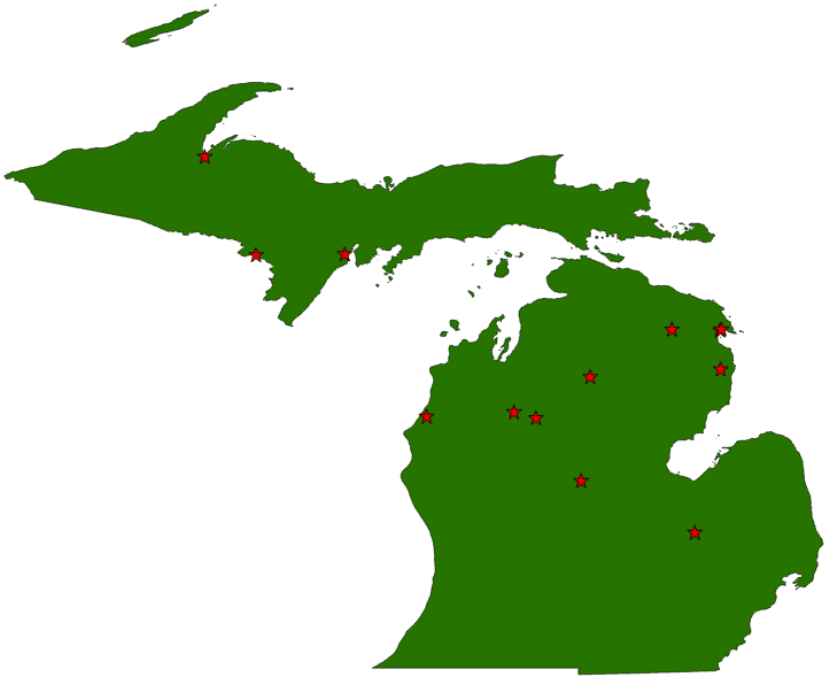
Economic Contributions of Wood-based Biomass Power Generation Industries in Michigan
2022 Version



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Acknowledgements

This report was produced as part of a 20-state project supported by the U.S. Department of Agriculture Forest Service Landscape Scale Restoration Grant 2022, administered by the Michigan Department of Natural Resources, Forest Resources Division on behalf of the Northeast-Midwest State Foresters Alliance Forest Markets & Utilization Committee.

The authors gratefully acknowledge the contributions of

Greg Alward, University of Idaho
John Wagner, SUNY College of Environmental Sciences and Forestry
Larry Leefers, Michigan State University
Omkar Joshi, Oklahoma State University
Rajan Parajuli, North Carolina State University &
Gary Melow, Michigan Biomass & Southeast Biopower Coalition
for their valuable insights and review throughout this project.

Suggested citation:

Gc, S., Pokharel, R., Poudel, J., & Dahal, R. (2025). Economic contributions of wood-based biomass power generation industries in Michigan: 2022 version. Report prepared for Michigan Department of Natural Resources. Michigan State University Department of Forestry.

Executive Summary

Decarbonizing Michigan's electricity sector requires an increased reliance on renewable energy sources, including biomass-based power generation. As of 2023, approximately 43% of Michigan's electricity was generated from natural gas, followed by nuclear power (23%), coal (19%), and renewables (11%). Biomass accounted for about 15% of Michigan's renewable electricity generation, with most of it coming from wood and wood-based 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 Michigan'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 using biomass" sector (Sector 45). 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

analysis were drawn from the Michigan Department of Natural Resources' 2022 and 2024 mail surveys of biomass power producers across a 20-state Northeast-Midwest region along with California, Georgia and Virginia as well as 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, Michigan generated approximately 1.47 million megawatt hours of electricity using wood and wood-derived fuel. This was about two percent less than the amount generated from woody-biomass 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 Michigan directly supported 107 jobs and generated $128 million in direct economic output. When accounting for indirect and induced effects throughout the economy, the industry supported a total of 1,442 jobs and contributed $293 million in total economic output. State and local tax revenues generated by industry were approximately $20 million, with an additional $19 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 Michigan's wood-based biomass power generation industry supported an additional $ 1.3 million in economic activity elsewhere in the state's economy. The industries most affected by the sector's activities in terms of employment, apart from the biomass power generation industry itself, included commercial logging, support services for agriculture and forestry, and commercial and industrial machinery and equipment repair and maintenance.

In comparison, the biomass power generation industry directly employed 106 individuals and generated $99 million (in 2022 dollars) in direct output in 2017. This represents a slight increase (1%) in direct employment and moderate increase in direct output (29%) between 2017 and 2022 in wood-based biomass power generation industry in MI. Similarly, total employment increased by 13% and output increased by 30% 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 portion 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.

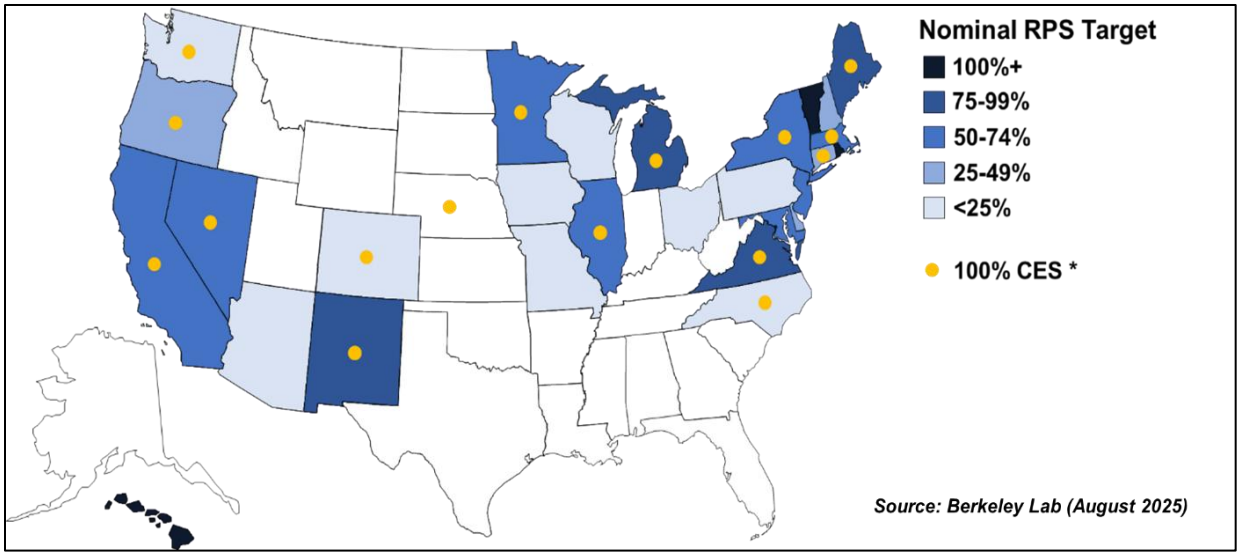

Figure1. Map of US depicting states with 100% Clean Energy Standards (CES) and associated Renewable Portfolio Standard targets (Source: Lawrence Berkeley National Laboratory, 2025).

In Michigan, RPS was established in 2008 through Public Act 295, initially requiring electric providers to generate at least 10% of their electricity from renewable sources by 2015. This standard was later expanded in 2016 to reach 15% by 2021, and again in 2023 to reach 50% by 2030-2034 and 60% from 2035 onward (Michigan Public Service Commission 2025).

In 2023, approximately 11% of electricity generation in Michigan came from renewable sources, with wind as the largest contributor. Biomass made up roughly 15% of Michigan'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 Michigan, woody biomass accounted for approximately 1.5% of the state's total electricity production in 2001, decreasing to about 1.3% in 2022 and 1.1% in 2024 (U.S. 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 Michigan, there were a total of 12 biopower facilities using wood and wood-derived fuels in 2022 (Figure 3; U.S. EIA 2025d). Table 1 provides the names, locations, sector classifications, and full fuel portfolios of Michigan facilities using wood and wood-derived fuels in 2022.

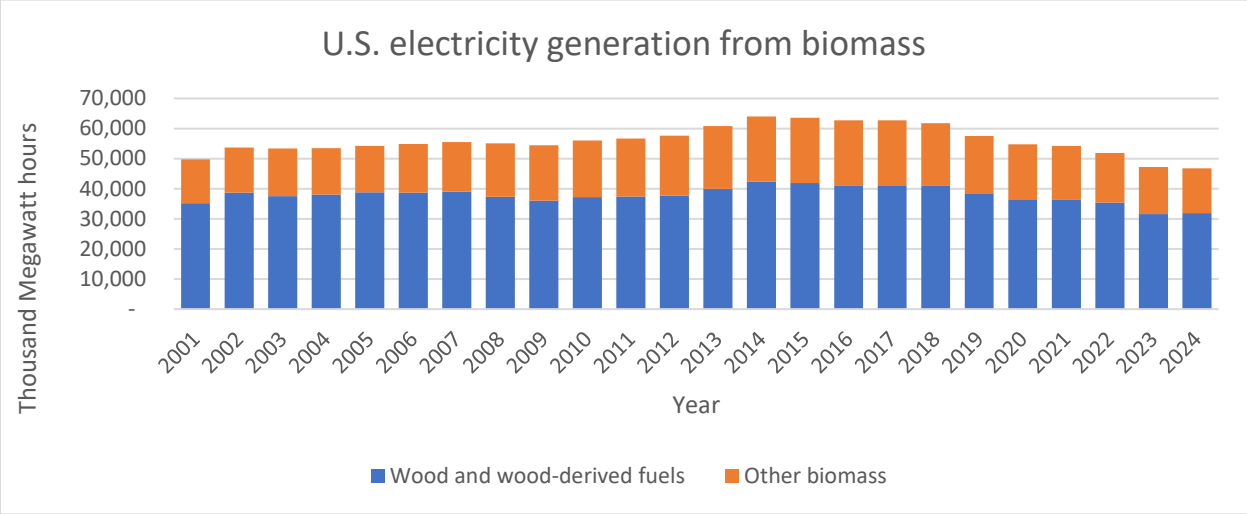

Figure 2. U.S. electricity generation from biomass, 2001 to 2024. (Source: U.S. Energy Information Administration 2025d).

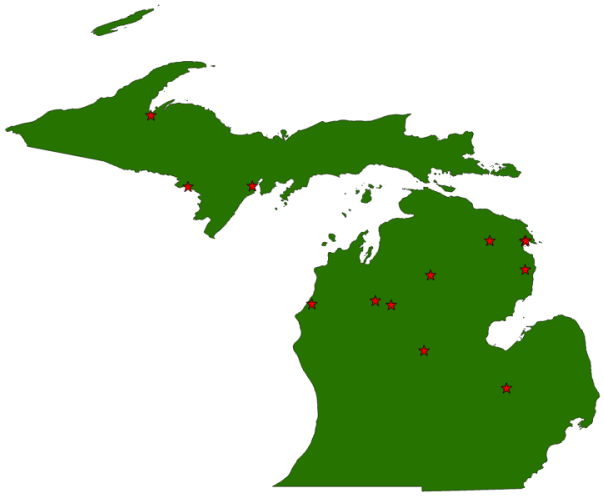

Figure 3. Map depicting locations of biomass power plants using wood and wood-derived fuels in Michigan in 2022 (Source: U.S. Energy Information Administration 2025d).

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

Plant Name	Street Address	City	County	Sector Name	Fuel Type Used*
John H Warden	157 S Main St	L'Anse	Baraga	IPP Non-CHP	NG,WDS,TDF
Decorative Panels Intl	416 Ford Ave	Alpena	Alpena	Industrial CHP	NG,WDS
Escanaba Mill	7100 County 426 M-5 Road	Escanaba	Delta	Industrial CHP	SLW,NG,WDS,TDF,RFO,BLQ,BIT
Hillman Power LLC	750 Progress Street	Hillman	Montmorency	IPP Non-CHP	WDS,NG,TDF
Grayling Generating Station	4400 W 4 Mile Rd	Grayling	Crawford	IPP Non-CHP	NG,WDS,TDF
Billerud Quinnesec Mill	US Hwy 2	Norway	Dickinson	Industrial CHP	NG,WDS,BLQ,BIT
National Energy of McBain	6751 W. Gerwoude Dr	McBain	Missaukee	IPP Non-CHP	NG,WDS,TDF
National Energy of Lincoln	509 West State Rd	Lincoln	Alcona	IPP Non-CHP	NG,WDS,TDF
TES Filer City Station	700 Mee St.	Filer City	Manistee	IPP CHP	NG,WDS,TDF,BIT
Cadillac Renewable Energy	1525 Miltner St.	Cadillac	Wexford	IPP Non-CHP	WDS
Genesee Power Station LP	5310 N Dort Hwy	Flint	Genesee	IPP Non-CHP	NG,WDS,TDF
Central Michigan University	1720 S. East Campus Dr	Mt. Pleasant	Isabella	Commercial CHP	NG,WDS

*Fuel Type Codes: NG = Natural Gas; WDS = Wood and Wood-Derived Solids; BLQ = Black Liquor; RFO = Residual Fuel Oil; OBS = PC = Petroleum Coke; BIT = Bituminous Coal; SLW = Sludge Waste; TDF = Tire-Derived Fuel.

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 Michigan, focusing on the industry's economic role in the state's economy. The sections that follow provide an overview of Michigan'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 Michigan in 2022

In 2022, the electric power industry in Michigan produced a total of ~117.5 million Megawatt hours of electricity. Natural gas was the major source of electricity generated across the state followed by coal and nuclear power respectively (Figure 4). Out of the total electricity generated, approximately 1.3% or ~1.5 million Megawatt hours were produced using wood and wood-derived fuel (Figure 4) (US EIA 2025d).

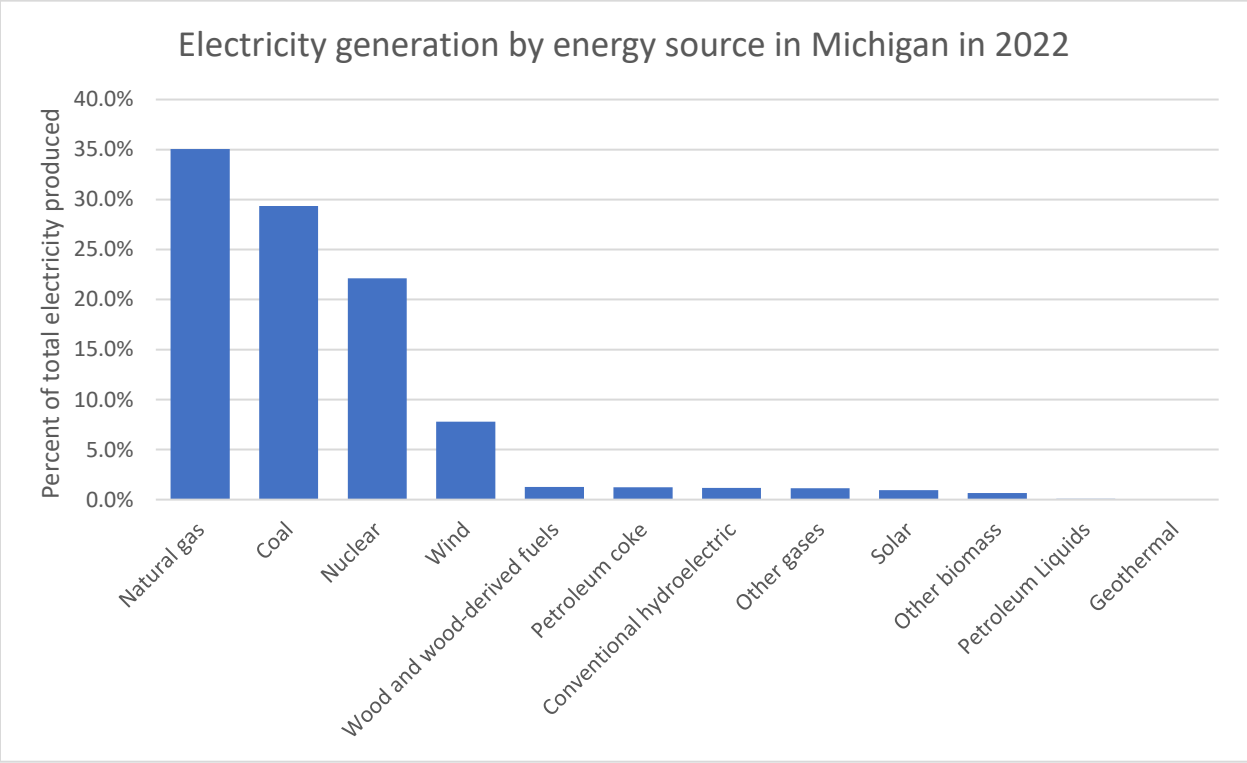

Figure 4. Percentage of total electricity generated in Michigan in 2022 by energy source (Source: U.S. Energy Information Administration 2025d).

Collectively the electric power generation, transmission, and distribution industry employed 19,007 people in 2022 which is equivalent to 0.33% 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 Michigan based on 2022 IMPLAN data.

IMPLAN Sector Code (Electric Power Generation)	Energy Source	Employment	Labor Income	Value-Added	Output
			(Millions of 2022 dollars)		
39	Hydroelectric	315	$54	$116	$232
40	Fossil fuel	5,233	$1,057	$3,313	$8,187
41	Nuclear	4,164	$959	$1,858	$3,946
42	Solar	85	$12	$26	$56
43	Wind	84	$16	$113	$222
44	Geothermal	-	$-	$-	$-
45	Biomass	121	$16	$46	$145
46	All other	97	$18	$(8)	$5
47	Electric power transmission and distribution	8,908	$1,790	$5,421	$13,051
	Total electric power generation, transmission, and distribution	19,007	$3,922	$10,886	$25,844
	Total All Sectors	**5,759,666**	**$390,218**	**640,458**	**1,280,254**

Forest Resources of Michigan

Michigan is rich in forests. Forestlands cover approximately 54% of the total land area in Michigan (USDA Forest Service, Forest Inventory and Analysis 2023). Out of this, ~95% of the forestland can produce commercial timber and is identified as timberlands. Most of the forests in the state (62%) are under private ownership, followed by the state and local governments (23%), and the federal government (15%) respectively (Figure 5). Maple/beech/birch and Oak/hickory are the major forest types in the state followed by Aspen/birch and Spruce/fir forest types (Table 3).

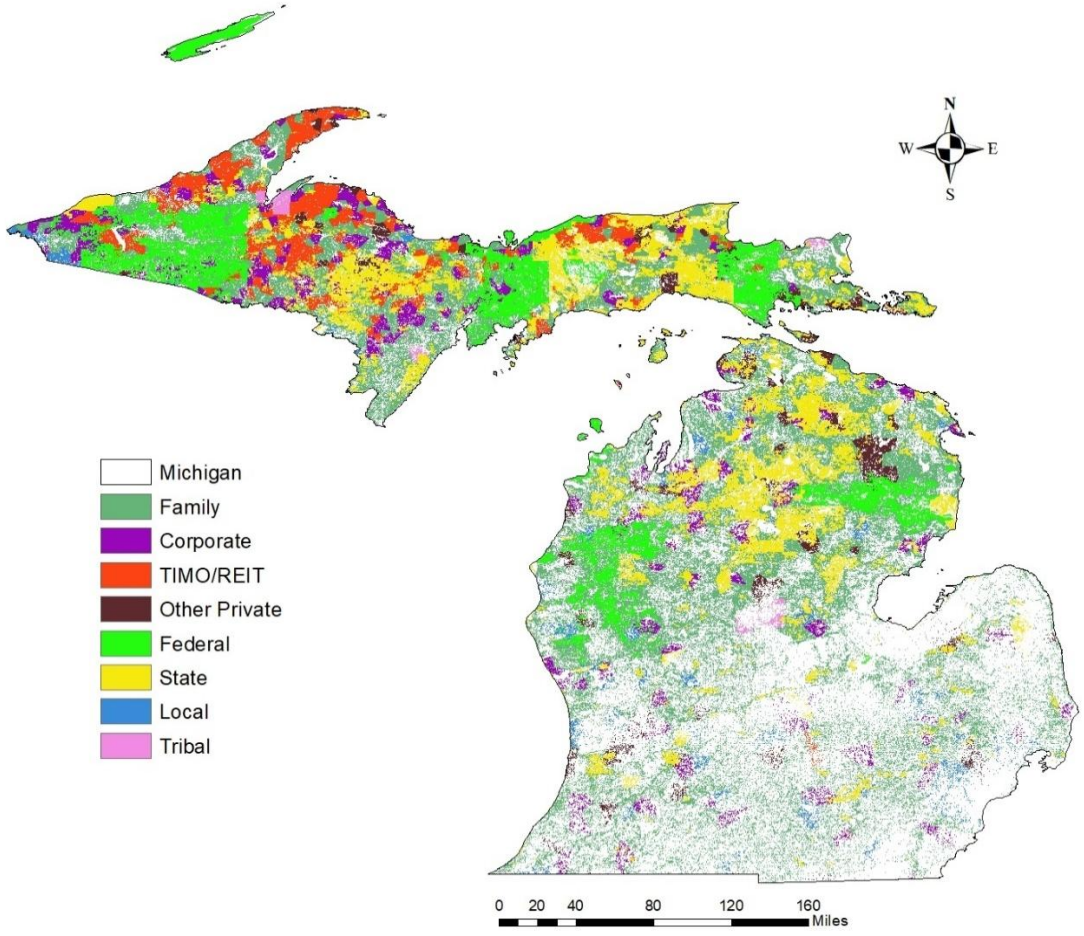

Figure 5. Forest ownership in Michigan (Data source: Sass et al. 2020).

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

Forest Type Group	Acres	Percentage
Maple/beech/birch group	6,035,082	30%
Oak /hickory group	3,283,869	16%
Aspen /birch group	2,829,494	14%
Spruce/fir group	2,565,613	13%
White/red /jack pine group	2,206,206	11%
Elm/ash /cottonwood group	1,955,568	10%
Oak/pine group	616,042	3%
Others	561,055	3%
Total	20,052,929	100%

The merchantable net bole volume of live trees in Michigan is estimated to be ~40 billion cubic feet (Table 4). The average annual net growth is 791 million cubic feet, annual removals are 469 million cubic feet, and annual mortality is 412 million cubic feet. Annual growth in the timberlands exceeded the removals by a ratio of 1.7, meaning that for each cubic foot of timber harvested in the region, about 1.7 cubic feet of timber grew in the timberlands. However, this ratio varies by ownership type. The growth to removals ratio in national forests is 3.6. In private forests, it is 1.7, 1.6 in the case of forests under state and local government, and 0.2 in forests under other federal ownership (Table 4). This suggests variation in management focus on timberlands owned by different forest ownership types. Across the state, the annual removals are close to 1.2% of the standing volume and annual mortality in the timberlands is close to annual removals (Table 4).

Table 4. Characteristics of state growing stock 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	39,987	791	469	412	1.7
National Forest	6,740	114	32	55	3.6
Other federal	21	0.4	2	0.4	0.2
State and local	7,628	158	96	79	1.6
Private	25,596	519	313	276	1.7
Not available	39,987	791	469	412	1.7

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 Michigan, 1.47 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 $128 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 Michigan. According to it, approximately 68.3% of the output of the biomass power generation industry was comprised of intermediate inputs and 31.7% was value-added. Value added was further broken into employee compensation (10.6%), proprietor income (0.5%), other property type income (12.7%), and taxes on production and imports (7.8%) following IMPLAN sector 45's percentage breakdown for Michigan. To estimate employment, the industry's total output was divided by the output per worker value for IMPLAN sector 45 (from Michigan's 2022 dataset). Using this method, the wood-based biomass power generation industry supported an estimated 107 jobs in Michigan 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 70 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 $2.4 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 Michigan, the wood-based biomass power generation industry directly employed 107 individuals in 2022 with a labor income of $14 million, value-added of $41 million, and an output or sales of $128 million in 2022 US dollars (Table 6). Including ripple effects, the industry supported a total of 1,442 jobs with $78 million in labor income. The industry contributed a total of $133 million in value-added and $293 million in total output to the economy of Michigan (Table 6). The top three industries affected in terms of employment by wood-based biomass power generation industry in the state, apart 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 multiplier for output across the region was estimated to be 2.3. This means that every $1 million in output in the region's wood-based biopower industry supported an additional $1.3 million in output to the rest of the economy. Likewise, the SAM multiplier for employment, labor income and value added were estimated to be 13.5, 5.5, and 3.3 respectively. 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 our study region contributed close to $20 million in annual state and local taxes and $19 million in federal taxes in 2022 (Table 7).

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

	Economic Contributions of Wood-based Biomass Power Generation Industry				
States Included		**Employment (Jobs)**	**Labor Income**	**Value-added ($MM 2022)**	**Output**
Michigan	Direct Contributions	107	$14.3	$40.6	$128.2
	Indirect Contributions	1,023	$46.0	$60.5	$108.4
	Induced Contributions	312	$17.9	$32.1	$56.7
	Total Contribution	1,442	$78.2	$133.2	$293.4
	SAM Multiplier	13.5	5.5	3.3	2.3

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

Impact	Sub County General	Sub County Special Districts	County	State	Federal	Total
Direct	$1.24	$2.00	$0.72	$6.12	$4.16	$14.24
Indirect	$0.75	$1.14	$0.41	$4.30	$10.35	$16.95
Induced	$0.36	$0.56	$0.20	$2.07	$4.38	$7.57
Total	$2.34	$3.70	$1.32	$12.49	$18.89	$38.75

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

		Impact			
	Industry affected (IMPLAN Sector)	**Direct**	**Indirect**	**Induced**	**Total**
1	Commercial logging (16)	0	683	0	683
2	Support activities for agriculture and forestry (19)	0	113	0	113
3	Electric power generation – Biomass (45)	107	0	0	107
4	Commercial and industrial machinery and equipment repair and maintenance (515)	0	57	1	57
5	Forestry, forest products, and timber tract production (15)	0	29	0	29

Summary

This study assessed the economic contributions of wood-based biomass power generation industry in Michigan using IMPLAN, an input-output analysis software and online version of 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 Michigan was found to directly support 107 jobs and contribute $128 million in output to the state's economy. Including direct, indirect, and induced effects, the industry contributed a total of 1,442 jobs and $293 million in output in Michigan.

Compared to 2017, direct employment in wood-based biomass power generation industry in Michigan increased by one percent (from 106 employees in 2017 to 107 employees in 2022) and direct output increased by 29% (from $99 million in 2017 to $128 million in 2022) in 2022 dollars. Similarly, total employment increased by 13% and output increased by 30% in 2022 compared to 2017.

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