Report on

Feedstock availability for Filer City powerplant and its economic impact to the state.

For

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Abbreviations

AEO	Annual Energy Outlook by EIA
CEO	Chief Executive Officer
dt	dry US tons
EIA	US Energy Information Administration
DNR	Department of Natural Resources
FIA	Forest Inventory Analysis
GDP	Gross Domestic Product
gt	green US tons
IMPLAN	Impact Analysis for Planning
MI	Michigan
LP	Lower Peninsula of Michigan
LURA	Land Utilization and Resource Allocation Model
MDNR	Michigan Department of Natural Resources
UP	Upper Peninsula of Michigan
USDA	United States Department of Agriculture
US EPA	United States Environment Protection Agency
WI	Wisconsin

Executive Summary

This proposed bio-energy facility has the potential to stimulate local economy, utilize available biomass, and accomplish the sustainability initiatives of NorthStar Clean Energy with its full conversion to renewable feedstock sources. It has been determined that to meet the objective of NorthStar Clean Energy, the plant requires 680,000 *green tons (gt)*/year of biomass feedstock. To estimate the feedstock availability, network analysis is outlined to determine procurement zones from which this biomass could be sourced at current market prices. Procurement zones are then overlayed with USDA Forest Inventory and Analysis (FIA) plots to estimate the historical biomass availability of biomass. Next, the Land Utilization and Resource Allocation (LURA) model is used to evaluate future biomass availability from different sources to satisfy the annual capacity. LURA is a partial equilibrium model used to determine the optimal allocation of resources while considering cross-sectoral supply and demand interactions. The supply of forest products is accounted for using growth and yield with FIA data, and the demand for forest products is estimated using Annual Energy Outlook projections from the US Energy Information Agency (EIA). Ten (10) scenarios were developed, with a biopower facility at Filer City and depots at Escanaba, Menominee, Cedarville, and Gulliver to procure biomass in the Upper Peninsula of Michigan (UP) and barge to Filer City. We assume an average delivered wood price of $25/*gt* for forest biomass in Michigan based on surveys done by Michigan DNR and $10/*gt* for barging cost (provided by NorthStar).

If biomass is only procured around the Filer City (no UP depot), the 10-year average (2009-19) available biomass from forests was estimated at 30.90 million dry tons. Historic availability of biomass from Filer City and Escanaba Depot in UP (Scenario 2) indicated 10-year average availability at 38.77 million dry tons when $10/*gt* is used for barging biomass from Escanaba. The available biomass increased to 41.45 million *dt*/year and 48.85 million *dt*/year as we increased the depots to two (Menominee and Gulliver) and four (Escanaba, Menominee, Gulliver, and Cedarville) locations, respectively. The future availability of biomass from the LURA model outputs indicated that more than half of the feedstock demand (371 thousand *dt*/year) for Filer City would be available in the form of softwood pulp logs, and the remaining amount (309 thousand *dt*/year) would be primary forest product manufacturing facilities (mill) residuals from nearby forest products manufacturing facilities, primarily sawmills. The average cost of procuring feedstock around Filer City is $27.21/*gt* with the specific cost of mill residues at $25.09/*gt* and forest biomass (pulp logs) at $29.48/*gt*. The cost of procuring forest biomass is higher than mill residues. If the Filer City facility only utilized forest biomass, almost all of the biomass used would be softwood pulp logs (613,000 thousand *dt*/year) with about 67 thousand *dt*/year of hardwood logs and a higher average cost of biomass of $30.14/*gt.*

When depots in UP are included in the analysis, the mix between the forest biomass and mill residues stays similar. The Filer City facility with a depot in Escanaba feedstock supply was estimated at 308 thousand *dt*/year from forests and 372 thousand *dt*/year from sawmills. Of the 308 thousand *dt*/year of feedstock from forests, 100 thousand *dt*/year comes through the Escanaba depot. The cost of procurement from Escanaba is higher than around the Filer City location. The average cost of biomass feedstock is $32.70/*gt* when half of it comes from UP through the Escanaba depot and port. If only forest biomass is procured in this scenario, the average cost is slightly higher at $33.76/*gt*. The Filer City facility with

depots in Menominee and Gulliver (Scenario 4) resulted in 305 thousand *dt*/year from forests and 375 thousand *dt*/year from sawmills as feedstock for the facility. Of the 305 thousand *dt*/year of feedstock from forests, 11 and 166 thousand *dt*/year come from the Menominee and Gulliver depots, respectively. The average cost of biomass is $31.93/*gt* when about two-thirds of biomass is procured and barged from UP. The average cost is slightly lower at $31.38/*gt* if only biomass from forests (pulp logs) were used in Scenario 4. The average cost of biomass was $32.15/*gt* if forest biomass (pulp logs) is procured equally (one-fifth of the demand) from the Filer City and depot in Escanaba, Menominee, Gulliver, and Cedarville (Scenario 5). The lowest cost of logs in this scenario was at the Filer City location ($29.34/*gt*) and the highest when procured through Gulliver depot ($36.07/*gt*).

The economic impact analysis was done using IMPLAN (Impact Analysis for Planning) based on the number of employees and employment compensation provided by NorthStar. The direct, indirect, and induced effects of the facility conversion were assessed. In addition to the 40 direct employees at the facility, there are an additional 104 indirect jobs and 76 induced jobs leading to a total number of 220 jobs in Michigan created with an upgrade to the Filer City biopower facility to utilize 680,000 *gt*/year. The direct value added due to increased usage of biomass for bioenergy is $15.87 million in 2021 dollars in Michigan economy, which will add $18.64 million indirect and $7.45 million in induced value added. This leads to a total added value of $100.11 million. The total output in the economy is $100 million, where $47.35 million is the direct output, $39.57 million is the indirect output, and $13.19 million is the induced output. Since 40 jobs are directly created from facility conversion, we assume 40 jobs are retained as long as the facility is operational with 680,000 *gt*/year biomass consumption. Individual employee wages are estimated at $137,000 and determined from the division of direct labor income by the number of retained employees. The direct labor income was $5,480,000, as reported by IMPLAN analysis. The Michigan Average for 2022 income is $58,000, as reported by the Bureau of Labor Statistics (whereas the mean annual income of a powerplant factory employee in Michigan is $91,810 (Bureau of Labor Statistics 2023). Hence, the employee wages of the retained 40 individuals are $79,000 above the regional average and $45,190 above the industry average. However, the wages could vary a lot between personnel based on specificity (engineers), managerial (CEO, CFO), and general (equipment operators and labors) appointments. Additionally, bioengineers have an average salary of $97,350 in Michigan, while the typical Chief Executive Officer (CEO) in this region will earn $312,710.

In conclusion, there is a large quantity of biomass available to accomplish NorthStar's goals and initiatives. These results, in tandem with the economic impacts and benefits, indicate that moving forward with the facility's conversion would impact the state economy in a positive way in addition to creating markets for low-value wood, and residuals.

1. Background

Energy production for goods and services is vital in a nation's economic and social development (Asghar, 2008). The United States spent close to $1 trillion USD on energy production, this is equivalent to 4.8% of the country's total Gross domestic Product (GDP) (Ackerman and Pulkki 2004). Primary energy sources in the United States are derived from natural gas, coal, petroleum and some renewable sources such as biomass. About 12% is of the renewable energy comes from woody biomass (Ackerman and Pulkki 2004). Various efforts have been introduced and promoted to encourage the use of renewable energy sources and decrease GHG emissions in the atmosphere. One such policy is to produce electricity using biomass. The current total share of biomass energy consumption in the US is 5%, and the US government is promoting an increase in its contribution to the total energy consumption (Mueller et al. 2009). Biomass energy can be sourced from wood and woody waste materials. These waste materials include chips, pellets, firewood, lumber, furniture, pulp, and paper mill waste. These biomass feedstocks are then directly converted to heat energy via ignition (or burning) or other thermochemical conversion processes such as pyrolysis or gasification (Roy and Dias 2017).

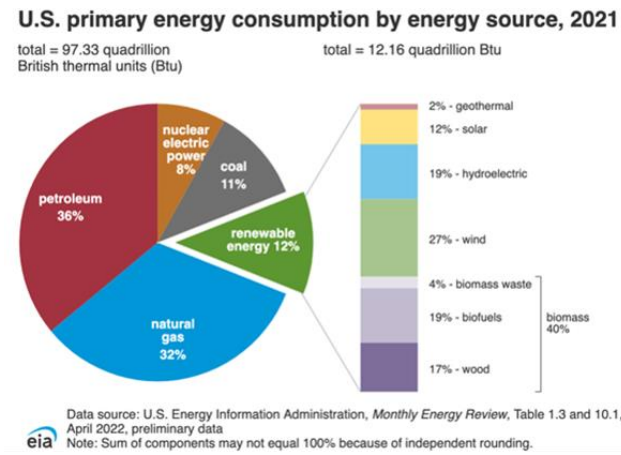

Figure 1. Energy consumption by energy source in the United States, 2021 (EIA, 2022).

Under the current administration, the United States is gearing up to reduce greenhouse gas emissions for climate change mitigation goals. With growing interest in the use of biomass in the energy sector in the last decade, coupled with its renewability and lower cost, the demand is expected to increase. Optimizing biomass feedstock procurement logistics stands as the major constraint for its economic viability (Atashbar et al. 2018; Han et al. 2018b; Visser et al. 2022).

Michigan is a state rich in forest resources, where almost 55% of the land is forested (Stewart 2005). According to the USDA Forest Service (USDA Forest Service 2020), approximately 62% of Michigan's timberland is privately owned, 23% is owned by state and local governments, and 15% is owned by the federal government. Michigan has an estimated 20 million acres of forestland. In Michigan, annual growth on growing stock is 0.74 billion cubic feet, while annual removal on growing stock equates to 0.30 billion cubic feet (Figure 2). Annual mortality on growing stock is

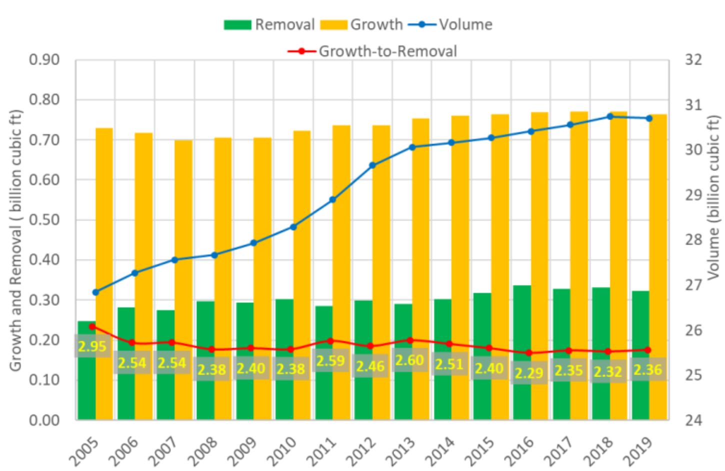

Figure 2. Growth, Removal, merchantable timber volume, and Growth-to- Removal (Growth-to-Drain) ratio in Michigan

estimated at around 0.29 billion cubic feet. Of Michigan's 20 million acres of forestland, 305,445 acres are treated by cutting (harvest, thinning, and other tending mechanisms) annually (USDA Forest Service 2020). The growth has historically been higher than removals in Michigan, with an average growth-to-removal or growth-to-drain ratio of 2.47, indicating that only about 41% of annual growth is removed and utilized. Figure 2 shows the historical growth, removal, total timber volume and growth-to-drain ratio between 2005 and 2019 in Michigan. Thus, Michigan has the potential for biomass procured for bioenergy production.

The Filer City biopower facility is expected to utilize 680,000 green tons (*gt*) of biomass per year with ongoing upgrades at the facility. The facility is located in Filer City in the Lower Peninsula of Michigan (LP), on the coast of Lake Michigan, with an opportunity to procure biomass using both roads (trucks) and waterways (barge). Barge transportation can support the procurement of biomass from the Upper Peninsula of Michigan (UP), which holds 45% of the forests in the state (Pugh 2018). NorthStar Clean Energy owns and operates a power plant that currently utilizes coal, tire-derived fuel, biomass, and natural gas as fuel. It desires conversion and upgrades to utilize an additional 680 thousand *gt*/year of biomass annually to produce electricity. The conversion would demand around 2000 *gt*/day to feed the plant. However, economically feasible feedstock supply is uncertain, with competition among existing biomass power generators and other industries acting as a hurdle. The delivery options to the plant could include delivery by truck, rail, and boat utilizing the existing coal dock. Feedstock procurement zones need to be identified to optimize the transportation and procurement costs and estimate available biomass within a feasible cost region to evaluate the economic feasibility of using biomass for power generation. Competition must be determined from those procurement zones, along with the type and amount of biomass from surrounding forests and primary forest product manufacturing facilities (mills). The Filer City facility needs to accrue approximately 680,000 *gt*/year of biomass. The facility plans to procure this woody biomass from nearby forests and mills in LP, procure and collect biomass in depots alongside deep-water ports in UP, and barge it to Filer City. Potential ports and depots are in Escanaba, Menominee, Gulliver, and Cedarville in UP. Just because woody biomass exists in the forests and timberlands does not mean the owner(s) would sell it. More than half of Michigan's private landowners do not manage forests for timber products (Huff et al. 2019). Also, most of the federal and national forests will not sell wood products. Therefore, the availability of woody biomass is dependent on past ownership behaviors and markets.

Objectives

The objectives of this study are as follows: -

1. Create procurement zones and competition hotspots for biomass in Michigan.
2. Estimate available biomass using FIA data at Filer City powerplant and a depot in Escanaba, Menominee, Gulliver, and Cedarville when delivered by trucks.
3. Evaluate fiber (feedstock) availability using Land Utilization and Resource Allocation (LURA) model with increased biomass usage of 680 thousand *gt*/year for 2020-2035.
4. Assess the economic impacts of additional usage of biomass in the state economy.

2. Methodology & Materials

2.1 Data

Data was gathered via personal communications from Michigan's Department of Natural Resources (MDNR), forestry industry stakeholders, and literature. The current delivered biomass price was obtained from MDNR. The road network data was from Esri (Esri Data and Maps 2017). Furthermore, 2019 FIA data was obtained from USDA FIA Datamart (FIA 2021). The Impact analysis for planning (IMPLAN) data for 2021 was bought from IMPLAN Inc. The Land Utilization and Resource Allocation (LURA) model analysis was outsourced to Latta Consulting, Inc., which maintains the required data for the model independently. LURA model, procurement mapping, and data description are available from various published peer-reviewed papers (Latta et al. 2018; Pokharel and Latta 2020; Pokharel et al. 2022; Visser et al. 2022).

2.2 Scenarios for analysis

Table 1 outlines the scenarios and its descriptions that are used for the analysis.

Table 1. Location-based scenarios to estimate feedstock availability.

Scenario	Sub-class	Scenario Name	Depot/Ports	Future Feedstocks	Procurement Proportion
1	1a	*FilerOnly*	None	Forest biomass and mill residues[1]	100% from forests and mills around Filer City
	1b	*FilerOnly_log*	None	Forest biomass only	100% from forests around Filer City
2	2a	*FilerEC*	Escanaba	Forest biomass and mill residues[1]	50% from LP (no barging) and 50% from Escanaba depot
	2b	*FilerEC_log*	Escanaba	Forest biomass only	50% from LP (no barging) and 50% from Escanaba depot
3	3a	*FilerGV*	Gulliver	Forest biomass and mill residues[1]	50% from LP (no barging) and 50% from Gulliver depot
	3b	*FilerGV_log*	Gulliver	Forest biomass only	50% from LP (no barging) and 50% from Gulliver port
4	4a	*FilerMNGV*	Menominee & Gulliver	Forest biomass and mill residues[1]	One-third of feedstock from LP (no barging) Menominee and Gulliver ports
	4b	*FilerMNGV_log*	Menominee & Gulliver	Forest biomass only	One-third of feedstock from LP (no barging) and Menominee and Gulliver ports
5	5	*FilerAll_log*	Escanaba, Cedarville, Menominee, & Gulliver	Forest biomass only	One-fifth of feedstock from LP (no barging) and Escanaba, Cedarville, Menominee, and Gulliver ports, respectively

[1] allocated optimizing the cost by the model.
Note: Use the Excel dashboards to look at other scenarios for more information on feedstock availability and projections not included in this report.

2.3 Procurement zone identification

Efficient procurement logistics is important in the economic viability of woody biomass industry as transportation comprises a significant share of biomass's final delivered price (Stewart 2005; Atashbar et al. 2018). Lack of cost-effective logistics is a hurdle in efficient supply chain and utilization of unutilized resources in the locality (Woo et al. 2020). Studies have built and used optimization frameworks in assessing the procurement logistics for the merchantability of forest products at different scales of operations and strategic planning (Han et al. 2018b). Some major optimization frameworks are based on minimizing hauling time and total costs and maximizing the total profit and net present value (Atashbar et al. 2018). Assessment of the merchantability of the biomass feedstocks is important to examine the existing and potential competition over the available feedstock as well as sustained supply at a competitive price (Yemshanov et al. 2014; Pokharel and Latta 2020). With the increase in demand of biomass residues, the competition over resources will increase, which would further drive the prices up thus, managers are interested in exploring time-effective and cost-effective options for procuring sustained resources (Yemshanov et al. 2014). Studies have used GIS-based road network optimization interface in assessing the procurement areas, competition hotspots for resources, optimal size, and the number of establishing forest-related industries, optimizing costs of transportation, and establishing and analyzing various transport scenarios to identify short haul transport (Brewington et al. 2000; Ackerman and Pulkki 2004; Stewart 2005; Alam et al. 2012; Han et al. 2018a; Pokharel and Latta 2020; Woo et al. 2020; Visser et al. 2022). Other factors, such as varying biomass production levels, export levels, and potential availability of logging residues optimized on both costs and the resulting carbon fluxes, have also been considered in resource optimization studies (Latta et al. 2018; Visser et al. 2022). Thus, understanding of the available resources and potential competition along with balancing the sustained supply will help interested bioenergy plant owners plan the transportation logistics, identify feedstock supply and costs for the new bioenergy facilities, and benefit from carbon-related incentives for sustainable forest ecosystems and bioenergy production.

We used locations for each scenario (Table 1) and a road network database to determine the geographical extent of each facility or depot's service area using delivered wood prices following the approach developed by Pokharel and Latta (2020; 2022). This is accomplished using the 'Network Analyst' extension in Esri ArcGIS. To map the service area, we converted delivered wood price to haul time as a surrogate for transportation costs using Equation 1 (Pokharel et al. 2022).

$$t = \left(0.5 * \frac{(p - p_h - p_s) * w}{r} * 60\right) - t_l \qquad 1$$

where, t is the transportation or haul time supported by p, p is the current price of the average mill delivered wood, p_h is the cost of harvesting wood products, p_s is the stumpage price, w is the weight limit of a truck trailer to haul wood products, r is the cost of operating a truck for an hour, and t_l is the loading and unloading time. For this conversion, we use p = \$25/gt (obtained from Michigan DNR), p_h= 33% of delivered wood prices, p_s = 0 (assumes no stumpage price is paid for biomass), w = 25 gt (a conventional trailer carries this much of chips), r = \$85/hour (calculated using costs of a truck, fuel, labor, etc., and cross verified with stakeholders) and t_l = 40 minutes (only includes time while the engine is running). These numbers were obtained from forestry stakeholders, Michigan DNR, and calculated at Forest Economics Lab at MSU.

The competition hotspots were generated using the same method stated above for all biomass facilities (27) in the Lake States region by overlapping their procurement zones. Based on these hotspots, we created competition classes or quintiles to identify regions where competition is high and regions without competition. A competition hotspot is a region where several biomass biopower facilities could potentially compete for feedstock at a given price of biomass.

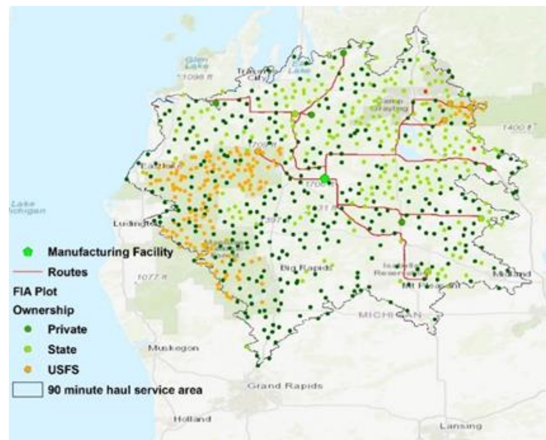

Figure 3. Example of the optimized routes from FIA plots and feedstock allocation to produce bioenergy in Central Michigan.

2.4 Historic woody biomass availability assessment

Once procurement zones for each scenario were identified, they were overlaid individually on top of FIA data (Each FIA plot representants 6 thousand acres of land) using the R package, rFIA (Stanke et al. 2020). This allows for estimating the total biomass available in each plot, which is then aggregated to procurement zones. The estimates were such that they can be classified into different categories – bole, logging residues, and other types along with information on ownerships, species, and locations (county and state). For this study, we only estimated biomass from growing stocks (5 inches or higher in diameter at breast height). This report presents estimates of logging residues (tops and saplings) for each scenario from state- and privately-owned forestlands. Please use the Excel Dashboard to estimate feedstock with various filters (biomass type, ownerships, species, haul cost, county, etc.).

2.5 Future biomass availability assessment using LURA Model

We feed the facility and port locations, haul distance and haul time between all forest product manufacturing facilities (mills) and FIA plots, and manufacturing capacities of each facility into the LURA model (Latta et al. 2018) to identify mills and FIA plots along with estimates of biomass quantities that can supply feedstock at minimal costs to the Filer City facility or ports/depots in the UP. LURA utilizes detailed, spatially explicit forest resource information combined with individual mill data to generate a spatial market equilibrium for forest products while accounting for a cascading wood flow through the supply chain. The model is solved using a dynamic recursive framework meaning that a market-clearing solution is found on an annual basis (static phase), and then the forest resource is adjusted to reflect removals and growth specific to forest type, Eco-Province, and site class, mills change capacity dependent on profitability, and macroeconomic changes shift demand between these annual solutions (dynamic phase).

We allocate exogeneous harvest levels or biomass demand with additional logistical detail from the Filer City biopower plant to evaluate the region's shift in harvesting and forest product utilization. One of the benefits of this modeling approach is that we can establish and assess the impacts of this facility and depots in UP for 2020-2035. Also, LURA solves for the continental US; therefore, the output allows us to track the demand and supply of biomass and market shifts nationally. LURA grows forests using embedded regional growth and yield models and creates forest product demands at each milling facility based on the US EPA's Annual Energy Outlook (AEO) projections. The AEO projections are published yearly and describe annual economic and energy usage changes for the entire country. AEO projections use housing developments, energy usage, industry development, and infrastructure (among other things) to describe the projections for the following year.

Figure 4 shows the cascading of wood flow from the forest to different industries that are tracked in the LURA model. The type of woody biomass is separated into hardwood and softwood, further categorizing them into logs, pulp, sawdust, bark, and woodchips. Finally, we run future projections for scenarios in Table 1 in LURA to estimate the feedstock availability and identify FIA plots and mills to meet the annual demand of 680 thousand *gt*/year of woody biomass at The Filer City powerplant. The output from the LURA model includes different types and quantities of woody biomass available as feedstocks and their corresponding weighted average cost of transporting the feedstock to the Filer City plant and/or the depots. The cost does not include the price paid for the biomass at the source.

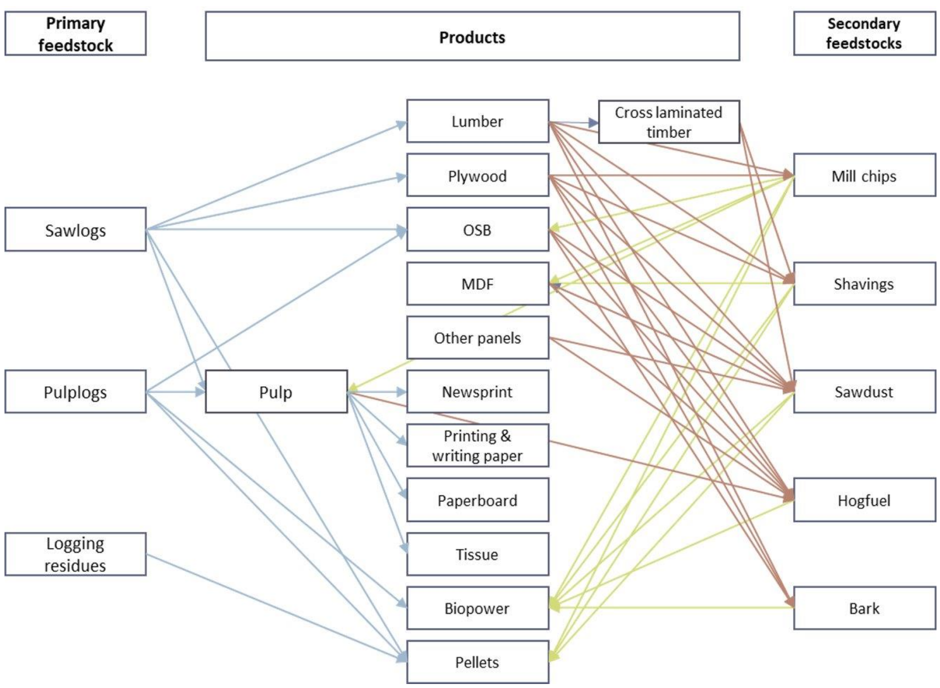

Figure 4. Diagram displaying the cascading flow of wood in the forest product industry used in LURA model (Visser et al. 2022).

2.6 Economic Impact Analysis

The biomass biopower industry influences the economy in three ways: direct (when the industry responds to demand), indirect (initiated by the directly impacted industry through transactions with other industries in the supply chain), and induced effects (household spending by employees in the directly and indirectly impacted industries) (Figure 5). Input-output modeling using IMPLAN

(Minnesota IMPLAN Group Inc. 2004) is a conventional approach to documenting the economic contribution of forest products industries.

Economic contribution analysis is derived from the economic base theory and is an *ex-post* analysis based on the existing economy as described by a social accounting matrix (SAM). It estimates the relative importance of an existing industry to the regional economy. Economic impact analysis on the other hand estimates net changes in new economic activity attributed to an industry, event, or a policy in an existing regional economy (Watson et al. 2007). That is, it estimates the net changes to the economic base of a region given an exogenous shock such as the entry or an exit of an industry (Henderson et al. 2017).

IMPLAN represents the flows of money in an economy among industries, government, and households within a region and imports into and exports out of the region (Dahal et al. 2020). In an Input-Output model like IMPLAN, the flow of money among entities in the economy is arranged according to a set of input-output accounts where a portion of the output (i.e., sales) of one industry will appear as an input (i.e., purchases) of another industry. IMPLAN expresses how income or expenses in one part of the economy ultimately affects other parts based on purchasing and selling relationships. Economic contributions and impacts are generally reported as three components, depending on how they occur: direct, indirect, and induced, as explained in Figure 5. Major economic indicators generated by IMPLAN include employment (full- and part-time jobs as well as self-employed individuals), labor income (employee compensation and propriety income), total output, and value-added.

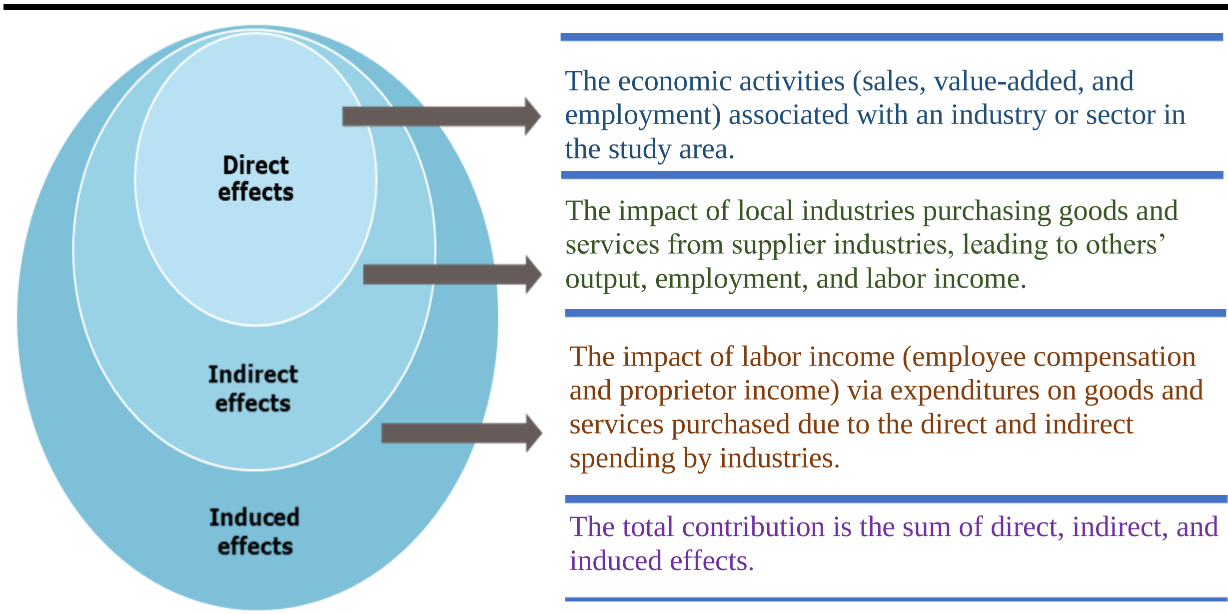

Figure 5. Concept of total economic contribution and impacts analysis (Poudel 2022).

For this study, we utilized employment numbers, employee compensation, and other information specific to the power plant in Filer City provided by NorthStar Company to estimate localized economic impacts inclusive of employment, labor income, gross output, and value-added. Employment represents full-and part-time jobs and proprietors, the gross output represents the value of production by the industry, and value-added is the difference between gross output and intermediate input. We utilized IMPLAN data for sector 45 (Electric power generation using biomass) for 2021; results are reported in 2021 US$.

Assumptions of economic analysis include assumptions typical of input-output models and some unique to IMPLAN. Assumptions typical of input-output models are as follows:

1. Constant returns to scale: the same number of inputs is needed per unit of the output regardless of the level of production (output increase of 5% means input requirements increase by 5%).
2. No supply constraints: the model assumes there are no restrictions to employment and raw materials such that unlimited amount of product can be produced.
3. Fixed input structure: Any changes in an economy will affect the industry's level of output but not the mix of services and commodities needed to produce that output.
4. Same industry technology: An industry uses the same technology to produce each product.
5. Constant make matrix: an industry by-product coefficient is constant. An industry will always produce the same mix of commodities regardless of the level of production. An industry will not increase the output of one product without proportionally increasing the output of all other products.
6. Static model: No price changes are built into the model, rather, it must be updated to reflect changes in price.

Assumptions unique to IMPLAN include a closed economy model, such that the economic analysis is restricted to one region or state. This indicates that the model outputs do not affect the economics of other regions and are not affected by what happens in other regions and states. Additionally, data sources are limited to what is provided through the IMPLAN software.

3. Results

3.1 Historical and future feedstock availability for Filer City Powerplant.

Analysis of FIA data estimates shows that about 30.90 million *dt* (61.80 million *gt*) of biomass is available within the procurement zone around Filer City when $25/*gt* is paid for biomass procurement (transportation+ harvest cost). This includes the biomass from the tops and limbs of growing stocks (trees with a diameter of 5 inches or more). In reality, the biomass would also be available from bole volume unsuitable for lumber, pulp, chips, or other forest products.

Establishing a depot in Escanaba and barging biomass to Filer City would increase the biomass estimate to 60.03 million *dt* (120 million *gt*) for the $25/gt procurement cost. However, there is a cost for barging. If the cost of barging is $10/*gt*, the procurement cost of biomass in ports would be reduced to $15/*gt*. This reduces the total available biomass estimates to 38.77 million *dt* (77.54 million *gt*) at Filer City when biomass is procured at $25/*gt* to the Filer City facility in LP and $15/*gt* to Escanaba port and barged to Filer City at $10/*gt*.

After factoring in the barging costs, the total available annual biomass estimates are 35.11 million *dt* (70.22 million *gt*) for the Filer City facility and Gulliver port, 41.45 million *dt* (82.90 million *gt*) for the Filer City facility and Gulliver and Menominee ports, at 48.85 million *dt* (97.70 million *gt*) for Filer City facility and Cedarville, Gulliver, Escanaba, and Menominee ports when $25/*gt* is paid for procurement, including barging costs.

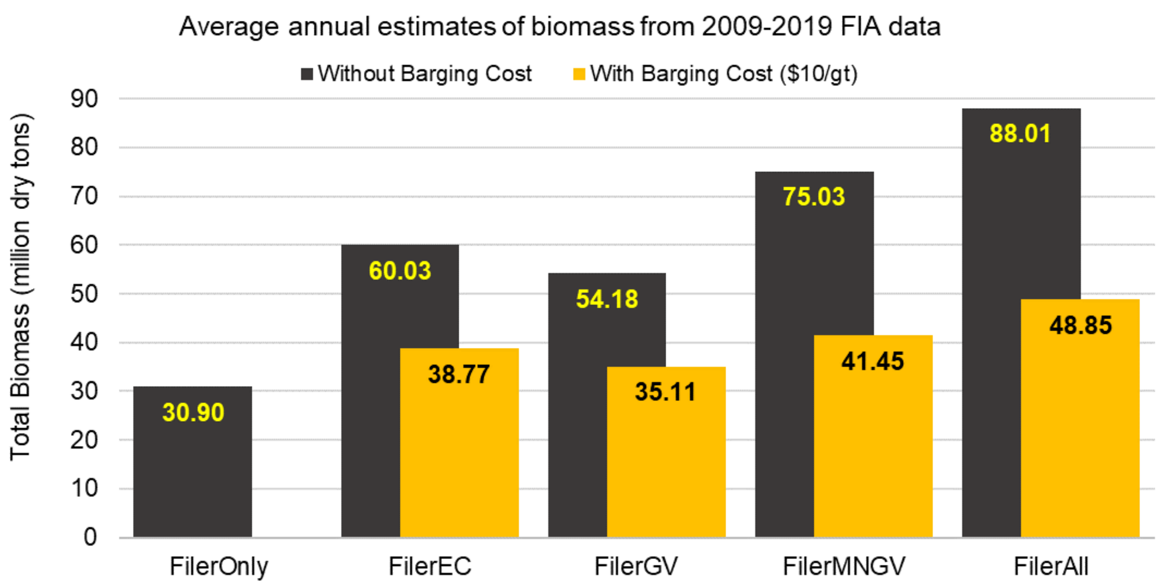

Figure 6. Availability of forest biomass from tops and saplings (logging residues) at $25/gt for various scenarios from growing stocks in private and state-owned forests in Michigan. Yellow bars show biomass availability when $15/gt is paid for biomass at ports and $10/gt is used for barging.

The procurement zone for Filer City and other ports is shown in Figure 7. The map's color scheme of green-to-blue shows lower to higher competition for biomass from other biomass biopower producers. The map shows the higher competition for biomass in Wisconsin, some competition in the LP around Filer City, but no competition for biomass in the Central UP region. We can observe competition from less than five other biomass facilities in Filer City, indicating some competition but not significant to limit biomass availability for the Filer City plant. The estimated demand is 680 thousand *gt*/year for the Filer City facility, which is only about 1.1% of the total available biomass within Filer City's $25/gt procurement zone. Adding a port in Escanaba increases the availability and reduces the proportion of demand to availability to 0.89%. The proportion goes further down with additional ports in UP. This indicates that there is an abundant amount of biomass available for the Filer City facility at a procurement cost of $25/*gt*.

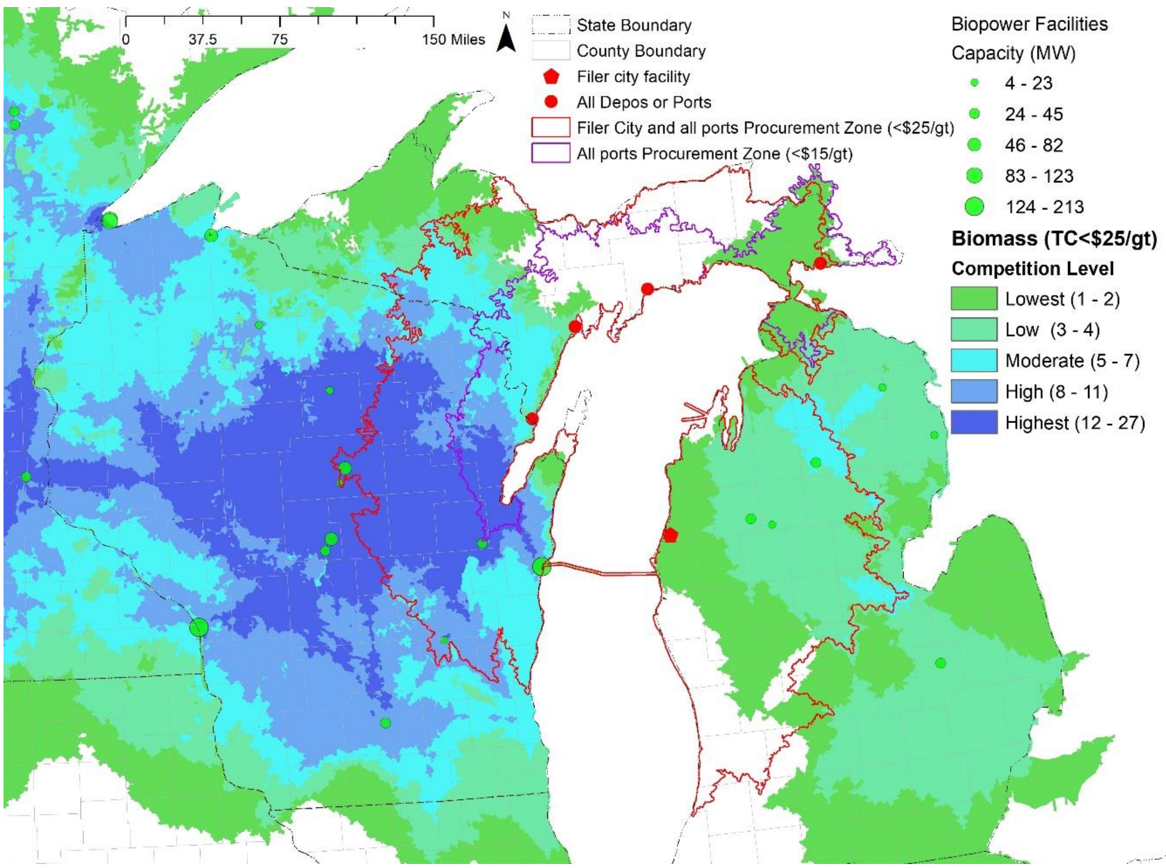

Figure 7. Procurement zone for Filer City *facility and depot at Menominee, Escanaba, Gulliver, and Cedarville ports for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.*

Table 2. Average annual feedstock from LURA model projections for Filer City Powerplants from 2020-2035.

Scenario	Procurement Location	Forest Sources			Mill Sources					Total
		Hardwood Pulplog	Softwood Pulplog	Total	Hardwood Sawdust	Hardwood Shavings	Softwood Sawdust	Softwood Shavings	Total	
		------------------------thousand gt/year -----------------------								
FilerOnly	Filer City	0	370.9	370.9	7.8	84.1	100.0	117.2	309.1	680
FilerOnly_log	Filer City	66.9	613.1	680	x	x	x	x	x	680
FilerEC	Filer City	0	208.6	208.6	31.8	49.9	22.2	27.6	131.5	340
	Escanaba	0	99.9	99.9	15.2	48.0	86.1	90.7	240	340
	Total	*0*	*308.5*	308.5	*47.0*	*97.9*	*108.3*	*118.3*	371.5	*680*
FilerEC_log	Filer City	24.8	315.2	340	x	x	x	x	x	340
	Escanaba	0	340	340	x	x	x	x	x	340
	Total	*24.8*	*655.2*	*680*	x	x	x	x	x	*680*
FilerGV	Filer City	0	208.9	208.9	32.1	49.2	23.3	26.4	131	340
	Gulliver	0	187.5	187.5	5.2	33.8	52.9	60.6	152.5	340
	Total	*0*	*396.4*	396.4	*37.3*	*83.1*	*76.2*	*87.0*	283.6	680
FilerGV_log	Filer City	29.3	310.7	340	x	x	x	x	x	340
	Gulliver	0.4	339.6	340	x	x	x	x	x	340
	Total	*29.7*	*650.3*	*680*	x	x	x	x	x	*680*
FilerMNGV	Filer City	0	128.4	128.4	25.4	35.7	17.6	19.7	98.4	226
	Menominee	0	10.7	10.7	0	50.9	78.6	86.5	216	226
	Gulliver	0	165.6	165.6	5.1	20.6	15.7	19.7	61.1	226
	Total	*0*	*304.7*	304.7	*30.5*	*107.1*	*111.8*	*125.8*	375.2	*680*
FilerMNGV_log	Filer City	0	226	226	x	x	x	x	x	226
	Menominee	0	226	226	x	x	x	x	x	226
	Gulliver	0	226	226	x	x	x	x	x	226
	Total	*0*	*680*	*680*	x	x	x	x	x	*680*
FilerAll_log	Filer City	0	136	136	x	x	x	x	x	136
	Menominee	0	136	136	x	x	x	x	x	136
	Gulliver	0	136	136	x	x	x	x	x	136
	Escanaba	0	136	136	x	x	x	x	x	136
	Cedarville	2.3	133.7	136	x	x	x	x	x	136
	Total	2.3	*677.7*	*680*	x	x	x	x	x	*680*

Table 2 shows the information related to future biomass procurement from forests and mills into the Filer City powerplant for different scenarios.

For the *FilerOnly* scenario, the total amount of biomass from forest sources is 370.9 thousand *gt*/year of softwood biomass. There won't be any hardwood species used in this scenario within the next 15 years. The total amount of biomass sourced from mills is 7.8 thousand *gt*/year of hardwood sawdust, 84.1 thousand *gt*/year of hardwood shavings, 100.0 thousand *gt*/year of softwood sawdust, and 117.2 thousand *gt*/year of softwood shavings. The total biomass from mills is 309.1 thousand *gt*/year to meet the annual demand of 680 thousand *gt*/year. For the *FilerOnly_log* scenario where the demand is met by forest biomass only, the 613.2 thousand *gt*/year of biomass would come from softwood species, and 66.9 thousand *gt*/year would come from hardwood species.

For the *FilerEC* scenario, the total amount of biomass from forest sources is 308.5 thousand *gt*/year of softwood biomass, of which 99.9 thousand *gt*/year will be procured through the Escanaba depot. The total amount of biomass from mills is 47 thousand *gt*/year of hardwood sawdust, 97.9 thousand *gt*/year of hardwood shavings, 108.3 thousand *gt*/year of softwood sawdust, and 118.3 thousand *gt*/year of softwood shavings. The total biomass from mills is 371.5 thousand *gt*/year, of which 240 thousand *gt*/year will be procured through Escanaba port to meet the annual demand of 680 thousand *gt*/year. For the *FilerEC_log* scenario where the demand is met by forest biomass only, the 655.2 thousand *gt*/year of biomass would come from softwood species, and 24.8 thousand *gt*/year would come from hardwood species. About 340 thousand *gt*/year of softwood logs would be procured through Escanaba and sent to Filer City. No hardwood species will be procured through Escanaba.

For the *FilerMNGV* scenario, the total amount of biomass from forest sources is 304.7 thousand *gt*/year of softwood biomass. There will not be any hardwood forest biomass procurement in this scenario. The total amount of biomass from mills is 30.5 thousand *gt*/year of hardwood sawdust, 107.1 thousand *gt*/year of hardwood shavings, 111.8 thousand *gt*/year of softwood sawdust, and 125.8 thousand *gt*/year of softwood shavings. The total biomass from mills is 375.2 thousand *gt*/year, of which 61.1 thousand *gt*/year will be procured through Gulliver port and 216 thousand *gt*/year will be procured through Menominee port to meet the annual demand of 680 thousand *gt*/year. For the *FilerMNGV_log* scenario where the demand is met by forest biomass only, all of the biomass would come from softwood species, where 226 thousand *gt*/year would come from each location.

For the *FilerAll_log* scenario where the demand is met by forest biomass from all locations (Filer City and four depots in UP), most of the biomass would come from softwood species, except 2.3 thousand *gt*/year from hardwood through Cedarville port.

Table 3. Average and weighted feedstock (biomass) procurement cost for the Filer City facility excluding barging costs for 2020-2035.

Scenario	**Procurement Location**	**Average Cost**			**Weighted Average Cost**
		Forest Source	Mill Source	Total	
		---------------------$ / *gt* ---------------------			
FilerOnly	Filer City	29.48	25.09	27.21	27.21
FilerOnly_log	Filer City	30.14	0	30.14	30.14
FilerEC	Filer City	31.08	23.55	26.13	32.70
	Escanaba	35.74	39.27	39.27	
FilerEC_log	Filer City	31.17	0	31.17	33.76
	Escanaba	36.35	0	36.35	
FilerGV	Filer City	31.08	23.62	26.27	30.99
	Gulliver	36.76	35.33	35.72	
FilerGV_log	Filer City	30.92	0	30.92	33.52
	Gulliver	36.12	0	36.12	
FilerMNGV	Filer City	29.68	20.15	21.68	31.93
	Menominee	23.89	39.21	39.21	
	Gulliver	36.02	34.32	35.00	
FilerMNGV_log	Filer City	30.63	0	30.63	31.38
	Menominee	27.90	0	27.90	
	Gulliver	35.61	0	35.61	
FilerAll_log	Filer City	29.34	0	29.34	32.15
	Menominee	27.59	0	27.59	
	Gulliver	36.07	0	36.07	
	Escanaba	34.74	0	34.74	
	Cedarville	33.01	0	33.01	

Table 3 provides information on the average and weighted average costs of biomass for the Filer City facility and depots and ports in the UP. For the *FilerOnly* scenario, the average cost of procuring forest biomass is $29.48/*gt*, and mill residues is $25.09/*gt*. The weighted average cost of biomass for Filer City without any ports in UP is $27.21/*gt*. If all of the demand (680k *gt*/year) is met with forest biomass, the weighted average cost of biomass (does not include stumpage cost) for Filer City is $30.14/*gt*.

When a depot in Gulliver meets half of the biomass demand, then the average cost of biomass is $26.27/*gt* in the LP and $35.72/*gt* in the UP. The weighted average cost is $30.99/*gt*. If all the demand is met with forest biomass, the weighted average cost of biomass is $33.52/*gt*.

When a depot in Escanaba meets half of the biomass demand, then the cost of biomass is $31.08/*gt* from the forest and $23.55/*gt* from the mills for the LP, and $35.74/*gt* from the forest and $39.27/*gt* from the mills for Escanaba Port. The weighted average cost of biomass is $32.70/*gt*. If all of the demand is met with forest biomass, the weighted average cost of biomass is $32.70/*gt*.

When one-third of the biomass demand is met by two depots in UP at Gulliver and Menominee and the Filer City facility, then the cost of biomass is $29.68/*gt* from the forest and $20.15/*gt* from the mills for Filer City, $23.89/*gt* from the forest and $39.21/*gt* from the mills for Menominee Port, and $36.02/*gt* from the forest and $34.32/*gt* from the mills for Gulliver Port. The weighted average cost of biomass is $31.93/*gt*.

The average cost of procuring biomass from forests and mills in the LP directly into the Filer City facility is the lowest level of competition. However, when biomass is procured from the UP, obtaining a mix of forest and mill residues is better to lower the cost. Also, ports in Menominee and Escanaba had lower costs for forest biomass procurement than those in the eastern part of UP.

3.2. Economic Impact Analysis

Table 4. Economic impacts of Filer City biopower facility on the economy with a capacity upgrade to consume 680,000 gt/year.

Impact	Employment	Labor Income	Value Added	Output
	(#)	---------------------------- *million $ (2021)* ----------------------------		
Direct	40	$5.48	$15.87	$47.35
Indirect	104	$9.66	$18.64	$39.57
Induced	76	$4.26	$7.45	$13.19
Total	*220*	*$19.39*	*$41.96*	*$100.11*

Table 4 shows the economic impacts of upgrading the Filer City facility to consume an additional 680 thousand *gt*/year of biomass expressed in terms of the number of jobs created or supported, labor income, value-added, and output generated in the state economy. The Filer City biopower facility creates or supports 40 direct jobs, generates $5.48 million in direct labor income, adds $15.87 million in direct value-added, and produces $47.35 million in direct output. This expands the spending in the economy to generate 104 additional indirect and 76 induced jobs, creating a total of 220 jobs in Michigan. This facility is anticipated to generate $19.39 million in total labor income, $41.96 million in total value added, and $100.11 million in total outputs in Michigan. In the next ten years, this facility is expected to create 220 jobs and contribute more than a billion dollars in output to Michigan's economy.

Since 40 jobs are directly created from facility conversion, we assume 40 jobs are retained as long as the facility is operational with 680,000 *gt*/year biomass consumption. Individual employee wages are estimated at $137,000 and determined from the division of direct labor income by the number of retained employees. The direct labor income was $5,480,000, as reported by IMPLAN analysis. The Michigan average for 2022 income is $58,000, as reported by the Bureau of Labor Statistics (whereas the mean annual income of a powerplant factory employee in Michigan is $91,810 (BLS, 2022). Hence, the employee wages of the retained 40 individuals are $79,000 above the regional average and $45,190 above the industry average. However, the wages could vary a lot between personnel based on specificity (engineers), managerial (CEO, CFO), and general (equipment operators and laborers) appointments. Additionally, bioengineers have an average salary of $97,350 in the state of Michigan, while the typical CEO in this region will earn $312,710.

Table 5. Impact on average annual taxes with a capacity upgrade to consume 680,000 gt /year.

Impact	Sub County General	Sub-County Special Districts	County	State	Federal	Total
			--------------------*million $ (2021)* --------------------			
Direct	$0.65	$1.06	$0.39	$3.02	$0.31	$5.44
Indirect	$0.40	$0.63	$0.23	$1.95	$1.56	$4.78
Induced	$0.09	$0.15	$0.05	$0.50	$0.81	$1.60
Total	*$1.14*	*$1.84*	*$0.68*	*$5.47*	*$2.69*	*$11.83*

Table 5 shows the total tax impacts generated as a result of upgrades in the Filer City facility. The direct annual tax impact from the facility is $5.44 million per year. The total tax impact generated in the economy is $11.83 million annually, of which $5.47 million is the state taxes.

Table 6. Industry impacted by a capacity upgrade to consume 680,000 gt/year.

Rank	Industry Sector	Industry Total Output	Direct Output
		--------------------*million $ (2021)* ---------------	
1	Electric power generation - Biomass	$138.84	$47.44
2	Electric power transmission and distribution	$11,294.19	$14.14
3	Electric power generation - Fossil fuel	$9,351.71	$6.17
4	Employment services	$16,446.82	$2.80
5	Electric power generation - Nuclear	$2,407.60	$1.587
6	Pipeline transportation	$1,279.26	$1.05
7	Other local government enterprises	$4,794.14	$0.89
8	Local government electric utilities	$413.93	$0.46
9	Scenic and sightseeing transportation and support activities for transportation	$1,925.96	$0.44
10	Rail transportation	$974.93	$0.35
11	Electric power generation - Hydroelectric	$283.52	$0.19
12	Water, sewage, and other systems	$226.19	$0.13
13	Electric power generation - Wind	$85.13	$0.06
14	Electric power generation - Solar	$57.29	$0.04
15	Electric power generation - All other	$7.45	$0.005

Table 6 shows the impacts on other industries with upgrades in the Filer City facility. As expected, electric power generation ($47.44 million) using biomass is the most impacted sector, followed by electric power transmission and distribution ($14.14 million), power generation from various other sources, employment services ($2.80 million), and local government enterprises ($0.89 million) and utilities ($0.46 million) and rail transportation ($0.35 million) sectors in Michigan.

3.3 Results Specific to Scenarios.

Scenario 1: Biomass procurement to Filer City facility.

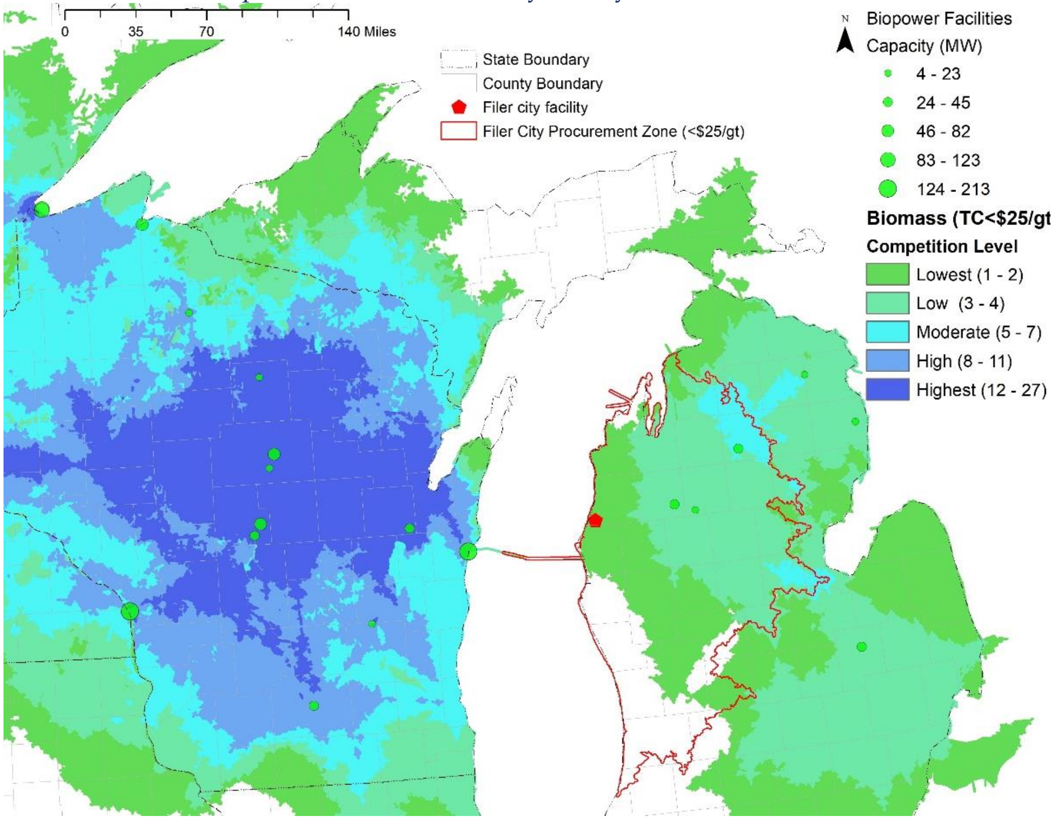

Figure 8. Procurement zone for Filer City facility for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.

Figure 8 depicts the location of the Filer City facility and its procurement zone surrounding the facility, outlined with a red line. The map's color scheme of green-to-blue shows lower to higher competition for biomass from other biomass biopower producers. Low levels of competition exist around the facility for the delivered wood price of $25/*gt*.

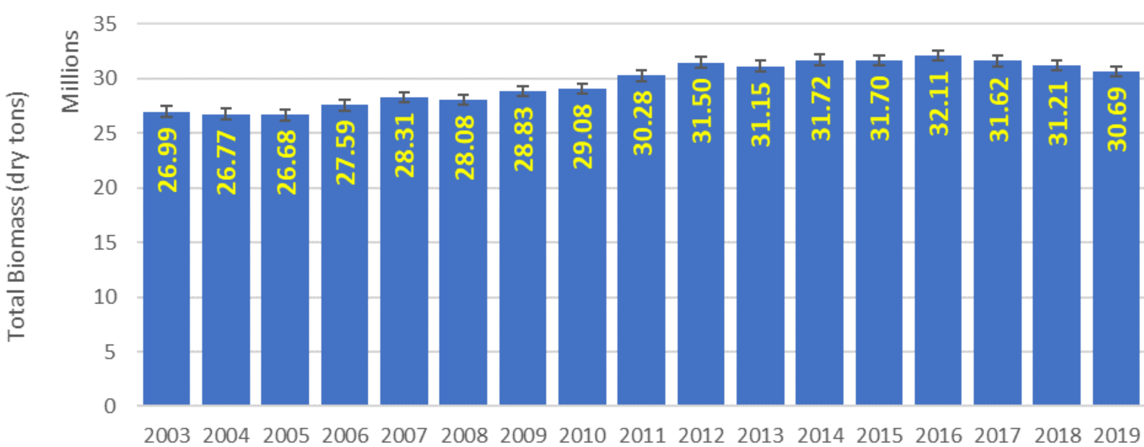

Figure 9. Historic availability of biomass (logging residues only) at Filer City facility for average delivered wood price of $25/gt from state and private forestlands.

Figure 9 displays the historic availability of biomass when the feedstock demand is procured from logging residues from state- and privately-owned forests. The availability of forest biomass has increased over time and peaked in 2016 at 31.22 million *dt*. Then, the availability slightly declined.

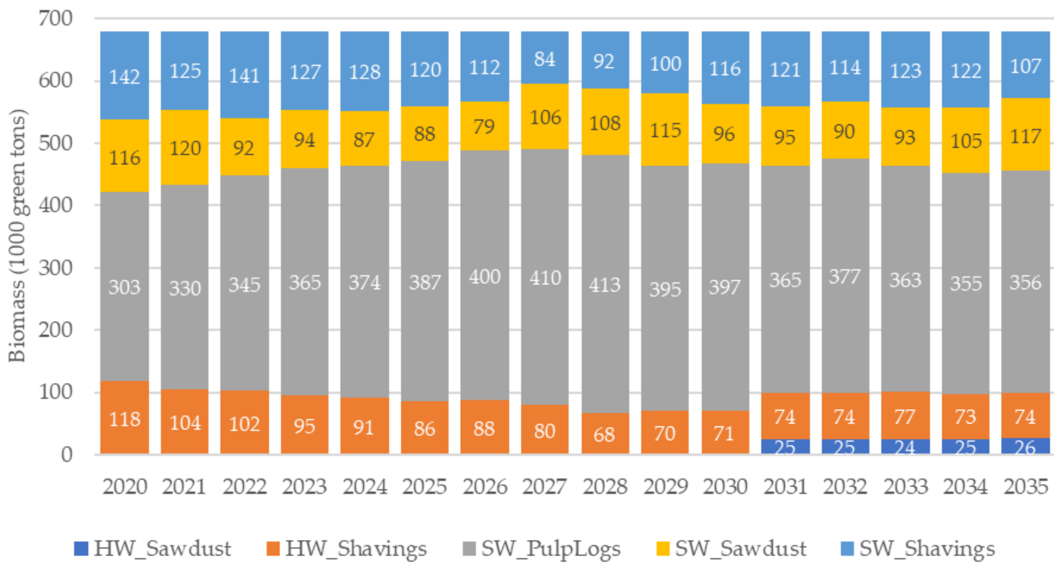

Figure 10. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility (no ports or depots).

Figure 10 shows different types of feedstocks potentially used by the facility for the next 15 years. About half of the feedstocks would come from forests and were predominantly softwood pulp logs. The mill residues include a mix of hardwood and softwood sawdust and shavings. Figure 11 shows the potential quantity of hardwood and softwood pulp logs if the Filer City facility utilized all forest biomass but no mill residues to fulfill its capacity.

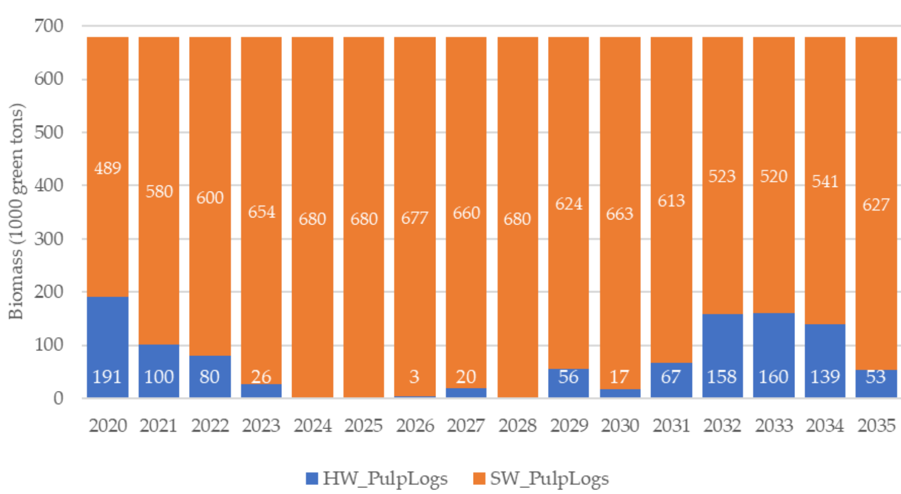

Figure 11. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility (no ports or depots).

Scenario 2: Biomass procurement to Filer City facility and one depot in Escanaba.

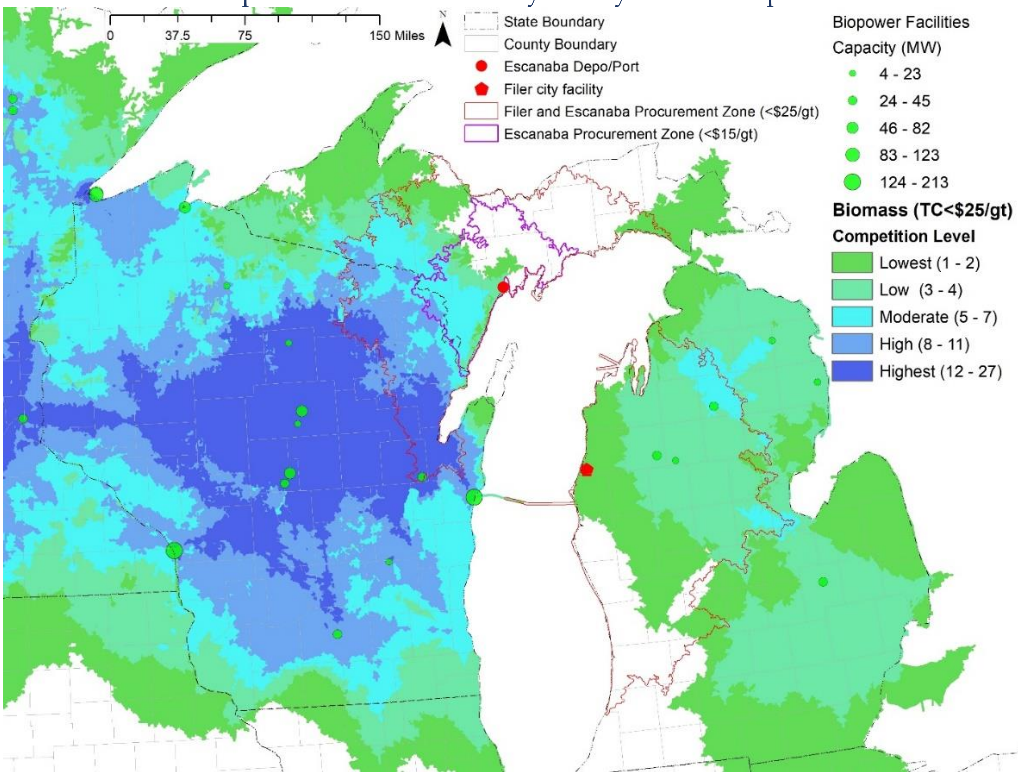

Figure 12. Procurement zone for Filer City facility and depot at Escanaba for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.

Figure 12 shows competition hotspots and procurement zone around the Filer City facility, along with one depot at Escanaba located in the UP. The red polygons show the service area for the facility and depot when biomass is paid $25/*gt* at the gate. However, biomass from Escanaba needs to be barged to Filer City. With a $10/gt of barging cost, the procurement zone for Escanaba depot shrinks, and the purple polygon shows the service area. This also indicates the sensitivity of price on the procurement potential of biomass. In terms of competition, there is a low level of competition in both regions.

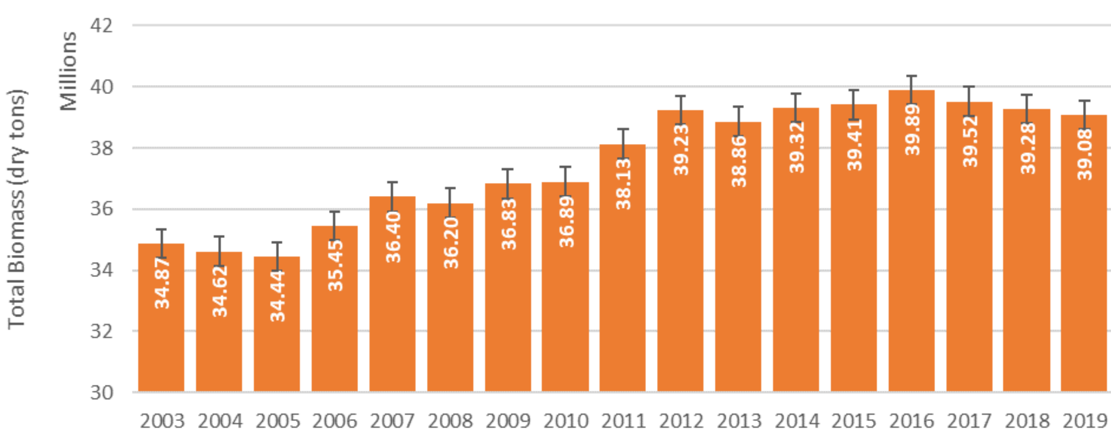

Figure 13. Historic availability of biomass (logging residues only) at Filer City facility and depot at Escanaba for average delivered wood price of $15/gt at ports (Escanaba) and $25/gt at Filer facility from state and private forestlands.

Figure 13 shows the historical availability of biomass at $15/*gt* at ports (Escanaba) and $25/*gt* at the Filer facility when the feedstock demand is procured from logging residues from forests from state- and privately-owned forests. The availability of forest biomass has increased over time and peaked in 2016 at 39.89 million dt. Then, the availability slightly declined. The trend in increasing biomass is steeper than Scenario 1, indicating that the growth rate has been higher in the Escanaba procurement region.

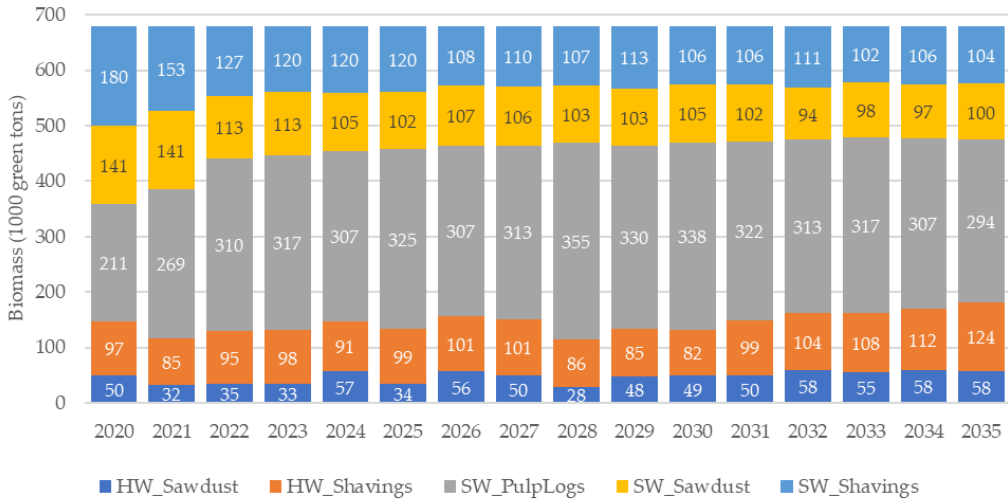

Figure 14. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depot in Escanaba.

The LURA model output in Figure 14 shows different types of feedstocks potentially used by the facility for the next 15 years. Most feedstocks come from mills as residues and softwood pulp logs. The mill residues include a mix of hardwood and softwood sawdust and shavings. Figure 15 shows the potential quantity of hardwood and softwood pulp logs if the Filer City facility utilized all forest biomass but no mill residues to fulfill its capacity. Hardwood is not used in most of the years, indicating that it is cheaper to get softwood pulp logs for bioenergy, and hardwood is only used when softwood biomass is not sufficient or available.

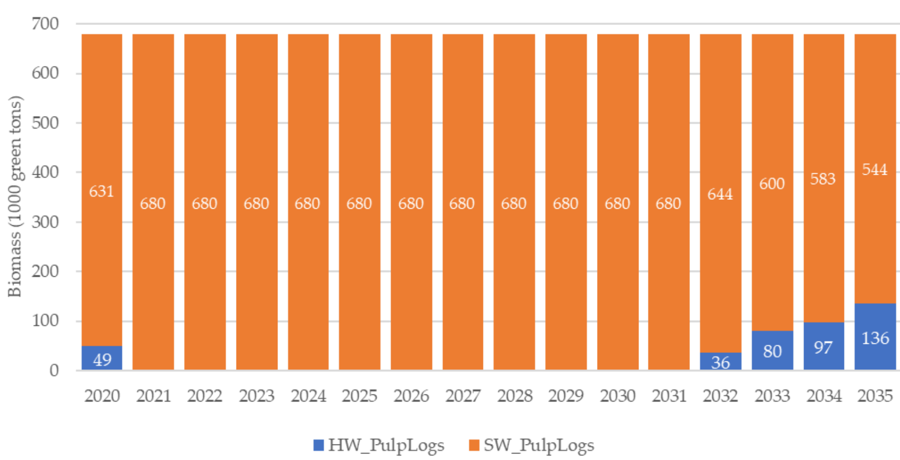

Figure 15. LURA model outputs projecting available biomass (logging residues only) in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depot in Escanaba.

Scenario 3: Biomass procurement to Filer City facility and a depot in Gulliver

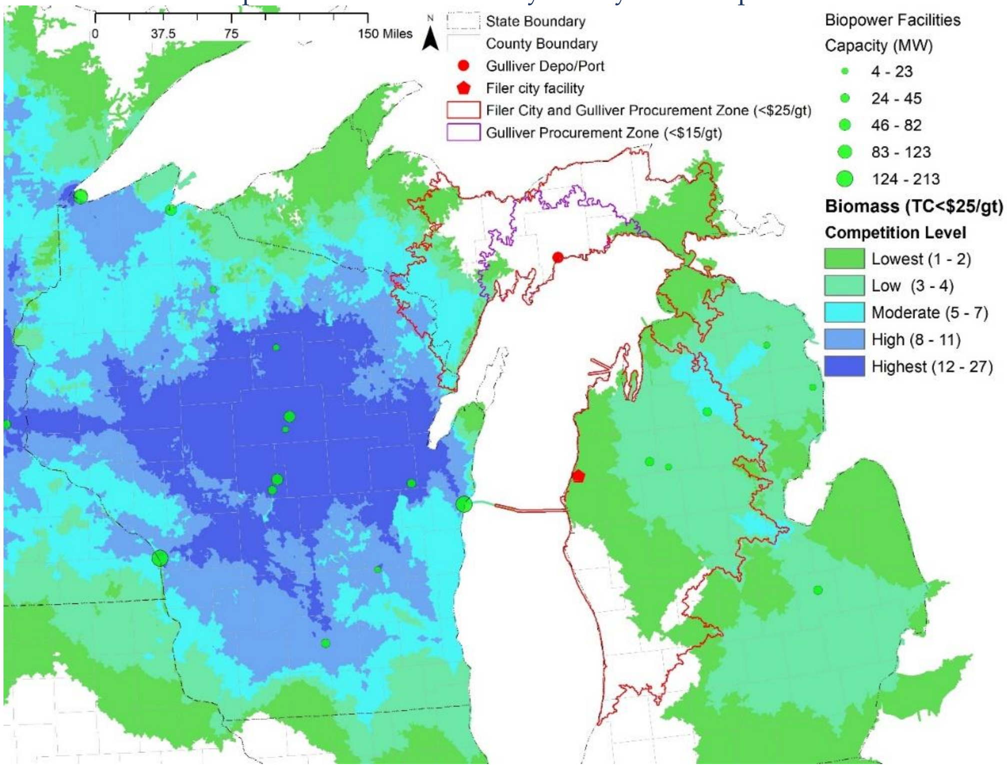

Figure 16. Procurement zone for Filer City facility and depot at Gulliver for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.

Figure 16 shows competition hotspots and procurement zone around the Filer City facility, along with one depot at Gulliver located in the UP. The red polygons show the service area for the facility and depot when biomass is paid $25/*gt* at the gate. However, biomass from Escanaba needs to be barged to Filer City. With a $10/*gt* of barging cost, the procurement zone for Escanaba depot shrinks, and the purple polygon shows the service area. This also indicates the sensitivity of price on the procurement potential of biomass. There is a low level of competition in Filer City, whereas there is almost no competition in the procurement zone around Gulliver in UP.

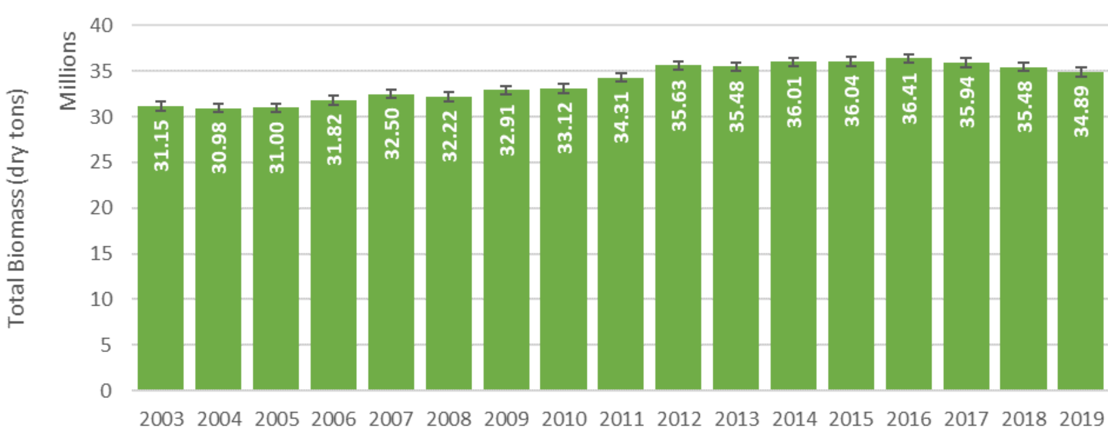

Figure 17. Historic availability of biomass (logging residues only) at Filer City facility and depot at Gulliver for average delivered wood price of $15/gt at ports and $25/gt at Filer facility from state and private forestlands.

Figure 17 shows the historical availability of biomass for scenario 3. This historic availability followed a similar trend as Scenario 1, with almost the same amount of biomass availability. The biomass availability is slightly lower in recent years compared to Scenario 2. However, this will not be a limitation or resource constraint for having a depot in Gulliver.

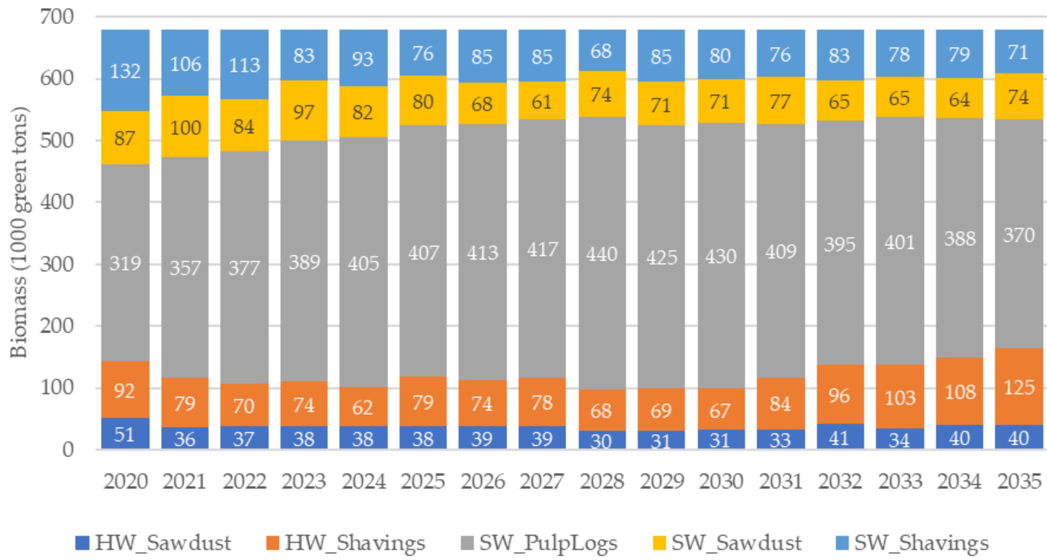

Figure 18. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depot in Gulliver.

The LURA model output in Figure 18 shows different types of feedstocks potentially used by the facility for the next 15 years. The trend stays the same as in previous scenarios, where a majority of the feedstocks come from mills as residues and softwood pulp logs. Similarly, as shown in Figure 19, softwood logs will be exclusively used if only forest biomass is used for power production, with expectation around the end of the 15-year period. Hardwood logs will only be used when there are insufficient softwood pulp logs for this facility to procure and use.

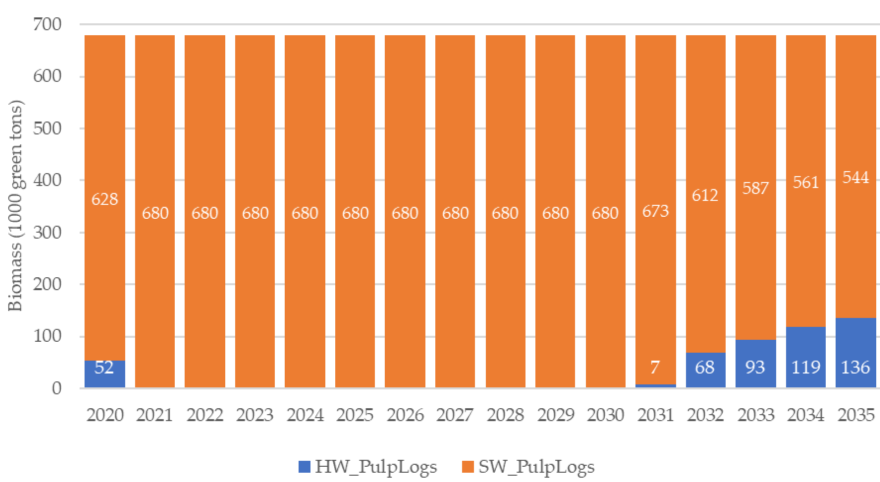

Figure 19. LURA model outputs projecting available biomass (log residues only) in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depot in Gulliver.

Scenario 4: Biomass procurement to Filer City facility and depots in Menominee and Gulliver

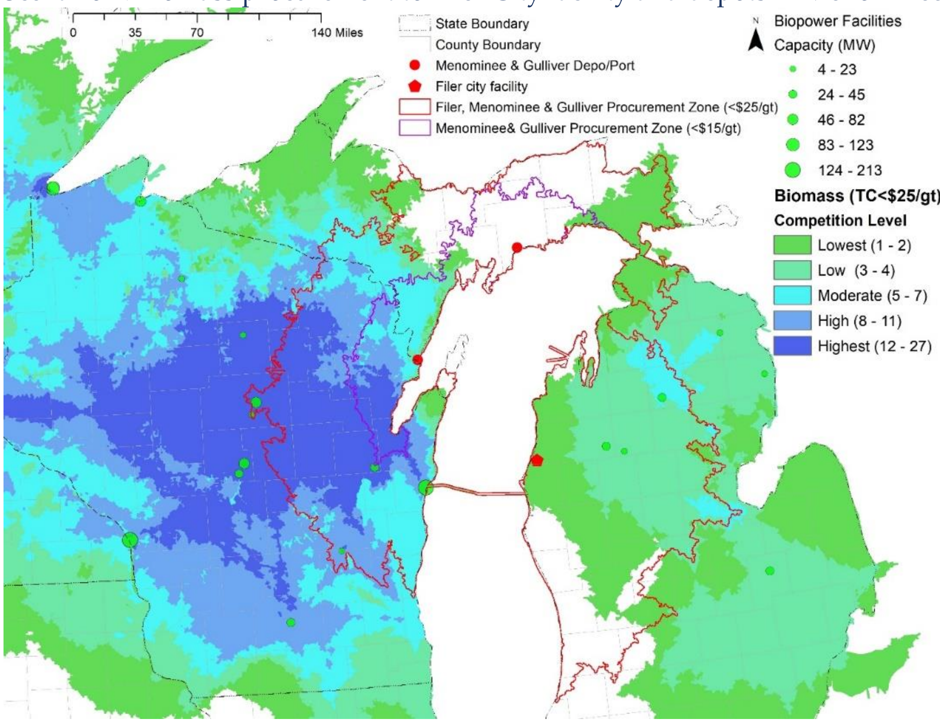

Figure 20. Procurement zone for Filer City facility and depots at Menominee and Gulliver for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.

Figure 20 shows competition hotspots and procurement zone around the Filer City facility, along with two depots at Gulliver and Menominee located in the UP. The red polygons show the service area for the facility and depot when biomass is paid $25/*gt* at the gate, and the purple polygon shows the service area when biomass is paid $15/*gt*. In terms of competition, there is a low level of competition in Filer City, no competition in Gulliver, but moderate competition for biomass in the Menominee procurement area. Some regions, especially in Wisconsin, in the service area of Menominee depot, will experience very high competition.

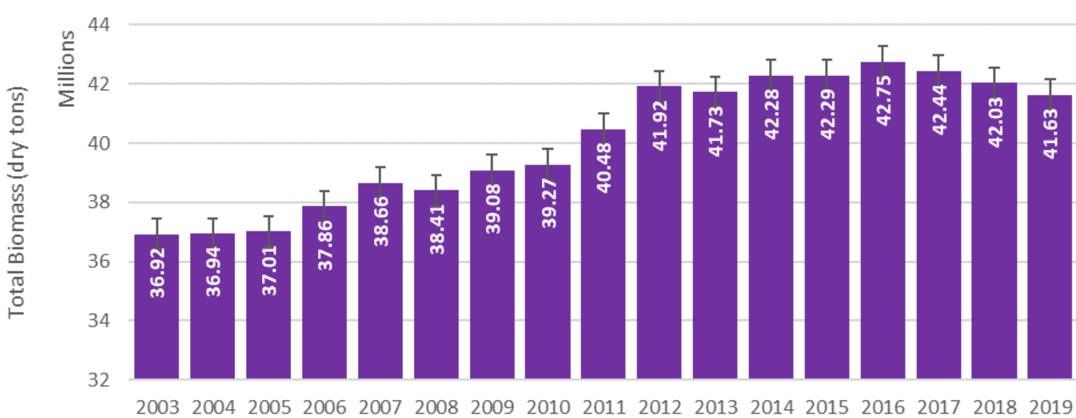

Figure 21. Historic availability of biomass (logging residues only) at Filer City facility and depots at Menominee and Gulliver for average delivered wood price of $15/gt at ports and $25/gt at the Filer facility from state and private forestlands.

Figure 21 shows the historical availability of biomass for scenario 3. This historic availability followed a similar trend as Scenario 2. The availability of biomass has been higher in recent years compared to Scenario 1-3 since there are two ports in UP expanding the service area. Higher competition around Menominee could affect the prices of biomass in that region but not the quantity due to the abundance of available biomass.

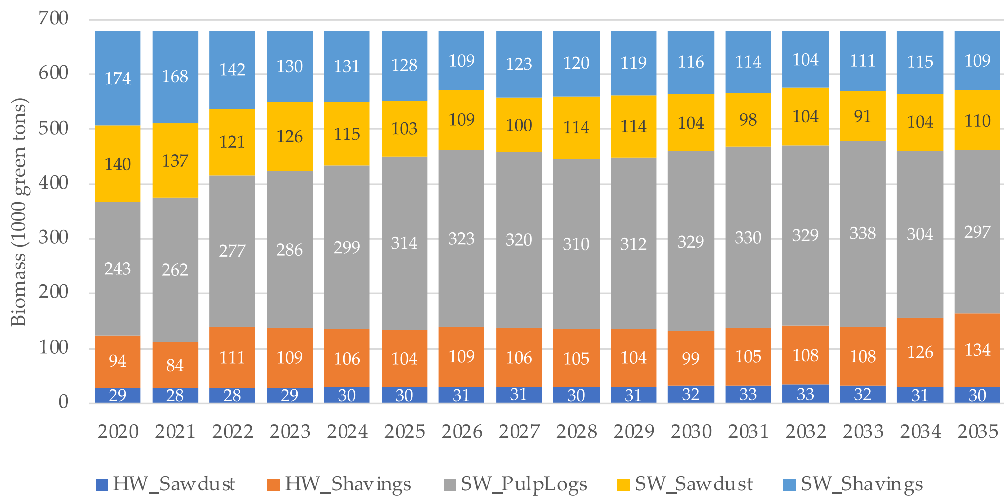

Figure 22. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depots at Menominee and Gulliver.

The LURA model output in Figure 22 shows different types of feedstocks potentially used by the facility for the next 15 years. The trend stays the same as in previous scenarios, where a majority of the feedstocks come from mills as residues and softwood pulp logs. The use of pulp logs increases over time compared to mill residues.

Figure 23 shows that softwood logs will be exclusively used if only forest biomass is used for power production in Filer City with two ports in UP. With expanded procurement zones, there are enough softwood pulp logs for the next 15 years; hence, the hardwood is not being used or procured.

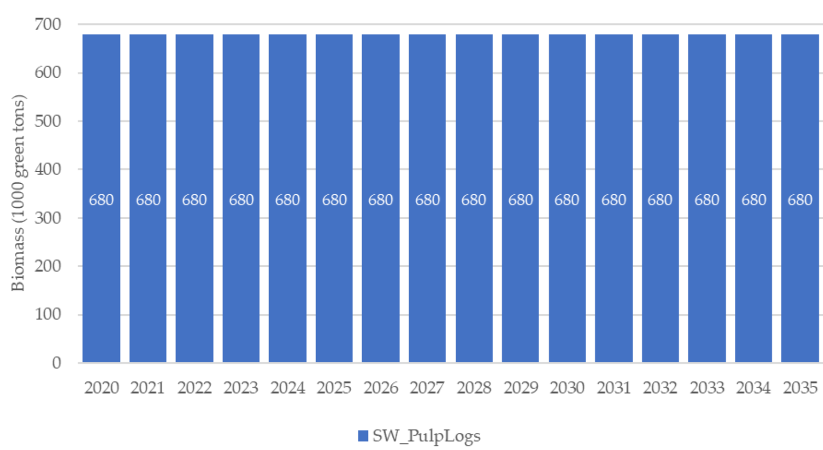

Figure 23. LURA model outputs projecting available biomass in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depots at Menominee and Gulliver (logs only scenario).

Scenario 5: Biomass procurement to Filer City facility and depots in Menominee, Escanaba, Gulliver, and Cedarville

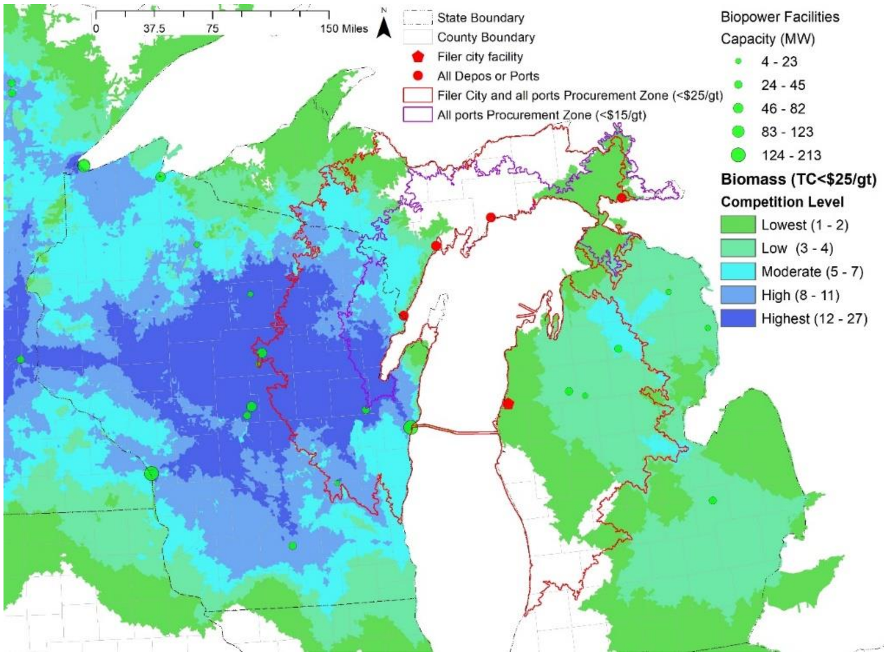

Figure 24. Procurement zone for Filer City facility and depot at Menominee, Escanaba, Gulliver, and Cedarville for average delivered wood price of $25/gt and the competition hotspots for biomass procurement.

Figure 24 shows competition hotspots and procurement zone around the Filer City facility, along with four depots at Menominee, Escanaba, Gulliver, and Cedarville located in the UP. The red polygons show the service area for the facility and depot when biomass is paid $25/*gt* at the gate, and the purple polygon shows the service area when biomass is paid $15/*gt*. With four depots, the procurement zone expands from eastern UP to central UP and some of northeastern Wisconsin. There is a low level of competition in Filer City, Escanaba, and Cedarville, with no competition in Gulliver but moderate competition for biomass in the Menominee procurement area. Some of the regions, especially in northeastern Wisconsin, around the Menominee depot, will experience very high competition.

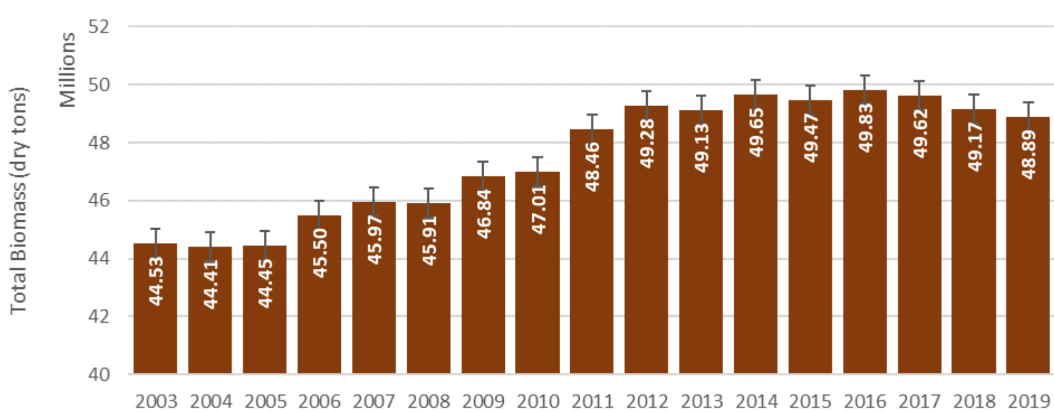

Figure 25. Historic availability of biomass (logging residues only) at Filer City facility and depot at Menominee, Escanaba, Gulliver, and Cedarville for average delivered wood price of $15/gt at ports and $25/gt at Filer facility from state and private forestland.

Figure 25 shows the historical availability of biomass for scenario 3. This historic availability followed a similar trend to Scenarios 2 and 4. The availability of biomass is higher compared to Scenario 1-4 since UP has four ports expanding the service area. Higher competition around Menominee could affect the biomass prices in that region but not the quantity due to the abundance of available biomass.

Since the last four scenarios had a similar trend of a mix of mill and forest biomass as potential feedstock for the next 15 years, we did not run a model to specify and estimate the quantities. However, the model used to look at that biomass mix (hardwood and softwood) when all feedstocks are procured from forests (no mill residues) shows that softwood logs will be exclusively used in Filer City with four ports in UP with some hardwood biomass usage as time progresses (Figure 26).

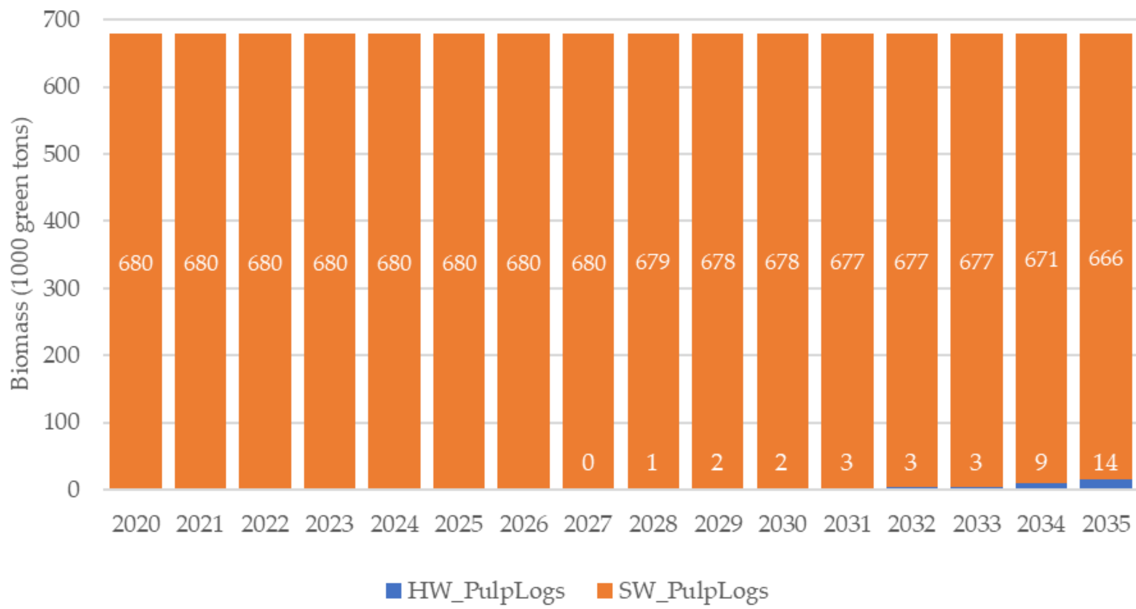

Figure 26. LURA model outputs projecting available biomass (from forest only) in thousand gt from 2020 to 2035 for procurement into the Filer City facility and depot at Menominee, Escanaba, Gulliver, and Cedarville

4. Conclusions

The Filer City power facility, located on the coast of Lake Michigan in the LP, has an opportunity to convert from non-renewable to renewable power generation with an expected utilization of 680,000 *gt* of biomass per year. This study identified procurement zones and biomass competition hotspots at a current market price of biomass and estimated the available biomass by overlying the procurement zones with FIA data around the Filer City facility and depots in Escanaba, Menominee, Gulliver, and Cedarville. Then, the LURA model was used to evaluate the feedstock sources and availability for the next 15 years. Lastly, the economic contributions of this additional biomass usage were assessed in terms of the state's economy.

Biomass availability, when paid at a current market price ($ 25/*gt*) ranges from 30.90 to 88.01 million *dt*, when barging cost is excluded and from 30.90 to 48.85 million *dt*, when barging cost is included. The significant drop in the available biomass shows the sensitivity of the cost of procuring biomass for biopower production. Results indicate that a significant amount of biomass is available for procurement for the purposes of bioenergy production that is currently not being used by other industries.

The LURA model predictions indicated that a mix of biomass dominated by mill residues would be used for power production under all scenarios. Almost all of the forest biomass will be softwood pulp logs. Softwood sawdust and shavings, followed by hardwood sawdust, will be the primary feedstocks from mills for the Filer City facility. Harwood residues and pulp logs will start being used as we move further into the future. This is mostly due to the increasing demand for softwood logs for other purposes, forcing the utilization of hardwood species to meet the 680,000 *gt* demand of the facility.

Economic impact analysis indicated that the upgrade would create 40, 104, and 76 in direct, indirect, and induced employment. The labor income generated from direct, indirect, and induced sources will be $5.48 million, $9.66 million, and $4.26 million, respectively. The direct, indirect, and induced value added in the economy with these upgrades will be $15.87 million, $18.64 million, and $7.45 million, respectively. The direct, indirect, and induced output are $47.35 million, $39.57 million, and $13.19 million, respectively, resulting in about 100 million in total output in the Michigan economy.

In addition to economic impacts, the conversion of Filer City would create markets for low-value woods and residuals. This can be a crucial market opportunity to utilize low-value Jack Pine stands in LP to support Kirtland's Warbler habitat and the use of residues from sawmills that are being sent to the landfills. Thus, the benefits transcend beyond direct economic impacts into ecological and social benefits in Michigan. Conversion of the facility to utilize local biomass would also help meet the sustainability initiatives and carbon emission mitigation commitments, all while procuring feedstock at affordable rates, creating jobs, increasing the added value of the local economy, and increasing fiscal gain for this organization.

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Appendix

A. Output from LURA Model on feedstock availability for a capacity upgrade to 500k *gt*/year

Table A1. Average annual Feedstock availability for various scenarios for Filer City Power Plants from 2020-2035 with a capacity upgrade to consume 500,000 gt per year.

Scenario	Location	Forest Sources		Mill Sources			
		HW_PulpLogs	SW_PulpLogs	HW_Sawdust	HW_Shavings	SW_Sawdust	SW_Shavings
		-------------------- thousand gt/year-----------------------------					
Filer Only	Filer City		241.7	1.4	73.1	85.5	98.2
FilerGV	Filer City		88.7		65.0	46.7	49.6
	Gulliver		68.3		55.3	59.0	67.4
FilerEC	Filer City		85.6		60.4	54.5	49.5
	Escanaba				64.2	87.4	98.4
FilerMNGV	Filer City		26.8		54.4	41.3	44.1
	Menominee				16.2	72.9	77.5
	Gulliver		67.0		43.0	24.3	32.4
FilerOnly_Logs	Filer City	0.9	499.1				
FilerGV_log	Filer City		250.0				
	Gulliver		250.0				

Table A2. Average and weighted cost of feedstock (biomass) supplied to the Filer City, excluding barging costs for 2020-2035 with a capacity upgrade to consume 500,000 gt per year.

Scenario	Location	Average Cost			Weighted Average Cost
		Forest Sources	Mill Sources	Total	
		------------------ *$/gt* -------------------			
FilerOnly	Filer City	28.71	24.22	26.39	$26.39
FilerGV	Filer City	28.29	16.57	20.72	$23.50
	Gulliver	31.18	24.44	26.28	
FilerEC	Filer City	26.55	17.11	20.35	$22.39
	Escanaba	9.53	24.43	24.43	
FilerMNGV	Filer City	25.16	15.87	17.36	$22.04
	Menominee	9.53	20.13	20.13	
	Gulliver	30.68	27.36	28.70	
File Only_Log	Filer City	29.93	0.00	29.93	$29.93
FilerGV_log	Filer City	28.40	0.00	28.40	$30.77
	Gulliver	33.13	0.00	33.13	

B. Economic impact of capacity upgrade to 500k *gt*/year in Filer City facility

Table B1. Economic impact of Filer City facility on the economy with a capacity upgrade to consume 500,000 gt per year.

Impact	Employment	Labor Income	Value Added	Output
	(#)	---------------------------- *million $* ----------------------------		
Direct	29	$4.39	$12.72	$37.96
Indirect	84	$7.74	$14.94	$31.73
Induced	61	$3.41	$5.97	$10.58
Total	*173*	*$15.54*	*$33.64*	*$80.26*

Table B2. Average annual taxes with a capacity upgrade to consume 500,000 gt per year.

Impact	Sub County General	Sub County Special Districts	County	State	Federal	Total
		--------------------*million $* --------------------				
Direct	$0.52	$0.85	$0.32	$2.42	$0.25	$4.36
Indirect	$0.32	$0.51	$0.19	$1.57	$1.25	$3.83
Induced	$0.07	$0.12	$0.04	$0.40	$0.65	$1.29
Total	*$0.92*	*$1.48*	*$0.55*	*$4.38*	*$2.16*	*$9.48*

Table B3. Industry impacted with a capacity upgrade to consume 500,000 gt per year.

Rank	Industry Sector	Industry Total Output	Impact Output
		--------------------*million $* --------------------	
1	Electric power generation - Biomass	$138.84	$38.03
2	Electric power transmission and distribution	$11,294.19	$11.34
3	Electric power generation - Fossil fuel	$9,351.71	$4.94
4	Employment services	$16,446.82	$2.24
5	Electric power generation - Nuclear	$2,407.60	$1.273
6	Pipeline transportation	$1,279.26	$0.84
7	Other local government enterprises	$4,794.14	$0.71
8	Local government electric utilities	$413.93	$0.37
9	Scenic and sightseeing transportation and support activities for transportation	$1,925.96	$0.36
10	Rail transportation	$974.93	$0.28
11	Electric power generation - Hydroelectric	$283.52	$0.15
12	Water, sewage, and other systems	$226.19	$0.10
13	Electric power generation - Wind	$85.13	$0.05
14	Electric power generation - Solar	$57.29	$0.03
15	Electric power generation - All other	$7.45	$0.004

End of Report