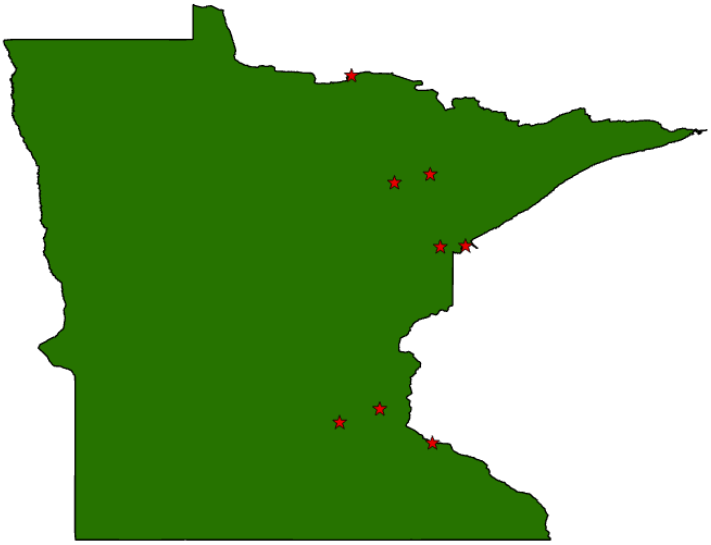
Economic Contributions of Wood-based Biomass Power Generation Industries in Minnesota 2022 Version



Prepared for
Minnesota Department of Natural Resources
Saint Paul, Minnesota

Prepared by
Shivan Gc and Raju Pokharel, Michigan State University
Jagdish Poudel, Michigan Department of Natural Resources
Ram Dahal, Wisconsin Department of Natural Resources

NORTHEAST-MIDWEST STATE FORESTERS ALLIANCE

Department of Forestry
MICHIGAN STATE UNIVERSITY

DEPARTMENT OF NATURAL RESOURCES

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Executive Summary

Decarbonizing Minnesota's electricity sector requires an increased reliance on renewable energy sources, including biomass-based power generation. As of 2023, approximately 33% of the total electricity generated in Minnesota came from renewable energy sources, 24% from natural gas, 24% from coal, and 21% from nuclear power. Biomass accounted for about 6% of the state's renewable electricity generation, with most of it coming from wood and wood-derived fuels. Unlike many other renewable sources, woody biomass can provide consistent, around-the-clock baseload power. When harvested and managed sustainably, wood-based biomass helps reduce greenhouse gas emissions compared to fossil fuels, supports employment and income in rural, forest-dependent communities, provides a market outlet for low-value forest materials, helps divert waste from landfills, and can contribute to improved forest health.

This report analyzes the economic contributions of Minnesota's wood-based biomass power generation industry, providing an overview of the state's electric power generation sector and its role in the broader economy. The analysis is part of a series of coordinated comparable reports produced for multiple Northeast Midwest U.S states along with California, Georgia and Virginia. Forest resource statistics used in the report were drawn from the U.S. Forest Service's Forest Inventory and Analysis (FIA) data, while economic modeling was conducted using the 2022 Impact Analysis for Planning (IMPLAN) data via the cloud-based platform.

To isolate the economic effects of wood-based biomass power generation specifically, the study applied IMPLAN's detailed impact analysis activity type which is analogous to its Analysis-by-Parts (ABP) technique. IMPLAN does not provide a dedicated sector for wood-based biomass power; instead, these activities are included under the broader "electric power generation—biomass" sector (Sector 45 in cloud version of IMPLAN data). This sector also encompasses electricity generation from other biomass sources, including agricultural byproducts, landfill gas, municipal solid waste, black liquor, and sludge waste. Using the detailed impact analysis activity type, we developed a customized sector profile based on

budgetary spending patterns and labor income specific to wood-based biomass power generation. Supplementary data for the analysis came from the Michigan Department of Natural Resources' 2022 and 2024 mail survey of biomass power producers across a 20-state Northeast-Midwest region, alongside a review of recent literature on biomass energy in the United States.

The economic contribution estimates presented in this report are expressed in constant 2022 dollars. In 2022, Minnesota generated approximately 0.9 million megawatt hours of electricity using wood and wood-derived fuel. This was about 31% less than the amount of electricity generated from woody-biomass in the state in 2017. The estimated cost of producing electricity from wood and wood-derived fuels per MWh was estimated to be $87 in 2022 (Obtained from the mail survey of biomass power facilities located in the twenty state Northeast Midwest region in 2024).

In 2022, the wood-based biomass power generation industry in Minnesota directly supported 64 jobs and generated $77 million in direct economic output. When accounting for indirect and induced effects throughout the economy, the industry supported a total of 826 jobs and contributed $177 million in total economic output. State and local tax revenues generated by industry were approximately $13 million, with an additional $11 million in federal tax contributions. The social accounting matrix (SAM) multiplier for industry output was estimated at 2.3, indicating that every $1 million of output from Minnesota's wood-based biomass power generation industry supported an additional $ 1.3 million in economic activity elsewhere in the state's economy. In terms of employment, the industries most affected by the wood-based biomass power generation industry in the state, aside from the industry itself, include commercial logging, support activities for agriculture and forestry, and the commercial and industrial machinery and equipment repair and maintenance sector. In comparison, the biomass power generation industry directly employed 106 individuals and generated $91 million (in 2022 dollars) in direct output in 2017. This represents a decline of 40% in direct employment and 15% in direct output from 2017 to 2022 in wood-based biomass power generation industry in Minnesota. Similarly, total employment decreased by 35% and output decreased by 17% in 2022 compared to 2017.

Glossary

Biomass: Renewable organic material that comes from plants and animals. It contains stored chemical energy from the sun. Sources of biomass for energy include wood and wood processing wastes, agricultural crops and waste materials, biogenic materials in municipal solid waste, animal manure, and human sewage.

Woody Biomass: It encompasses biomass obtained from the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest management.

Biopower: Biopower technologies convert biomass fuels into heat and electricity. There are three main methods of releasing the energy stored in biomass to produce biopower: burning, bacterial decay, and conversion to gas/liquid fuel.

Net Electric Power Generation: Generation is a measure of electricity produced over time. Some portions of the electricity produced by the power plants is used internally to operate these plants. Net generation excludes electricity use for power plant operations.

Renewable Portfolio Standard (RPS): It is a regulatory requirement that electricity providers must supply a specified minimum share of their total electricity sales from eligible renewable energy sources.

Power Plant Capacity: It is the maximum level of electricity that a power plant can supply at a specific point in time under certain conditions.

Nameplate Capacity: Nameplate generator capacity is determined by the generator's manufacturer and indicates the maximum output of electricity a generator can produce without exceeding design thermal limits.

Kilowatt (kW): A standard unit for measuring electricity. 1 kW is equivalent to 1,000 Watts.

Kilowatt-hour (kWh): One kW of electricity generated or used for one hour.

Megawatt (MW): 1,000 kW

Megawatt hour (MWh): 1,000 kWh

Economic Contribution Terms

Direct effects/contributions: The economic activities (e.g., output, employment, labor income, and value-added) associated with an industry or sector in the study area. These can describe the current economic sectors or changes to those sectors.

Employment: The number of full- and part-time jobs associated with an industry plus self-employed individual.

Indirect effects/contributions: The impact of local industries purchasing goods and services from other industries, leading to others' outputs, employment, and labor income.

Induced effects/contributions: The impact of labor income (employee compensation and proprietor income) via goods and services purchased due to the direct and indirect spending by industries.

Labor income: The dollar total of employee compensation and proprietor income; the latter is associated with self-employed individuals.

Output: The dollar measure of production within an area; it is also viewed as sales.

Type I multiplier: These multipliers are derived by dividing the sum of direct and indirect effects by the direct effects.

Social Accounting Matrix (SAM) multipliers: These multipliers are derived by dividing the sum of direct, indirect, and induced effects by the direct effects. The social accounts include payments made between households, households, and government and more. These are available for output, employment, labor income, and value-added and are used to assess the effects of changes in industry activity (i.e., "ripple effects").

Total effects/contributions: The sum of direct, indirect, and induced effects.

Value-added (also known as gross state product, or GSP): The sum of labor income, other property income (e.g., rents and profits), and indirect business taxes (e.g., excise and sales taxes). It is the difference between an industry's total output and the cost of its intermediate inputs. The sum of value-added for all economic sectors within the state equals the total GSP.

Forest Inventory and Analysis Terms

Forestland: It is a land that has at least 10 percent canopy cover of trees of any size or has had at least 10 percent canopy cover of trees in the past that will be naturally or artificially regenerated. To qualify as forest land, an area must be at least 1 acre in size and have a minimum width of 120 feet to ensure continuity of forest conditions.

Merchantable net bole volume: It is the volume of sound wood in the merchantable bole (from the 1-foot stump to merchantable top), after deductions for rot, missing sections, or other defects.

Annual net growth: It is the average annual increase in net volume of live or growing-stock trees on forest land during the inventory period.

Annual removals: It is the average annual net volume of trees removed from forest land during the inventory period due to harvest, land-clearing, or other land-use changes.

Annual mortality: It is the average annual net volume of live trees that died from natural causes during the inventory period.

Introduction

Renewable energy plays an increasingly important role in the U.S. electricity sector, driven by concerns over greenhouse gas emissions from fossil fuels, energy security, and the potential for local and rural economic development. In 2023, the United States generated 4.18 trillion kilowatt-hours (kWh) of electricity, with approximately 60% produced from fossil fuels, 19% from nuclear energy, and 21% from renewable sources (U.S. Energy Information Administration [EIA], 2025a). Renewable electricity generation more than doubled over the past two decades, increasing from 357 billion kWh in 2000 to over 900 billion kWh in 2022 (EIA, 2025b). Despite this growth, the electricity sector remains a major contributor to national greenhouse gas emissions, accounting for roughly 25% of total U.S. emissions in 2022 (U.S. Environmental Protection Agency [EPA], 2025).

This expansion of renewable energy has been strongly supported by state and local policies, including renewable portfolio standards (RPS) and voluntary renewable energy goals. These policies aim to increase the share of renewable energy in electricity generation, reduce emissions, and stimulate local investment. In addition, some states have adopted clean energy standards (CES), which often encompass RPS requirements while also including broader low-emission technologies (National Conference of State Legislatures, 2025). As of 2025, 28 states, along with the District of Columbia, have enacted RPS mandates (Lawrence Berkeley National Laboratory, 2025). Three additional states and one U.S. territory (Guam) have adopted voluntary renewable energy targets, further reinforcing the nationwide momentum toward cleaner energy systems (National Conference of State Legislatures 2025). Additionally, sixteen states have established a broader 100% CES in combination with RPS (Lawrence Berkeley National Laboratory, 2025). Figure 1 highlights the states with 100% CES commitments and the range of RPS targets currently in place.

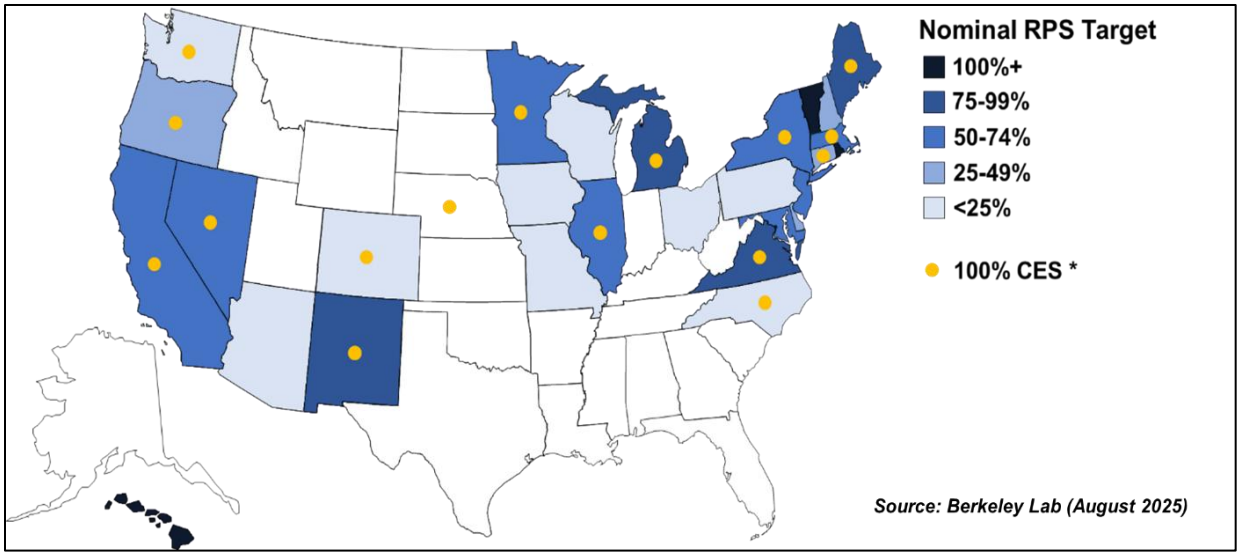

Figure1. Map of US depicting states with 100% Clean Energy Standards (CES) and associated Renewable Portfolio Standard targets (Source: Lawrence Berkeley National Laboratory, 2025).

In Minnesota, the voluntary renewable energy objective was initiated in 2001, which was then transitioned to a mandatory RPS in 2007 requiring utilities to source at least 7% of retail electricity from renewables by 2010. This standard was subsequently escalated to 12% by 2012, 17% by 2016, 20% by 2020, and 25% by 2025 for most utilities in the state (DSIRE 2025). Furthermore, in 2023, legislative changes raised Minnesota's RPS to 55% renewable electricity by 2035 (National Conference of State Legislatures, 2025). Renewable resources accounted for the largest share of electricity generated in Minnesota in 2023. About 33% of the total electricity generated in the state came from renewable sources, with wind as the largest contributor. Biomass made up roughly 6% of Minnesota's renewable electricity, with most of this biomass electricity coming from wood and wood-derived fuels (US EIA 2025c).

Woody biomass offers unique benefits. It provides baseload power, reduces greenhouse gas emissions, supports rural economies, and creates a market for forest residues and byproducts from forest management, wildfire reduction, and wood product manufacturing (National renewable energy laboratory 2023, USDA Forests and Rangelands 2023, Gan and Smith 2007). Biomass power can also help offset the costs of forest restoration and hazardous fuel treatments (Page-Dumroese et al. 2022).

Despite its benefits, electricity generation from woody biomass in the U.S. has remained relatively stable over the past two decades, with a slight decline in recent years (Figure 2). In Minnesota, woody biomass contributed about 1.2% of the total electricity produced in-state in 2001. By 2017, it increased to about 2.2% and declined to 1.5% in 2022 and 2024 (US EIA 2025d). Nationwide, the number of power plants utilizing wood and wood-derived fuels declined from 247 in 2017 to 219 in 2022, and further to 197 in 2024 (U.S. EIA 2025d). In Minnesota, there were a total of eight biopower facilities using wood and wood derived fuels in 2022 (Figure 3; U.S. EIA 2025d).

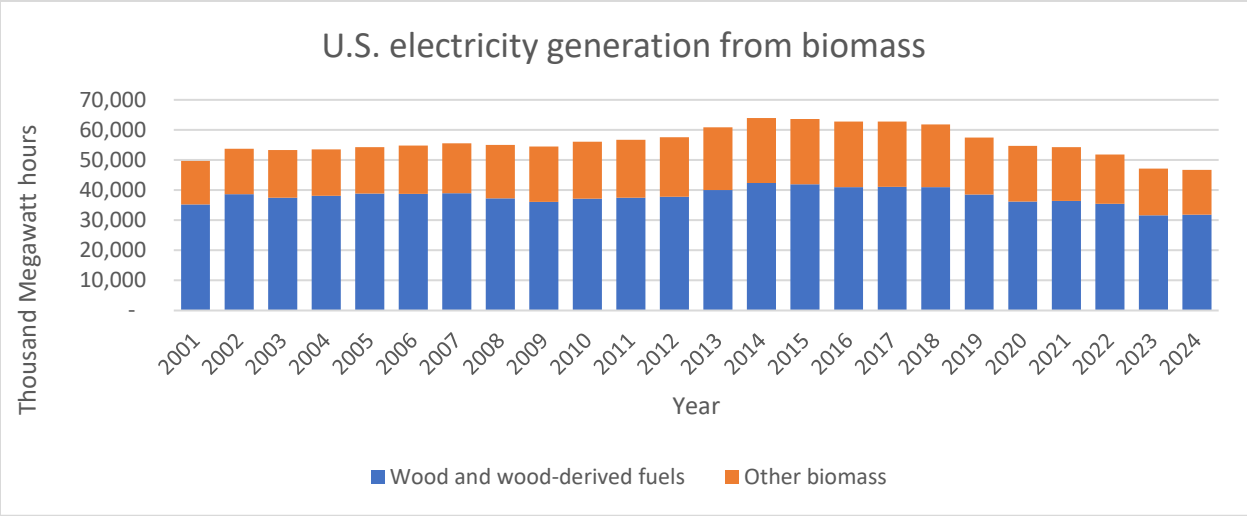

Figure 2. U.S. electricity generation from biomass, 2001 to 2022. (Source: U.S. Energy Information Administration 2025d).

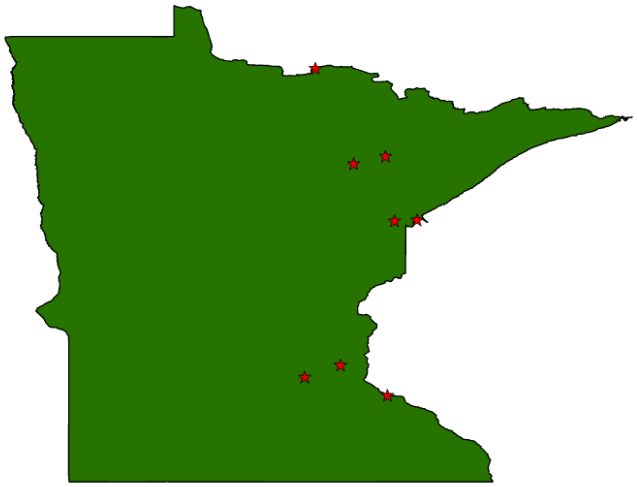

Figure 3. Locations of biomass power plants using wood and wood-derived fuels in Minnesota in 2022 (Source: U.S. Energy Information Administration 2025d).

Table 1: List of Minnesota power generation facilities using wood-based fuels in 2022.

Plant Name	Street Address	City	County	Sector Name	Fuel Type Used*
M L Hibbard	4913 Main Street	Duluth	St Louis	Commercial CHP	NG,WDS,SUB
Red Wing	801 5th st. East	Red Wing	Goodhue	Electric Utility	MSB,NG,WDS,MSN
Hibbing	1832 Sixth Avenue East	Hibbing	St Louis	Electric Utility	NG,WDS,SUB
Virginia	618 2nd St South	Virginia	St Louis	Electric Utility	NG,WDS,SUB
Boise Cascade International Falls	400 Second Street	International Falls	Koochiching	Industrial CHP	SLW,NG,WDS,BLQ
Sappi Cloquet Mill	2201 Avenue B	Cloquet	Carlton	Industrial CHP	SLW,NG,DFO,WDS,WAT,BLQ
St Paul Cogeneration	125 Shepard Road W	St. Paul	Ramsey	IPP CHP	NG,WDS
Koda Biomass Plant	975 3rd Avenue West	Shakopee	Scott	IPP CHP	NG,WDS,AB

*Fuel Type Codes: NG = Natural Gas; WDS = Wood and Wood-Derived Solids; DFO = Distillate Fuel Oil; SUB= Subbituminous coal; BLQ = Black Liquor; WAT = Wastewater Treatment Digester Gas; MSB = Municipal Solid Waste (Biogenic Portion); MSN = Municipal Solid Waste (Non-biogenic Portion); SLW = Sludge Waste; AB= Agricultural Byproduct.

Estimating the economic contributions of the wood-based biomass power generation industry is essential for highlighting its broader impacts on regional and state economies, and for supporting efforts to sustain and expand the industry. In 2022, the Michigan Department of

Natural Resources (MI DNR) Forest Resources Division commissioned a research team from Michigan State University's Department of Forestry along with collaborators from North Carolina State University, Oklahoma State University, the University of Idaho, SUNY College of Environmental Science and Forestry, and Michigan Biopower to assess the economic contributions of this industry for calendar years 2017 and 2022.

As part of this project, the research team developed a 2022 regional report analyzing the economic contributions of the wood-based biomass power generation industry across a 20-state Northeast and Midwest regions. In addition to the regional analysis, individual state reports are prepared for the participating states which include California, Connecticut, Georgia, Illinois, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Vermont, Virginia, and Wisconsin. These reports summarize the industry's economic contributions within each state.

This report presents the results for Minnesota, focusing on the industry's economic role in the state's economy. The sections that follow provide an overview of Minnesota's electric power generation industry, a brief description of the state's forest resources, an explanation of the methods used in this analysis, and a summary of the findings from the 2022 study.

Electric power generation in Minnesota in 2022

In 2022, the electric power industry in Minnesota produced a total of 58.9 million Megawatt hours of electricity. Coal was the major source of electricity generated across the state followed by wind energy and nuclear power respectively (Figure 4). Out of the total electricity generated, approximately 1.5% or 888 thousand megawatt hours were produced using wood and wood-derived fuel (Figure 4) (US EIA 2025d).

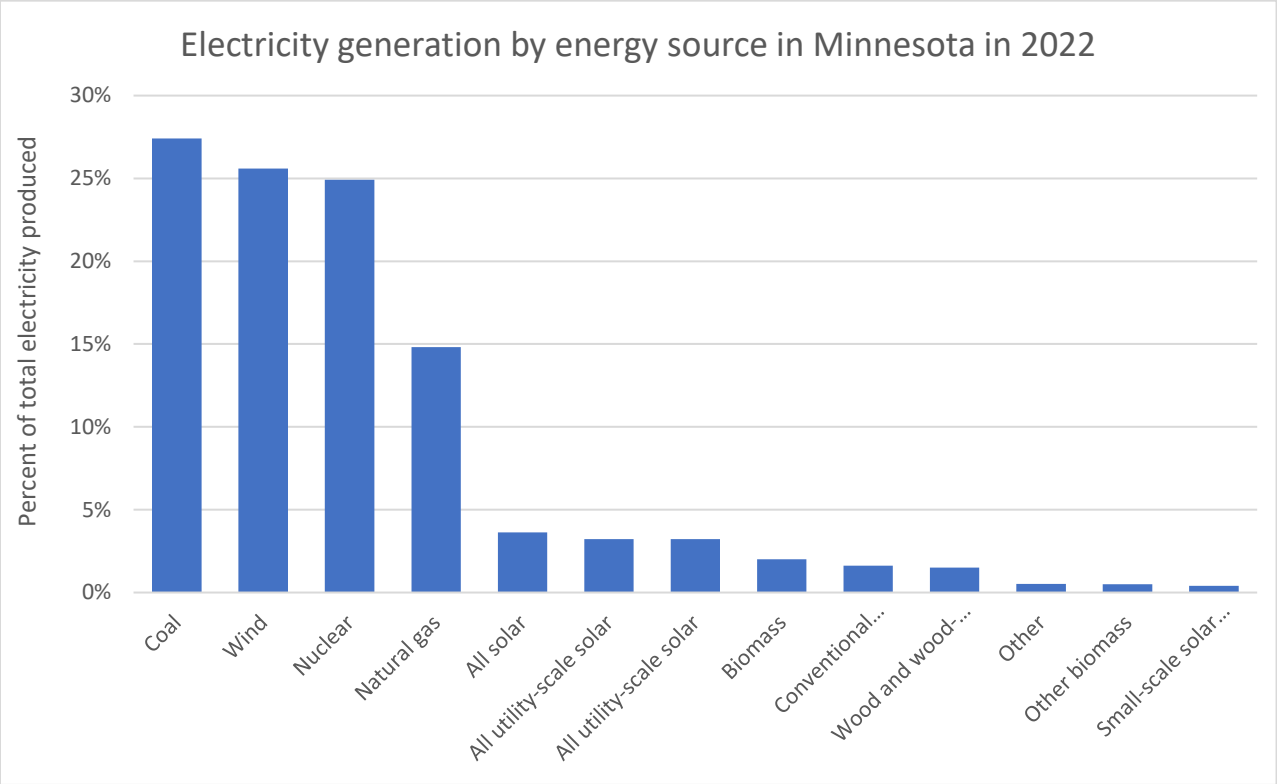

Figure 4. Percentage of total electricity generated in Minnesota in 2022 by energy source (Source: U.S. Energy Information Administration 2025d).

Collectively the electric power generation, transmission, and distribution industry employed 11,811 people in 2022 which is equivalent to 0.31% of total jobs in the state the same year (IMPLAN 2022). The direct economic effects resulting from various power-generating industries within the state including biomass are listed in Table 2.

Table 2. The direct economic effects of power generating industries in Minnesota based on 2022 IMPLAN data.

IMPLAN Sector Code (Electric Power Generation)	Energy Source	Employment	Labor Income (Millions of 2022 dollars)	Value-Added	Output
39	Hydroelectric	491	$55	$135	$315
40	Fossil fuel	1,932	$338	$1,119	$2,919
41	Nuclear	1,597	$304	$625	$1,426
42	Solar	82	$17	$34	$63
43	Wind	320	$61	$444	$856
44	Geothermal	-	$-	$-	$-
45	Biomass	78	$11	$31	$94
46	All other	204	$45	$(22)	$10
47	Electric power transmission and distribution	7,108	$1,306	$4,063	$10,152
	Total electric power generation, transmission, and distribution	11,811	$2,136	$6,430	$15,835
	Total All Sectors	**3,807,870**	**281,962**	**455,582**	**849,182**

Forest Resources of Minnesota

Minnesota has an estimated 17.6 million acres of forests which cover approximately 33% of the state's total land area (USDA Forest Service, Forest Inventory and Analysis 2023). Most of the forests in Minnesota (45%) are under private ownership, followed by the state and local governments (39%), and the federal government (16%) respectively (Figure 5). Aspen/birch is the major forest type found in Minnesota, followed by Spruce/fir and Oak/hickory forest types (Table 3).

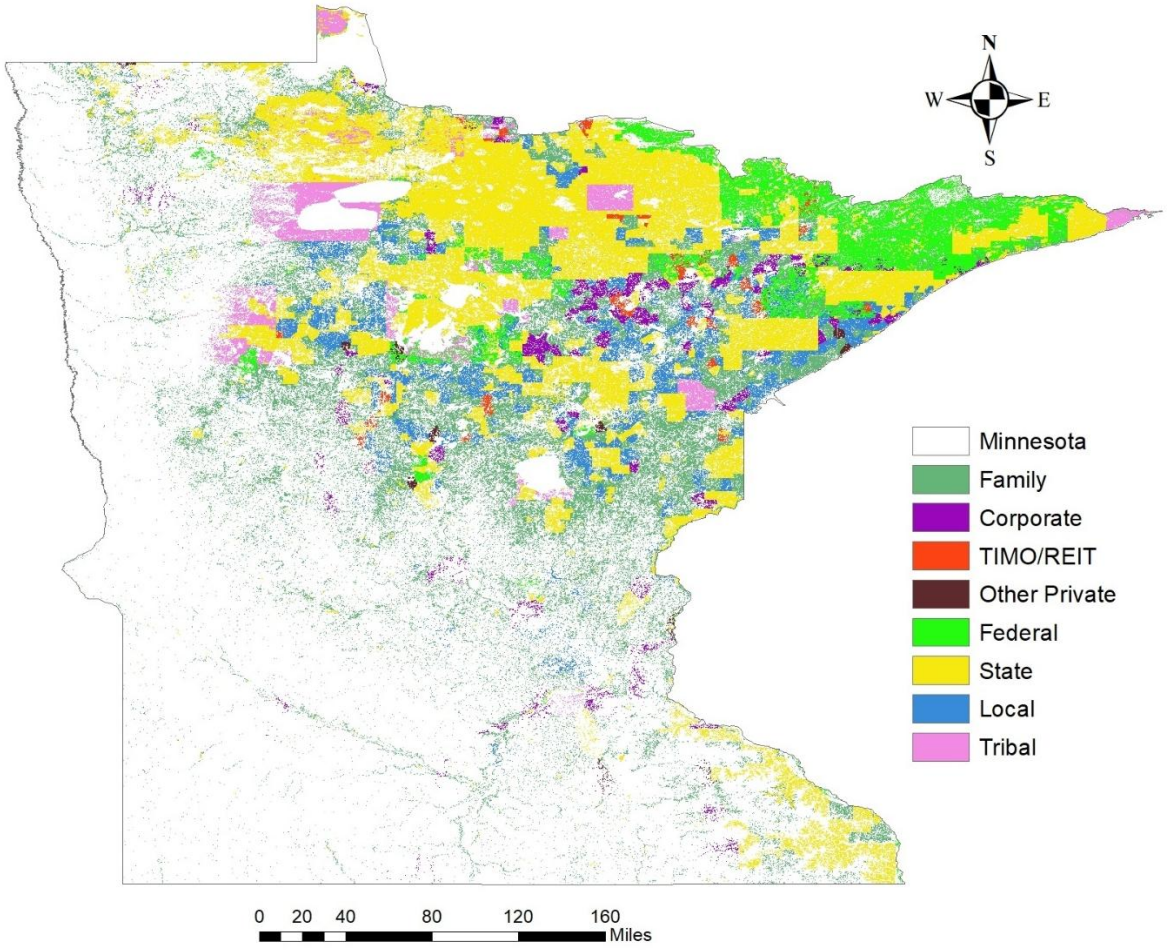

Figure 5. Forest ownership in Minnesota (Data source: Sass et al. 2020).

Table 3. Forestland area in Minnesota by forest type (Source: USDA Forest Service, Forest Inventory and Analysis 2023).

Forest Type Group	Acres	Percentage
Aspen / birch group	6,415,679	36%
Spruce / fir group	4,326,619	24%
Oak / hickory group	2,270,532	13%
Elm / ash / cottonwood group	1,647,850	9%
Maple / beech / birch group	1,225,770	7%
White / red / jack pine group	1,072,148	6%
Others	707,210	4%
Total	17,665,808	100%

The merchantable bole volume of live trees on timberlands in Minnesota is estimated to be ~21 billion cubic feet (Table 4). The average annual net growth is 526 million cubic feet, annual removals are 264 million cubic feet, and annual mortality is 285 million cubic feet. Annual growth in the timberlands exceeded the removals by a ratio of 2.0, meaning that for each cubic foot of timber harvested in the region, about 2.0 cubic feet of timber grew in the timberlands. However, this ratio varies by ownership type. The growth to removals ratio in national forests is 3.1. In private forests, it is 2.7, and 1.5 in the case of forests under state and local government (Table 4). This suggests variation in management focus on timberlands owned by different forest ownership types. Across the region, the annual removals are close to 1.3% of the standing volume and annual mortality in the timberlands are slightly greater than annual removals (Table 4).

Table 4. Characteristics of state growing stock in Minnesota in 2023 (million cubic feet) (Source: USDA Forest Service, Forest Inventory and Analysis 2023).

Ownership	Net Volume	Annual Net Growth	Annual Removals	Annual Mortality	Growth/Removals
Total	20,809	526	264	285	2.0
National Forest	3,013	74	24	47	3.1
Other federal	16	1	-	0	-
State and local	6,631	194	132	97	1.5
Private	11,149	257	97	139	2.7

Methods

The analysis was conducted using impact analysis for planning (IMPLAN) software and 2022 IMPLAN data using the Analysis-by-Parts (ABP) technique accomplished through detailed industry impact analysis activity type in IMPLAN. The ABP technique was chosen because it allows the user to create a customized industry sector by using the information about that sector's budgetary spending pattern and labor income (Lucas 2022). So far IMPLAN does not have a separate sector to represent wood-based biomass power generation. Instead, it is incorporated as a part of the electric power generation using the biomass industry. This means that it includes power generation from all sources of biomass including agricultural byproducts, landfill gas, municipal solid waste, woody biomass, black liquor, and sludge waste. To separate the economic contributions associated with wood-based power generation from power generation using all forms of biomass, the analysis-by-parts (ABP) technique was used. The resulting economic contributions are measured in terms of full- and part-time employment, industry output, value-added, labor income, other property income, and business taxes.

The information about industry spending patterns for the biomass power generation industry using woody biomass was obtained from Dahal et al. (2020) and corroborated or supplemented (where applicable) with the information collected through the mail survey of biomass power generation plants located in the twenty state Northeast-Midwest region. In fall 2022 and 2024, Michigan Department of Natural Resources conducted a mail survey of 120 biomass power industries located in the 20-state Northeast-Midwest region along with California, Georgia, and Virginia to collect the financial and resources utilization data for the year 2017 and 2022 respectively. Overall, 11 responses were obtained in the 2022 survey (9.2% response rate), and five responses were obtained in the 2024 survey (4.2% response rate). The data obtained from these responses were used to inform and supplement the industry spending pattern for wood-based biomass power generation industries for regional and state level reports for participating states. The average operation and maintenance expenditure for the wood-based biomass power generation industry used for the economic contribution analysis is listed in Table 5.

The 2024 survey asked respondents to indicate the total amount of electricity produced in 2022 using wood and wood-derived fuel along with the total cost of production. This information was used to estimate the cost per megawatt hour of electricity produced. It was estimated to be $87/MWh on average when weighed by the size of production for respondents who responded to the survey. This cost falls within the range of levelized cost of electricity generation from biomass ($77.16 to $95.16) as listed by the US energy information administration in the Annual Energy Outlook (2023). Hence, we used $87/MWh of electricity production as the cost of generating biopower from woody biomass for our 2022 analysis. The details of the survey method along with the information collected are included in the twenty-state Northeast-Midwest biopower economic contribution analysis report.

The per unit cost of electricity produced using wood and wood-derived fuel was multiplied by the total electricity produced using wood and wood-derived fuel within a state to obtain the direct output from the wood-based biomass power-generating industry in that state. Information about the total electricity produced by the electric power generation industry using wood and wood-derived fuels in 2022 was obtained from US EIA (2025d).

In Minnesota, ~0.9 million Megawatt hours of electricity were generated using wood and wood-derived fuel in 2022. At the rate of $87/MWh of electricity produced, this translated into a direct output of $77.3 million for the wood-based biomass power generation industry in the state. The direct output was then allocated into intermediate input and value-added following the percentage breakdown of output into its component parts for IMPLAN sector 45 (electricity generation using biopower industry) using 2022 IMPLAN data for Minnesota. According to it, approximately 67.4% of the output of the biomass power generation industry was comprised of intermediate inputs and 32.6% was value-added. Value added was further broken down into employee compensation (11.1%), proprietor income (0.3%), other property type income (12.9%), and taxes on production and imports (8.3%) following IMPLAN sector 45's percentage breakdown for Minnesota. The total number of employees in the wood-based biomass power generation industry was obtained by dividing total output by output per worker information obtained for sector 45 from IMPALN 2022 data. In total, there were 64 people employed in the wood-based biomass power generation industry in Minnesota in 2022.

When estimating the economic contribution of the biomass power generation industry in IMPLAN using the ABP technique, the local purchase percentage (LPP) for all other items in the industry spending pattern except woody biomass, was set to default SAM value. For woody biomass, LPP was set to 100%. This is because all wood used by the biomass power generation industry is sourced locally as per the findings obtained from the mail survey (within 60 miles radius). Since it is not possible to precisely identify the location of production, transport, and purchase of other items included in the industry spending pattern for the wood-based biomass power generation industry, LPP was set to default SAM values for those items. Like Dahal et al. (2020), we estimated total taxes (including emission fee) to be 1.85% of total operation and maintenance cost, which amounted to $1.4 million. This was modeled separately, and the resulting indirect and induced effects obtained from tax contributions were added to the total economic contribution summary for the state.

Table 5. Percentage distribution of annual operation and maintenance expenditures for the wood-based biomass power generation industry. Percentages are based on Dahal et al. (2020) and supplemented with data collected from a mail survey of wood-based power generation facilities in the Northeast and Midwest United States.

IMPLAN Sector	Cost category (sector)	Percentage
16	Biomass	58.6%
20	Natural Gas	0.05%
39	Utilities	2.8%
49	Water	1.6%
60	Building expenses	0.4%
154	Oil and diesel	0.8%
162	Chemical	1.3%
167	Supplies (consumable, urea, ammonia)	1.9%
384	Office supplies and expenses	0.2%
408	Gasoline (retail)	0.1%
433	Communication	0.2%
444	Insurance	1.6%
453	Equipment rental	0.1%
457	Outside support services (water treatment, vendor services)	0.6%
462	Consulting fees	0.4%
470	Office administrative service	1.0%
474	Travel and entertainment	0.1%
476	Janitorial	0.3%
479	Ash freight and waste management	3.0%
512	Vehicle repair	0.1%
515	Maintenance	7.2%
50001	Employee compensation	15.6%
	Total taxes (including emission fee)	1.8%
	Total operation and maintenance cost	100.0%

Results

The results obtained from the economic contribution analysis indicated that in Minnesota, the wood-based biomass power generation industry directly employed 64 individuals in 2022 with a labor income of ~$8.8 million, value-added of $25.2 million, and an output or sales of $77.3 million in 2022 US dollars (Table 6). Including ripple effects, the industry supported a total of 826 jobs with $47.6 million in labor income. The industry contributed a total of $80.7 million in value-added and $177.3 million in total output to the economy of Minnesota (Table 6). The top three industries affected in terms of employment by wood-based biomass power generation industry in the state, aside from itself, include commercial logging (IMPLAN sector 16), support activities for agriculture and forestry (IMPLAN sector 19), and commercial and industrial machinery and equipment repair and maintenance (IMPLAN sector 515).

SAM multipliers for employment, labor income, value-added, and output across the state were estimated to be 13.0, 5.4, 3.2, and 2.3 respectively. The output multiplier of 2.3 indicates that every $1 million in output in the state's wood-based biopower industry supported an additional $1.3 million in output to the rest of the economy. The relatively high employment multiplier compared to output, labor income, and value-added multipliers, reflect the biomass power industry's supply chain and spending patterns. It reflects the wood-based biomass power sector's dependence on labor-intensive upstream industries, especially commercial logging and forestry support services. These industries generate many jobs per dollar of spending, but with relatively modest wages and value added per worker. Additional induced effects in service industries such as hospitals, restaurants, and retail further increase job counts. Consequently, employment multipliers are substantially higher than output, labor income, or value-added multipliers. It should be noted that IMPLAN employment is jobs including part-time, seasonal workers and proprietors head count, hence sectors that add lots of part-time, low-hour service jobs tend to increase the employment count though labor income and output remain modest.

The wood based biopower industry in Minnesota contributed approximately $12.7 million in annual state and local taxes and just over $11.2 million in federal taxes in 2022 (Table 7).

Table 6. Economic contributions of wood-based biomass power generation industry in Minnesota in 2022 US dollars using IMPLAN software version (3.1.1001.12) and 2022 IMPLAN data.

States Included	Economic Contributions of Wood-based Biomass Power Generation Industry				
		Employment (Jobs)	Labor Income ($MM 2022)	Value-added	Output
Minnesota	Direct Contributions	64	$8.8	$25.2	$77.3
	Indirect Contributions	580	$27.3	$35.2	$65.2
	Induced Contributions	182	$11.5	$20.3	$34.8
	Total Contribution	826	$47.6	$80.7	$177.3
	SAM Multiplier	13.0	5.4	3.2	2.3

Table 7. Total tax contributions of wood-based biomass power generation industry in Minnesota in 2022 US dollars ($MM) using 2022 IMPLAN data.

Impact Type	Sub-county general	Sub-county special districts	County	State	Federal	Total
Direct	$0.95	$0.80	$0.97	$4.11	$2.53	$9.36
Indirect	$0.38	$0.32	$0.39	$2.55	$5.93	$9.56
Induced	$0.24	$0.20	$0.25	$1.55	$2.77	$5.01
Total	$1.58	$1.32	$1.60	$8.21	$11.23	$23.93

Table 8. The top five industries affected in terms of employment by wood-based biomass power generation industry in Minnesota in 2022

		Impact			
	Industry affected (IMPLAN Sector)	Direct	Indirect	Induced	Total
1	Electric power generation – Biomass (45)	64	0	0	64
2	Commercial logging (16)	0	426	0	426
3	Support activities for agriculture and forestry (19)	0	28	0	28
4	Commercial and industrial machinery and equipment repair and maintenance (515)	0	27	0	28
5	Forestry, forest products, and timber tract production (15)	0	19	0	19

Summary

This study assessed the economic contributions of wood-based biomass power generation industry in Minnesota using IMPLAN, an input-output analysis software and 2022 IMPLAN data. It provides a snapshot of the economic effects of wood-based biomass power generation industry in terms of employment generated, value-added contributed and output produced using analysis by parts technique. The ABP technique was used to separate the economic contributions of wood-based biomass power generation from the contributions of biomass power generation in general, which also includes biomass sources other than wood and wood-derived fuel. The wood-based biomass power generation industry in Minnesota was found to directly support 64 jobs and contribute $77 million in output to the state's economy. Including direct, indirect, and induced effects, the industry contributed a total of 826 jobs and $177 million in output in Minnesota.

Compared to 2017, direct employment in wood-based biomass power generation industry in Minnesota declined in 2022 by 40% (from 106 employees in 2017 to 64 employees in 2022) and direct output declined by 15% (from $90.6 million in 2017 to $77.3 million in 2022). Similarly, total employment declined by 35% and output declined by 17% in 2022 compared to 2017.

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