PACIFIC NORTHWEST WOOD-BASED BIOFUELS

Volume I | PRELIMINARY SCOPING

IDX Studio - Fall 2014

Northwest Advanced Renewables Alliance

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ABBREVIATIONS

AHB	Advanced Hardwood Biofuels Northwest
BDT	Bone Dry Tons
Brownfield	Abandoned or underutilized site with real or perceived contamination
C&D	Construction and Demolition Debris
CIA	Community Impact Analysis
EDD	Economic Development Districts
EDO	Economic Development Organizations
Greyfield	Vacant or underutilized site with no contamination (e.g., former commercial property)
IBR	Integrated Biorefinery
LCA	Life Cycle Analysis
MC2P	Mid Cascades to Pacific Supply Chain Region
MRF	Material Recycling Facility
NARA	Northwest Advanced Renewables Alliance
OSU	Oregon State University
PNW	Pacific Northwest
RFA	Resource Flow Analysis
RWW	Recycled Wood Waste
SLS	Site Location Selection
UI	University of Idaho
USFS	United States Forest Service
WMC	Western Montana Corridor
WSU	Washington State University

AUTHORS

Tamara Laninga, UI

Karl Olsen, WSU

Vincent McIntyre, WSU

Scott Millman, UI

Jon Potter, WSU

Michele Vachon, UI

Vikram Yamada, WSU

Jorge Jordan Zamalloa, UI

Rui Zhu, WSU

EDITORS

Charles Burke

Tamara Laninga

Scott Leavengood

Eini Lowell

Jacob Smith

Vikram Yamada, WSU

LAYOUT & DESIGN

Jacob Smith

Michele Vachon

Northwest Advanced Renewables Alliance

Pacific Northwest Wood-Based Biofuels

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 (PNW), specifically in Oregon, Washington, Idaho and Montana during 2014/2015. The four-state region is shown in Figure ES 1. This Preliminary Scoping 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.

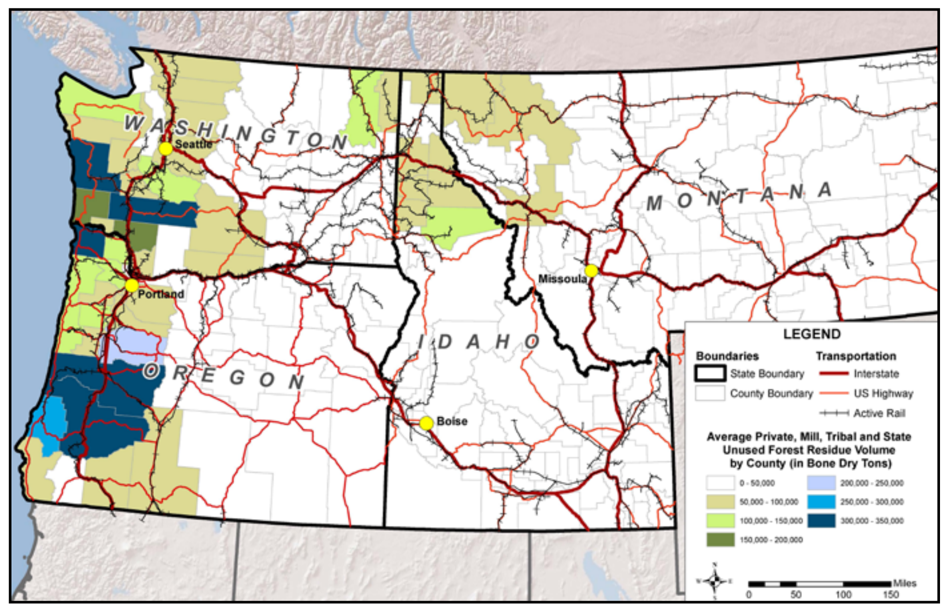

Figure 1.0.1. NARA Pacific Northwest Four-State Region

CHALLENGE

The overall goal of the PNW 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 PNW. 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 PNW supply chain study include the following:

- Determining regional market demand in various regions across the PNW 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 PNW 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 Preliminary Scoping 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 PNW 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 PNW. 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 PNW 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 and 5 are document references and appendix. The appendix lists the assets, grouped by community capitals, that have been collected from local, regional, state and federal sources.

RELATED DOCUMENTS: The PNW Preliminary Scoping document is the first of three documents. The second document, the PNW 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, PNW 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. The Design document is anticipated to be complete by July 2015.

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.

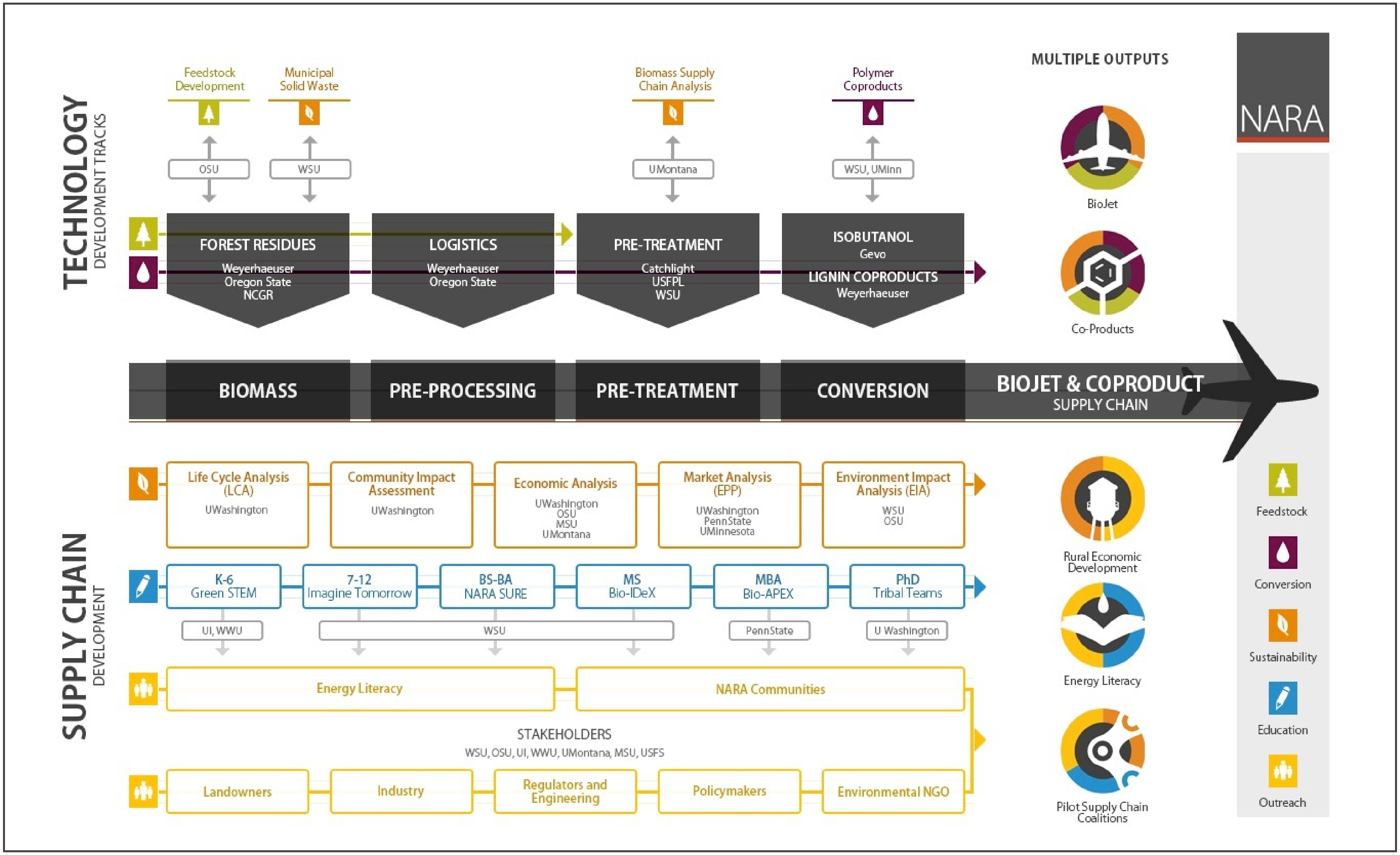

Figure 1.0.2. NARA Team Structure and Goals

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-

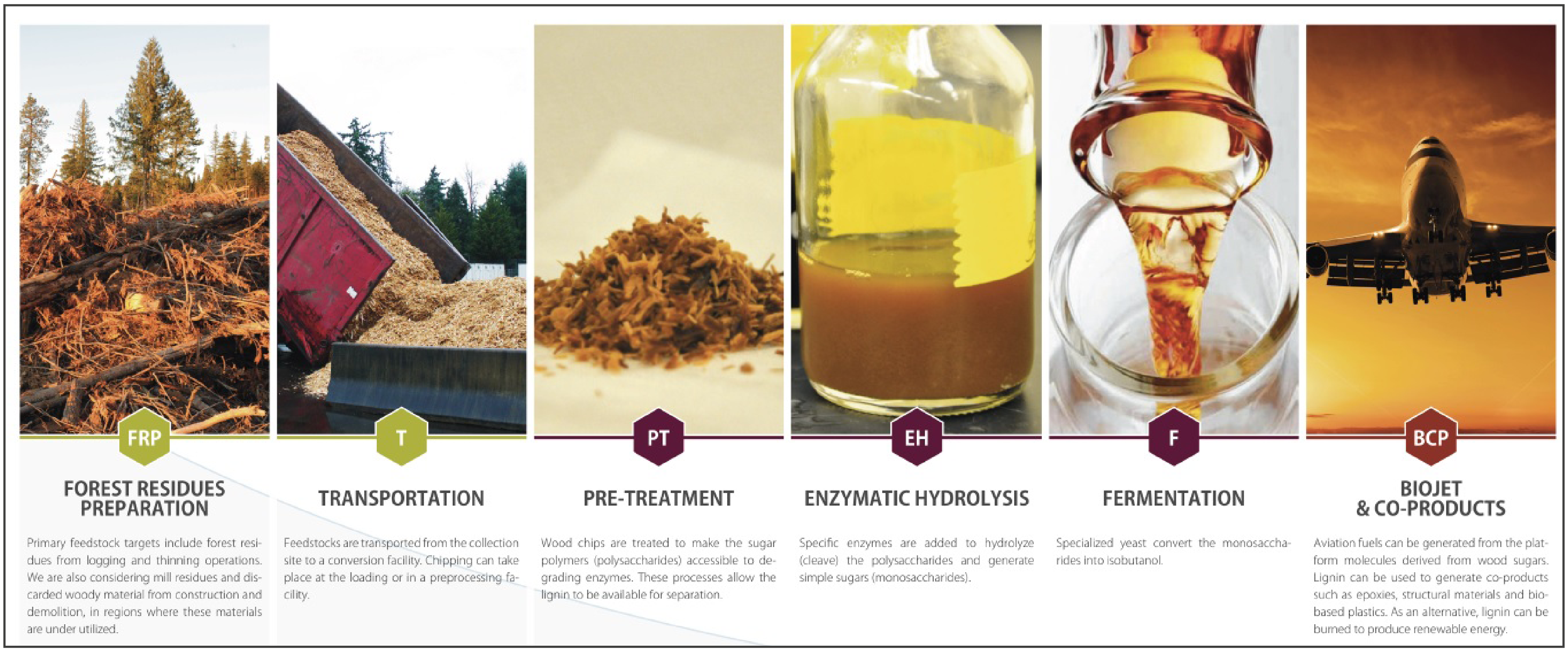

Figure 1.1.1. Overview of NARA Supply Chain

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.

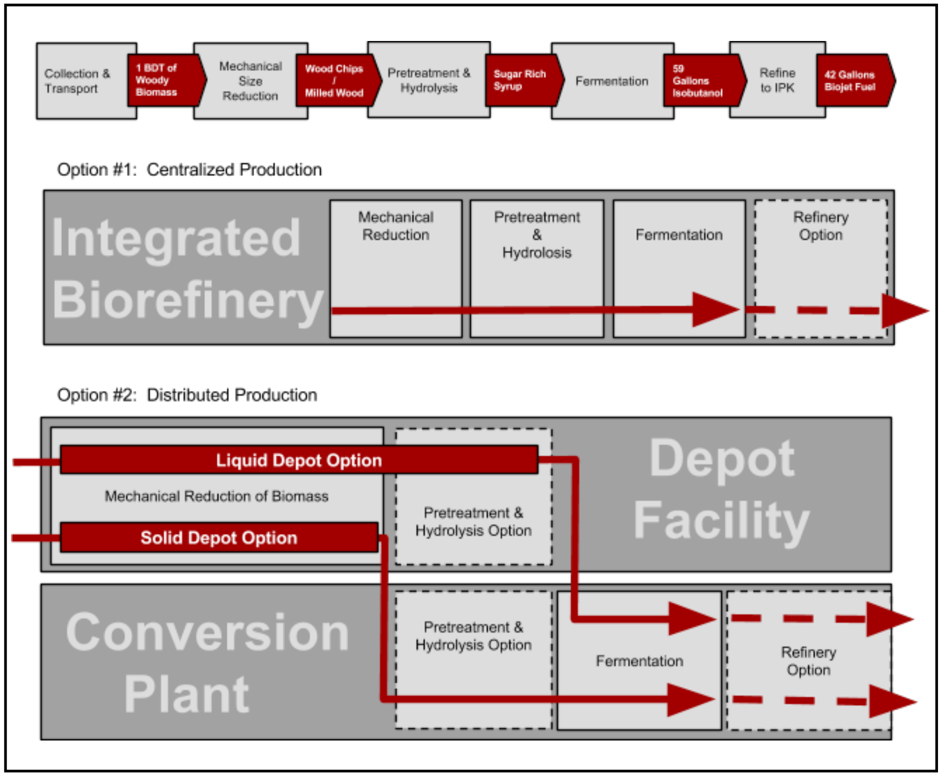

Figure 1.1.2. Wood to Biofuels supply chain pathway options

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 PNW 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 PNW 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.

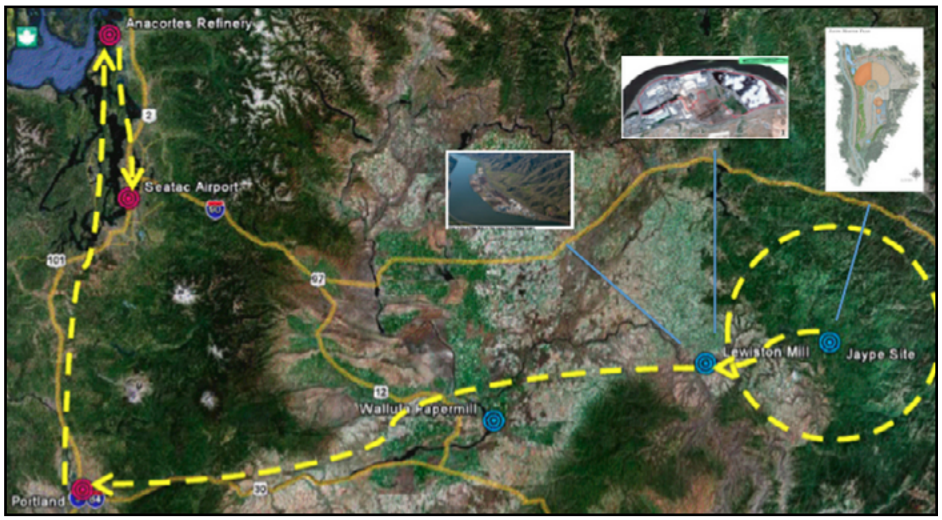

Figure 1.1.3. Clearwater Basin, Idaho, Yellow-dotted line represents the pilot supply chain

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.

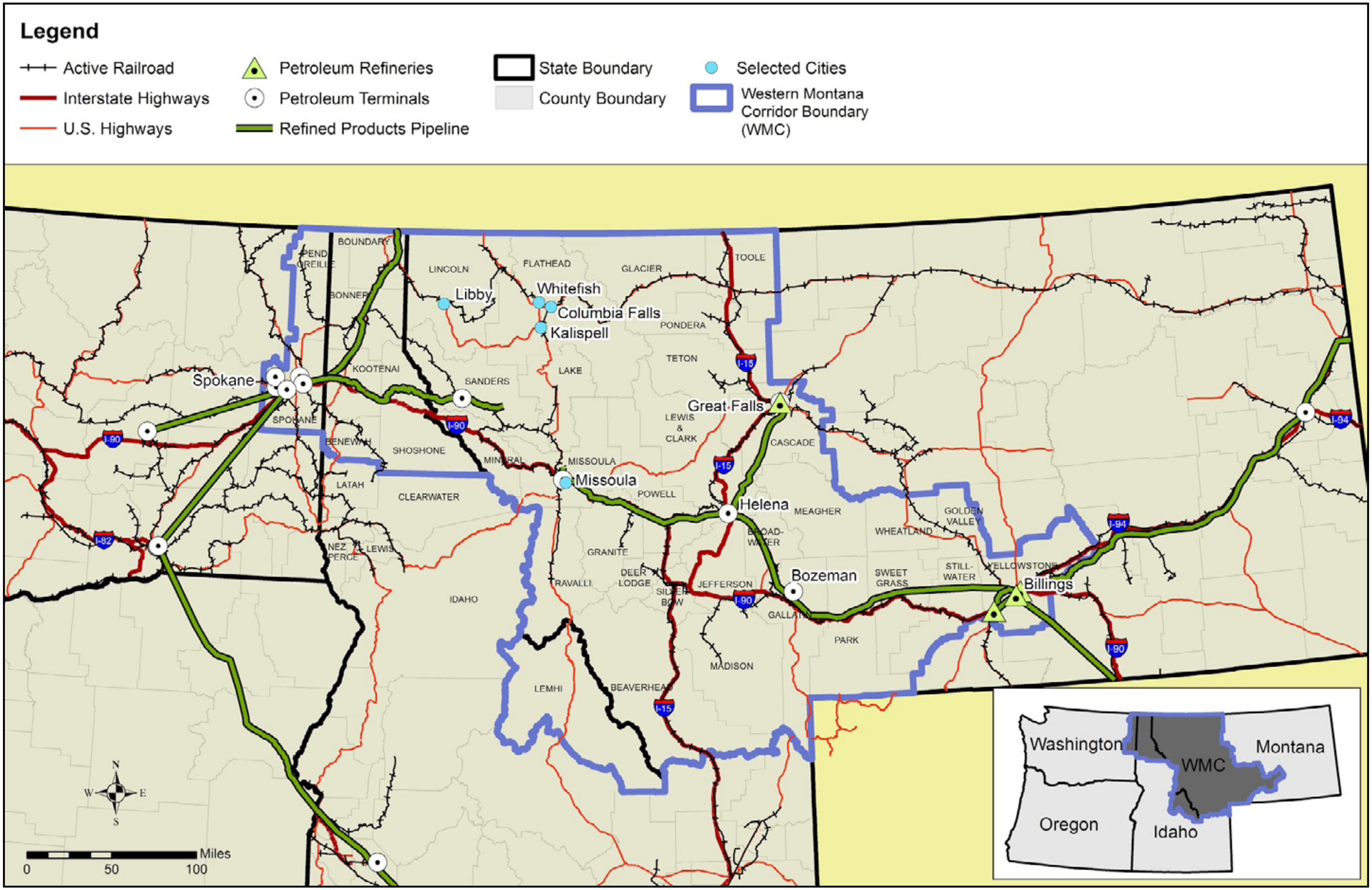

Figure 1.1.4. Western Montana Corridor (Northeast WA, Northern ID, and Western MT)

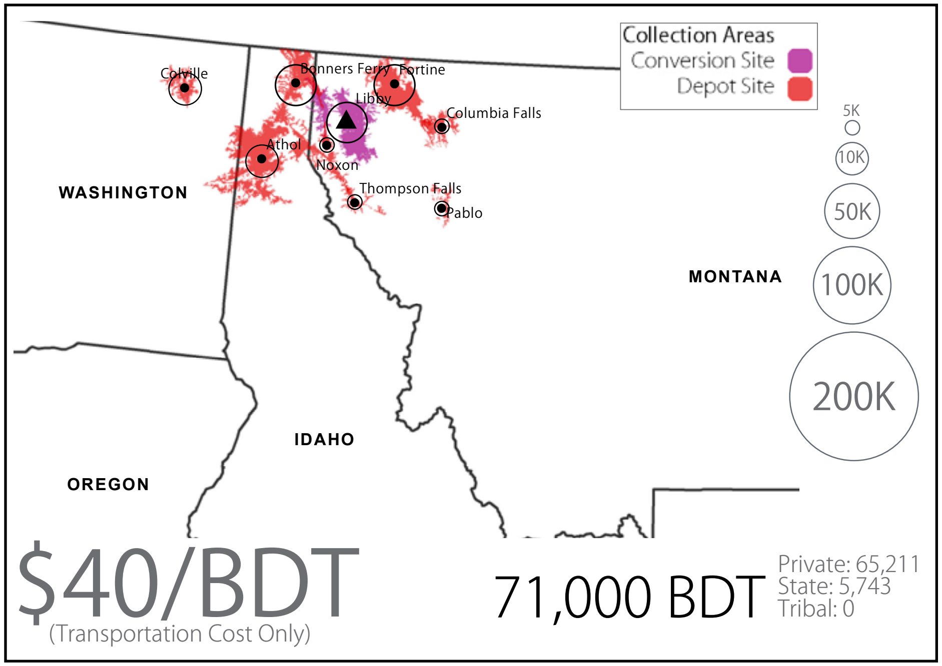

Figure 1.1.5. Libby conversion facility and depot sites using road network, $40/BDT

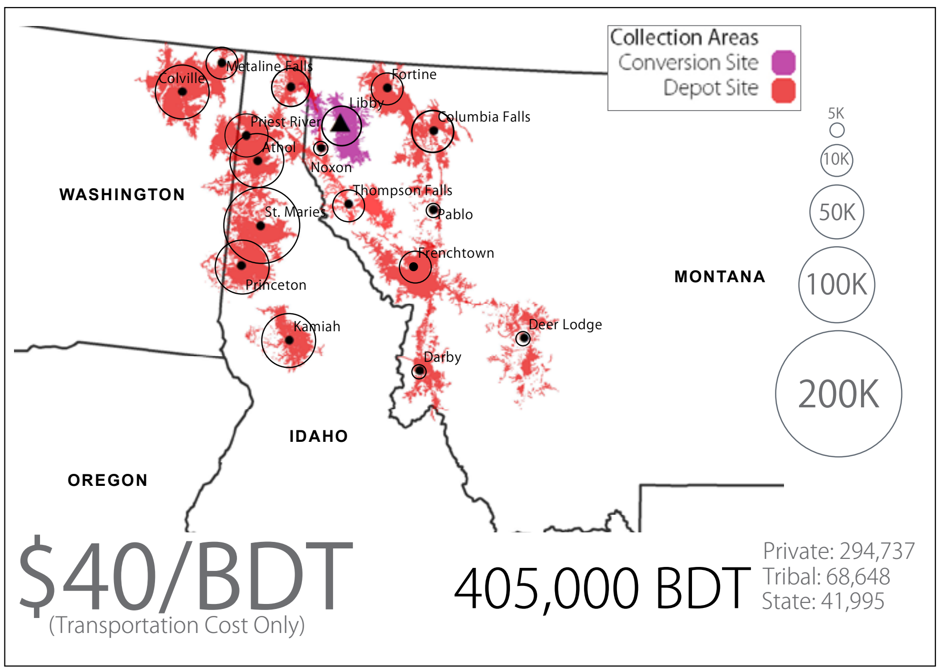

Figure 1.1.6. Libby conversion facility and depot sites using rail network, $40/BDT

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

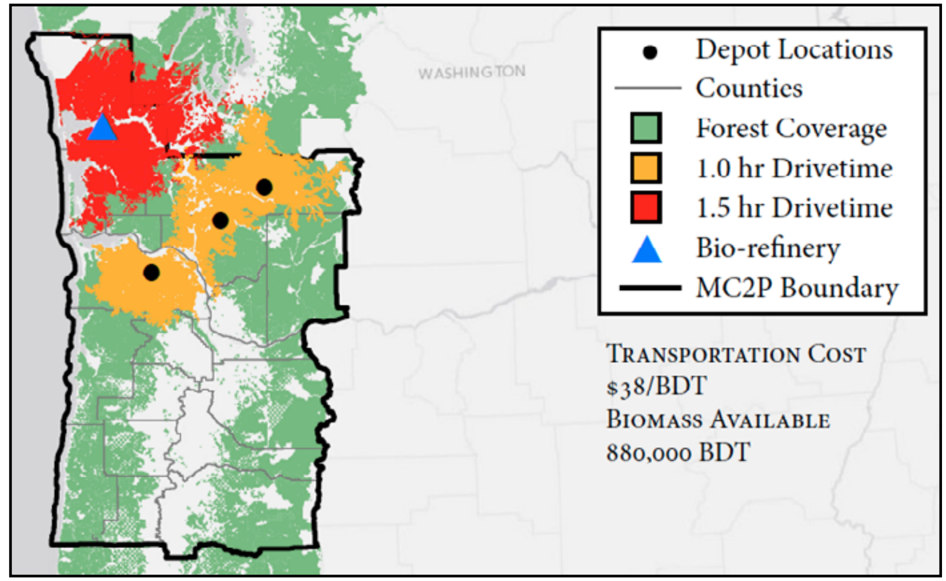

Figure 1.1.8. Proposed IBR in MC2P region supported by depots

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 PACIFIC NORTHWEST (PNW) FOUR-STATE 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 PNW. 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 PNW Study include:

- Determining regional market demand in various regions across the PNW 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 PNW 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 PNW to vet and refine the list of regional assets, identify gaps, and assess progress on the supply chain objectives.

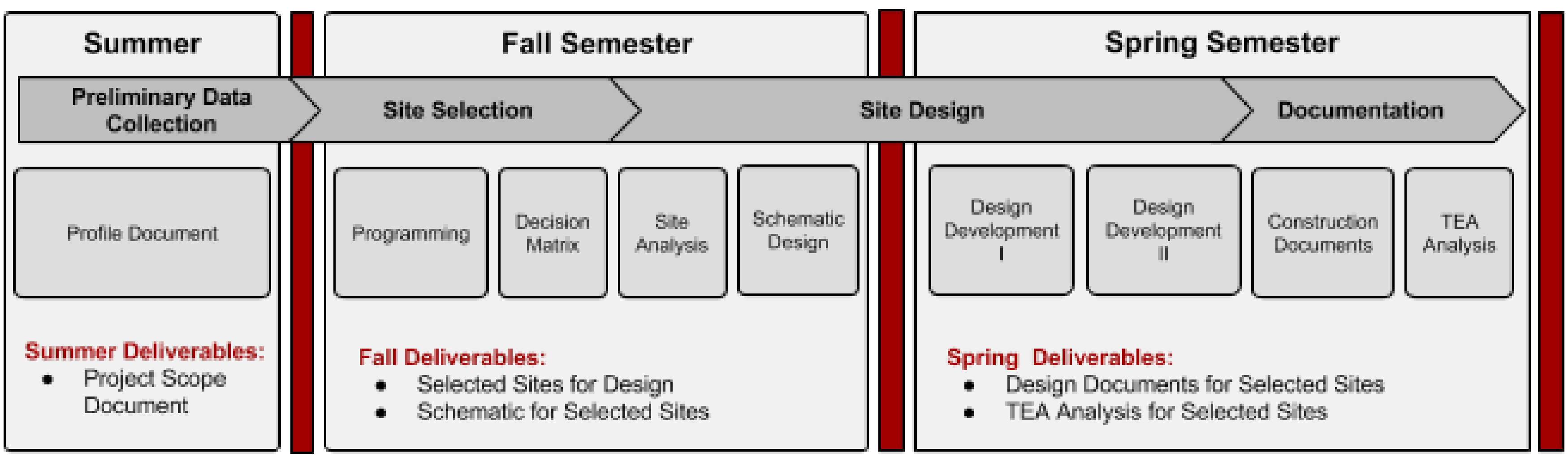

Figure 1.1.9. IDX structure and PNW supply chain stages

1.1.4 STRUCTURE OF PACIFIC NORTHWEST (PNW) 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 PNW 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 PNW 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 PNW 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 PNW, 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 Preliminary Scoping document outlines known and identified assets in the four-state region. The intent of this Preliminary Scoping 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 PNW.

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 PNW 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 PNW 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 PNW supply chain analysis will be two-fold: 1) a list of potential solids and liquids depots and conversion/IBR sites in the PNW; 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 PNW 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 PNW Design report. More details on the supply chain methodology appear in Section 3 of this document.

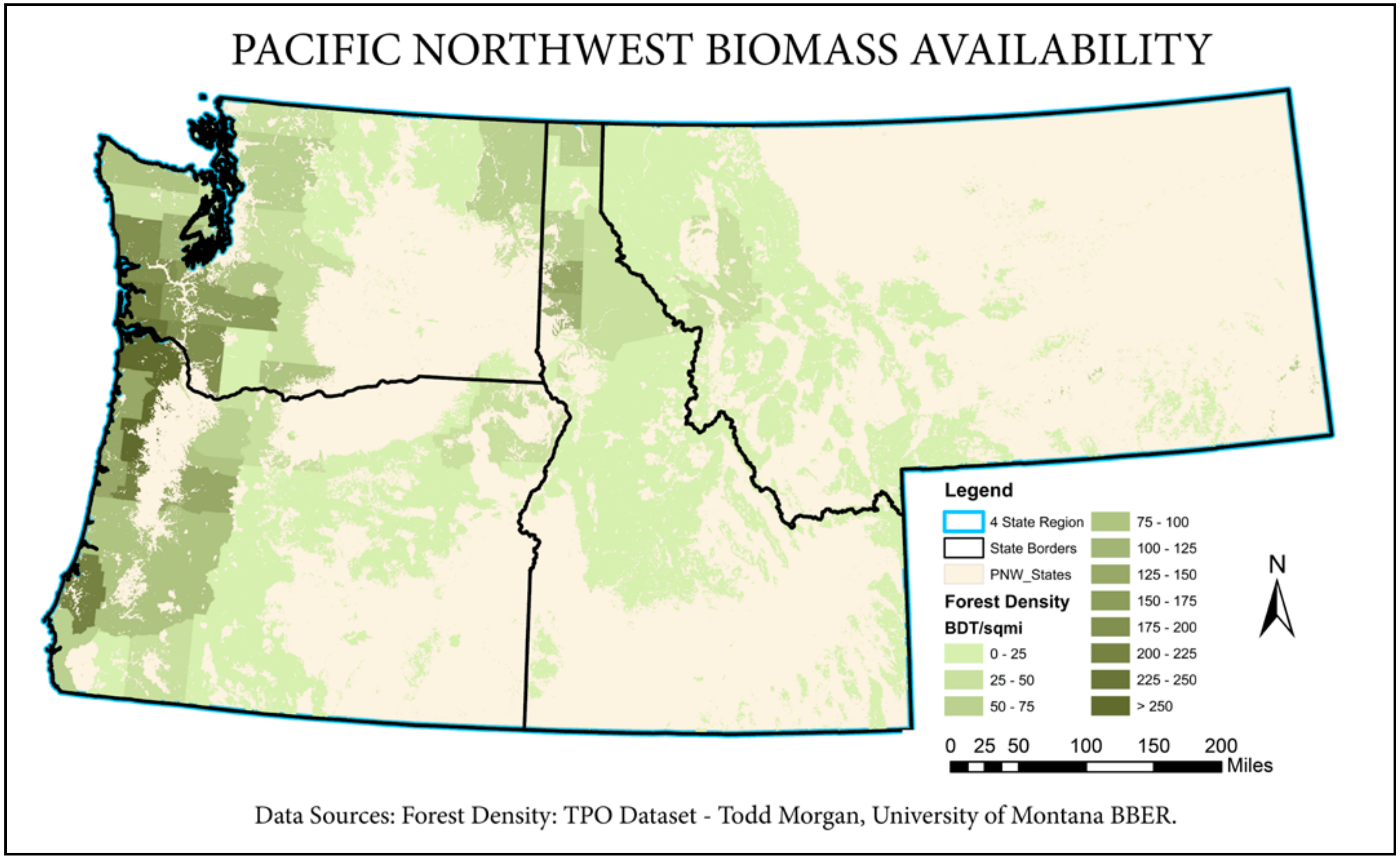

Figure 1.2.1. PNW biomass availability

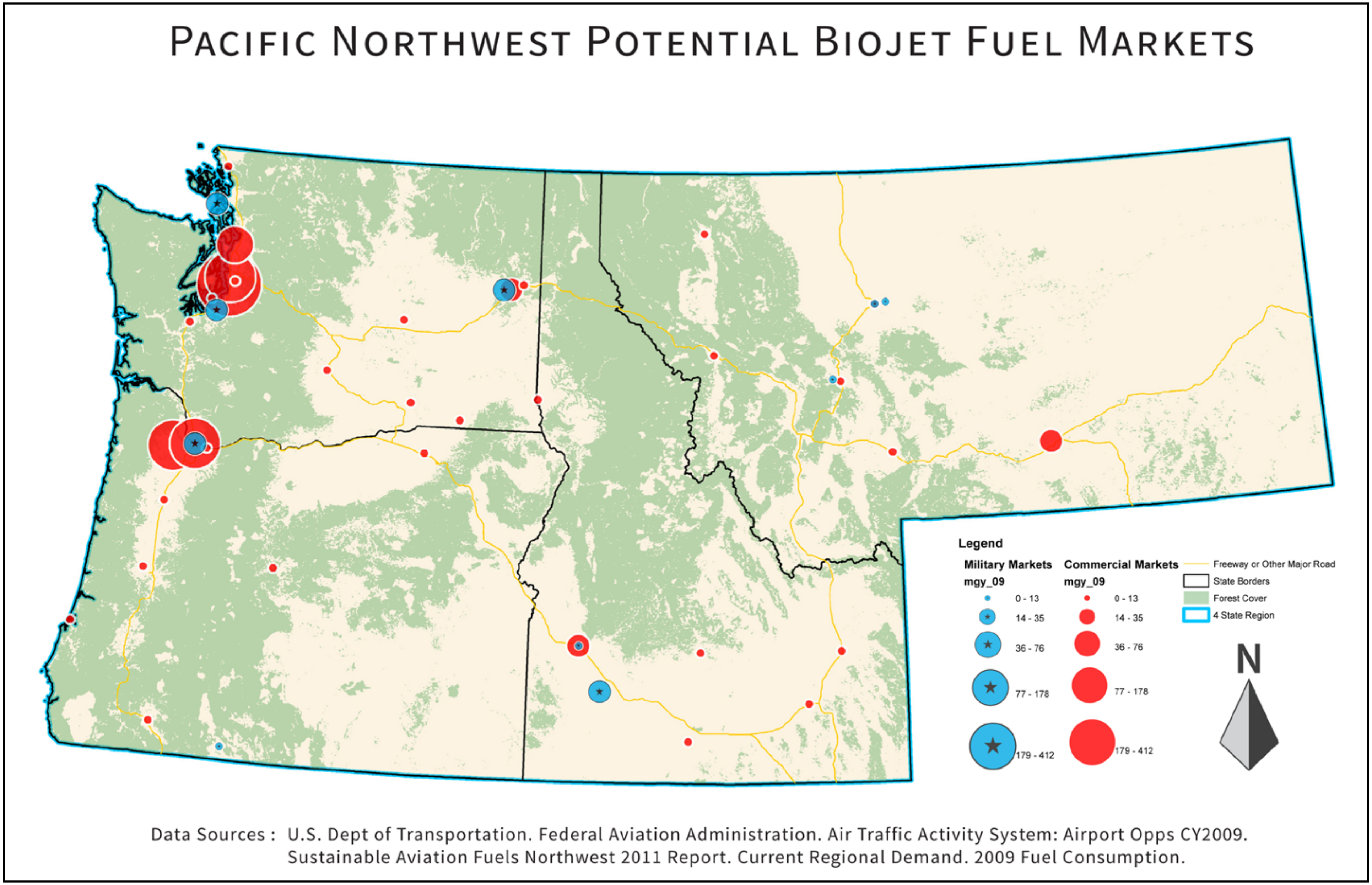

Figure 1.2.2. PNW biojet fuel markets

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 PNW.

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, (is there a group from Idaho? - check with Randy). 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.

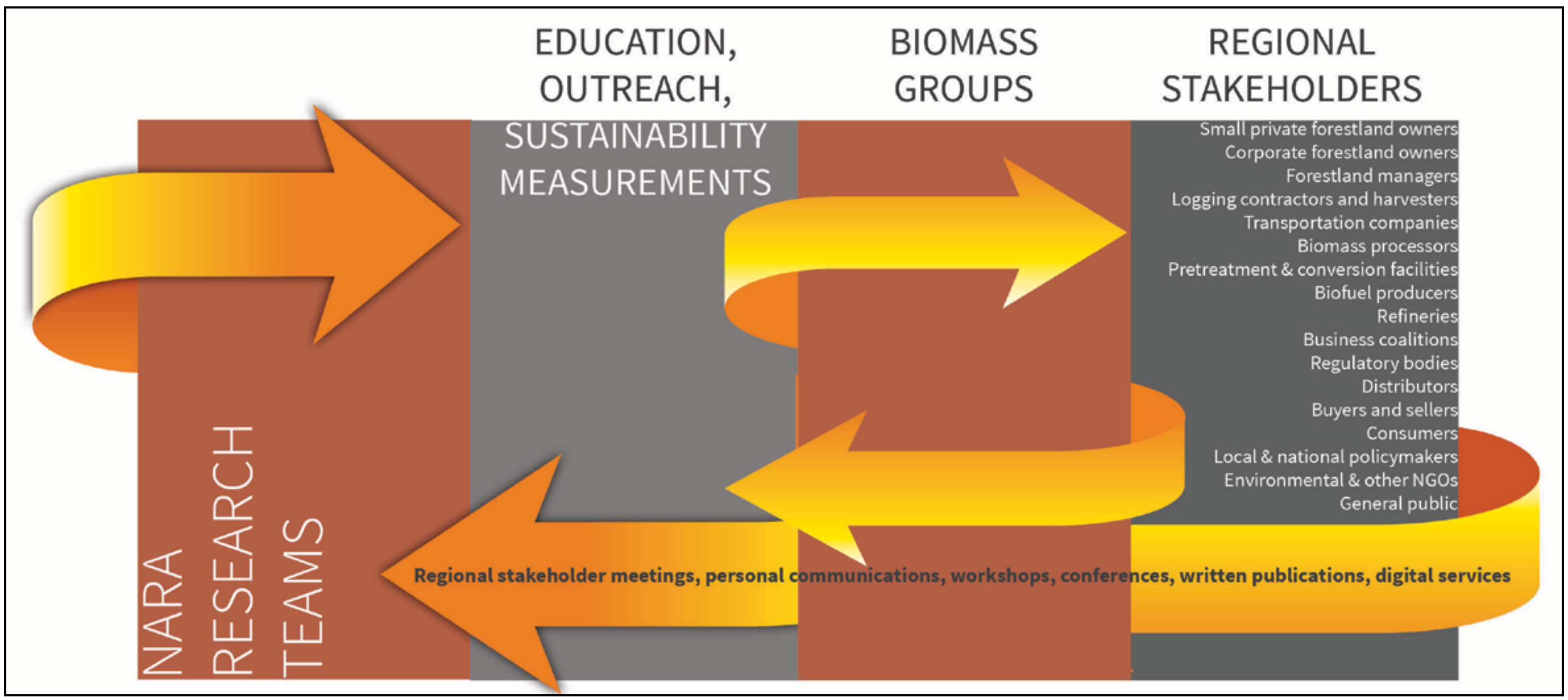

Figure 1.2.3. Communication mechanisms between NARA members and regional stakeholders

1.2.3 STAKEHOLDER ROLES AND RESPONSIBILITIES

NARA has developed a number of partnerships with working groups and stakeholders in the PNW 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 PNW 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.

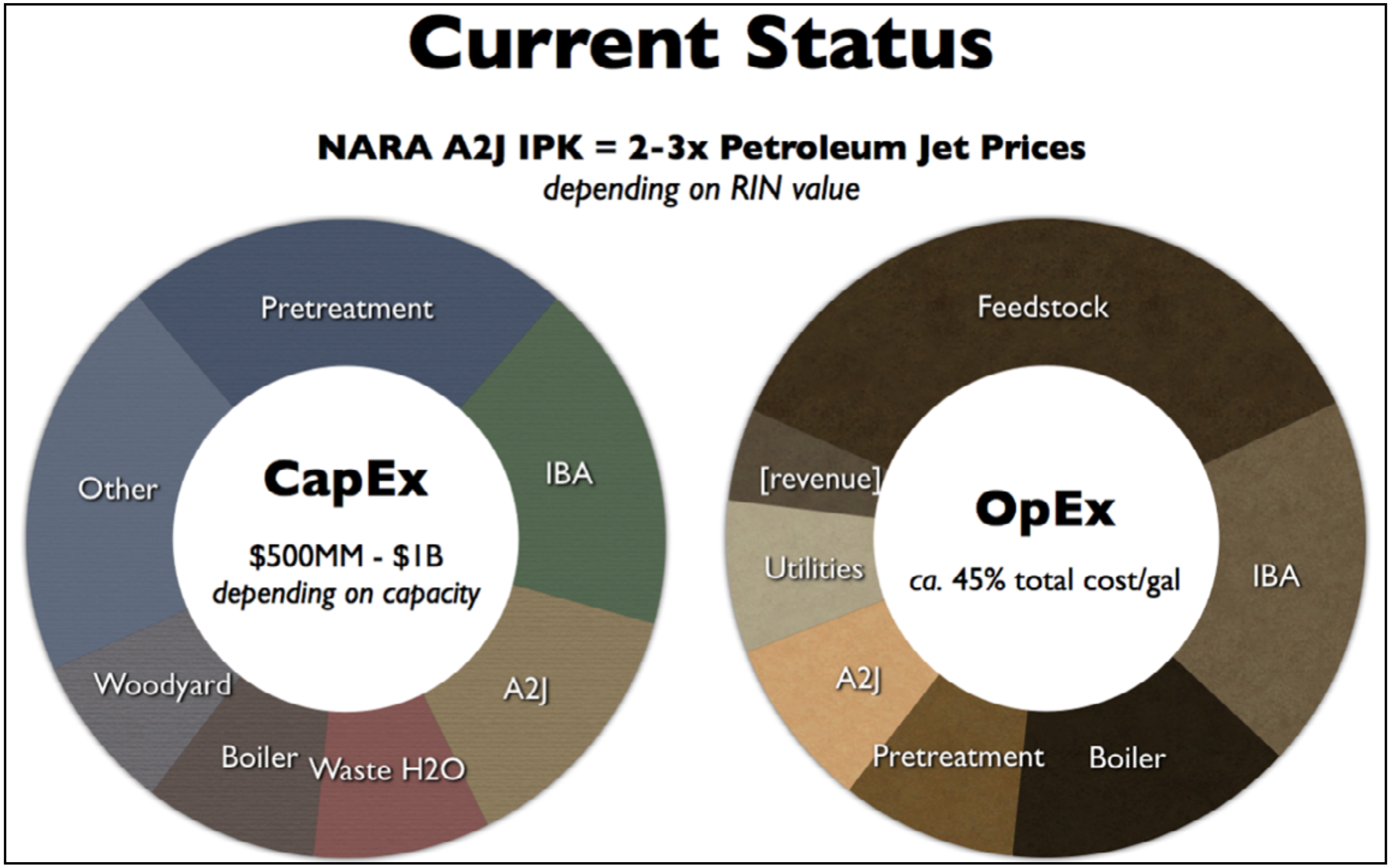

Figure 1.2.4. Techno-Economic Analysis

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 PNW. 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 PNW. 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 PNW 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 PNW 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 PNW 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.

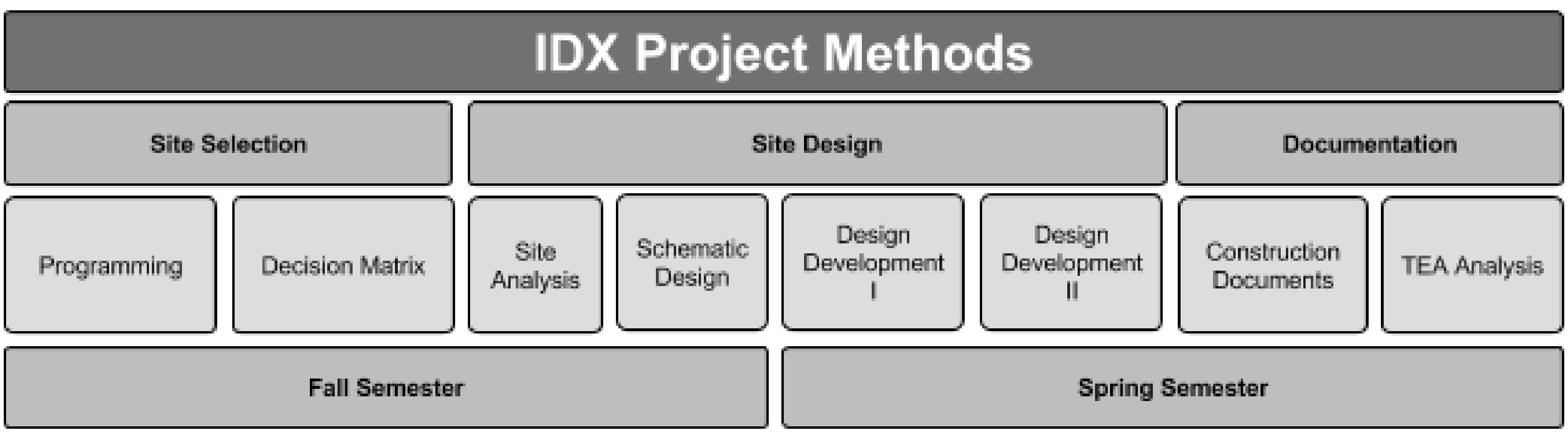

Figure 1.3.1. PNW supply chain analysis and design techniques

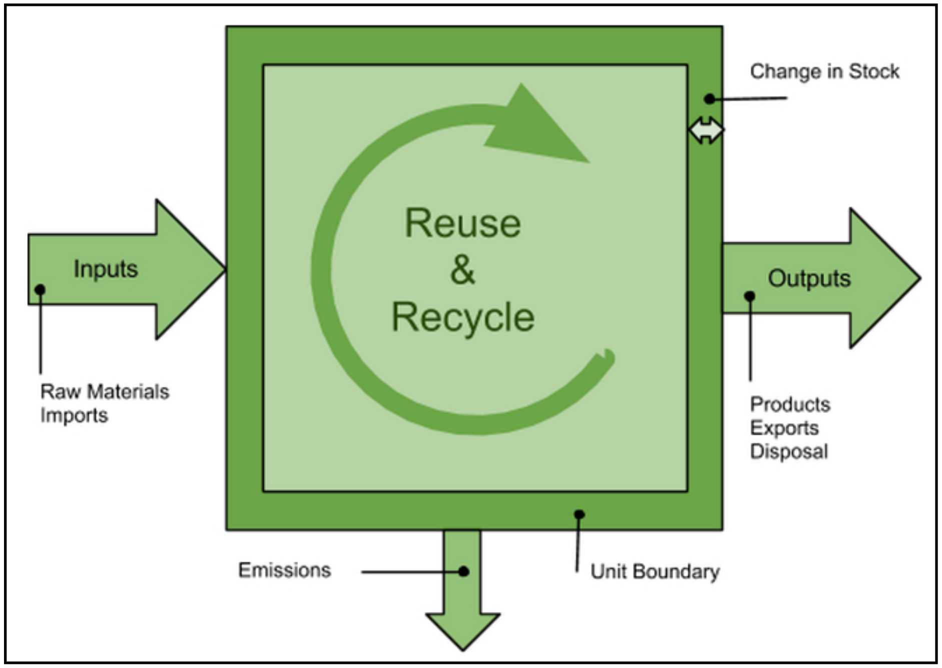

Figure 1.3.2. Flow of mass through geography or economic unit (Linstead and Ekins 2001)

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 PNW 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 PNW 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 PNW 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 PNW 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 APPENDIX

The Appendix describes regional assets identified and, for the most part, collected for the PNW wood-to-biofuels supply chain study. The majority of the data is available through the IDX shared server as GIS files.

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 four-state wood-based biofuels supply chain. For more details on our approach, please see Section 1.3.0 - Project Methods. The assets are divided into the following categories: Natural Capital (1.5.1), Physical Capital (1.5.2), Civic Capital (1.5.3), Financial Capital (1.5.4), and Policy Capital (1.5.5). A final category included in the appendix is Markets (1.5.6).

1.5.1 NATURAL CAPITAL

Natural capital consists of ecosystem-based resources. For the NARA supply chain analysis, the key natural capital assets considered include:

- Woody Biomass - forest density, coverage, and approximate average harvest amounts. Necessary to determine availability of feedstock.
- Water Resources - streams and rivers. Important for providing water for facility operations and potentially for transportation via barge
- Air Quality - non-attainment areas. This may impact where a facility could be located based on air quality attainment status.
- Natural Amenity Index - this is related to quality of life characteristics that might draw potential businesses or employees.

WOODY BIOMASS AVAILABILITY

A) FOREST COVERAGE: This shapefile is the total US forest coverage that is clipped to the four state region. It only shows the coverage, the attribute table has no pertinent information so it should only be used for visuals.

B) FOREST DENSITY: This shapefile (once it is merged) will have the feedstock availability by ownership, as well as a density (BDT/sq.mi.) in the last column. The density is calculated by first finding the area of each polygon (the polygons were created by clipping the county information to the forest coverage) and then by multiplying that area by the Private_Mill column. This column represents the total residuals coming from private lands and mills. This information was compiled by Natalie Martinkus and Todd Morgan.

C) FOREST OWNERSHIP: This shapefile (once it is merged) displays the different forest ownership classes. It is broken down by the following: Federal Land, Local Land, Private Conservation Land, State Land, Private Land, Native American Land and Unknown.

D) FOREST TREE TYPE: This data set was downloaded off of the ArcGIS website and was put together as a collaborative effort between the USFS Forest Inventory and Analysis and Forest Health Monitoring programs and the USFS Remote Sensing Applications Center. It breaks down the forest cover into 28 forest type groups. The original shapefile was clipped to the PNW region and its projection was changed to the NARA PNW projection. Location: I:\Biological(forest, rivers, wildlife,etc.)

WATER RESOURCES

This information will be added to the IDX GIS database when it is available.

AIR RESOURCES

A) AIR QUALITY FACILITIES: This shapefile consists of a list of companies in Oregon, Washington, Idaho and Montana that have air quality permits and emit air pollutants, relevant for the following years: Oregon (2005), Washington (2010), Idaho (2005) and Montana (2002).The attribute table contains data pertaining to CO, NOx, PM 2.5, and VOCs with units of short tons per year. This shapefile was created by Natalie Martinkus in 2012. Location: I:\Physical (roads, rail, cities, etc.)\Air Quality Facilities

NATURAL AMENITY INDEX

The natural amenities scale is a measure of the physical characteristics of a county area that enhance the location as a place to live. This index was developed by the United States Department of Agriculture. And it accounts for water area, temperature, humidity, sunshine, and terrain. A higher score indicates more natural amenities in a county.

The scale was constructed by combining six measures of climate, topography, and water area that reflect environmental qualities most people prefer. These measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area. The data for the PNW by county is available in a shapefile. For most current data refer to the USDA website: http://www.ers.usda.gov/data-products/natural-amenities-scale.aspx#.U81nQVayjwI

1.5.2 PHYSICAL CAPITAL

Physical capital is the built environment that supports the community, such as telecommunications, industrial parks, water and sewer systems, and transportation linkages (e.g., roads, rail, pipelines, and barge routes). Key physical capital assets relevant to the NARA supply chain analysis include the following: sites where solids and liquids depots, conversion plants or IBRs could be located, such as existing or idle pulp and paper mills, primary wood processing facilities, wood waste facilities and refineries; linkages critical for moving materials through the supply chain including roads, rail, and pipelines; and the power grid, which shows major transmission lines and substations.

SITES

A) PULP AND PAPER FACILITIES

B) PRIMARY WOOD PROCESSING FACILITIES

This information will be added to the IDX GIS database when it is available.

C) WOOD WASTE

- Material Recycling Facilities (MRFs)

This shapefile was created for the purpose of locating and spatially analyzing wood recycling facilities (WRFs) in the PNW 4 State Region. The address of each MRF was used to determine their corresponding longitude and latitude by using the location finder tool. MRFs were contacted during a survey process in order to collect recycled wood waste quantities which is a feature located in the attribute table. Also in the attribute table, the eventual use of the recycled wood waste was broken down and coded as H: Hog Fuel, E: Energy, C: Compost, and M: Mulch. All figures are reported in tons - not necessarily BDT because there is not a standard for MRFs to record their recycled wood waste. This file was created by Gerald Schneider on 06/12/2013. Location:I:\Physical (roads, rail, cities, ect.)\Const. & Demo.Waste

- Landfills

This shapefile was created for the purpose of locating landfills and analyzing municipal solid waste (MSW) and recycled wood waste (RWW) quantities within the PNW 4 State Region. Landfill address locations in Washington, Oregon, and Idaho were used to determine their latitude and longitude by using the location finder tool. Montana landfill locations were provide through the Montana website http://nris.mt.gov/default.asp . Washington landfill data was collected through the Washington DOE website and by Gretchen Newman of the Washington DOE. Oregon landfill data was provided through the Oregon DEQ website and by Peter Spendelow of the Oregon DEQ. Montana landfill data was provided by Mary Henderson of the Montana DEQ. Idaho landfill data was provided by individual landfills and county solid waste departments. All numerical data in the attribute table is reported in tons. This shapefile was created by Gerald Schneider on 06/12/2013. Location: I:\Physical (roads, rail, cities, ect.)\Const. & Demo. Waste

- Wastesheds

This shapefile was created in order to represent municipal solid waste (MSW) and recycled wood waste (RWW) quantities per wasteshed in the PNW 4 State Region. MSW and RWW quantities were recorded in terms of wastesheds to account for counties that work together to manage solid waste needs. Wasteshed shapefiles were created by merging MSW-corresponding county shapefiles. MSW and RWW quantities were added to the wasteshed shapefiles by joining Microsoft Excel spreadsheets with the wasteshed shapefile. County shapefiles were provided by the Department of Crop and Soil Sciences at Washington State University. Washington MSW and RWW quantities were provided by the Washington DOE website and Gretchen Newman of the Washington DOE. Oregon MSW and RWW quantities were provided by the Oregon DEQ and Peter Spendelow of the Oregon DEQ. Montana MSW quantities were provided by Mary Henderson of the Montana DEQ. Idaho MSW and RWW quantities were provided by individual landfills and county solid waste departments. All numerical data is reported in tons. In the attribute table, MSW_2011 data is specific to municipal solid waste, CD_2011 data is all construction and demolition waste, and Wood_2011 data is reported wood waste. This shapefile was created by Gerald Schneider on 05/10/2013. Location: I:\Physical (roads, rail, cities, ect.)\Const. & Demo. Waste

D) PETROLEUM REFINERIES & PIPELINES

Due to national security concerns, locations of petroleum pipelines beyond 1:1,000,000 scale are not released to the general public. The U.S. Energy Information Administration does provide approximate locations that can be used for relative reference. The PNW Petroleum Pipeline layer was created based on the petroleum pipeline map provided by the U.S. energy mapping system. The layer has been clipped to the PNW 4 state region and changed projection to the NARA PNW projection. Location: I:\Physical (roads, rail, cities, ect.)\Pipeline

LINKAGES

A) HIGHWAYS, INTERSTATES, PRIMARY/SECONDARY (ESRI)

U.S. Major Highways represents the major highways of the United States. These include interstates, U.S. highways, state highways, and major roads.This dataset is from the Census 2000 TIGER/Line files. It contains all Class 1 and 2 roads segments plus any other road segments necessary to provide network connectivity for the Class_Rte field. Source: ESRI, Tele Atlas North America. 11/3/2010. The data set was last edited by VM where it was clipped to the PNW 4 state region and the projection was changed to NARA PNW. Location: I:\Physical (roads, rail, cities, ect.)\Transportation

B) RAIL (ESRI)

The data set provides location and partial attribute information for use in national and regional network analysis applications.The Rail Network is a comprehensive database of the nation's railway system at the 1:100,000 scale or better. The data set covers all 50 States plus the District of Columbia however, this set is clipped to the

PNW 4 State Region and change to the NARA PNW States projection. Source: ESRI and the Federal Railroad Administration (FRA). Last updated by JP, summer 2014.

C) PIPELINES

Pipelines, terminals and refineries for the PNW are in one file under Pipeline. Location: I:\Physical (pipeline)

D) BONNEVILLE POWER ELECTRIC GRID

We are working on finding a GIS layer for the Bonneville Power Electric grid. The following links shows maps of utility districts that receive electricity from the Bonneville Power Administration and the utility lines.

- http://www.bpa.gov/news/pubs/maps/NW_Utility.pdf
- http://www.bpa.gov/news/pubs/maps/BPA_Tlines_all.pdf http://gis.bpa.gov/

1.5.3 CIVIC CAPITAL

Civic capital assets have to do with the skills and abilities residents have, as well as their characteristics. A region's available labor force is crucial to the success of its industries. Unemployment, age, and educational attainment are all factors in the readiness of labor. The Pacific Northwest has traditionally been engaged in forest related industries, and workers with related or easily-transferrable skills may be available to a certain degree for employment in a biofuels supply chain. As rural economic development is one of the tasks of the NARA project, unemployment is an important factor. By putting people back to work, communities have an opportunity to revitalize and inject new money into their economies. In some Pacific Northwest communities, a once-dominant logging industry has significantly declined. Because of this, there may be a number of potential workers who are currently unemployed or underemployed, who have knowledge and experience in the wood-products industry.

LABOR FORCE PARTICIPATION RATE

The labor force is the sum of employed and unemployed persons. The labor force participation rate is the labor force as a percent of the civilian population.
Data collected from selected attributes from the 2010 Census, 2008-2012 ACS 5-year estimates and County Business Patterns (CBP) for selected geographies. File format: Shapefiles (.shp) and Geodatabases (Includes metadata). Location: I:\Civic\Labor Force

EDUCATIONAL ATTAINMENT

Educational attainment is important for all levels of the supply chain. Proper training will be needed for the operation of harvesting and transportation equipment, and advanced education is important for the highly technical operation of biofuel facilities. This implies that existing educational attainment among the labor force, as well as proximity to facilities for furthering education can play a role in facility site location.

Data collected from selected attributes from the 2010 Census, 2008-2012 ACS 5-year estimates and County Business Patterns (CBP) for selected geographies. File format: Shapefiles (.shp) and Geodatabases (Includes metadata). Location: I:\Civic

UNEMPLOYMENT RATE

The unemployment rate is a measure of the prevalence of unemployment and it is calculated as a percentage by dividing the number of unemployed individuals by all individuals currently in the labor force.

Data collected from selected attributes from the 2010 Census, 2008-2012 ACS 5-year estimates and County Business Patterns (CBP) for selected geographies. File format: Shapefiles (.shp) and Geodatabases (Includes metadata). Location: I:\Civic\Unemployment Rate

DEMOGRAPHIC DATA

U.S. demographic data from the 2010 census is recorded by 5-digit zip code and clipped to the PNW region. Shapefile fields include zip code, population, race, gender, age, family status, residential status, and square mile of the zip code. Source: ArcGIS online 060213 by NM.

1.5.4 ECONOMIC CAPITAL

The cost of doing business in a particular county based on tax and utility rates, average wages, as well as incentives for locating a business in a community. Much of this data is not available as GIS layers. It may be necessary to create a layer, after doing research, into specific costs.

AVERAGE WAGE

This information will be added to the IDX GIS database when it is available. The weblink below shows a map of the average US weekly wage, averaged annually, for 2013.

TAX RATES (PROPERTY AND/OR BUSINESS)

Table 1.5.1 provides links to the state offices that work with businesses and publish tax rates for property and businesses.

UTILITY RATES BY PROVIDER

This information will need to be researched by individual utility provider. The following link is a map that shows which public utility districts provide electricity in a particular county: http://www.bpa.gov/news/pubs/maps/NW_Utility_counties.pdf.

Table 1.5.1. Business resources by state

State	Business Website	Tax Rate Website
Washington	http://access.wa.gov/topics/business/startbusiness	http://dor.wa.gov/content/FindTaxesAndRates/
Oregon	http://www.oregon.gov/business/Pages/index.aspx	http://www.oregon.gov/dor/bus/pages/corp-tax_main.aspx
Idaho	http://commerce.idaho.gov/business-climate	http://tax.idaho.gov/i-1044.cfm#sub1
Montana	http://businessresources.mt.gov/default.mcpx	http://revenue.mt.gov/home/businesses.aspx#horizontalTab3

1.5.5 POLICY CAPITAL

Policy capital assets are the rules and regulations that influence communities, the economy and the environment. For example, land ownership and management have important implications for the NARA project. Feedstocks from federal lands are not eligible under the federal renewable fuels standards, whereas forest residuals from private, state and tribal lands are. Outside of land ownership files, much of the policy data is hard to map. Links and information about policies relevant to biomass utilization and biofuels production are provided below.

NATIVE AMERICAN TRIBES (4 STATE REGION)

The Geodatabase obtained from the U.S. Census Bureau, 2008-2012 American Community Survey (geodatabase join geography from the TIGER/Line Shapefiles to the 2008-2012 American Community Survey 5-year estimates). Location: I:\Policy\Native American Tribes

POLICIES: INCENTIVES/REGULATIONS

A) FEDERAL LEVEL

The US federal government has a number of policies and incentives aimed at increasing the research, development and use of liquid biofuels.

Alternative Fuels Data Center: http://www.afdc.energy.gov/ provides information, data, and tools to help transportation decision makers find ways to reduce petroleum consumption through the use of alternative and renewable fuels, advanced vehicles, and other fuel-saving measures.

US EPA Renewable Fuels Standard: http://www.epa.gov/otaq/fuels/renewablefuels/ provides information about the renewable fuel volume mandates for the U.S., including information on qualifying feedstocks, which does not include woody biomass from federal lands.

B) STATE LEVEL

Washington, Oregon, Idaho and Montana have policies and incentives to facilitate wood-based bioenergy and biofuels developments in the Pacific Northwest. These policies are shown in Tables 1.5.2 -1.5.5

1.5.6 SUPPLY CHAIN MARKETS

COMMERCIAL/MILITARY AIRPORTS

Primary biojet fuel markets are separated into commercial and military airports. These shape files are located in the I-Drive > Physical > PNW Fuel Markets. The attribute table for these layers include the Airport name, location (lat., long.), FAA identifier, total operations (take-offs and landings for 2009), and estimated total fuel consumption in million gallons per year for the 2009 calendar year. The total operations data was gathered from the FAA's Air Traffic Activity System (ATADS). The fuel consumption data was taken from the Sustainable Aviation Fuels Northwest (SAFN) 2011 report (pg. 36-37). To merge the two sets of data into one consistent metric, a common factor (operations*0.00016 = fuel consumption) was found between overlapping data points and used to estimate fuel consumption. Major international airports like Seattle and Portland use much more fuel per operation and therefore they were not used in determining the linear relationship. This step was needed because the ATADS did not include all military airfields in their report. Source: Shapefile created by VM, summer 2014. Location: I:\Physical (roads, rail, cities, ect.)\Markets\Primary Markets

Table 1.5.2. Washington woody biomass utilization policy

Washington Woody Biomass Utilization Policy

Type of Action	Policy Listed in 2008 State Woody Biomass Utilization Policy	Policy Update (March 2013)	Reference Code	Brief Description of 2013 Policy	Website Link (March 2013)
Contact					
				Peter Moulton, Senior Energy Policy Specialist - Bioenergy Coordinator, Washington Department of Commerce, Phone: (360) 725-3116	peter.moulton@commerce.wa.gov
Grant					
	Alternative Fuel Grant and Loan Program (Revised Code of Washington 43.325)	Alternative Fuel Loans and Grants	Reference Revised Code of Washington 43.325	Washington DOC administers Energy Freedom Program. Provides technical assistance. Will expire June 30, 2016.	http://www.afdc.energy.gov/laws/laws/WA/user/3263
	Renewable Energy Grant (Bonneville Environmental Foundation)	Renewable Energy Grant (Bonneville Environmental Foundation)		NGO that helps fund renewable energy projects in the Pacific Northwest.	http://www.b-e-f.org/
Program					
	Sustainable Natural Alternative Power Program (Chelan County Public Utility District)	Sustainable Natural Alternative Power Program (Chelan County Public Utility District)		Customers pay a little extra for renewable energy. Money is distributed once a year to SNAP producers (schools, individuals, NGO's, etc.)	https://www.chelanpud.org/snap.html
		Biofuel Quality Program	Reference Revised Code of Washington 19.112	Tests and assesses biofuel quality and quantity to resolve any quality issues before the product reaches the consumer. The goal of the program is to create equity in the biofuel marketplace for refiners, suppliers, distributors, and retailers, and protect consumers.	http://www.afdc.energy.gov/laws/laws/WA/user/3263
Standard					
	Net Metering (Rev. Code Wash. § 80.60)	Net Metering of Electricity	Chapter 80.60 RCW	Net metering standards for facilities generating electricity from renewable energy sources.	http://apps.leg.wa.gov/rcw/default.aspx?cite=80.60

Table 1.5.3. Oregon woody biomass utilization policy

Oregon Woody Biomass Utilization Policy

Type of Action	Policy Listed in 2008 State Woody Biomass Utilization Policy	Policy Update (March 2013)	Reference Code	Brief Description of 2013 Policy	Website Link (March 2013)
Grant					
	Energy Trust – Open Solicitation Program (Energy Trust of Oregon)	Energy Trust – Open Solicitation Program (Energy Trust of Oregon)		Grant funding available for renewable energy sources	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OR22F&re=1&ee=1
	Renewable Energy Grant (Bonneville Environmental Foundation)	Renewable Energy Grant (Bonneville Environmental Foundation)		NGO that helps fund renewable energy projects in the Pacific Northwest.	http://www.b-e-f.org/
Loan					
	Small-Scale Energy Loan Program (ORS § 470.050 et seq.)	Small-Scale Energy Loan Program	ORS § 470.050 et seq.	Oregon Department of energy makes low interest loans to qualifying renewable energy sources.	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OR04F&re=0&ee=1
Program					
	Mandatory Utility Green Power Option (SB 838)	Mandatory Utility Green Power Option	ORS § 469A.205	Requires renewable energy option from utility provider.	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OR24R
	Oregon Biomass Working Group (U.S. Department of Energy's State Energy Program	Oregon Biomass Working Group (U.S. Department of Energy's State Energy Program		The FBWG is comprised of a wide range of stakeholders in the private, public and non-profit sectors working to advance sustainable biomass utilization in Oregon. Participation in the FBWG is open to any member of the public interested in contributing to this end.	http://www.oregon.gov/energy/RENEW/Biomass/Pages/forest_biomass_working_group.aspx
	Oregon Renewable Action Energy Plan (Oregon Department of Forestry)	Oregon Renewable Action Energy Plan (Oregon		The plan's overarching goals are to encourage and accelerate the sustainable production of energy from renewable sources; stimulate	http://www.oregon.gov/energy/renew/

Table 1.5.4. Idaho woody biomass utilization policy

Idaho Woody Biomass Utilization Policy

Type of Action	Policy Listed in 2008 State Woody Biomass Unitization Policy	Policy Update (March 2013)	Reference Code	Brief Description of 3013 Policy	Website Link (April 2013)
Grant					
	Renewable Energy Grant	Renewable Energy Grant	Bonneville Environmental Foundation	Representatives from the foundation serve as expert advisors and project consultants.	http://www.b-e-f.org/
	Renewable Energy Project Bond Program	Renewable Energy Project Bond Program	Idaho Statutes 67-8901 et seq.	Created to finance the construction of electric generation and transmission projects by electric utilities.	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ID06F
Tax					
	Alternative Fuels Tax Exemption and Refund	Alternative Fuels Tax Exemption and Refund	Reference Idaho Statutes 63-2401, 63-2402, and 63-2423	State excise tax does not apply to some special fuels, including fuel suitable for use in diesel engines	http://www.afdc.energy.gov/laws/law/ID/8301
	Biofuel Fueling Infrastructure Tax Credit	Expired	Idaho Statutes 63-3029M	NA	NA
	Residential Alternative Energy Tax Deduction	Residential Alternative Energy Tax Deduction	IC § 63-3022C	Taxpayers can apply this 40% deduction in the year in which the system is installed and can also deduct 20% of the cost each year for three years thereafter.	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ID01F

Table 1.5.5. Montana woody biomass utilization policy

Montana Woody Biomass Utilization Policy

Type of Action	Policy Listed in 2008 State Woody Biomass Utilization Policy	Policy Update (April 2013)	Reference Code	Brief Description of 2013 Policy	Website Link (April 2013)
Grant					
	Mandatory Utility Green Power Option	Mandatory Utility Green Power Option	MCA § 69-8-210	In Montana, regulated electric utilities are required to offer customers the option of purchasing electricity generated by certified, environmentally-preferred resources that include, but are not limited to, wind, solar, geothermal and biomass.	http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MT04R&re=0&ee=0
	Renewable Energy Grant	Renewable Energy Grant	Bonneville Environmental Foundation	Representatives from the foundation serve as expert advisors and project consultants. We have helped pioneer cutting-edge technologies with economically viable financing models—making the implementation, replication and expansion of on-site renewable energy projects as easy as possible.	http://www.b-e-f.org/
Tax					
	Alternative Energy Investment Tax Credit	Alternative Energy Investment Tax Credit	MCA § 15-32-401 et seq.	The credit may only be taken against net income produced by the eligible equipment or by certain associated business activities. Associated facilities, manufacturing plants producing alternative energy equipment and new or expanded businesses using the energy generated by the alternative energy investment may use the tax credit.	http://www.deq.mt.gov/Energy/renewable/taxincentrenew.mcpx
	Biodiesel blending and storage tax credit	Biodiesel blending and storage tax credit	15-32-703 MCA	There is a credit against Montana income tax for costs of investments in depreciable property for the storage and blending of biodiesel from Montana-produced ingredients with petroleum diesel.	http://www.deq.mt.gov/Energy/renewable/taxincentrenew.mcpx#15-32-702
	Biodiesel production facility tax credit	Biodiesel production facility tax credit	15-32-702 MCA	For depreciable property for constructing or equipping a facility in Montana to produce biodiesel or bio-lubricants.	http://www.deq.mt.gov/Energy/renewable/taxincentrenew.mcpx#15-32-702