WESTERN MONTANA CORRIDOR

SUSTAINABILITY

Community Impact

Northwest Advanced Renewables Alliance

4.3.1 COMMUNITY IMPACT EXECUTIVE SUMMARY

4.3.1.1 Project Purpose

An input-output model is created for the Western Montana Corridor (WMC) region and used to measure the impact on county-level economies from the production of biofuels using forest residues as the feedstock. This project is a first attempt to study and measure the importance of the production of biojet fuels using forest residue feedstock to the local economies and its impact on the livelihood and businesses within the WMC region. A similar analysis will be completed for the western region of Oregon and Washington. Improvements in methodology and estimates of expenditures realized in that study will be applied to this study as they are made.

4.3.1.2 Data Collection

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

4.3.1.3 Methodology

The study uses input-output analysis to examine how economic activity flows through the economy to generate additional indirect and induced impacts. Indirect impacts measure the effects of direct economic impacts on other connected businesses. Induced impacts measure the spending effects by households associated with direct and indirect impacts.

IMPLAN data was used to create a workbook-based model to measure the direct and indirect impacts. IMPLAN data on employment and value added, i.e., wages, and other income, was also used to make households behave like industries by selling their services, earning revenues and making purchases, thereby allowing the induced effects to be calculated using the value-added multiplier.

The workbook-based model is an economic account at the county level from which multipliers are calculated. The multipliers form the basis to measure economic impacts from new activity. Impacts from added economic activity associated with biojet fuel production are entered in a spreadsheet linked to county multipliers. Then, direct, indirect and induced effects are summarized.

The estimates are believed to be conservative. We use a conservative market price for forest residues to estimate the added activity in the feedstock delivery market. We also do not correct for leakage from purchases made within the WMC region when using economic accounts at the county level. Leakage in input-output terminology refers to purchases made outside of the region, i.e., the payments for imported goods and services. Since the economic effects of these purchases occur outside of the region, their impacts are not counted, e.g., when analysis of economies at the county level were done, purchases that were likely to be made in nearby counties that are inside the WMC boundary were not counted as part of the county's domestic product.

4.3.1.4 Results

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

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

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

The combined effect of $249 million expenses results in $533 million dollars in direct and indirect economic impact with nearly twenty five hundred new workers and $179 million in value added. The sum of these direct, indirect and induced economic effects totals $712 million annually.

The distribution of the effects can be significant for several county-level economies. The distributional effect is due to the locational aspects of forest residue production. In five counties, the added economic activity created by new demand for feedstock by the biorefinery is significant, representing increases from 0.9% to 1.5% new gross domestic product.

The biorefinery operation, without feedstock purchases, creates a larger indirect effect than induced effect; whereas feedstock purchases create a larger induced effect than indirect effect. This is a result of the intensity of labor use in each of these activities: the biorefinery operation, sans feedstock purchases, is more capital intensive than the feedstock purchasing enterprise. Whereas the employment coefficient calculated from employment numbers and industrial output reported by IMPLAN associated with the forestry/fishery sector is quite high.

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

4.3.2 INTRODUCTION

The report describes and quantifies the magnitude of economic activity accounted for by the introduction of a new biojet fuels refinery in the Western Montana Corridor (WMC). We measure three aggregate economic impacts: total economic output, value-added and employment. Value-added and employment impacts are used to calculate average wage benefits associated with the added economic activity.

The impacts are measured with an input-output model created for the WMC region. The model consists of economic accounts for each county in the WMC region. Economic activity is county specific, such as the case of forest residual harvests, and, in those instances, is summed to get the impact measure for the WMC region. The accounts are stored as individual spreadsheets within an Excel workbook and can be used by community planners and others to analyze other issues related to economic development in the WMC region.

An important consideration in defining the boundaries of the economic analysis is that of leakage due to the need to purchase goods and services outside of the region. A percentage of county-level purchases are likely to be made outside of the county but within the WMC region and are not accounted for. Hence the estimates of economic impacts are considered to be conservative.

4.3.3 THE INPUT-OUTPUT TABLE FOR WMC

4.3.3.1 Description of the Transaction Table

The transaction table is a detailed set of economic activity measuring purchases and sales by industry and household and government institutions. IMPLAN data for 2011 for each county in the WMC region is used to construct the transaction table. Since the focus of the exercise is industry impacts we focus on an industry-by-industry transaction table and calculate the induced effect using household purchase data. The industry-by-industry transaction table consists of inter-industry transactions, also called intermediate demand, final demand transactions with consumers such as households, government, capital goods sector and markets outside the region, and a third section, final payments, also called primary inputs.

4.3.3.2 Definitions and Conventions

REGION

The geographical region is the 37 counties in three states known as the Western Montana Corridor (WMC). The region is bounded by Spokane and Pend Oreille counties in eastern Washington on the west to Yellowstone County in Montana on the east. Lemhi County, Idaho forms the southwest corner and Toole County, Montana forms the Northeast corner (Figure 4.3.1).

BASE YEAR

The base year for the analysis is 2011.

SECTORING PLAN

Sectors were aggregated at two levels: a 10 sector model and a 66 sector model. The 10 sector model is developed mainly to allow ease of model development using a smaller number of sectors, and to determine the sensitivity of the models to sector aggregation. We report results using the 66 sector model. Table 4.3.1. describes the 66 sectors.

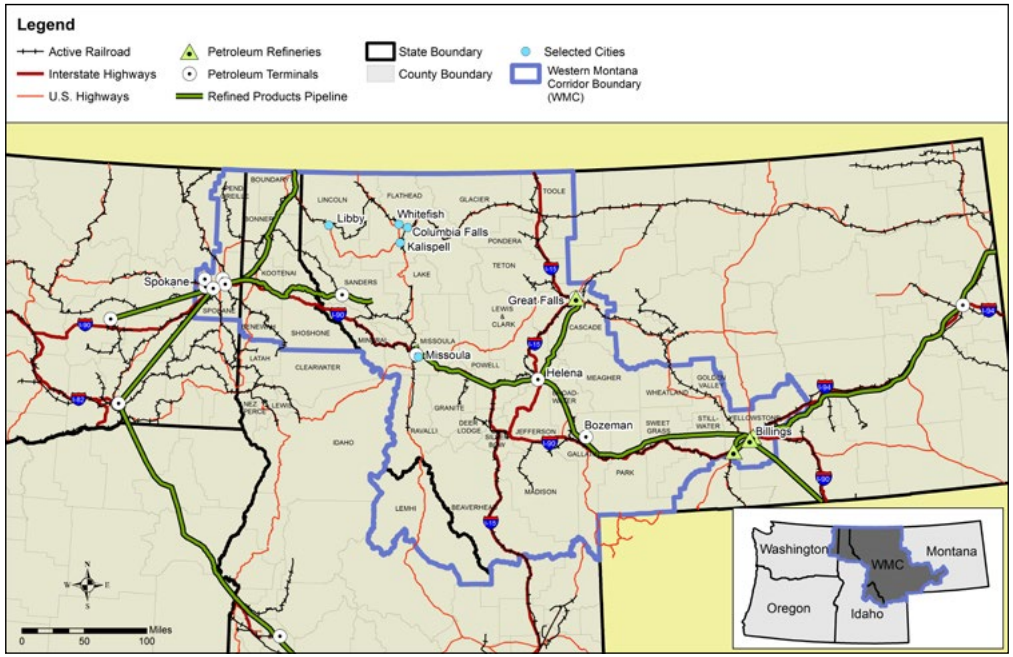

Figure 4.3.1 Map of the Western Montana Corridor region

Table 4.3.1. Numbering and naming convention with a description of sectors

Sector Number	Sector Name	Sector Description
1	FARMS	Farms
15	FORFISH	Forestry fishing and related activities
20	OGEXTRACT	Oil and gas extraction
21	MINING	Mining except oil and gas
28	MINESUP	Support activity for mining
31	UTILITIES	Electricity and other utilities
34	CONSTR	Construction and maintenance activities
41	FOOD	Food beverage and tobacco
75	TEXTILE	Textile mill and textile products
86	APPAREL	Apparel and leather and allied products
95	WOODPROD	Wood products
104	PAPER	Paper products
113	PRINT	Printing activities
115	PETRO	Petroleum and coal products
120	CHEM	Chemical Products
142	PLASTIC	Plastic and rubber
153	NOMETAL	Nonmetallic mineral products
170	PRIMMETAL	Primary metals manufacturing
179	FABMETAL	Fabricated metals manufacturing
203	MACH	Machinery
234	COMPELEC	Computer and electronic products
259	ELECEQ	Electrical equipment appliances and components
276	MOTORV	Motor vehicles bodies trailers and parts
284	OTHTRANS	Other transport equipment
295	FURNITURE	Furniture and related
305	MISCMANU	Miscellaneous manufacturing
319	WHOLE	Wholesale trade
320	RETAIL	Retail
332	AIR	Air transportation
333	RAIL	Rail transportation
334	WATER	Water transportation
335	TRUCK	Truck transportation
336	TRANSIT	Transit and ground transportation
337	PIPE	Pipeline transportation
338	OTHERTRANS	Other transportation and support activities
340	WHARE	Warehousing and storage
341	PUBLISH	Publishing
346	MOTION	Motion pictures and sound recording industries
348	BROAD	Broadcasting and telecommunications
350	INFO	Info and data processing industries
354	FED	Federal reserve bank
356	SECURITIES	Securities commodity contracts and investments
357	INSURE	Insurance carriers and related activities
359	TRUSTS	Funds trusts and other financial instruments
360	REALES	Real estate
361	IMPUTE	Inventory adjust and owner occupied dwellings
362	RENT	Rental and leasing services
367	LEGAL	Legal services
368	MISCSERV	Miscellaneous services
371	COMPU	Computer system designs and related services
381	MANAGE	Management and support services
382	ADMIN	Administrative and support
390	WASTE	Waste management services
391	EDUC	Educational services
394	AMBUL	Ambulatory health care services
397	HOSPI	Hospital and nursing services
399	SOCIAL	Social services
402	PERF	Performing arts and related activities
407	AMUSE	Amusement industries
411	ACCOM	Accommodations
413	FOODSER	Food services and drinking places
414	OTHERSER	Other services except government
427	FEDENT	Federal enterprises
430	STATEENT	State enterprises
437	STATEPAY	State general
439	FEDPAY	Federal general

4.3.4 APPLICATION OF THE INPUT-OUTPUT MODEL

4.3.4.1 Descriptive Analysis

Employment in the WMC region was 928,817. Industrial output is the sum of the value added across all sectors in the economy plus intermediate demand from industrial uses and reached nearly $120 billion. Gross regional product, measured as value added, which is the sum of wages and other incomes paid, totaled $63 billion.

Table 4.3.2 presents the employment, gross regional product (value added), and industrial output by county. Spokane is the county with the largest economy representing 29%, 31%and 28% of employment, value added and industrial output within the WMC region respectively. Golden Valley is the county with the smallest economy representing less than 0.1% of the regional economy in employment, value added and industrial output.

Table 4.3.2. Employment Value added and industrial output by county in the WMC region

County	Employment	Percent	Value Added ($MM)	Percent	Industrial Output ($MM)	Percent
Beaverhead	5,618	0.60%	$401	0.63%	$764	0.64%
Benewah	4,937	0.53%	$280	0.44%	$533	0.45%
Bonner	22,985	2.47%	$1,279	2.02%	$2,604	2.18%
Boundary	5,328	0.57%	$284	0.45%	$568	0.47%
Broadwater	2,141	0.23%	$119	0.19%	$247	0.21%
Cascade	50,890	5.48%	$3,894	6.14%	$7,718	6.45%
Deer Lodge	5,413	0.58%	$286	0.45%	$462	0.39%
Flathead	58,176	6.26%	$3,394	5.35%	$6,393	5.34%
Gallatin	64,896	6.99%	$3,781	5.96%	$6,732	5.62%
Glacier	7,066	0.76%	$452	0.71%	$760	0.64%
Golden Valley	546	0.06%	$22	0.04%	$52	0.04%
Granite	1,862	0.20%	$81	0.13%	$173	0.14%
Jefferson	5,731	0.62%	$352	0.55%	$637	0.53%
Kootenai	74,883	8.06%	$4,486	7.07%	$8,521	7.12%
Lake	13,428	1.45%	$715	1.13%	$1,308	1.09%
Lemhi	3,730	0.40%	$224	0.35%	$390	0.33%
Lewis and Clark	53,608	5.77%	$3,577	5.64%	$5,399	4.51%
Lincoln	8,812	0.95%	$562	0.89%	$1,021	0.85%
Madison	5,688	0.61%	$307	0.48%	$597	0.50%
Meagher	891	0.10%	$49	0.08%	$100	0.08%
Mineral	2,020	0.22%	$98	0.16%	$194	0.16%
Missoula	73,139	7.87%	$4,419	6.96%	$7,796	6.51%
Park	9,268	1.00%	$465	0.73%	$905	0.76%
Pend Oreille	4,554	0.49%	$341	0.54%	$625	0.52%
Pondera	3,328	0.36%	$188	0.30%	$417	0.35%
Powell	5,029	0.54%	$266	0.42%	$417	0.35%
Ravalli	18,459	1.99%	$970	1.53%	$1,921	1.61%
Sanders	5,144	0.55%	$284	0.45%	$546	0.46%
Shoshone	6,743	0.73%	$566	0.89%	$970	0.81%
Silver Bow	19,769	2.13%	$1,785	2.81%	$3,079	2.57%
Spokane	265,390	28.57%	$19,865	31.30%	$33,339	27.85%
Stillwater	5,243	0.56%	$674	1.06%	$1,086	0.91%
Sweet Grass	2,559	0.28%	$232	0.37%	$386	0.32%
Teton	4,065	0.44%	$250	0.39%	$530	0.44%
Toole	3,559	0.38%	$277	0.44%	$534	0.45%
Wheatland	1,088	0.12%	$56	0.09%	$152	0.13%
Yellowstone	102,830	11.07%	$8,181	12.89%	$21,830	18.24%
Total	928,817	100.00%	$63,462	100.00%	$119,706	100.00%

4.3.4.2 Impact Analysis

TECHNICAL INPUT-OUTPUT

The possible introduction of a new bioenergy sector in the WMC that utilizes manufacturing plants, equipment, labor, and forest residue feedstock, among other variable inputs, to produce biojet fuel creates economic activity. We measure the impact from this new economic activity by developing input-output tables that examine the expenditures made by paying wages to variable inputs, workers and feedstock. The analysis of expenditures together with the use of input-output models allows us to measure how the direct economic effects ripple through the economy to generate additional indirect and induced impacts. Indirect impacts measure the effects of purchases by forest-related businesses for their variable inputs on the economy. Induced impacts capture spending by, say, the forestry firm's labor force and owners as well as the wages and dividends they earn. Knowing the expenditure profile of the bioenergy sector allows the estimation of the total (direct and indirect) economic impact using input-output tables. Induced impacts can be estimated by applying wage and dividends generated by the firm to an average household expenditure pattern and then by estimating the ways in which these expenditures produce further economic activity.

We report results on three measures of impact defined below: 1. Direct and indirect impacts: Added industrial output directly and indirectly attributed to new expenses made; 2. Induced effects: Value of compensation (wages, benefits and other income sources) paid to employees and owners and the ripple effect through the economy; 3. Employment: Number of jobs.

Aggregation of sectors is completed using IMPLAN modeling software. An alternative aggregation software using GAMS was also developed and compared to IMPLAN-derived matrices. The principle differences between the two are assumptions regarding the value of trade contained in the transaction tables. Transaction tables produced using the IMPLAN modeling software are then imported into spreadsheets that calculate direct purchase coefficients, and from these coefficients, multipliers for each aggregated sector.

TECHNICAL INPUT-OUTPUT

Multipliers are calculated using IMPLAN data on industry transactions for 10 and 66 sector models. Table 4.3.3 presents the multipliers calculated for Toole County for the 10 sector model as an example. It includes the multiplier associated with value added (last row). The value-added multiplier is the total value added generated in all sectors of the economy per dollar of output in the industry. It is used to calculate the induced effect, and works with the personal consumption expenditure (PCE) (last column). The multiplier table is a square table (number of rows equals the number of columns) with the values in the diagonal cells equal to the direct effect, and numbers off-diagonal under the sector-heading column equal to the indirect effects. Column sums, excluding the value added multiplier, gives the total (direct and indirect) economic effect. For instance, the total effect per dollar of output in the AG industry is $1.60, i.e., the sum of 1.10814 through 0.01323.

Table 4.3.3. Multipliers for the 10 sector model and value added sector for Toole County

SECTOR	AG	MINING	UTILITIES	CONST	MANUF	WHOLE	RETAIL	TRANSWHR	SERVICES	GOVT	PCE
AG	1.10814	0.00439	0.00391	0.00410	0.02096	0.00447	0.00000	0.00289	0.00431	0.00424	0.00432
MINING	0.04199	1.12489	0.24234	0.04319	0.14776	0.02739	0.00000	0.04104	0.02709	0.02913	0.02508
UTILITIES	0.03356	0.04664	1.02925	0.02321	0.03174	0.03355	0.00000	0.02264	0.03154	0.02927	0.02847
CONST	0.00716	0.04512	0.02685	1.00444	0.01039	0.00628	0.00000	0.01122	0.00941	0.00604	0.00376
MANUF	0.01029	0.00900	0.00728	0.01006	1.01535	0.00635	0.00000	0.01083	0.00628	0.00633	0.00605
WHOLE	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000
RETAIL	0.06088	0.06724	0.08143	0.09903	0.05999	0.09143	1.00000	0.06195	0.07769	0.09900	0.10145
TRANSWHR	0.03850	0.04179	0.07780	0.03060	0.03969	0.05682	0.00000	1.12448	0.03198	0.02832	0.02727
SERVICES	0.28990	0.42167	0.41878	0.36211	0.25071	0.47471	0.00000	0.36103	1.52523	0.42770	0.43015
GOVT	0.01323	0.01771	0.01659	0.01274	0.01232	0.02243	0.00000	0.02763	0.02000	1.01636	0.01572
Value added	0.57551	0.67405	0.96568	0.85569	0.39255	1.01119	0.00000	0.64936	0.90132	1.24893	1.28932

WMC MULTIPLIERS

Multipliers for the 10 and 66 sector models are contained in workbooks and are available from the authors upon requests. Included in the workbooks is an Impact Summary worksheet that calculates the total impact associated with new economic activity. In addition to industrial input-output and value-added multipliers, direct employment coefficients are calculated from estimates of employment and output in the input-output table. The coefficient measures the total number of jobs per million dollars of output, and is used to calculate the number of jobs associated with new economic activity (Table 4.3.4).

It should be noted that the employment coefficient for the forest sector calculated using IMPLAN data is fairly large. A large number of employees work in the sector with relatively small industrial output. Other sectors with large employment coefficients include social services (SOCIAL: 28.3), performing arts (PERF: 27.6), TRANSIT (22.6), forest and fisheries (FORFISH: 22.5), education (EDUC: 20.4) and food services (FOODSER: 19.0).

IMPACT ESTIMATION PROCEDURE

We measure impacts by multiplying the added economic activity by the input-output multipliers for each county that contributes new economic activity associated with forest residue production or biorefinery plant operations. We calculate the regional impact by adding county-level effects.

New economic activity is defined in two steps. A first step recognizes that forest residue production and collection occurs across the region in varying amounts. The second step assumes that the hypothetical biorefinery most resembles the existing chemical sector in its expenditures with some modifications.

Table 4.3.4. Employment coefficients by sector

Sector	Coefficient	Sector	Coefficient	Sector	Coefficient
FARMS (1)	10.2	MOTORV (276)	1.9	REALES (360)	9.1
FORFISH (15)	22.5	OTHTRANS (284)	3.0	IMPUTE (361)	0.0
OGEXTRACT (20)	3.2	FURNITURE (295)	6.3	RENT (362)	3.9
MINING (21)	2.0	MISCMANU (305)	6.0	LEGAL (367)	9.3
MINESUP (28)	2.9	WHOLE (319)	6.6	MISCSERV (368)	11.2
UTILITIES (31)	1.3	RETAIL (320)	15.0	COMPU (371)	10.1
CONSTR (34)	9.5	AIR (332)	3.9	MANAGE (381)	5.9
FOOD (41)	1.8	RAIL (333)	2.5	ADMIN (382)	18.9
TEXTILE (75)	6.2	WATER (334)	3.1	WASTE (390)	4.1
APPAREL (86)	6.8	TRUCK (335)	7.3	EDUC (391)	20.4
WOODPROD (95)	4.5	TRANSIT (336)	22.6	AMBUL (394)	9.3
PAPER (104)	1.6	PIPE (337)	1.5	HOSPI (397)	10.2
PRINT (113)	0.2	OTHERTRANS (338)	10.3	SOCIAL (399)	28.3
PETRO (115)	0.0	WHARE (340)	17.6	PERF (402)	27.6
CHEM (120)	1.2	PUBLISH (341)	5.9	AMUSE (407)	16.7
PLASTIC (142)	3.8	MOTION (346)	10.4	ACCOM (411)	10.8
NOMETAL (153)	4.0	BROAD (348)	2.5	FOODSER (413)	19.0
PRIMMETAL (170)	1.4	INFO (350)	4.8	OTHERSER (414)	14.2
FABMETAL (179)	4.7	FED (354)	3.3	FEDENT (427)	8.5
MACH (203)	2.9	SECURITIES (356)	7.4	STATEENT (430)	5.8
COMPELEC (234)	2.2	INSURE (357)	5.6	STATEPAY (437)	0.0
ELECEQ (259)	3.2	TRUSTS (359)	2.9	FEDPAY (439)	0.0

FEEDSTOCK IMPACT PROCEDURE

New economic activity associated with feedstock is calculated using estimates of the available feedstock within the WMC region, the average price of the material delivered to either a depot or the refinery site, and an estimated breakout of the activity associated with the transportation and forestry sectors.
Table 4.3.5 contains the location and volume of feedstock. A total of 705,000 bone dry tons (BDT) is assumed available. Table 4.3.5 also contains the valuation and assumed expenses by forestry and transportation sectors. The breakout of forestry and transportation sector percentage of expenses is calculated using Washington state data on forest residue production and cost. Twenty percent of the value of the forest residue is attributable to land rent; the remaining 80% is attributable to transportation. This is a first cut estimation of the breakout between the two sectors.

Table 4.3.5. The location, amount, and value of feedstock

City	County	State	Facility Type	County Forest Residue Volume (BDT)	Valued@$65/ton	20% Land	80% Transportation
Metaline Falls	Pend Oreille	WA	Depot	74,886	$4,867,590	$973,518	$3,894,072
Priest River	Bonner	ID	Depot	29,402	$1,911,130	$382,226	$1,528,904
Athol	Kootenai	ID	Depot	65,066	$4,229,290	$845,858	$3,383,432
St. Maries	Benewah	ID	Depot	93,317	$6,065,605	$1,213,121	$4,852,484
Bonners Ferry	Boundary	ID	Depot	75,233	$4,890,145	$978,029	$3,912,116
Noxon	Sanders	MT	Depot	36,081	$2,345,265	$469,053	$1,876,212
Thompson Falls	Sanders	MT	Depot	36,081	$2,345,265	$469,053	$1,876,212
Libby	Lincoln	MT	Depot/Biorefinery	50,417	$3,277,105	$655,421	$2,621,684
Fortine	Lincoln	MT	Depot	50,417	$3,277,105	$655,421	$2,621,684
Columbia Falls	Flathead	MT	Depot	69,669	$4,528,485	$905,697	$3,622,788
Pablo	Lake	MT	Depot	25,182	$1,636,830	$327,366	$1,309,464
Missoula	Missoula	MT	Depot/Biorefinery	69,498	$4,517,370	$903,474	$3,613,896
Darby	Ravalli	MT	Depot	5,462	$355,030	$71,006	$284,024
Deer Lodge	Powell	MT	Depot	24,057	$1,563,705	$312,741	$1,250,964
Total					$45,809,920	$9,161,984	$36,647,936

BIOREFINERY IMPACT PROCEDURE

The hypothetical biorefinery plant consists of estimates of the manufacturing costs to produce biojet fuels. Preliminary estimates are for a manufacturing process that includes two recently identified and quantified co-products: Lignosulfonates from spent sulfite liquor that be used in cement additives, for example, and activated carbon from hydrolyzed, fermented, distilled pulp solids. We compared the expenditures associated with the biorefinery to the wood products and chemical manufacturing sectors already existing in the WMC, and found similarities in the purchase coefficients between the biorefinery and the chemical manufacturing sector, with some noted exception. For one, feedstock purchases from the forest sector do not exist in the chemical sector. The purchase coefficients were sufficiently similar to use expenditures from the chemical sector as an initial point of investigation to study the hypothetical biorefinery (Table 4.3.6).

Table 4.3.6. A comparison of purchase coefficients between a hypothetical biorefinery and the chemical sector in the WMC

Sector	Purchase Coefficient	Purchase Coefficient
Feedstock and handling	0.10	0.08
Various materials (enzymatic, fermentation processes and others)	0.14	
Chemical sector purchases (assumed feedstock)		0.16
Utilities plus power boiler	0.03	0.03
Fixed costs (Labor, prop tax, insurance,)maintenance	0.14	0.16
Total manufacturing costs (has fixed costs, no taxes)	0.46	0.46
Income tax	0.05	0.01

Notes: Purchase coefficients (1) are for biorefinery; purchase coefficients (2) are for chemical sector. They are calculated as the value of purchases in each sector divided by the total industrial output.

4.3.5 RESULTS

Results are presented in the following order. The impacts on all sectors from expenditures on forest residues are presented first, followed by a table with the biorefinery impacts on all sectors. The two tables are used to present the economic impact associated with a new biorefinery plant located in the WMC region.

DIRECT AND INDIRECT IMPACTS

The direct plus indirect effects from feedstock purchases amount to $74 million (Table 4.3.7). These effects from biorefinery operations equal $459 million (Table 4.3.8). The expenditures combined from a new biorefinery in the WMC region sum to $533 million.

INDUCED EFFECTS

Value added from expenditures associated with forest residues amounts to $36 million (Table 4.3.7). The induced effect associated with biorefinery operations equals $143 million (Table 4.3.8). Combined, the expenditures induce household and other institutions to spend an additional $179 million.

EMPLOYMENT

Employment in the forestry and transportation sectors associated with added activity to deliver forest residue feedstock to the biorefinery amounts to 736 new employees (Table 4.3.7). The biorefinery operations add 1,754 new employees (Table 4.3.8). Together the number of new employees amount to 2,490.

Table 4.3.7. Direct, indirect and induced effects from $35.2 MM additional spending on feedstocks

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

Table 4.3.8. Direct, indirect and induced effects from $203.6 MM additional spending on biorefinery operations

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

OTHER ECONOMIC CONSIDERATIONS

Since forest residue production occurs across different counties with varying levels, the new demand from the biorefinery operations will affect local economies according to their potential to supply residues. In some counties the impact the new economic activity created by the biorefinery installation is substantial. Five counties increase their value added (gross county output) by greater than 0.9 percentage points. Benewah County expands its gross county output by 1.5% (Table 4.3.9.)

Table 4.3.9. Percent changes in employment, value added and industrial output from new feedstock demand

	Employment	Value Added	Industrial Output
Benewah County	1.63%	1.50%	2.43%
of Total	0.01%	0.01%	0.01%
Bonner County	0.14%	0.11%	0.18%
of Total	0.00%	0.00%	0.00%
Boundary County	1.43%	1.18%	1.88%
of Total	0.01%	0.01%	0.01%
Flathead County	0.14%	0.12%	0.20%
of Total	0.01%	0.01%	0.01%
Kootenai County	0.10%	0.09%	0.14%
of Total	0.01%	0.01%	0.01%
Lake County	0.24%	0.18%	0.30%
of Total	0.00%	0.00%	0.00%
Lincoln County	1.31%	0.91%	1.55%
of Total	0.01%	0.01%	0.01%
Missoula County	0.11%	0.11%	0.17%
of Total	0.01%	0.01%	0.01%
Pend Oreille County	1.28%	0.93%	1.56%
of Total	0.01%	0.00%	0.01%
Powell County	0.45%	0.38%	0.78%
of Total	0.00%	0.00%	0.00%
Ravalli County	0.03%	0.03%	0.04%
of Total	0.00%	0.00%	0.00%
Sanders County	1.53%	1.16%	1.98%
of Total	0.01%	0.01%	0.01%
All Counties	0.08%	0.06%	0.09%

4.3.6 FUTURE WORK

We report results using IMPLAN data and models that calculate industry input-output multipliers, value-added multipliers and employment coefficients. We combine these data and models that calculate the effects new economic activity has on existing economies in the WMC region with estimates of expenditures from a hypothetical biorefinery and production of forest residues delivered to depots or a refinery. We chose to use multipliers associated with chemical sector after a comparison between expenses associated with the hypothetical biorefinery and the chemical sector in the WMC region. The study method used chemical-sector multipliers subtracting the expenses associated with feedstock purchases, and used the forest and transportation sector multipliers to assess feedstock purchases. This is akin to saying that the biorefinery operations industry has a business separate that is in charge of purchasing feedstock and then passes it along to its "parent" business, without additional charge. While the procedure produces estimates of the economic impacts, there is room to improve upon the data associated with both expenses for feedstock and biorefinery operations.

As an alternative methodology, we can insert a new biorefinery sector in the input-output tables. While data on purchases made by the biorefinery may not be lacking, data on other sector and household and government institution uses of products made by the biorefinery would be needed. We will explore this option as we develop the data and models for the western Washington and western Oregon regional study, and update this study for the WMC region.

Employment coefficients calculated from IMPLAN employment numbers seem high. Forestry is often thought of as a capital intensive industry since the time value is so high. We will investigate whether further disaggregation from fisheries affects the results presented here.

Imports play a role in determining the multipliers since they affect purchase coefficients. We assume that purchases outside the county and region reflected in the current purchase coefficients are adequate. We will continue to explore regional purchase coefficients and their methods of calculation by IMPLAN procedures.

One time purchases for the biorefinery plant are not included in the analysis and will be completed in future updates.

We will investigate the industry by commodity accounts to describe how sales of products including the co-products leads to added economic activity. The approach is related to the point raised above in paragraph 2.

New estimates of feedstock availability are being calculated using the NARA model by Darius Adams and Greg Latta out of Oregon State University. We will use these estimates when made available to revisit feedstock purchase impacts on economics in the WMC.