Butte Landfill	Corvallis, OR	NA	NA	33,728
Cowiltz County Landfill	Longview, WA	NA	NA	89,421
Georgia Pacific Consumer PR Wauna Mill Landfill	Clatskanie, OR	54	NA	NA
GP-Toledo Mill Landfill	Toledo, OR	NA	264	NA
Lady Island Landfill	Camas, WA	744	NA	NA
Hillsboro Landfill [WM]	Hillsboro, OR	NA	NA	74,857
Riverbend Landfill, Recycling Center, and Energy Plant	McMinnville, OR	NA	NA	43,543
Stafford Creek Woodwaste Landfill	Aberdeen, WA	5,736	19,114	NA
Weyerhaeuser Regional Landfill	Castle Rock, WA	1,717	14,927	NA

Table 1.6.3. Recycled Wood Waste per Material Recycling Facility (MRF)

MATERIAL RECYCLING FACILITY NAME	LOCATION	RECYCLED WOOD WASTE (TONS)
Allwood Recyclers Inc	Fairview, OR	Data Not Available
Best Buy in Town Landscape Supply	Hillsboro, OR	Data Not Available
Clackamas Compost Products [SH Landscape Supplies and Recycling]	Clackamas, OR	Data Not Available
Clayton Ward Recycling	Salem, OR	Data Not Available
Environmentally Conscious Recycling	Portland, OR	Data Not Available
Greenway Recycling LLC	Portland, OR	16,200
JB Wood Recyclers	Monmouth, OR	300
KB Recycling	Clackamas, OR	Data Not Available
McFarlane's Bark—Milwaukie	Milwaukie, OR	5,120
Northwest Environmental and Recycling [SH Landscape Supplies and Recycling]	Cornelius, OR	Data Not Available
Northwest Wood and Fiber Recovery	Portland, OR	19,500
Recology	Portland, OR	20,000
SH Landscape Supplies and Recycling—Hillsboro	Hillsboro, OR	2,250
SH Landscape Supplies and Recycling—Tualatin	Tualatin, OR	12,750
SP Newsprint	Newberg, OR	Data Not Available
Trails End Recovery	Warrenton, OR	3,600
Tualatin Valley Waste Recovery [Waste Management]	Hillsboro, OR	Data Not Available
Wood Waste Management	Portland, OR	7,374
City Bark LLC	Vancouver, WA	4,709
West Van Material Recovery Center	Vancouver, WA	5,800
Known Total		97,603

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1.7.0 APPENDIX A2: PHYSICAL CAPITAL

Physical capital refers to built infrastructure such as buildings, roads, and railways. Usually there is a distinction between infrastructure, which is often built or owned by the public (roads, electric power systems), versus capital, such as a conversion plant or factory that is built and owned by a private firm and used for a specific production process. We have broken the physical capital resources into two groups called Sites (nodes) and Transportation (linkages). The Site category represents facilities that receive biomass or biofuel inputs, and includes mills (saw and pulp), chipping facilities, and petroleum refineries. The Transportation category includes the roadway system, railways, barge transportation, airports, and pipelines. Physical capital is important in the biomass-to-biofuels conversion process, as the nodes represent places to store or convert the biomass, and the linkages represent ways to transport the biomass.

1.7.1 MC2P SITES

Identifying existing sites in the MC2P region aids in finding suitable locations where feedstocks can be processed and converted to biojet. Co-locating some activities, such as forest residue densification through chipping at an operating mill or at an idle mill site with existing infrastructure (e.g., roads, utilities, buildings) can substantially reduce capital expenditures for a depot or conversion facility.

WOOD USING INDUSTRIES AND PETROLEUM FACILITIES

Figure 1.7.1 shows the location of wood-using industries, including primary wood processors, roundwood pulp chip conversion, composite pellets and co-generation facilities, pulp and paper mills, and petroleum facilities in Oregon and Washington.

1.7.2 OREGON SITES

PRIMARY PRODUCTS INDUSTRY:

Oregon's forests and forest products industry provide direct employment for over 76,000 people, making forestry the second largest traded sector employer in the state. Oregon has been the nation's top producer of softwood lumber and structural panel products for decades. Oregon sawmills provide over 15 percent of the softwood lumber produced in the United States. A useful report on forest products in Oregon was produced by the US Forest Service in 2008 titled Oregon's Forest Products Industry and Timber Harvest.

Pulp mills in Oregon: Georgia Pacific (Toledo, Wauna, and Halsey), International Paper (Springfield), Cascade Pacific Pulp Co. (Halsey), SP Fiber Technologies (Newberg)

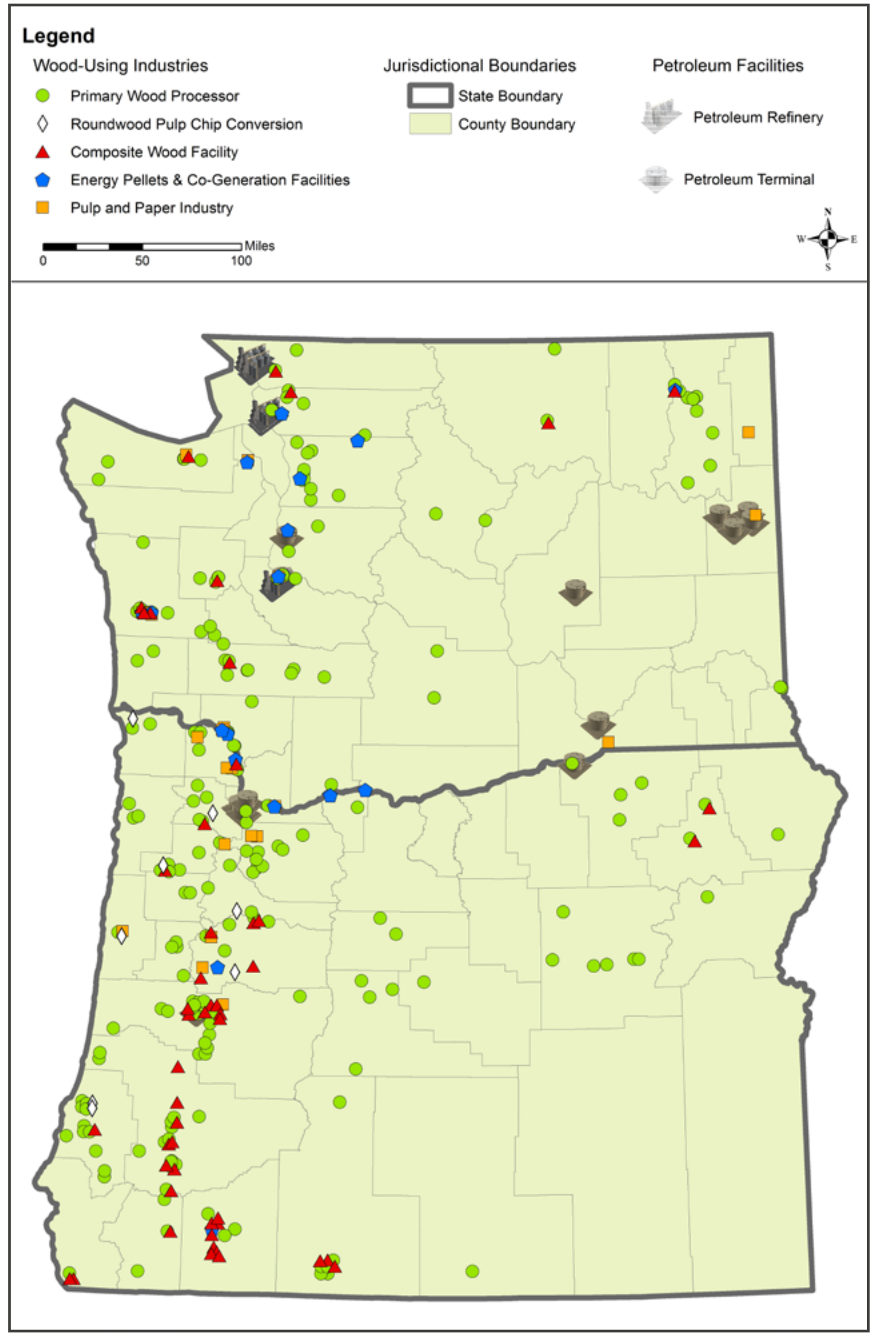

Figure 1.7.1. Washington and Oregon Petroleum and Wood-Using Facilities

Oregon has a number of bioenergy facilities producing biofuels and other biomass related products. These facilities can be viewed at the Oregon ArcGIS Online site, "Oregon Bioenergy Resource Map."

Zeachem, a cellulose-based biorefinery company, operates a 250,000 gallon/year biorefinery in Boardman, OR . The primary feedstock used by Zeachem is hybrid poplar trees.

Biomass One is a 30 megawatt, wood waste fired cogeneration plant which annually recovers 355,000 tons of wood waste in White City, OR.

Cascade Pacific Biorefinery in Clatskanie, Oregon, owned by Gloabal Partners, LP, contains rail transloading facility serviced by the Burlington Northern Sante Fe (BNSF) Railway; 200,000 barrels of storage capacity; a deepwater marine terminal; a 1,200-foot dock and the largest ethanol plant on the West Coast.

Pellet/densified fuels plants: A number of plants exist in Oregon. They are: Bear Mountain, West Oregon Wood Products, Blue Mountain Lumber Products, Pacific Pellet, Woodgrain Millwork, Elkhorn Biomass, Integrated Biomass Resources, Malheur Lumber, and Frank Lumber.

Facilities using Combined Heat/Power (CHP): Several CH P facilities are located in Oregon. They are: Freres Lumber mill, Rough & Ready Lumber mill, Seneca Sawmill, Roseburg Forest Products, Douglas County Forest Products, and Interfor Pacific.

1.7.3 WASHINGTON SITES

PRIMARY PRODUCTS INDUSTRY:

Forestry and the forest products industry contribute significantly to the economy of the state of Washington. Washington's forests provide more than 10 percent of the softwood timber harvested in the United States, and Washington sawmills provide 13 percent of softwood lumber produced in the country (USD A Forest Service 2010). A comprehensive list and distribution of primary and secondary products industry in Washington is available at the Communitywalk website under "Washington Forest Products Industry."

The Washington state mill survey is published once every two years. The survey reports key statistics about Washington's wood products processing industry (e.g, origin of the logs and conversion of logs into products by mills).

Pulp Mills in Washington: Pulp mills in Washington include: Boise Inc (Wallula), Harbor Paper (Hoquiam), Georgia-Pacific (Camas), Inland Empire Paper (Spokane), Longview Fiber Paper and Packaging (Longview), Nippon Paper (Port Angeles), Port Townsend Paper (Port Townsend), Sonoco (Sumner), and Weyerhaeuser (Longview).

Washington has a number of bioenergy facilities using biomass to produce electricity or combined heat and power (CHP). Table 1.7.1 summarizes the characteristics of such plants.

Table 1.7.1. Facilities in Washington using Biomass to produce energy

FACILITY NAME	LOCATION	MEGAWATT	TYPE
Sierra Pacific	Aberdeen	18	Electricity only
SDS Lumber	Bingen	9	Electricity only
Avista	Kettle Falls	51	Electricity only
Longview Fibre	Longview	25	Electric-led CHP
Sierra Pacific	Mount Vernon	28	Electricity only
Nippon Paper	Port Angeles	20	Electric-led CHP
Simpson Tacoma	Tacoma	55	Electric-led CHP
Simpson Shelton	Shelton	31	Electric-led CHP
Seattle Steam	Seattle	-	Thermal only
Cosmo Fiber Fuels	Cosmopolis	-	Thermal only
Port Townsend Paper	Port Townsend	15	Electric-led CHP
Weyerhaeuser Longview	Longview	44	Electric-led CHP
Georgia-Pacific	Camas	52	Electric-led CHP
Sierra Pacific	Burlington	28	Electricity only
Hampton Lumber	Darrington	7	Thermal-led CHP
Wind River Biomass Utility LLC	Stevenson	2-4	Electric-led CHP

MATERIAL RECYCLING FACILITIES (MRFs)

Material recycling/recovery facilities (MRF) remove wood from municipal solid waste (MSW), these waste streams include industrial waste, and construction and demolition (C&D) debris. The US Environmental Protection Agency (EPA) defines an MRF as a facility that separates, processes, and consolidates recyclable materials for shipment to one or more recovery facilities rather than to a landfill or other disposal site (US EPA 2002). MRFs may include transfer station convenience sites or privately owned companies that provide service to commercial and residential customers. Materials typically recycled in an MRF include paper, plastic, glass, metal, wood, and other miscellaneous materials found in municipal or C&D waste streams. MRFs that recycle wood waste may grind wood into small chips called hogged fuel and sell it to various markets, or resell the wood as reused or reclaimed. See Figure 1.6.4 for MRFs located in Washington and Oregon.

1.7.4 MC2P LINKAGES

Transportation costs are one of the critical factors in determining the economic viability of biofuel production from biomass. An understanding of existing transportation infrastructure, their requirements and constraints, and cost structure are necessary for a meaningful analysis. A general rule of thumb is that transportation by barges is one-third the cost of rail, and rail is one-third the cost of trucks.

RAIL

Figure 1.7.2 shows the Oregon rail system. Oregon does not have major rail traffic volume or tonnage. The primary focus of the rail carriers is along the east-west I-84 long haul corridor. Regional and short-line rail carriers play an important part in connecting smaller communities and shippers, particularly in rural areas, to the national rail system.

The Burlington Northern Santa Fe and the Union Pacific railways are the two primary transcontinental rail providers in Washington, which along with 17 other smaller railroads service 3,666 miles of track throughout the state. A detailed Washington rails system map is presented in Figure 1.7.3

ROAD

The state highway system in Oregon has about 8,000 miles of state highways and Washington has a network of over 7,000 miles of state highways. Detailed highway system maps of both states are shown in Figure 1.7.4 and Figure 1.7.5.

BARGES, AIRFIELDS, PIPELINES, REFINERIES AND OTHER INFRASTRUCTURE

Airports in Oregon, listed by the National Plan of Integrated Airport Systems (NPIAS), are listed by category as shown in Table 1.7.2. There are an additional 40 airports in Oregon not listed in NPIAS.

Table 1.7.2. Airport categories and numbers in the NPIAS

AIRPORT CATEGORIES	NAME	NUMBER
Primary	Portland (PDX)	6
	Redmond (RD M)	
	North Bend (OTH)	
	Medford (MFR)	
	Klamath Falls (LMT)	
	Eugene (EUG)	
General Aviation		48
Government/Military	Kingsley Field (Klamath Falls)	3
	Portland Air National Guard (Portland)	
	McNary Field (Salem)	
Commercial Service Airports		3

Table 1.7.3. Pipelines in Oregon

TYPE	CODE	START POINT	END POINT	DIAMETER (INCHES)
Natural gas	C2	Calgary, Canada	Barstow, CA	2*34, 36
Natural gas	C46	Salt Lake City, UT	Pendleton, OR	22
Natural gas	C35	Mountain Home, ID	Reno, NV	15
Gasoline, propane and ethylene	C38	Port Arthur, TX	Albany, NY	2*16, 20

Figure 1.7.2. Oregon Rails System Map

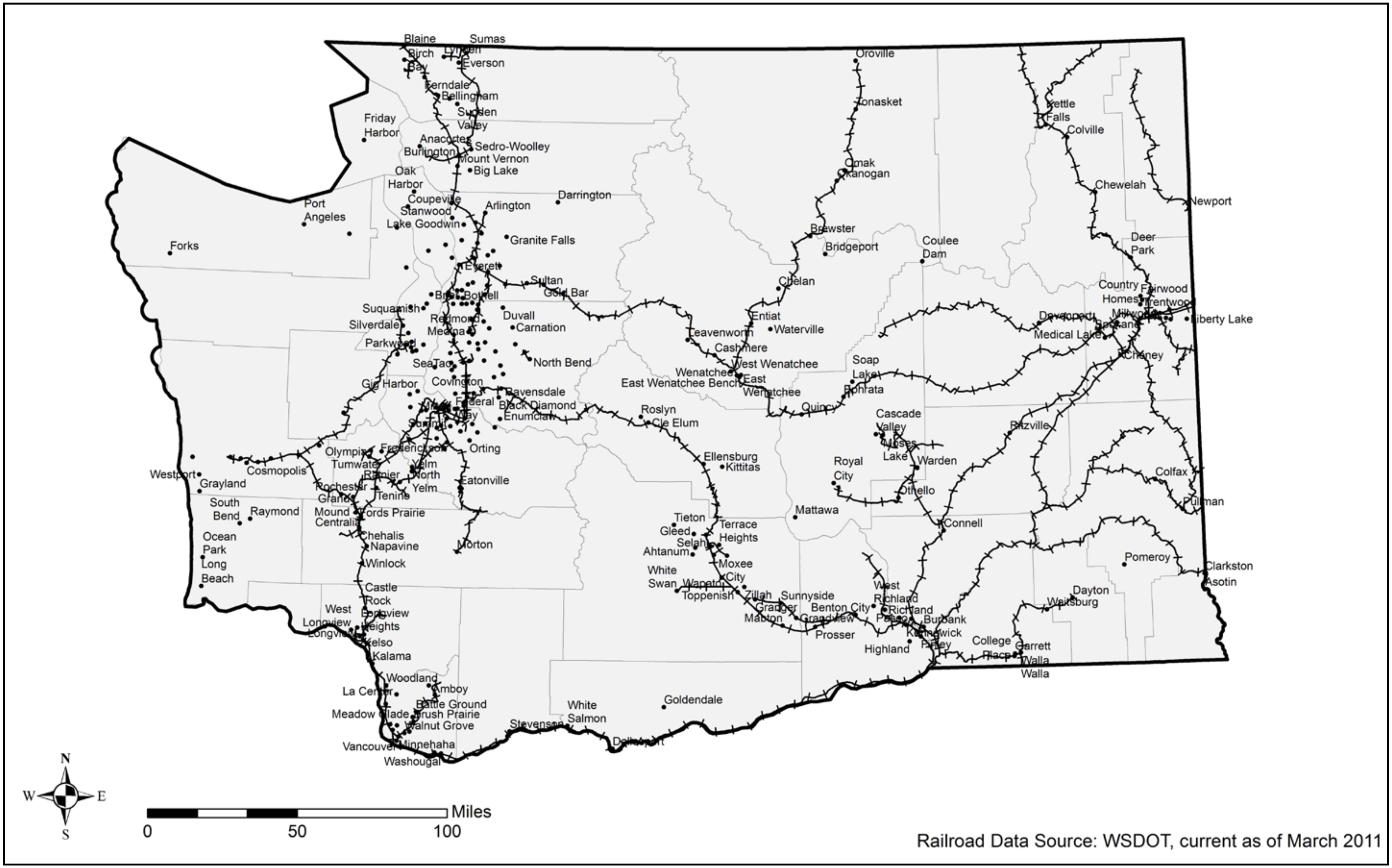

Figure 1.7.3. Washington Rails System Map

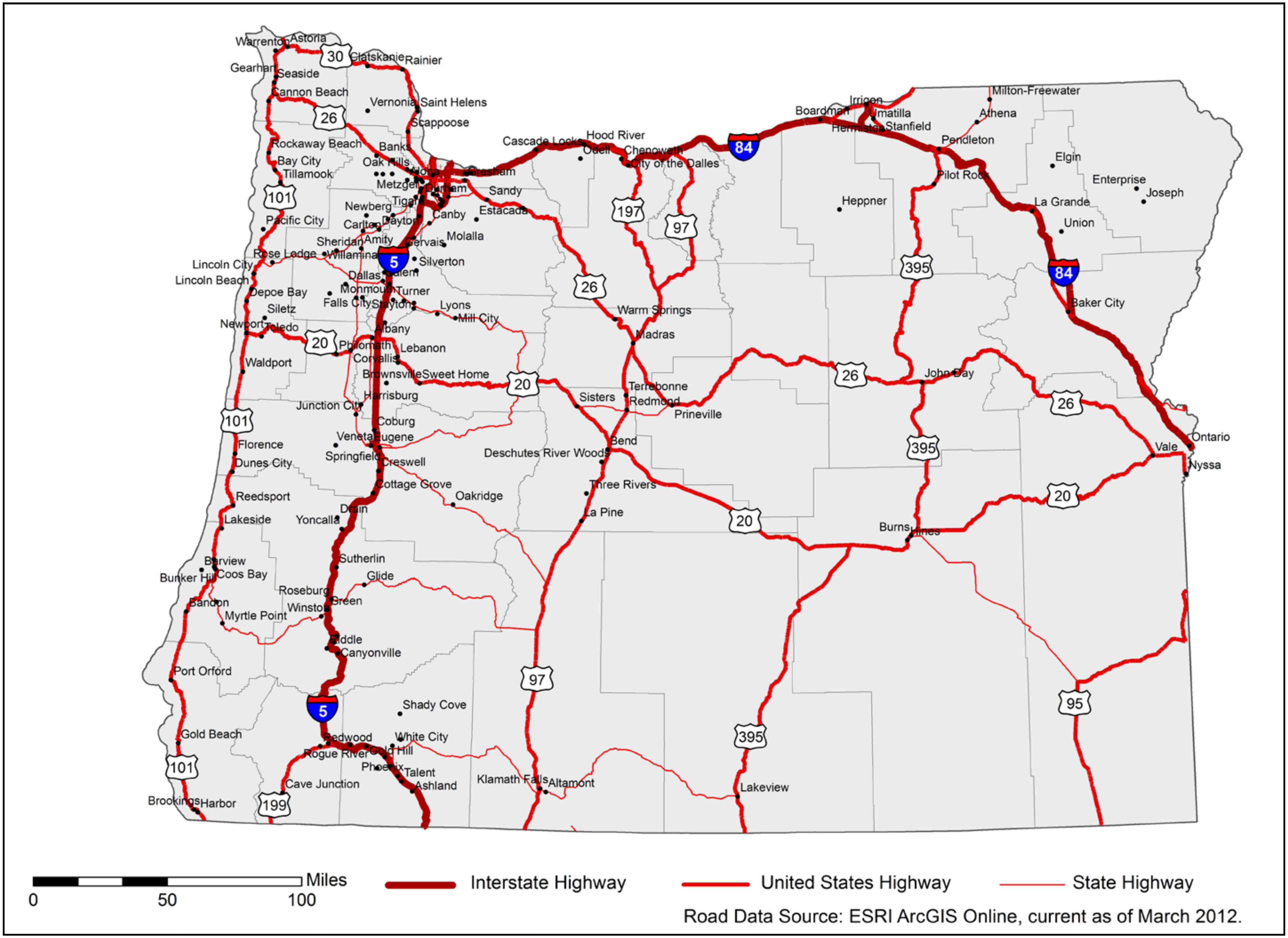

Figure 1.7.4. Oregon Highway System Map

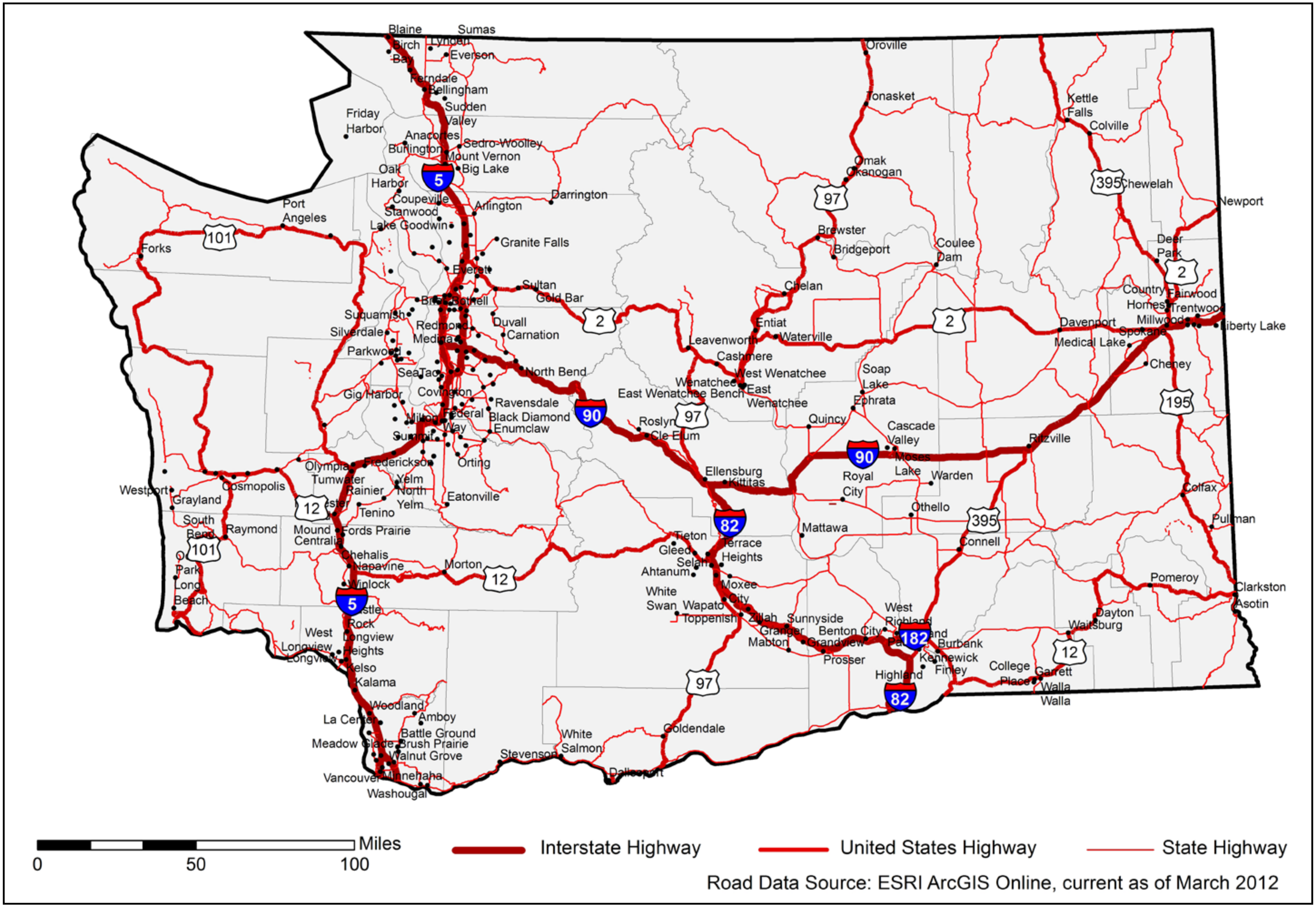

Figure 1.7.5. Washington Highway System Map

1.7.5 WASHINGTON INFRASTRUCTURE

Washington also has a well developed airfield system, including 64 public-use airports listed in NPIAS, 75 other public-use airports not listed in NPIAS, and 17 Military and private-use airports (communitywalk.airport 2013).

Washington has 75 port districts that move freight regionally, nationally, and internationally via the Columbia/Snake River system and the Pacific Ocean. This collection of districts is the world's largest locally controlled port system (WSDOT Marine 2013).

Table 1.7.4 shows the major oil pipelines for crude oil crossing Washington (Theodora 2008). As a state with leading refinery capacity, Washington also has several petroleum refinery facilities with different production capacities, as summarized in Table 1.7.5.

Table 1.7.4. Pipelines in Washington

TYPE	CODE	START POINT	END POINT	DIAMETER (INCHES)
Natural gas	C2	Calgary, Canada	Barstow, CA	2*34, 36
Natural gas	C10	Medicine Hat, Canada	Billings, MT	-
Natural gas	C46	Salt Lake City, UT	Pendleton, OR	-
Gasoline, propane and ethylene	C8	Billings, MT	Minot, ND	8
Gasoline, propane and ethylene	C38	Port Arthur, TX	Albany, NY	2*16, 20
Gasoline, propane and ethylene	C42	Spokane, WA	Billings, MT	10

Table 1.7.5. Petroleum refinery facilities in Washington and their production capacity

FACILITY NAME	COMPANY	PRODUCING CAPACITY
Cherry Point Refinery	British Petroleum (BP)	209,000 bbl/d
Conoco Phillips Ferndale Refinery	Conoco Phillips	100,000 bbl/d
Shell Anacortes Refinery	Shell Oil Company	145,000 bbl/d
Targa Sound Terminal (formerly Sound Refining)	Targa Sound Terminal	8,000 bbl/d
Tacoma Refinery	U.S. Oil and Refining	35,000 bbl/d
Tesoro Anacortes Refinery	Tesoro	108,000 bbl/d

1.7.6 REFERENCES

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1.8.0 APPENDIX A3: CIVIC CAPITAL

Civic capital denotes the human assets available in a region including population demographics and various key educational and employment attributes associated with that population. Civic Capital also includes vocational technical and higher education opportunities, highlighting certifications and degrees relevant to the biofuels industry. Employment trends and labor participation rates have been gathered for each county, and these factors combined with the educational data were used to assess the readiness of the region to support a new biofuels industry. In addition to the region's tangible support for the industry, this section also examines its social and cultural assets by looking at collaborations already occurring in the region. The civic capital assets highlight the region's readiness and acceptance for a new biomass industry in the region.

1.8.1 HUMAN ASSETS

Human assets include the knowledge, skills and abilities of the population. Looking at the human assets within the population provides an understanding of the potential workforce available within a region to work in a particular industry. This section starts by reviewing the key occupational codes relevant to the biofuels industry. It then looks at labor force and median age in the MC2P region.

POPULATION TRENDS

Between 2000 and 2012, the population for twelve northwestern Oregon counties included in the MC2P region has steadily increased. On the other hand, of the eight selected counties in Washington, only five have shown marginal growth. One of the counties, Pacific, actually saw its population decline from 2000 to 2010 (see Table 1.8.1).

Table 1.8.1. Population in Oregon and Washington MC2P counties

	Total population 2000	Total Population 2010	Total Population 2011	Total Population 2012
OREGON				
Benton	78,153	85,579	85,928	86,430
Clackamas	338,391	375,992	38,0207	383,857
Clatsop	35,630	37,039	37,153	37,301
Columbia	43,560	49,351	49,402	49,286
Lincoln	44,479	46,034	45,933	46,151
Linn	103,069	116,672	118,122	118,360
Marion	284,834	315,335	318,872	319,985
Multnomah	660,486	735,334	748,031	759,256
Polk	62,380	75,403	75,993	76,353
Tillamook	24,262	25,250	25,403	252,87
Washington	445,342	529,710	540,410	547,672
Yamhill	84,992	99,193	100,000	100,255
WASHINGTON				
Clark	345,238	425,363	433,418	438,287
Cowlitz	92,948	102,410	102,478	101,996
Grays Harbor	67,194	72,797	72,546	71,692
Lewis	68,600	75,455	75,901	75,621
Pacific	20,984	20,920	20,930	20,575
Skamania	9,872	11,066	11,137	11,187
Thurston	207,355	252,264	256,591	258,332
Wahkiakum	3,824	3,978	3,991	3,993

MEDIAN AGE

Median age is a useful demographic variable to consider when looking at available workforce.

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 regional biofuels economy (Daniels, Keller, Lapping, and Daniels 2010).

The median age in the MC2P Oregon counties reflect the increasingly aging population of the state and country. For the most part, although the median age over the twelve year period has increased, it has been a slow increase. In Tillamook and Lincoln counties the median age is over 45.

In the MC2P Washington counties, the median age is not only higher, but has increased at a much faster rate between year 2000 to 2012 (see Table 1.8.2)

Table 1.8.2. Median Age in Oregon and Washington MC2P counties

	Median age 2000	Median Age 2010	Median Age 2011	Median Age 2012
OREGON				
Benton	31.1	32.1	32.1	32.4
Clackamas	37.5	40.6	41.1	40.1
Clatsop	40	43.2	43.5	43.5
Columbia	37.7	41.3	41.9	42.3
Lincoln	44.1	49.6	50.1	50.3
Linn	37.4	39.2	39.3	39.6
Marion	33.7	35.1	35.3	35.5
Multnomah	34.9	35.7	36	36.2
Polk	36.5	37.1	37.2	37.3
Tillamook	43.5	47.5	47.7	48
Washington	33	35.3	35.6	35.8
Yamhill	34.1	36.8	37.2	37.5
WASHINGTON				
Clark	34.2	36.7	37	37.3
Cowlitz	36.9	40.2	40.7	41.3
Grays Harbor	38.8	41.9	42.3	42.7
Lewis	38.4	41.5	41.8	42.1
Pacific	45.8	50.8	51.1	51.5
Skamania	38.7	44	44.6	45
Thurston	36.5	38.5	38.5	38.6
Wahkiakum	44.4	52.3	52.8	53.2

LABOR FORCE

The availability of a workforce is a vital element when establishing a new and emerging industry. The amount of unemployed people is just as important to evaluate as the total population currently in the labor force. Oregon and Washington unemployment rates vary across the MC2P, with a wide range as low as 6.1% in Benton County, OR and as high as 12.5% in Grays Harbor, Washington (Table 1.8.3).

Table 1.8.3. MC2P Counties Labor Force Data (2012 Annual Averages)

Counties in MC2P	Total Population 2012	Total Labor Force	Employed	Unemployed	Unemployment Rate
OREGON					
Benton	86,430	44422	41694	2728	6.1
Clackamas	383,857	199576	183824	15752	7.9
Clatsop	37,301	20664	19066	1598	7.7
Columbia	49,286	24221	21912	2309	9.5
Lincoln	461,51	22592	20492	2100	9.3
Linn	118,360	54547	48607	5940	10.9
Marion	319,985	154899	140106	14793	9.6
Multnomah	759,256	404357	373015	31342	7.8
Polk	76,353	38442	35198	3244	8.4
Tillamook	252,87	12504	11440	1064	8.5
Washington	547,672	293472	272777	20695	7.1
Yamhill	100,255	48611	44475	4136	8.5
WASHINGTON					
Clark	438,287	211442	189421	22021	10.4
Cowlitz	101,996	43067	38380	4687	10.9
Grays Harbor	71,692	29101	25468	3633	12.5
Lewis	75,621	29898	26182	3716	12.4
Pacific	20,575	8729	7740	989	11.3
Skamania	11,187	5060	4515	545	10.8
Thurston	25,8332	126669	116798	9871	7.8
Wahkiakum	3,993	1473	1294	179	12.2

OCCUPATIONAL CODES

Further examination of the labor force can be broken down into various knowledge, skills and abilities that each job requires and likewise, the characteristics of the existing labor force or unemployed population. The Bureau of Labor Statistics' categorizes this information in its recent 2010 Standard Occupational Classification System (SOC), which contains links to major groups, broad occupational definitions, and detailed occupational definitions. The O*NET Resource Center, the nation's primary source of occupational information, goes a step further and provides comprehensive occupational descriptions and data for use by job seekers, workforce development offices, human resources professionals, students, researchers, and others (O*NET 2013). O*NET OnLine is sponsored by the U.S. Department of Labor, Employment and Training Administration, and developed by the National Center for O*NET Development.

As part of its efforts to keep up with new and emerging sectors and corresponding occupations, the National Center for O*NET Development investigated the impact of green economy activities and technologies on occupational requirements and identified New and Emerging (N&E) occupations. Results of the research led to the identification of green economic sectors, green increased demand occupations, green enhanced skills occupations, and green N&E occupations. These occupations are now reflected in the O*NET-SOC system. The industries that most closely resemble proposed operations in the NARA project are classified under the biofuels/ethanol and biodiesel sectors.

Major work activities of the green economy cover a broad spectrum. To efficiently and effectively determine the potential occupational implications of a green technology such as biofuels production, workplace activities are categorized under different sectors of the economy. Table 1.8.1 highlights twelve major sectors of employers that contribute to the biofuels industry.

Table 1.8.4. Broad Sectors of Biofuels Related Employers Identified by O*NET

Renewable Energy Generation	Transportation	Energy Efficiency
Green Construction	Energy Trading	Energy and Carbon Capture and Storage
Research, Design, and Consulting Services	Environmental Protection	Agriculture and Forestry
Manufacturing	Recycling and Waste Reduction	Governmental and Regulatory Administration

For a complete listing of these SOC , see Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations (Dierdorff et al 2009) and Greening of the World of Work: Revisiting Occupational Consequences (Dierdorff et al 2011). In addition to these reports on the green economy, the National Center for O*NET Development maintains a Green Book of References that is updated quarterly. Most recently, green tasks have been developed for green enhanced skills and green new and emerging occupations; see the O*NET Green Task Development Project report.

MAJOR INDUSTRIAL PLAYERS IN THE MC2P

The following list shows a partial listing of companies relevant to the NARA project in the MC2P region.

OREGON:

- Weyerhaeuser
- Roseburg Forest Products
- JELD-WEN
- Hampton Affiliates
- Collins Companies
- International Paper
- Georgia Pacific
- Boise Wood Products
- Giustina Resources
- Interfor
- Stimson
- Swanson Group
- Lone Rock Timber Company
- Hancock Timber Resource Group

WASHINGTON:

- Weyerhaeuser (NARA affiliate)
- Catchlight Energy (NARA affiliate)
- Cosmo Speciality Fibers
- Boeing
- Alaska Airlines

EDUCATIONAL ATTAINMENT

Educational attainment identifies the highest level of education that individuals in a population have received. Educational attainment categories range from less than a 9th grade education to graduate or professional degree. Low educational attainment is a liability to building a biofuel supply chain, which will require well-educated people.

The number of people in Washington and Oregon who are achieving greater educational success is encouraging. In half of the MC2P Oregon counties, the number of individuals finishing less than a 9th grade education went down from 2000 to 2011.

In all of the MC2P Oregon counties there was an increase in people receiving high school diplomas, as well as increases in those receiving college and graduate level education.

For the MC2P Washington counties, the number of people having less than a 9th grade education was mixed. Lewis County, for example, saw a decrease in its population receiving less than a 9th grade education, while Clark County saw an increase in people receiving less than a 9th grade education. As with Oregon, all the Washington counties saw an increase in people receiving a high school diploma and education beyond that level (see Table 1.8.5).

Table 1.8.5. Oregon and Washington Education Statistics

MC2P Counties in Oregon & Washington (2011 survey)	pop. over 25	less than 9th grade (%)	9-12th grade, no diploma (%)	H.S. diploma or eq. (%)	some college no degree (%)	assoc. degree (%)	bach. degree (%)	grad. or prof. degree (%)
OREGON								
Benton	49,632	1.95	3.89	16.43	23.14	7.16	25.26	22.16
Clackamas	255,523	2.50	5.70	23.96	28.20	8.05	20.56	10.64
Clatsop	26,016	2.18	6.30	29.33	31.10	8.98	13.94	8.18
Columbia	33,711	3.03	8.54	34.68	27.54	9.43	11.01	5.77
Lincoln	34,845	3.37	6.72	27.37	31.07	7.08	15.29	9.10
Linn	77,907	3.36	8.09	32.38	30.18	9.31	11.71	4.98
Marion	199,563	8.45	9.04	26.94	25.97	8.91	13.25	7.45
Multnomah	505,443	4.36	6.35	20.60	23.71	6.70	23.49	14.79
Polk	47,573	4.19	5.99	25.80	27.43	8.42	18.11	10.05
Tillamook	18,642	4.66	7.28	34.97	27.84	5.92	13.12	6.21
Washington	346,009	4.53	4.97	19.05	23.79	8.21	25.84	13.61
Yamhill	63,325	5.84	7.54	30.26	26.29	7.52	14.45	8.10
WASHINGTON								
Clark	274,062	2.82	6.36	25.85	29.23	9.93	16.87	8.93
Cowlitz	68,936	3.87	9.66	30.22	30.81	10.47	9.66	5.31
Grays Harbor	50,219	5.76	9.82	31.54	28.45	10.25	9.45	4.73
Lewis	51,335	4.09	10.35	32.19	29.13	9.28	9.09	5.87
Pacific	15,908	5.26	8.84	31.93	29.22	8.19	11.16	5.39
Skamania	7,709	1.83	7.91	31.64	28.21	7.99	14.88	7.54
Thurston	168,259	1.90	5.12	23.70	26.89	9.81	19.66	12.86
Wahkiakum	2,878	2.85	5.80	32.90	33.67	10.01	8.13	6.64

EDUCATIONAL OFFERINGS IN THE MC2P

Understanding the educational offerings in MC2P provides employers with an understanding of the educational opportunities available to their current and future employees. This section covers technical degrees and four-year degrees available in the MC2P.

TECHNICAL/PROFESSIONAL DEGREES

Washington offers more technical, two year and professional degree programs relevant to an emerging biofuels industry than Oregon does. Table 1.8.6 provides a list of the technical degrees in the MC2P.

Table 1.8.6. Oregon and Washington Educational Programs

TECHNICAL/ COMMUNITY COLLEGES	CITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OREGON																
Linn-Benton CC	Elmira			X	X											
West Lane Technical	Corvallis		X													
Pioneer Pacific College	Wilsonville		X	X										X		
Clatsop CC	Astoria		X	X		X							X			X
Tillamook Bay CC	Tillamook	X														
ITT Technical Institute	Salem			X	X			X								
NECA-IBEW Electrical	Portland						X	X								
Chemeketa CC	Salem		X	X	X											X
Portland CC	Portland	X	X	X	X			X								
Linfield College	McMinnville	X		X	X				X							
WASHINGTON																
Clark College	Vancouver		X	X	X	X			X							X
Charter College	Vancouver			X	X									X		X
West Coast Training	Woodland											X				
Everest College	Vancouver	X		X										X		
Lower Columbia College	Longview	X	X	X	X				X	X		X		X		X
Grays Harbor College	Aberdeen	X	X	X		X			X			X			X	X
South Puget Sound CC	Olympia	X	X	X	X						X					X

LEGEND
1. Accounting
2. Automotive
3. Business
4. Computer science/technology
5. Construction
6. Energy technology
7. Engineering
8. Environmental science
9. Fire science technology
10. Geographic information systems
11. Heavy equipment operator, CD L, crane operator
12. Industrial technology
13. Law
14. Natural resources/ecology/sustainable studies
15. Welding

RELEVANT HIGHER EDUCATION PROGRAMS AND TRAINING

Universities across Oregon and Washington are presented in the table below. Larger institutions, such as the universities listed, draw on a more geographically diverse populations and upon graduation, students tend to take jobs farther away from their homes.

Oregon has a number of institutions of higher learning. Universities have been listed below for their outstanding programs, ranging from accounting to specific environmental studies focusing on sustainable design, which would be of use in the biofuel industry.

In the state of Washington there are numerous programs that involve environmental studies and forest management. Washington State University offers programs that cover many topics of use in the biofuel industry (Table 1.8.7).

Table 1.8.7. Oregon and Washington Higher Education Degrees

UNIVERSITY	CITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
OREGON																	
Eastern Oregon	La Grande				X	X							X				
George Fox	Newberg	X			X	X			X								
Lewis-Clark	Portland					X				X			X				
Oregon State	Corvallis			X	X	X			X		X			X	X		
Pacific University	Forest Grove	X			X					X			X			X	
Portland State	Portland	X			X	X		X	X	X						X	X
Southern Oregon	Ashland				X	X				X			X				
University of Portland	Portland					X			X	X							
Willamette University	Sale	X			X	X			X	X	X						
WASHINGTON																	
Eastern Washington	Cheney				X			X		X				X			X
Evergreen State College	Olympia									X							
Gonzaga University	Spokane	X			X	X			X	X			X				
Puget Sound University	Tacoma				X	X				X				X			
University of Washington	Seattle				X		X	X	X	X	X						X
Washington State	Pullman	X	X			X	X		X	X	X			X			
Western Washington	Bellingham	X			X					X							X

LEGEND
1. Accounting
2.Bioproducts & Bioenergy
3.Biosystem modeling
4.Business
5.Computer science/ technology
6.Construction
7. Economics
8. Engineering
9. Environmental studies
10.Forest extension/ management
11.Geographic Information Systems (GIS)
12.Law
13.Natural resources
14.Renewable materials
15.Sustainability
16. Urban & regional/community & environment planning

RESEARCH & TECHNOLOGY INNOVATIONS

Understanding the educational offerings in MC2P provides employers with a research and technological innovation contribute to a region's economic successes. Often, colleges and universities provide access to basic and advanced research which can lead to technological innovation and help propel regional economic development. In the MC2P Region university-led research could advance the development of a new and emerging biofuels industry. Understanding the current and future research agendas of the various higher education facilities within the region not only helps regional leaders identify the core research assets, but also identify the emerging workforce and brainpower of the region. These factors can lead to innovation and the commercialization of technology that will under-gird the biofuels industry.

A tool for assessing a region's potential for innovation is called the Innovation Index, developed by the Purdue Center for Regional Development and the Indiana Business Research Center. The index incorporates a mix of input measures that characterize the place and its people (accounting for 60 percent of the overall index score) and output measures that characterize its economic success (40 percent of the overall score). The state context category is provided for reference, but is not part of the broader index. The index specifically has five components with weighted percentages:

1. Human Capital - 30%
2. Economic Dynamics - 30%
3. Productivity and Employment - 30%
4. Economic Well-Being -10%
5. State Context - for reference only

The overall Innovation Index scores for the MC2P counties in Oregon and Washington are 86.5 and 88.4, respectively. The breakdown of the individual index components are listed in Table 1.8.8.

The county level innovation index scores for the MC2P counties in Oregon and Washington are provided in Table 1.8.9.

A brief description of biofuels related research and innovation occurring in the MC2P region is outlined in the following section.

Table 1.8.8. Innovation Index Scores for Oregon and Washington

INNOVATION INDEX COMPONENTS	OREGON	WASHINGTON
Human Capital	117.4	106.2
Economic Dynamics	85.6	78.4
Productivity and Employment	80.9	76.1
Economic Well-being	98.4	101.7
State Context*	100	100

Table 1.8.9. Innovation Index Scores for MC2P counties in Oregon and Washington

STATE	COUNTY	INNOVATION INDEX
OREGON	Benton	99.7
	Clackamas	90.3
	Clatsop	81.8
	Columbia	80.1
	Lincoln	80.5
	Linn	77.6
	Marion	79.3
	Multnomah	88.0
	Polk	83.6
	Tillamook	76.0
	Washington	119.1
	Yamhill	87.3
WASHINGTON	Clark	94.0
	Cowlitz	78.9
	Grays Harbor	79.3
	Lewis	79.2
	Pacific	75.3
	Skamania	92.5
	Thurston	89.5
	Wahkiakum	78.8

CURRENT RESEARCH

Advanced Hardwood Biofuels Northwest (AHB) is a research, extension and education project led by a team directed by the University of Washington. The project is focused on converting hybrid poplar and other fast-growing woody biomass to biofuels in a cost-effective manner.

Northwest Advanced Renewable Alliance (NARA) is a research, extension and education project led by Washington State University. This project plans to utilize low value forest residual waste from softwood species such as Douglas-fir, Western hemlock, Ponderosa pine, Lodgepole pine, Grand fir, and recycled wood waste to produce jet fuels and other co-products.

TECHNOLOGY/DEVELOPMENT

Several institutions and companies are located in Oregon and Washington that are involved in research and development directly related to the NARA project. Some of these entities are described below.

OREGON:

SolaGen: SolaGen is the only US manufacturer of both large industrial wood drying systems and solid fuel combustors which utilizes a small portion of the dried material as fuel for the drying process. SolaGen has it roots in heavy industrial wood fuels applications, wood fuel preparation, and pellet manufacturing facility design.

Peterson Pacific Corp.: manufacturer of industry-leading Whole Tree Chippers and Debarkers, Horizontal Grinders, and Blower Trucks and Trailers.

HM3 Energy: HM3 Energy has developed a proprietary process to turn biomass into clean fuel to replace coal in coal-fired power plants. Existing power plants designed to burn coal can co-fire biomass with coal, or directly use torrefied (dried or roasted) biomass in place of coal, drastically reducing carbon and other harmful emissions such as mercury, sulfur and nitrous oxides.

Three Dimensional Timberlands: develops biomass pyrolysis facilities that produce both bio-oil and biochar at a commercially viable capacity.

WASHINGTON:

Aviation Biofuels Work Group: This work group has generated the first of two reports to the Washington Legislature summarizing the current state of the aviation biofuels industry, what the work group has done, and the next steps for the Work Group in 2013.

Pacific Northwest National Laboratory (PNNL): Pioneering work is being conducted in the area of biofuels at PNNL. Research is ongoing on advanced biotechnology and thermal processes to produce hydrocarbon intermediates, and convert these intermediates into the next generation of hydrocarbon fuels.

Forest Concepts: Forest Concepts is a national leader in woody biomass processing technology. Their products and innovations enable a low cost supply of biomass feedstock to energy conversion and second-generation biofuels producers.

Catchlight Energy LLC: Catchlight Energy is a joint venture between Chevron and Weyerhaeuser. Primarily focus is on converting forest-based feedstock to liquid transportation fuels through multiple pathways based on combinations of biological, chemical and thermochemical process.

Imperium Renewables: Imperium Renewables is a 100 million gallon per year capacity BQ-9000® certified biodiesel refinery located in Washington. The company has developed proprietary technology and processes across the biofuel value chain. The company produces pure, unblended B100 biodiesel refined from variety of oils, including soy and canola grown in the Pacific Northwest and Canada.

Mercurius Biorefining, Inc.: Mercurius will build and operate a pilot plant that uses an innovative process that converts the cellulosic biomass into non-sugar intermediates, which are further processed into drop-in bio-jet fuel and chemicals. Several organizations are participating in this consortium led by Mercurius Biorefining, including Purdue University, Pacific Northwest National Laboratory, and Incitor.

Advanced Biofuels Corp.: The company has recently bought a legacy 7 million gallons per year (MMgy) ethanol plant in Moses Lake, WA, with plans to retrofit existing systems and install new pretreatment process equipment, converting the facility into a 6 MMgy advanced ethanol facility.

Wind River Biomass Utility LLC: Wind River Biomass is interested in conversion of wood biomass (slash, thinning, logs from treatments and plantations) into CH P (2-4 MW electrical power generators). The company has connections with local infrastructure on biomass collection and processing

COUNTY HEALTH RANKINGS

The County Health Rankings and Roadmaps is an organization developed by the Robert Wood Johnson Foundation and the University of Wisconsin to measure the health of a county through multiple metrics. Scores are awarded for various socioeconomic and clinical factors, health behaviors, and the physical environment of the area. Each county is analyzed by these factors and compared against other counties in the state (County Health Rankings 2013). The health ranking is one metric to assessing the quality of life in a particular county. It can be useful as a way to understand the overall health of a county's population, as well as a factor for businesses to consider in terms of the quality of life in a county that could attract potential employees.

Twelve counties in northwestern Oregon are compared to 36 other counties in the state. A county receiving a 1 is the most healthy county in the state of Oregon, compared to the other 36 counties. For example Benton County was the most healthy county in Oregon for the years 2010-2012 and then fell to the second most healthy county in Oregon in the year 2013. Lincoln County, although relatively unhealthy, showed improvement from being the 28th healthiest county in the state in 2010 to being the 24th healthiest county in Oregon in 2013.

Eight counties in western Washington are compared to 39 total counties in the state. Of the eight counties in the MC2P, all but two rank toward the bottom of the state's health ranking scoreboard. Thurston County was the only county to show improvement from the year 2010 to 2013. Wahkiakum County swung wildly from being ranked 24th healthiest in the state in 2010 to being 38th healthiest for two years in a row (2011, 2012) and then rebounding in 2013 to being ranked at 23rd healthiest (Table 1.8.10).

Table 1.8.10. Health Rankings for MC2P counties in Oregon and Washington

STATE	COUNTY	2010	2011	2012	2013
OREGON	Benton	1	1	1	2
	Clackamas	3	4	4	5
	Clatsop	19	17	11	12
	Columbia	12	19	21	12
	Lincoln	28	27	23	24
	Linn	26	28	24	23
	Marion	10	10	10	14
	Multnomah	21	16	14	15
	Polk	4	8	8	9
	Tillamook	23	24	27	25
	Washington	2	3	2	4
	Yamhill	18	12	6	6
WASHINGTON	Clark	8	9	8	11
	Cowlitz	34	32	33	34
	Grays Harbor	33	31	36	36
	Lewis	29	28	23	21
	Pacific	30	29	32	37
	Skamania	27	16	17	19
	Thurston	12	13	14	9
	Wahkiakum	24	38	38	23

POVERTY RATE

County poverty rates provide a picture of the percentage of a population living below the US poverty threshold. With respect to the biofuels industry, high poverty rates could be considered a liability for areas of the supply chain that require advanced skill sets, or they could be used as a factor in determining where to focus the new industry and provide new employment opportunities, especially in rural areas.

The increase in the rate of poverty in the MC2P counties in Oregon and Washington is greater than the marginal rate of population increase (1.8.11). Poverty impacts community capital and can erode the resilience and hope of communities.

Table 1.8.11. Percent of all people living in poverty In in the MC2P region of Oregon and Washington

STATE	COUNTY	2000	2010	2011
OREGON	Benton	8.79%	18.01%	20.60%
	Clackamas	6.82%	10.33%	10.90%
	Clatsop	11.77%	14.60%	18.31%
	Columbia	8.62%	13.28%	12.19%
	Lincoln	13.65%	16.80%	16.07%
	Linn	11.07%	17.91%	18.95%
	Marion	12.27%	17.45%	19.89%
	Multnomah	10.51%	17.76%	19.02%
	Polk	9.56%	15.32%	13.75%
	Tillamook	11.76%	15.29%	15.87%
	Washington	6.80%	9.61%	12.49%
	Yamhill	8.84%	13.93%	13.35%
WASHINGTON	Clark	9.19%	12.63%	13.54%
	Cowlitz	12.41%	20.30%	19.16%
	Grays Harbor	14.83%	17.23%	20.23%
	Lewis	13.46%	16.30%	14.72%
	Pacific	14.50%	18.97%	17.91%
	Skamania	11.47%	13.83%	14.78%
	Thurston	8.90%	10.61%	12.46%
	Wahkiakum	10.49%	13.60%	14.07%

1.8.2 SOCIAL ASSETS

Social capital is the value added to the region's population through networks and collaborations that create trust and shared values between individuals (Byass 2011). Every organization that creates communication links and networks within a region is adding to this asset. The interest in measuring social capital is motivated by trying to understand the relationship between the stock of social capital and effective political institutions, economic development, low crime rates, and reduced incidences of other social problems (Rupasingha, Goetz and Freshwater 2006). Ultimately, the value of social capital is its ability to contribute to more effective means of production through relationships that help to reduce transaction costs (Rupasingha et al 2006).

SOCIAL CAPITAL INDEX

The social capital index is derived from five variables: the number of social capital-generating associations per 10,000 residents (e.g., civic organizations, bowling alleys, golf courses, fitness centers, sports organizations, religious organizations, political organizations, labor organizations, business organizations and professional organizations); voter turnout in the 2005 presidential election; number of tax exempt non-profit organizations per 10,000; and participation in the decennial Census in 2000 (Rupasingha et al 2006). Table 1.8.12 shows the social capital index values for MC2P counties in Oregon and Washington. The higher the index, the higher the level of social capital. The lower the index, the lower the social capital in the county. Additional work by Goetz and Rupasingha (2006) found that counties with more-highly educated populations, greater ethnic homogeneity, more females in the labor force and that are rural have greater levels of social capital stocks than communities not meeting these characteristics. Furthermore, counties with greater numbers of residents who lived in the same county within the last five years, African-Americans and those employed in agriculture and professional activities likewise have greater stocks of social capital.

Table 1.8.12. Social Capital Index Values for MC2P Counties in Oregon and Washington

STATE	COUNTY	SOCIAL CAPITAL INDEX
OREGON	Benton	0.59
	Clackamas	-0.14
	Clatsop	1.022
	Columbia	-0.07
	Lincoln	0.35
	Linn	0.01
	Marion	-0.27
	Multnomah	0.50
	Polk	-0.14
	Tillamook	0.38
	Washington	-0.78
	Yamhill	-0.64
WASHINGTON	Clark	-1.08
	Cowlitz	-0.38
	Grays Harbor	-0.06
	Lewis	-0.41
	Pacific	1.56
	Skamania	-0.35
	Thurston	0.02
	Wahkiakum	-0.35

CRIME & POLICE OFFICERS

Crime has long been studied in association with social capital. Lower crime rates in rural areas are taken as an indicator of a high level of community trust and collaboration (Akcomak and Weel 2008). In Table 1.8.13 the shaded counties indicate that they are considered metropolitan counties. The unshaded counties indicate that these counties are considered non-metropolitan counties. Further explanation differentiating metropolitan and nonmetropolitan counties are described later in the section entitled Rural-Urban Continuum code.

Table 1.8.13. Violent Crime & Full-Time Enforcement Officer data for MC2P counties Oregon and Washington (2011)

STATE	COUNTY	POPULATION	VIOLENT CRIME	FULL TIME LAW ENFORCEMENT OFFICERS	FULL TIME OFFICERS: NUMBER OF PEOPLE
OREGON	Benton	85,928	20	62	1:1,386
	Clackamas	380,207	22	218	1:1,747
	Clatsop	37,153	7	26	1:1,429
	Columbia	49,402	Not Reported	35	1:1,411
	Lincoln	45,933	52	27	1:1,701
	Linn	118,122	19	75	1:1,575
	Marion	318,872	70	85	1:3,751
	Multnomah	748,031	45	105	1:7,124
	Polk	75,993	30	45	1:1,688
	Tillamook	25,403	15	56	1:454
	Washington	540,410	266	240	1:2,252
	Yamhill	100,000	31	45	1:2,222
WASHINGTON	Clark	433,418	248	132	1:3,283
	Cowlitz	102,478	78	43	1:2,383
	Grays Harbor	72,546	24	39	1:1,860
	Lewis	75,901	58	39	1:1,946
	Pacific	20,930	13	18	1:1,163
	Skamania	11,137	10	22	1:506
	Thurston	256,591	294	85	1:3,019
	Wahkiakum	3,991	6	7	1:570

COLLABORATIVE GROUPS

Organizations and collaborative groups bring together diverse stakeholders from a spectrum of federal, state and local government agencies to environmental groups, private companies, private landowners and the interested public. The goal of the common work is to share knowledge and resources to achieve desired outcomes for public lands and communities within statutory and regulatory frameworks (US BLM 2007). Tables 1.8.14 through 1.8.16 list different organizations working in Washington and Oregon relevant to the NARA project.

Table 1.8.14. Forest Landowner, Forestry and Biomass-related Organization

ORGANIZATIONS	WEBSITE
OREGON	
Oregon Forest Biomass Working Group	www.oregon.gov/energy
Oregon Small Woodlands Association	www.oswa.org
Southern Oregon Clean Energy Alliance	www.orsolutions.org
Associated Oregon Loggers	www.oregonloggers.org
Oregon Forest Industries Council	www.ofic.com
Central Oregon Intergovernmental Council	www.coic2.org
WASHINGTON	
Washington Farm Forestry Association	www.wafarmforestry.com
Washington Tree Farm Program	www.watreefarm.org
Washington Forest Protection Association	www.wfpa.org
Washington Contract Loggers Association	www.loggers.com
Washington State Urban and Community Forestry Council	www.dnr.wa.gov
Washington Association of Land Trusts	www.walandtrusts.org

Table 1.8.15. Community-based Conservation and Education

ORGANIZATIONS	WEBSITE
OREGON	
Applegate Partnership	www.applegatepartnership.org
Lake County Resources Initiative	www.lcri.org
Klamath-Siskiyou Wildlands Center	www.kswild.org
Lakeview Sustained Yield Unit	www.fs.usda.gov
WASHINGTON	
Olympic Forest Coalition	www.olympicforest.org
Northeast Washington Forestry Coalition	www.newforestrycoalition.org
North Cascades Institute	www.ncascades.org
Olympic Park Institute	www.naturebridge.org
Puget Sound Partnership	www.psp.wa.gov

Table 1.8.16. Nonprofit Organizations

ORGANIZATIONS	WEBSITE
OREGON	
Wallowa Resources	www.wallowaresources.org
Sustainable Northwest	www.sustainablenorthwest.org
Ecotrust	www.ecotrust.org
The Nature Conservancy of Oregon	www.nature.org
WASHINGTON	
Washington Environmental Council	www.wecprotects.org
Climate Solutions	www.climatesolutions.org
The Lands Council	www.landscouncil.org
Kettle Range Conservation Group	www.kettlerange.org
The Nature Conservancy	www.nature.org
North Olympic Land Trust	www.northolympiclandtrust.org
Olympic Forest Coalition	www.olympicforest.org
Air & Waste Management Association (PNW section)	www.pnwis.org
Conservation Northwest	www.conservationnw.org
Pacific Northwest Pollution Prevention Resource Center	www.pprc.org
American Water Resources Association - WA Chapter	www.waawra.org
Center for Environmental Policy & Law	www.celp.org
Inland Northwest Wildlife Council	www.wildlifecouncil.com
Network for Business Innovation & Sustainability	www.nbis.org
Northwest Energy Coalition	www.nwenergy.org
Washington Clean Technology Alliance	www.wacleantech.org
Environmental Coalition of South Seattle	www.ecoss.org

1.8.3 CULTURAL ASSETS

Cultural assets include shared experiences through traditions, values, heritage and history. Public perceptions, especially as they relate to wood-based biofuels production, are important to take into consideration. Cultural assets also account for the existence of creative industries and a creative class in the region.

PUBLIC PERCEPTIONS

Public perceptions are important to understand for a project using woody biomass for biofuels because of the differing views about key aspects of harvesting woody biomass, some of which will come from public lands. Furthermore, using woody biomass for energy is generally a new concept for the public (Oregon Forest Resource Institute 2006). If the public does not fully understand the purpose and management activities affiliated with a biomass removal project, it is less likely to be socially acceptable (Oregon Forest Resource Institute 2006).

It is important to understand the public's perceptions regarding forest health, forest management practices, utilization of woody biomass, and renewable energy. Both Oregon and Washington have many communities with a long history in the timber industry, and are seeking ways to retain their forest-based economy. There are several communities in the two states that have county-wide biomass working groups, and small-scale bioenergy facilities that have strong community support.

According to research conducted on public perceptions of woody biomass utilization, many citizens in both Oregon and Washington support a balanced approach to forest management where goals for both sustainable ecosystems and economic vitality are met (Oregon Forest Resource Institute 2006).

With respect to woody biomass utilization, there is guarded support for utilizing woody biomass. The support is tied to three motivations: the need to the need to reduce fire danger caused by high densities of small-diameter trees, the opportunity for rural economic development, and the need to increase use of renewable energy to reduce dependence on fossil fuels and lower CO_2 emissions (Oregon Forest Resource Institute 2006). Conservation groups consider biomass utilization as a way to restore forest health, and should be associated with restoration, and not to promote more aggressive forest harvesting activities. Many of these groups see woody biomass removal as a short-term strategy to transition forests back to where a natural fire regime can be re-established, and not a long-term, sustainable option for energy feedstock (Oregon Forest Resource Institute 2006).

CREATIVE VITALITY INDEX

The Creative Vitality Index (CVI) studies the impact that the arts have on the cultural health of the region. The metrics used for analysis are defined as all profit and non-profit arts-related creative enterprises and the key support and service industries that sustain them (Irby 2010). The Index was created in the state of Washington by art leaders to understand the contribution the art community makes to the cultural capital of a region (Herbert and Irby 2010). We include the CVI in our datasets as one measure of cultural capital. McGranahan and Wojan (2007) theorize that all towns need to attract a fraction of the creative population to be competitive in today's economy.

Using a national benchmark of 1.0, we can compare counties within the MC2P to each other, as well as contrast the scores with the United States as a whole. There are two major building blocks to the index. The first, called the 'Community Arts Participation Sub-Index,' tracks changes through selected arts-related businesses. The second, the 'Occupational Index of the Arts,' quantifies per capita clusters of arts-related employment in selected occupations (Herbert and Irby 2010). The nationwide aggregate Index value is "1," thus Index values greater than one reflect a creative economy more vibrant than the national average. The CVI for MC2P counties are shown in Table 1.8.17.

Table 1.8.17. Creative Vitality Index for MC2P counties in Oregon and Washington

STATE	COUNTY	SOCIAL CAPITAL INDEX
OREGON	Oregon as a whole	1.018
	Benton	1.135
	Clackamas	0.802
	Clatsop	1.151
	Columbia	0.287
	Lincoln	0.917
	Linn	0.308
	Marion	0.629
	Multnomah	2.25
	Polk	0.237
	Tillamook	0.794
	Washington	0.677
	Yamhill	0.431
WASHINGTON	Washington as a whole	1.041
	Clark	0.575
	Cowlitz	0.301
	Grays Harbor	0.303
	Lewis	0.317
	Pacific	0.355
	Skamania	0.252
	Thurston	0.762
	Wahkiakum	0.272

MUSEUMS

Both Oregon and Washington have a rich cultural environment, with several museum and opportunities to learn about state, regional and local history. Table 1.8.18 shows the number and type of museums in the MC2P counties relevant to the NARA project, including local history, timber and transportation related.

Table 1.8.18. Oregon and Washington MC2P counties' project-relevant museums

STATE	COUNTY	MUSEUMS	SOCIAL CAPITAL INDEX
OREGON	Benton	1	History-local, natural
	Clackamas	8	History-local, railroad, state
	Clatsop	7	Fire fighting; History-local, natural; Maritime; Transportation
	Columbia	3	History-local
	Lincoln	10	Ethnic- Native American; History- local, natural; Maritime; Transportation- railroad
	Linn	6	History- local
	Marion	13	History- local; Transportation- railroad, machinery;
	Multnomah	13	Ethnic- Jewish, Japanese; History- local, farm implements; Industry- timber/ forest products; Maritime; Police; Science; Transportation- railroad
	Polk	3	History- local, natural
	Tillamook	3	Aviation; History- local; Maritime
	Washington	4	Aviation; Geology; History- local
	Yamhill	3	Aviation; History- local
WASHINGTON	Clark	3	Aviation; History- local
	Cowlitz	5	Ethnic- Native American; History- local, natural
	Grays Harbor	4	History- local, natural; Maritime
	Lewis	1	History- local
	Pacific	6	History- local; Maritime; Transportation
	Thurston	2	Aviation; History
	Wahkiakum	1	History- local

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1.9.0 APPENDIX A4: FINANCIAL CAPITAL

Access to financial capital impacts the MC2P's potential for woody biomass extraction, conversion and use. Variables included in this section include tax rates and mill levies at the county and state level, state and federal funds coming into counties, income/wages in the region, as well as support through Small Business Development Centers (SBDC's) and other supporting information relevant to supporting a biofuels industry.

1.9.1 COST OF DOING BUSINESS

TAX RATES/MILL LEVIES

Tax rates and mill levies vary by county in the states of Oregon and Washington. County specific tax rates and mill levies have not been collected at this time. They will be collected during fall 2013. The tax assessors for each county will be able to provide details regarding this information.

UTILITY RATES BY PROVIDER

Both Oregon and Washington have websites with complete listings of electric utility providers (Oregon Department of Energy, Washington State Department of Labor and Industries). There are a variety of types of electric utility providers, including investor owned companies, cooperative owned companies, people's utility districts (PUD), and municipal electric utilities. The cost per kilowatt hour (kwh) is specific to each company as is the time of day, season of the year, and useage increment.

1.9.2 STATE AND FEDERAL FUNDING SOURCES

STATE AGENCY FUNDING SOURCES

Listed below are some government agencies which may provide funding opportunities to support and ensure the expanding production of advanced biofuels.

OREGON:

Community Renewable Energy Feasibility Fund Program

- The Community Renewable Energy Feasibility Fund, or CR EFF, is a grants program that funds feasibility studies for renewable energy, heat, and fuel projects in Oregon. All grants have been awarded as of February 2011. There will be no more awards made until projects are completed and funds are repaid. A list of funded projects is available on the Oregon Department of Energy website (Oregon Department of Energy 2013a).

Renewable Energy Development Grant Program

- The Oregon Department of Energy (ODOE) provides competitive grants for renewable energy production systems. The competitive review system applies to renewable energy production systems that use biomass, solar, geothermal, hydroelectric, wind, landfill gas, biogas or wave, tidal or ocean thermal energy technology to produce electrical energy (ORS 469B.250 through 469B.265). In 2013, there is $1.5 million in grant funds available (Oregon Department of Energy 2013b).

Wood Energy Cluster Project

- Nation's first grant to support developing biomass energy cluster projects that use materials from forest restoration treatments to provide heat and power to schools, hospitals, commercial buildings and mills (Oregon Department of Energy 2012).

LOANS:

State Energy Loan Program

- Offers low-interest loans for qualified projects. Eligible alternative fuel projects include fuel production facilities, dedicated feedstock production, fueling infrastructure, and fleet vehicles. Loan recipients must complete a loan application and pay a loan application fee (Oregon Revised Statutes 470) (Alternative Fuels Data Center 2013).

WASHINGTON:

Energy Freedom Program, Department of Commerce

- **Energy Freedom Account** under Energy Freedom Program provides state funds, primarily through low-interest loans, to public entities other than state agencies for a wide range of renewable energy projects, including those that convert farm products, wastes, cellulose or biogas directly into electricity, biofuel and other coproducts. Expires June 30, 2016. (RCW 43.325.020)
- **Energy Recovery Act Accoun**t under Energy Freedom Program directs federal funds to a wide range of renewable energy projects, including bioenergy. Unlike other Energy Freedom Program accounts, state agencies, nonprofit corporations and for-profit business are eligible to apply. Expires June 30, 2016. (RCW 43.325.020)
- **Green Energy Incentive Account** under Energy Freedom Program provides state funds to public entities other that state agencies for development of biofuels refueling infrastructure along interstate corridors. Expires June 30, 2016. (RCW 43.325.040)

FEDERAL PAYMENT IN LIEU OF TAXES FUND EXPENDITURES

PILT expenditures are Federal payments to local governments that help offset losses in property taxes due to non-taxable Federal lands within their boundaries. The formula used to compute the payments is contained in the PILT Act and is based on population, receipt sharing payments, and the amount of Federal land within an affected county. The PILT law recognizes that the inability of local governments to collect property taxes on Federally-owned land can create a financial impact. The payments are made annually for tax-exempt Federal lands administered by the BLM, the National Park Service, the U.S. Fish and Wildlife Service (all agencies of the Interior Department), the U.S. Forest Service (part of the U.S. Department of Agriculture), and for Federal water projects and some military installations (US Department of the Interior 2013). Table 1.9.1 shows the total number of acres of federal land and federal PILT payments for MC2P counties in Oregon and Washington.

SMALL BUSINESS DEVELOPMENT CENTER OFFICES, VENTURE CAPITAL

Access to business financing, especially for small businesses and entrepreneurial start-ups, is an important element in community economic development. Both Washington and Oregon have several local, rural/urban, regional and statewide programs to support community economic development. The following is a list of some of the programs and organizations available:

OREGON:

- Oregon Built Environment and Sustainable Technologies (BEST)
- Sustainable Valley Technology Group
- Southern Oregon Angel Investment Network
- Oregon Small Business Development Center Network

WASHINGTON:

- Innovate Washington
- Washington State Small Business Development Center

Table 1.9.1. Payment in Lieu of Taxes expenditures for MC2P counties in Oregon and Washington

STATE	COUNTY	TOTAL ACRES OF FEDERAL LAND (2000)	PAYMENT (2000)	TOTAL ACRES OF FEDERAL LAND (2013)	PAYMENT (2000)
OREGON	Benton	20,327	$2,144	73,460	$94,905
	Clackamas	520,784	$54,924	619,770	$404,022
	Clatsop	359	$0	1,504	$12,416
	Columbia	1	$0	10,961	$26,397
	Lincoln	183,112	$19,312	209,954	$69,672
	Linn	476,022	$50,203	561,806	$186,431
	Marion	203,654	$21,478	228,566	$75,848
	Multnomah	75,679	$7,981	80,345	$26,662
	Polk	435	$0	42,087	$97,455
	Tillamook	92,965	$9,804	131,255	$43,556
	Washington	2,606	$1,621	13,984	$33,675
	Yamhill	25,790	$2,720	58,793	$19,510
WASHINGTON	Clark	717	$0	126	$0
	Cowlitz	34,037	$3,590	35,085	$11,643
	Grays Harbor	146,204	$28,841	140,776	$158,833
	Lewis	474,840	$50,078	474,840	$157,572
	Pacific	2,433	$1,919	2,587	$6,230
	Skamania	846,998	$89,328	848,290	$281,499
	Thurston	623	$0	623	$909
	Wahkiakum	1	$0	1	$0

1.9.3 ECONOMIC DEVELOPMENT LANDSCAPE

Oregon and Washington have economic development districts funded by the U.S. Department of Commerce Economic Development Administration (U.S. EDA) that assist with many of the loans and incentive programs listed above.

Oregon is divided into twelve Economic Development Districts (EDD s) (Table 1.9.2). They cover the State's 36 counties, 297 municipalities (which include cities, towns and tribes) and 3.7 million residents. This statewide network of Economic Development Districts is part of a broader national network of 380 economic development districts designated and funded by the US Economic Development Administration (OEDD 2013).

The Washington network of EDD s covers 31 of the state's 39 counties (Table 1.9.3). Whatcom, Skagit, San Juan, Island, Thurston, and Walla Walla counties do not belong to an EDD and Clark County belongs to the Oregon-based Portland Regional Partners Council of Economic Development. Spokane County supports Greater Spokane, Inc., which receives EDA planning funding but is not recognized as an official EDD because it is a single county organization. The Washington EDD s are a network recognized by federal entities to provide community and economic development support throughout the State of Washington (WAEDD SS A 2011).

More information regarding these organizations is available for Oregon at the Oregon Economic Development Districts and Washington at State of Washington Economic Development Association.

Table 1.9.2. Oregon's Regional Economic Development Districts (EDD s)

OREGON EDDS	OFFICE LOCATION
Cascades West Economic Development District	Benton County
Portland Regional Partners/Portland-Vancouver EDD	Clackamas County
Columbia-Pacific Economic Development District	Clatsop County
Columbia-Pacific Economic Development District	Columbia County
Cascades West Economic Development District	Lincoln County
Cascades West Economic Development District	Linn County
Mid-Willamette Valley Council of Governments	Marion County
Portland Regional Partners/Portland-Vancouver EDD	Multnomah County
Mid-Willamette Valley Council of Governments	Polk County
Columbia-Pacific Economic Development District	Tillamook County
Columbia-Pacific EDD / Portland-Vancouver	EDD Washington County
Mid-Willamette Valley Council of Governments	Yamhill County

Table 1.9.3. Washington Regional Economic Development Districts (EDD 's)

WASHINGTON EDDS	OFFICE LOCATION
Benton-Franklin Council of Governments	Richland, WA
Big Bend Economic Development Council	Moses Lake, WA
Central Puget Sound Economic Development District	Seattle, WA
Columbia-Pacific Resource Conservation and Economic Development District	Montesano, WA
Cowlitz-Wahkiakum Council of Governments	Kelso, WA
Mid-Columbia Economic Development District	The Dalles, OR
Southeast Washington Economic Development Association	Clarkston, WA
Peninsula Development District	Port Angeles, WA
Portland Regional Partners	Portland, OR
Tri County Economic Development District	Colville, WA

1.9.4 COST OF LIVING

The cost of living index has been developed by the Council for Community and Economic Research. The COL Index compares the cost of living in counties across the US, compared to the US average ranked as 100 for purposes of comparison. The variables used to create the COL Index include: county population, density of people/square mile, personal income per capita, rate of population growth, average price for electricity, average price of natural gas, and government costs per unit of service (Council for Community and Economic Research 2013). Table 1.9.4 shows the COL Index values for MC2P counties in Oregon and Washington.

This index estimates cost of living based on six variables. For more information, see http://www.coli.org/CountyLevelIndex.asp.

Table 1.9.4. Cost of LIving Index for MC2P counties in Oregon and Washington

STATE	COUNTY	2012
OREGON	Benton	91.3
	Clackamas	98.2
	Clatsop	89.5
	Columbia	95.1
	Lincoln	91.2
	Linn	85.9
	Marion	95.6
	Multnomah	98.5
	Polk	94.0
	Tillamook	89.6
	Washington	97.1
	Yamhill	95.5
WASHINGTON	Clark	95.1
	Cowlitz	85.4
	Grays Harbor	85.1
	Lewis	85.8
	Pacific	85.6
	Skamania	88.7
	Thurston	105.7
	Wahkiakum	87.0

1.9.5 REFERENCES

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1.10.0 APPENDIX A5: POLICY CAPITAL

Policy capital refers to the regulatory frameworks at all levels of government, as well as incentives and programs relevant to biomass extraction and processing.

1.10.1 LAND OWNERSHIP

Of all Oregon's 63 million acres, near half - some 30 million acres are forested. 18 million acres of Oregon's forestland have come under federal ownership (60%). Other detailed ownerships percentages are shown in Figure 1.10.1 (Oregon Forest Resources Institute, 2010).

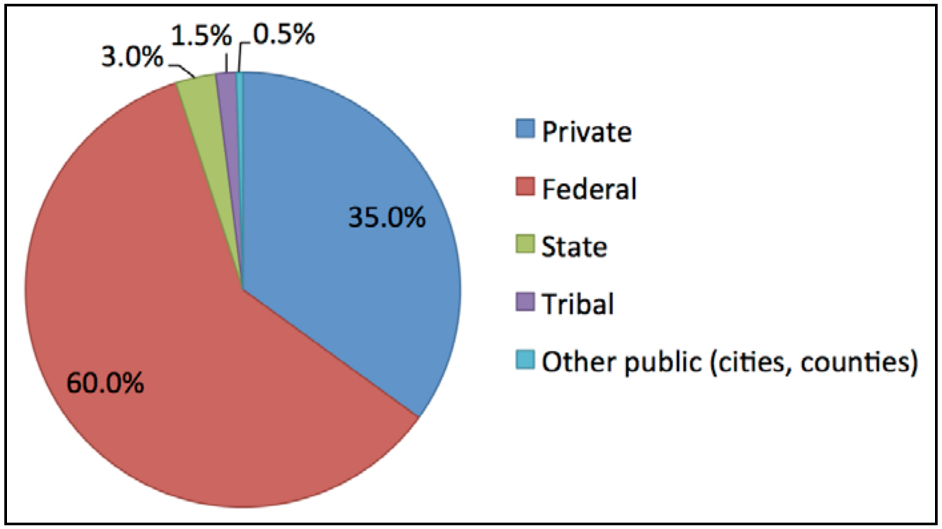

Figure 1.10.1. Percentages of Forest & Non Timber Land Ownership in Oregon

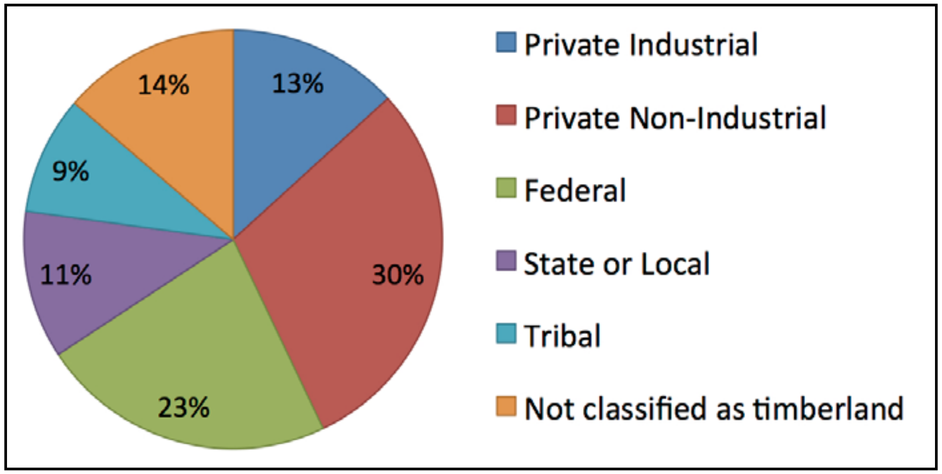

Figure 1.10.2. Percentages of Forest & Non Timber Land Ownership in Washington

Washington State has 21.9 million acres of forestlands with diverse ownership including: private industrial forest owners, private non-industrial forest owners, Federal forests, State/local forests, and tribal forests (Figure A5.2) (Washington DNR 2007).

1.10.2 LAND MANAGEMENT

Land management agencies play an important role in planning and supervising land use. Major agencies in Washington and Oregon are summarized below.

AGENCIES BASED IN OREGON

- Bureau of Land Management (BLM)
- USDA Forest Service
  - USDA Forest Service Pacific Northwest Research Station
  - USDA Forest Service State and Private Forestry
  - Corvallis Forestry Sciences Laboratory
- Bureau of Indian Affairs
- Oregon Department of Forestry
- Oregon Department of Energy
- Oregon Department of Environmental Quality
- Oregon Forest Resources Institute
- Business Oregon
- Oregon Built Environment and Sustainable Technologies (BEST)

AGENCIES BASED IN WASHINGTON

- Bureau Land Management (BLM)
  - Spokane office
  - Wenatchee office
- USDA Forest Service
  - Olympia Forestry Sciences Laboratory
  - Pacific Wildland Fire Sciences Laboratory
  - Wenatchee Forestry Sciences Laboratory
- WA Department of Natural Resources (DNR)
  - Aquatic Resources
  - Engineering & General Services
  - Forest Practices
  - Forest Resources & Conservation
  - Geology & Earth Resources
  - Resource Protection
- Washington Department of Commerce
  - State Bioenergy Coordinator
- Governor's Office of Indian Affairs (Northwest Regional Office)

1.10.3 NATIVE AMERICAN TRIBES IN WA AND OR

OREGON TRIBES

Burns Paiute Tribe - Located in Burns, OR. Departments include a natural resource department.

Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians - Located in Coos, OR. Departments include natural resource and planning.

Confederated Tribes of Grand Ronde - Located in Grand Ronde, OR. The tribe has a Natural Resource and a Land and Culture department.

Confederated Tribes of Siltez Indians - Located in Siltez, OR. Departments include a planning, as well as a forestry department that is within the umbrella of a natural resource department.

Confederated Tribes of the Umatilla Indian Reservation - Located in Pendleton, OR. The tribes have a natural resource department with a main interest in fisheries, etc.

Confederated Tribes of Warm Springs - Located in Warm Springs, OR. The tribes have a strong natural resource department, as well as a business and economic development unit.

Coquille Indian Tribe - Located in North Bend, OR. The tribe has many departments including Land, Resources and Environmental Services, Planning and Community Services.

Cow Creek Band of Umpqua Tribe of Indians - Located in Roseburg, OR. The tribe has a natural Resource Department with a history of working with other government organizations such as Bureau of Land Management, etc.

Klamath Tribes - Located in Chiloquin, OR. The tribes employ a number of people in several departments, two of which areas of interest are a natural resource department and a planning and enterprise department. The planning and enterprise department works to get people’s ideas into a working project.

WASHINGTON TRIBES

The Chehalis Tribe - Located in Oakville, OR. The natural resource department of this tribe focuses on fisheries, reality, and air quality.

The Confederated Tribes of Colville - Located in Keller, WA. The tribes have an extensive list of departments including Mont Tolman Fire Center, Parks and Recreation Department, and a Planning Department.

Makah Tribe - Located in Neah Bay, WA. The tribe is an active member of the Intertribal Forest Council, with a robust forest enterprise.

Quinault Indian Nation - Located in Taholah, WA. Department chairpersons exist for forestry, grants, natural resources, and resource protection.

Shoalwater Bay Tribe - Located in Tokeland, WA. Under the umbrella of the environmental department is a Geographic Information Systems (GIS) unit, forest practices/ management program, and a renewable energy program.

Spokane Tribe of Indians - Wellpinit, WA. The tribe has a program in planning and economic development, and works with the state Department of Natural Resources (DNR).

Yakama Nation - Located in Toppenish, WA. A number of departments of interest are part of the Yakama Nation. Some of the departments include the following: department of natural resources, economic development, environmental management program, forest development, geographic information systems, engineering program department of natural resources.

1.10.4 SUBSIDIES/INCENTIVES

OREGON

Listed below are a few of the incentives related to alternative fuels for Oregon (Database of State Incentives for Renewables & Efficiency 2013);

TAX INCENTIVES FOR COLLECTION & PRODUCTION

- **Biomass Producer or Collector Tax Credit:** The State of Oregon provides tax credits for the production, collection and transportation of biomass that is used for energy production. To be eligible for this credit, an applicant must be an agricultural producer or biomass collector and the biomass material must be sourced from within Oregon. In addition, the biomass must be used as biofuel or to produce biofuel in Oregon (Oregon Department of Energy 2013a).
- **Tax Credit for Renewable Energy Equipment Manufacturers:** Business owners of facilities used to manufacture equipment, machinery or other products that will be used exclusively for renewable energy resource generation/harvesting may be eligible for a state tax credit. The tax credit is 50% of eligible facility costs (Business Oregon 2013).
- **Biofuels Production Property Tax Exemption:** Property used to produce biofuels may be eligible for a property tax exemption if it is located in a designated Renewable Energy Development Zone. The Oregon Business Development Department must receive and approve an application from a qualified rural area to designate the area as a Rural Renewable Energy Development Zone (Oregon Revised Statutes 285C.350 through 285C.370) (Alternative Fuels Data Center (AFDC) 2013a).

WASHINGTON

Listed below are incentives, laws, and regulations related to alternative fuels for Washington (AFDC 2013b).

TAX INCENTIVES FOR PRODUCTION

- Reduced B&O rate is provided for manufacture of wood biomass fuel. (RCW 82.04.260(1)f)
- A B&O tax credit of $5/green ton is provided for forest-derived biomass sold or used for production of power, steam, heat or biofuel. Expires June 30, 2015. (RCW 82.04.4494)
- Cogeneration equipment integrated into a manufacturing site is exempt from retail sales and use taxes. (RCW 82.08.02565, 82.12.02565)
- Equipment, labor and associated services for power production of at least 1 kW from various renewable energy sources, including biomass energy, anaerobic digestion and landfill gas, are exempt from 75% of retail sales and use taxes. Expires January 1, 2020. (RCW 82.08.962, 82.12.962)
- Anaerobic digester construction and operation, and related services or components, are exempt from retail sales and use taxes. More than half of digester feedstock must be livestock manure. (RCW 82.08.900, 82.12.900)
- Land, buildings and equipment used for biodiesel feedstocks, or biodiesel, alcohol fuel or wood biomass fuel production are exempt from property and leasehold taxes for six years following date facility becomes operational. Exemption is not renewable. Claims must be filed by December 31, 2015. (RCW 82.29A.135, 84.36.635, 84.36.640)
- Sale and use of hog fuel or forest-derived biomass for production of power, steam, heat or biofuel is exempt from retail sales and use taxes. Expires June 30, 2024. (RCW 82.08.956, 82.08.957, 82.12.956, 82.12.957)
- Sale and use of waste vegetable oil for production of biodiesel for personal use is exempt from retail sales and use taxes. (RCW 82.08.0205, 82.12.0205)
- Producers of grid power from anaerobic digesters may be eligible for .15¢/ kWh incentive payments of up to $5,000/year from their intertied utility. Expires June 30, 2020. (RCW 82.16.120)

TAX INCENTIVES FOR DISTRIBUTION & USE

- New passenger cars, light duty trucks, and medium duty passenger vehicles powered exclusively by a clean alternative fuel (natural gas, propane, hydrogen or electricity) are exempt from retail sales and use tax. Vehicles less than two years old with no more than 30,000 miles, purchased in fleets of five or more following conversion to clean alternative fuel, are also eligible. (RCW 82.08.809, 82.12.809)
- Sales to and use of non-highway biodiesel and biodiesel blends by farm fuel users are exempt from retail sales and use taxes. Fuel used for space or water heating for human habitation is not included. (RCW 82.08.865, 82.12.865)
- Sales and use of equipment, and related services or components, used for retail sale of E85 and biodiesel blends of B20 or higher are exempt from retail sales and use taxes. Sales of fuel delivery vehicles, and related services or components, are exempt if at least 75% of the fuel is E85 or biodiesel blend of B20 or higher. Expires July 1, 2015. (RCW 82.08.955, 82.12.955)
- Retailers and distributors of biodiesel and E85 are eligible for a B&O tax deduction. Expires July 1, 2015. (RCW 82.04.4334)
- Fuel used directly in the extraction or manufacturing of the fuel is exempt from use tax. (RCW 82.12.0263)

1.10.5 POLICIES (LOCAL, STATE AND FEDERAL)

This section provides an overview of policies related to production, permitting, distribution and use of biofuels. Additional policies can be found at Alternative Fuels Data Center.

OREGON POLICIES

- Renewable Portfolio Standard: Originally enacted in 2007 through Senate Bill 838, the Oregon Renewable Portfolio Standard (RPS) requires Oregon utilities to deliver a percentage of their electricity from renewable resources by 2025. Eligible resources include biomass, geothermal, hydropower, ocean thermal, solar, tidal, wave, wind, and hydrogen (if produced from any of these sources) (Oregon Department of Energy 2013b).

WASHINGTON POLICIES

PUBLIC SECTOR PRODUCTION POLICIES

- Conservation districts and public development authorities may contract for crops, produce, sell and distribute biodiesel produced from instate feedstocks, and cellulosic ethanol. Municipal utilities and public utility districts may do the same, and use these fuels to generate power (RCW 35.21.465, 35.92.440, 54.04.190, 89.08.570).
- Counties may construct and own biopower facilities so long as a Public Utility District in the county owns or operates a combined-cycle natural gas turbine of at least 240 MW. Most feedstocks are allowed, except for biosolids, yard and food waste, and demolition and construction debris (RCW 36.140.010).
- Counties may enact "energy overlay zones" to facilitate siting of renewable energy projects based on feedstock availability, infrastructure and environmental impacts. Eligible technologies include biomass energy, mill waste, and landfill and wastewater treatment gas (RCW 36.70C.020, 36.70C.130).

EXPEDITED PERMITTING

- Anaerobic digesters are exempt from solid waste permitting if feedstocks are at least 50% livestock manure and no more than 30% organic waste, including yard waste and pre-consumer food waste, but not material collected through municipal solid waste programs. Certain design and operational standards must also be met (RCW 70.95.330).
- Anaerobic digester generators in operation since 2008 rated between 750 kW and 1 MW, located on agricultural lands of long-term significance, and meeting solid waste permit exemption criteria can defer air quality permitting related to sulfur emissions until December 31, 2016 (RCW 70.94.302).
- Office of Regulatory Assistance may develop a multiagency team to coordinate permitting and regulatory decision-making, beginning in the Puget Sound area. Energy projects are considered a priority (RCW 43.42.092).
- Aviation biofuel production facilities are deemed "projects of statewide significance" for the purpose of expedited permitting, and are eligible to seek bond funds through the Housing Finance Commission (RCW 43.157.010, 43.180.265).
- Expedited permitting of biofuel refineries capable of processing more than 25,000 barrels per day is available through the Energy Facility Site Evaluation Council (RCW 80.50.075).

PUBLIC SECTOR DISTRIBUTION & USE POLICIES

- Effective June 1, 2006, agencies complying with EPA's ultra-low sulfur diesel mandate must use at least 2% biodiesel as a lubricity additive, provided the use is warranted and biodiesel is comparable in performance and cost with other additives (RCW 43.19.642).
- Agencies using biodiesel shall file biannual reports with Department of Enterprise Services documenting fuel use and describing how any problems were resolved (RCW 43.19.642).
- Effective June 1, 2009, state agencies as a whole are required to use at least 20% biodiesel to operate diesel-powered vessels, vehicles and construction equipment. For the 2013-15 biennia, State Ferries is required to use at least 5% biodiesel so long as the price does not exceed diesel by more than 5% (RCW 43.19.642).
- Department of Enterprise Services must assist agencies seeking to meet their biodiesel use requirements by coordinating purchase and delivery, and may use long-term contracts of up to 10 years when purchasing from in-state producers using predominantly in-state feedstocks (RCW 43.19.646).
- Department of Enterprise Services may combine the needs of local governments, including ports, special districts, school districts and municipal corporations, and contract in advance with public or private producers, suppliers or other parties for the purchase of biofuels and biofuel blends (RCW 43.19.647).
- Beginning June 16, 2010, state agencies must purchase high efficiency petroleum-fueled vehicles, or ultra-low carbon vehicles at least 90% fueled by CNG, hydrogen, biogas or electricity (RCW 43.41.130).
- To the extent practicable, state agencies are to satisfy 40% of their fuel needs with electricity or biofuel by June 1, 2013. By June 1, 2015, 100% of state agency fuel needs are to be met by electricity or biofuel, to the extent practicable. By June 1, 2018, all local governments are to satisfy 100% of their fuel needs with electricity or biofuel, to the extent practicable. Transit agencies using CNG on June 1, 2018, are exempt. CNG, LNG or propane may be substituted if the Department of Commerce determines that electricity and biofuel are not reasonably available (RCW 43.19.648, WAC 194-28).

POWER SUPPLY REQUIREMENTS

- Electric utilities serving more than 25,000 customers are required to meet increasing targets for conservation and renewable energy use. Biennial conservation targets can include high-efficiency cogeneration. Renewable energy targets are 3% of load by 2012, 9% of load by 2016 and 15% of load by 2020. Qualifying energy resources include electrical generation from biogas, biodiesel, dedicated energy crops and a broad range of solid organic fuels used in facilities operational as of April 1, 1999. Electricity from biomass energy facilities in operation prior that date may qualify under certain conditions. Distributed generation of up to 5 MW offers twice the compliance credits. (RCW 19.285.040)
- Electric utilities are required to net meter up to 100 kW of electrical generation using biogas from animal waste. (RCW 80.60.20)
- Electric utilities are required to offer voluntary green power purchase programs to their customers. Qualifying energy resources include electricity and thermal energy from biogas, solid organic fuels and dedicated energy crops. (RCW 19.29A.090)

FUEL CONTENT REQUIREMENTS

- At least 2% of the total annual diesel sales must be biodiesel or renewable diesel by November 30, 2008. At least 5% must be biodiesel or renewable diesel when Agriculture determines instate oil seed crushing capacity and feedstocks can

satisfy a 3% requirement. (RCW 19.112.110)
- At least 2% of total gasoline sales, measured on a quarterly basis, must be ethanol by December 1, 2008. Ethanol content between 2% and at least 10% may be required if the Department of Ecology determines it will not jeopardize air quality standards for ozone pollution, and Agriculture determines instate raw materials are available to support economical production (RCW 19.112.120).
- Content requirements will be repealed when the diesel supply is at least 10% biodiesel made predominantly from instate feedstocks, and the gasoline supply is at least 20% ethanol made predominantly from instate feedstocks, without jeopardizing air quality standards for ozone pollution (RCW 19.112.170).

TWO BILLS PASSED IN THE 2013 WASHINGTON STATE LEGISLATIVE SESSION
- HB 1154: Separates carbon credits and renewable energy credits for digesters.
- SB 5099: Replaces local government rulemaking on vehicle electrification and biofuel use to the "extent practicable" with guidance from Commerce and practicability determination by local government, and exempts emergency response vehicles, engine retrofits that void warranties, and conventional equipment and vehicles owned prior to 2018.

1.10.6 COUNTY POLICY TYPE CODES

The USDA Economic Research Service has developed a series of mutually exclusive economic dependence categories that categorize counties in the US. The ERS looked at labor and proprietors' earnings by place of work are the basis for the economic dependence categories. Table 1.10.1 shows the economic dependence codes for counties in the MC2P.

The six categories of economic dependence are:
1=Farming-dependent
2=Mining-dependent
3=Manufacturing-dependent
4=Federal/State government-dependent
5=Services-dependent
6=Nonspecialized.

Selection of the industry type classifications was guided by regional economics theory. "Farming, mining, manufacturing, and Federal/State government industries produce goods or services for export outside the local economy. Exporting industries are termed 'basic' in regional economics and are often shown to be sources of larger growth in local economies (or declines during economic downturns) than industries that produce for the local market. Service industries may either produce for the local or export economies. ERS set a high service earnings threshold to help assure that the counties we classified as services-dependent do have service industries that serve more than the local population" (USDA ERS 2004).

Table 1.10.1. County Typology Codes in the MC2P counties in Oregon and Washington

STATE	COUNTY	2004
OREGON	Benton	3
	Clackamas	6
	Clatsop	6
	Columbia	3
	Lincoln	6
	Linn	3
	Marion	4
	Multnomah	5
	Polk	6
	Tillamook	6
	Washington	3
	Yamhill	6
WASHINGTON	Clark	6
	Cowlitz	3
	Grays Harbor	6
	Lewis	6
	Pacific	6
	Skamania	4
	Thurston	4
	Wahkiakum	3

1.10.7 RURAL/URBAN CONTINUUM CODE

The USDA Economic Research Service has developed the rural-urban continuum, which consists of 9 classifications that distinguish metropolitan counties by the population size of their metro area, and non-metropolitan counties by degree of urbanization and whether they are adjacent to a metro area. Each county in the U.S. is assigned one of the 9 codes. Table 1.10.2 shows the where the MC2P counties in Oregon and Washington fall on the rural-urban continuum.

Table 1.10.2. Rural-Urban Continuum Codes for MC2P counties in Oregon and Washington

Code	Description	Number of Counties per category	County, State (Total Population in 2013)
Metropolitan Counties			
1	Counties in metro areas of 1 million population or more	Oregon- 5 Washington- 2	Clackamas, OR (375,992) Columbia, OR (49,351) Multnomah, OR (735, 334) Washington, OR (529,710) Yamhill, OR (99,193) Clark, WA (425,363) Skamania, WA (11,066)
2	Counties in metro areas of 250,000 to 1 million population	Oregon- 2 Washington- 1	Marion, OR (315, 335) Polk, OR (75,403) Thurston, WA (252,264)
3	Counties in metro areas of fewer than 250,000 population	Oregon- 2 Washington- 1	Benton, OR (85,579) Linn,OR (116,672) Cowlitz, WA (102,410)
Non-metropolitan Counties			
4	Urban population of 20,000 or more, adjacent to a metro area	Oregon-1 Washington- 2	Clatsop,OR (37,039) Grays Harbor, WA (72,797) Lewis, WA (75,455)
5	Urban population of 20,000 or more, not adjacent to a metro area	Oregon- 1	Lincoln, OR (46,034)
6	Urban population of 2,500 to 19,999, adjacent to a metro area	Oregon- 1	Tillamook, OR (25,250)
7	Urban population of 2,500 to 19,999, not adjacent to a metro area	Washington- 1	Pacific, WA (20,920)
8	Completely rural or less than 2,500 urban population, adjacent to a metro area	Washington- 1	Wahkiakum, WA (3,978)
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area	None	None

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