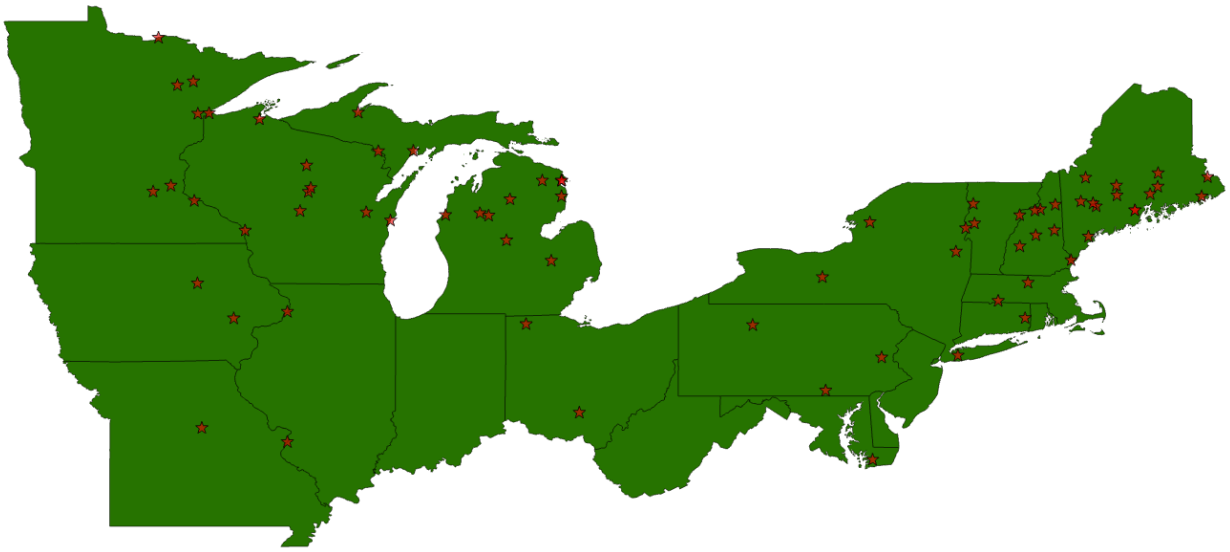
Economic Contributions of Wood-based Biomass Power Generation Industries in the Northeast and Midwest: 2022 Version



Prepared for
Michigan Department of Natural Resources
Lansing, Michigan

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

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Executive Summary

Decarbonizing the electricity sector necessitates a greater reliance on renewable energy sources, including biomass. As of 2023, approximately 60% of electricity in the United States was generated from fossil fuels, 19% from nuclear energy, and 21% from renewable sources. Biomass accounted for about 5% of total renewable electricity generation, with the majority derived from wood and wood-based fuels. Unlike most other renewable sources, woody biomass can deliver consistent, 24/7 baseload power. Compared to conventional fossil fuels, wood-based biomass offers several advantages: it reduces greenhouse gas emissions, supports job creation and economic activity in rural, forest-dependent communities, and provides a market for low-value or excess forest materials. When harvested and managed sustainably, woody biomass can also divert organic waste from landfills and promote forest health.

To evaluate the economic contributions of wood-based biomass power generation in the Northeast and Midwest, the Michigan Department of Natural Resources secured funding from the U.S. Forest Service through a Landscape Scale Restoration Grant. This 20-state report provides a regional summary of the sector's economic contribution in 2022 and serves as a follow-up to a similar report based on 2017 data. As in the previous effort, individual state-level reports were also developed for participating states that generated electricity using wood and wood derived fuel in the region including California, Virginia, and Georgia.

The economic contribution analysis was conducted using IMPLAN (Impact Analysis for Planning), an input-output modeling software, and 2022 IMPLAN data. A detailed impact analysis activity type was used to conduct the analysis in IMPLAN online which is analogous to its Analysis-by-Parts (ABP) methodology.

So far, IMPLAN does not include a distinct sector for wood-based biomass power generation; instead, this activity is grouped within the broader "Electric power generation using biomass" category (Sector 45 in the 2022 online version of IMPLAN dataset), which also includes generation from agricultural byproducts, landfill gas, municipal solid waste, black liquor, and sludge waste. To isolate the economic contribution of wood-based biomass specifically, the ABP method was used. This approach enables the construction of a customized sector by defining a

tailored spending pattern and labor income profile, allowing for more precise attribution of impacts to wood-based biomass power generation.

Supplementary data for this analysis were obtained through a mail survey of biomass power generation facilities across the 20-state study region, conducted by the Michigan Department of Natural Resources in Fall 2022 and 2024. Additional insights were drawn from a review of relevant literature on wood-based biomass power generation in the United States. All economic contribution estimates presented in this report are expressed in 2022 constant dollars.

In 2022, fourteen of the twenty states in the study region generated electricity from wood and wood-derived fuels, producing a combined total of 7.13 million megawatt-hours (MWh). This is 29% less than the amount of electricity generated across the region using woody biomass in 2017. Delaware, Illinois, Indiana, New Jersey, Rhode Island, and West Virginia did not generate electricity from woody biomass in 2022, nor did they in 2017. The cost of electricity generation using wood and wood-derived fuels was estimated at $87 per MWh, based on the data collected through a mail survey of biomass power plants in the study region conducted in Fall 2024.

In 2022, the wood-based biomass power generation industry directly employed 443 people and contributed approximately $621 million in direct output to the regional economy. When indirect and induced (ripple) effects are included, the industry supported a total of 5,487 jobs and generated $1.41 billion in total economic output. The industry also contributed an estimated $103 million in state and local tax revenues and $100 million in federal tax revenues.

The social accounting matrix (SAM) multiplier for industry output was estimated at 2.3, indicating that every $1 million in direct output supported an additional $1.3 million in output across the broader regional economy. Outside of the industry itself, the sectors most affected in terms of output included commercial logging, forestry, forest products, and timber tract production, and support activities for agriculture and forestry. Likewise, the industries most affected in terms of employment included commercial logging, electric power generation using biomass, and support activities for agriculture and forestry.

In comparison, the biomass power generation industry directly employed 722 people and generated $701 million (in 2022 dollars) in direct output in 2017. This represents a decline of nearly 39% in direct employment and 12% reduction in direct output between 2017 and 2022. Similarly, total employment declined by 34% and output declined by 19% 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 waste, 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 byproducts 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 in 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 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 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

As the U.S. electricity sector continues to make gradual progress toward reducing fossil fuel dependence, renewable energy sources are playing a growing role in power generation and emissions reduction strategies. Among these, wood-based biomass is uniquely positioned to provide reliable, 24/7 baseload power (Bracmort, 2015) while supporting rural economic development, utilizing low-value forest materials, and contributing to improved forest health when managed sustainably (National renewable energy laboratory 2023, Gan and Smith 2007). This report builds on a previous 2017 analysis to assess the economic contributions of the wood-based biomass power generation industry in 2022, with a focus on industry trend, employment and output across a 20-state Northeast Midwest region.

In 2024, biomass-based electricity accounted for 1.1% of total U.S. electricity generation, with woody biomass comprising the largest share, 68% of all electricity generated from biomass that year (U.S. EIA, 2025). Despite this dominant share, electricity generation from woody biomass has steadily declined since peaking at 42.3 million megawatt-hours (MWh) in 2014, falling to 35.5 million MWh in 2022 and 31.6 million MWh in 2023 (Figure 1) (U.S. EIA, 2025). This downward trend reflects a combination of economic, policy, and operational challenges. Chief among them is increasing competition from lower-cost renewable sources such as wind and solar, which benefit from stronger policy incentives and rapidly falling technology costs (McFall-Johnson et al. 2024). In addition, many biomass power facilities, often built decades ago, have been retired or repurposed due to aging infrastructure, high operating costs, and limited reinvestment. Regulatory uncertainty, along with growing public concern over carbon neutrality and air quality (Lindwall 2022), has also constrained expansion. Finally, feedstock costs and regional supply chain limitations have made continued operation financially challenging in many areas.

One of the key advantages of using biomass for power generation is its ability to provide baseload (firm) power, in contrast to intermittent renewable sources like solar and wind (Bracmort, 2015). Electricity generation from woody biomass offers a range of societal, economic, and environmental benefits. Compared to fossil fuels, it can reduce greenhouse gas emissions, support income and job creation in rural, forest-dependent communities, and divert

organic waste from landfills. Furthermore, when harvested and used in accordance with sustainability standards, woody biomass can enhance forest health (National Renewable Energy Laboratory, 2023; Gan & Smith, 2007).

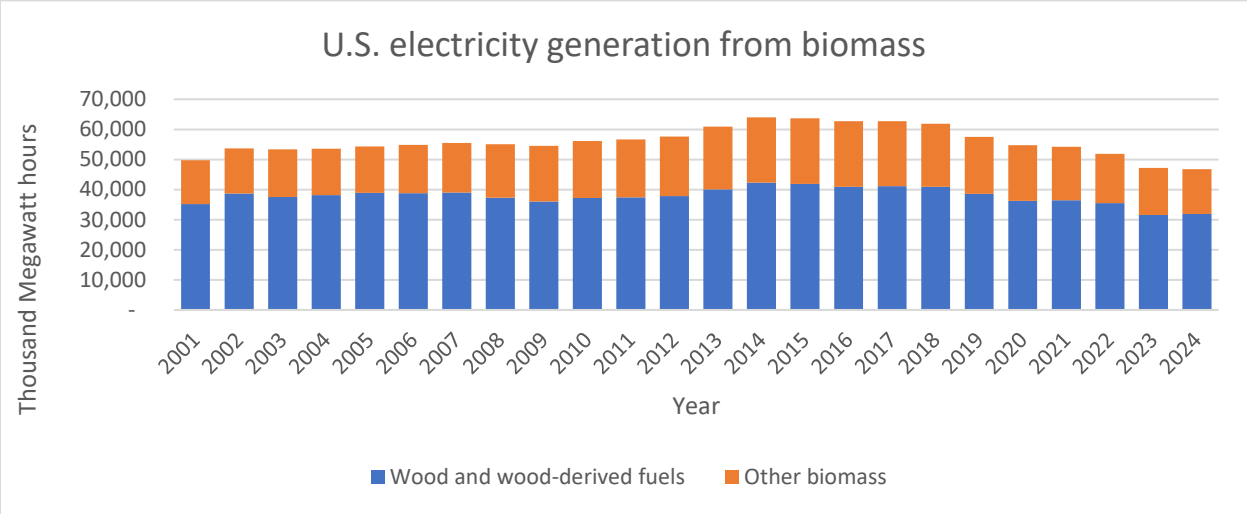

Figure 1. U.S. electricity generation from biomass, 2001 to 2024. (Source: U.S. Energy Information Administration 2025).

Substantial volumes of woody biomass are removed each year by private, state, and federal forest managers to reduce wildfire risk and address threats from insects, diseases, and invasive species. Additional sources include debris from natural disasters such as hurricanes and tornadoes, as well as urban tree maintenance and cleanup activities (USDA Forests and Rangelands, 2023). Without viable market outlets, such as biomass power generation, much of this material is left to decompose, burned on-site, or disposed of in landfills (USDA Forests and Rangelands, 2023).

Biomass power generation offers a valuable outlet for low-value wood material, reducing the need for open burning and thereby improving air quality, visibility, and public health. By creating economic value for non-merchantable and low-grade wood, it helps offset the high costs of forest management, hazardous fuel reduction, ecological restoration, and post-harvest cleanup (Page-Dumroese et al., 2022). In doing so, biomass energy indirectly supports wildfire risk reduction, while also contributing to the conservation of wildlife habitat and watersheds and promoting economic development in rural communities (USDA Forests and

Rangelands, 2023). Additionally, the wood products manufacturing sector, including producers of lumber, furniture, pallets, and paper, generates substantial volumes of wood residues. In the absence of strong market demand, much of this byproduct remains underutilized. Notably, less than half of a harvested tree typically ends up in final products, leaving significant quantities of residual material that can be repurposed for energy generation (Abbuelh et al., 2004).

While biomass-based electricity production often requires substantial upfront investment, it can yield stronger local economic impacts than fossil fuel-based power generation due to its reliance on locally sourced feedstocks (Faaij et al., 1998). When managed sustainably, woody biomass power is often considered carbon neutral, as the CO_2 emitted during combustion is offset by avoided fossil fuel emissions and the carbon sequestered by regrowing forests (International Energy Agency, 2022). However, to fully assess its carbon neutrality, the entire biomass supply chain must be considered including emissions from harvesting, processing, transportation, and energy conversion. Only through comprehensive life cycle analysis can the net climate benefits of biomass energy be accurately determined (International Energy Agency, 2022).

A recent study by Mirzaee et al. (2022) explored the relationship between biopower generation and forest conditions in the Northeastern United States, focusing on timberland structure indicators and carbon stocks from 2005 to 2017. Utilizing Forest Inventory and Analysis (FIA) data, the authors evaluated areas surrounding both wood-using and coal-burning power plants. The study found that wood-using power plants in the Eastern U.S. had no net negative impact on the number of live and dead trees or on associated carbon stocks. In fact, results revealed a positive temporal trend in both the number of live trees and the volume of carbon stored in live biomass in regions with sustained biopower activity. These findings suggest that, when guided by sustainability standards, wood-based biopower generation can support zero-emission renewable energy goals while maintaining or even enhancing forest carbon stocks.

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 noted in recent years (Figure 1). 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). Figure 2 shows the distribution of biomass power plants using wood and wood-derived fuels across the country in 2022.

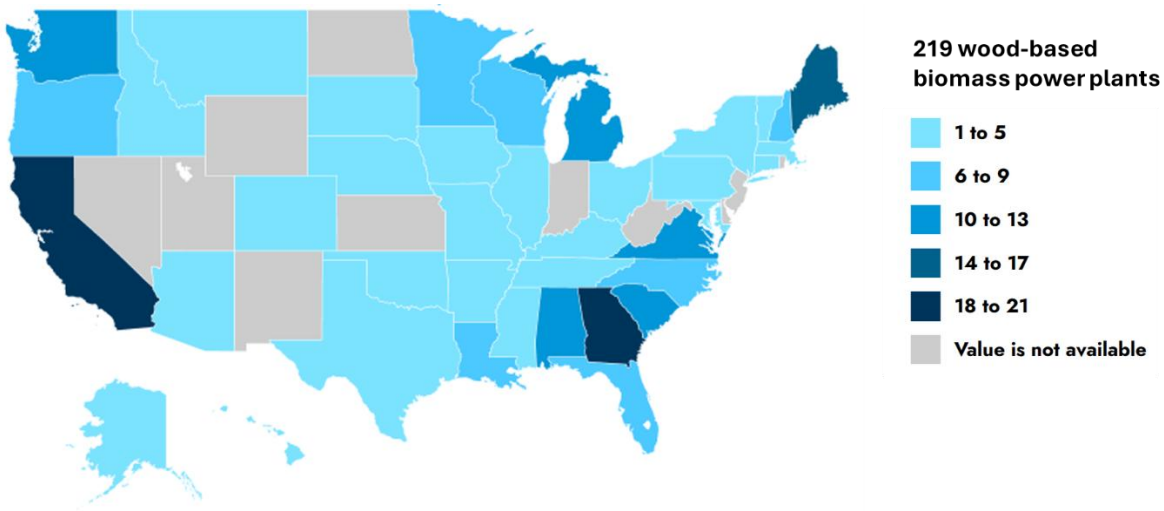

Figure 2. Distribution of 219 biomass power plants in the U.S. using wood and wood-derived fuels in 2022 (Source: US Energy Information Administration 2025).

Given this limited growth, quantifying the economic contributions of the wood-based biomass power industry is critical for demonstrating its broader value to regional economies. Estimating its direct and indirect impacts on employment, income, and output can inform policy, support investment, and strengthen efforts to sustain and expand the sector, particularly in rural, forest-reliant communities.

In recognition of this need, the Michigan Department of Natural Resources (MI DNR) Forest Resources Division commissioned a research team in 2022 from the Michigan State University Department of Forestry, in collaboration with North Carolina State University, Oklahoma State University, the University of Idaho, SUNY College of Environmental Science and Forestry, and Michigan Biopower, to conduct an economic contribution analysis of the wood-based biomass power generation industry. The study evaluated industry contribution across 20 states in the Northeast and Midwest, along with California, Georgia, and Virginia, for the 2017 and 2022 calendar years.

The 20-state region includes: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin. Of these, fourteen states were designated as participating states in the study: California, Connecticut, Georgia, Illinois, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Vermont, Virginia, and Wisconsin.

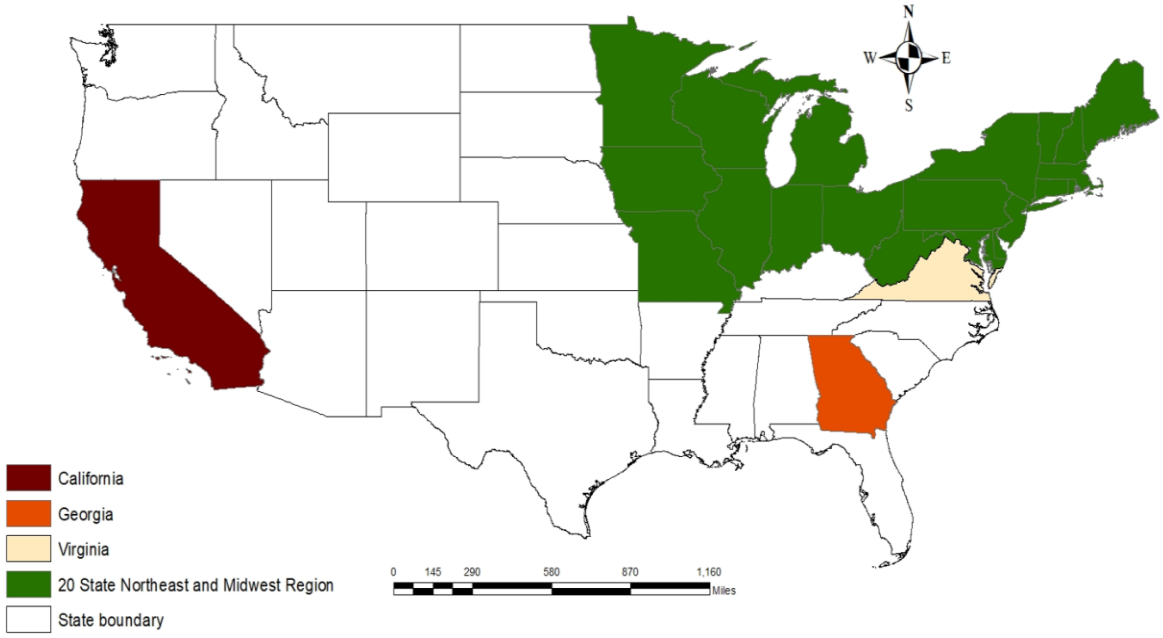

Figure 3. Study area illustrating 20 Northeast-Midwest states and California, Georgia, and Virginia.

Following the acceptance of the project proposal, the Michigan State University research team held multiple meetings with project partners to establish consensus on the analytical approach, identify supplementary data needs, and determine the structure of both regional and state-level reports. This report presents the findings from the 2022 economic contribution analysis of the wood-based biomass power generation industry across the twenty-state study region, serving as a follow-up to a similar analysis conducted for 2017. In addition to the regional assessment, individual state-level reports were developed for each participating state as part of the project deliverables.

The sections that follow outline the project objectives; provide an overview of electric power generation and forest resources in the twenty-state region as of 2022; describe the methodology used for the economic contribution analysis; and present and interpret the key findings.

Objectives of the project

1. Conduct an economic contribution analysis of wood-based biomass power generation industries for 20 Northeast Midwest U.S. states- as a region, and 14 participating states including California, Georgia and Virginia using supplementary data collected by the project partners.
2. Produce a report documenting the methods used for analysis for the Northeast-Midwest region and each participating state detailing the economic contributions of the wood-based biomass power generation sector using 2017 and 2022 impact analysis for planning (IMPLAN) data.
3. Disseminate information about the methods adopted and findings obtained with concerned stakeholders and the public via webinars and presentations.
4. Convene a meeting of economists familiar with power generation technologies to discuss and develop an analysis method for producing comparable estimates of economic valuation among the most prevalent power generation technologies – coal, natural gas, nuclear, geothermal, solar, and wind power generation – and woody biomass power generation.
5. Document the resulting recommendations and consensus method in a publishable journal manuscript draft.

Electric power generation in the Northeast and Midwest in 2022

In 2022, approximately 1.44 billion megawatt hours of electricity were generated in the twenty-states study region. Natural gas was the major source of electricity generated across the region followed by coal and nuclear energy respectively (Figure 4). Out of the total electricity generated, approximately 0.5% or 7.13 million Megawatt hours were produced using wood and wood-derived fuels (Figure 4) (US EIA 2023d).

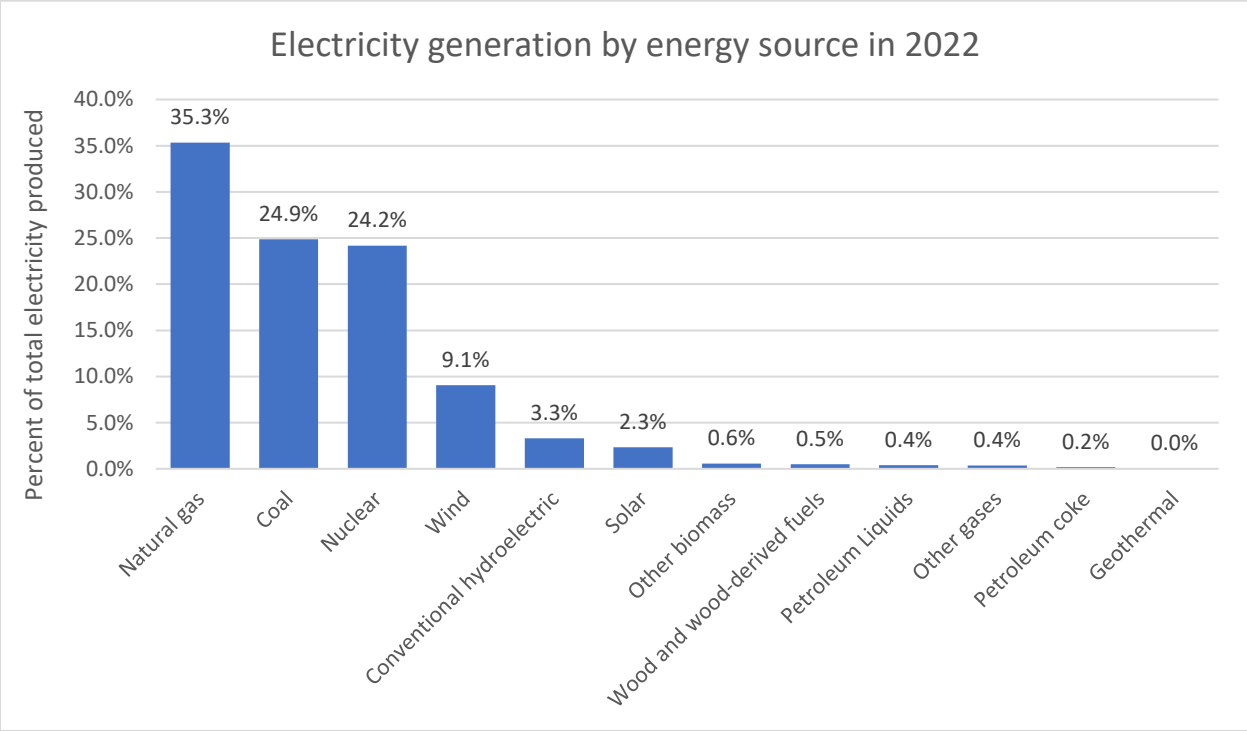

Figure 4. Percentage of total electricity generated in the twenty-state region in 2022 by energy source (Source: U.S. Energy Information Administration 2025).

Collectively the electric power generation, transmission, and distribution industry employed 190,989 people in 2022 across the region which is equivalent to 0.24% of total jobs in the region the same year (IMPLAN 2022). The direct economic effects resulting from various power generating industries in the study region including biomass are listed in Table 1. Biomass in table 1 includes all biomass (wood and wood derived fuels as well as other biomass).

Table 1. The direct economic effects of power generating industries in the twenty-state Northeast and Midwest regions 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	2,966	581	1,332	2,419
40	Fossil fuel	39,033	9,163	30,366	66,721
41	Nuclear	21,816	5,942	12,155	23,095
42	Solar	2,474	539	1,197	2,070
43	Wind	1,892	490	3,345	5,784
44	Geothermal	49	13	25	40
45	Biomass	843	160	492	1,183
46	All other	1,044	280	(1)	124
47	Electric power transmission and distribution	120,874	28,053	88,240	191,773
	Total electric power generation, transmission, and distribution	**190,989**	**45,222**	**137,151**	**293,209**
	Total All Sectors	**80,075,620**	**$6,136,940**	**$10,200,122**	**17,982,691**

Forest resources in the Northeast and Midwest

The twenty-state Northeast and Midwest region is heavily forested, with forestlands covering approximately 43% of the total land area equivalent to 174.3 million acres (USDA Forest Service, Evalidator, 2023). Of this forested area, 94% is classified as timberland, meaning it is capable of producing commercial timber. Forest ownership in the region is predominantly private, accounting for 73% of total forestland, followed by state and local governments (19%) and the federal government (8%) (Figure 7).

The dominant forest type groups in the region include Oak/Hickory and Maple/Beech/Birch, followed by Spruce/Fir and Aspen/Birch forests (Table 2).

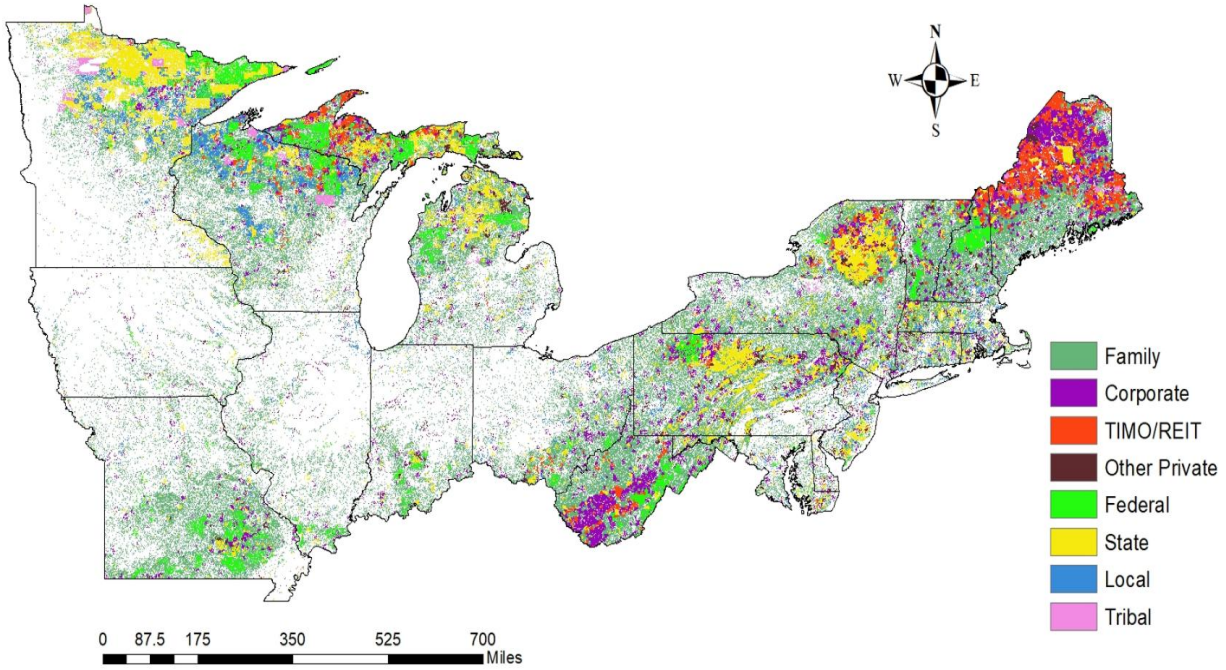

Figure 7. Forest ownership in the twenty-state study region (Data source: Sass et al. 2020).

Table 2. Forestland area in the twenty-state Northeast and Midwest region by forest type (Source: USDA Forest Service, Evalidator 2023).

Forest Type Group	Acres	Percentage
Oak / hickory group	62,739,804	36%
Maple / beech / birch group	45,041,827	26%
Spruce / fir group	15,894,581	9%
Aspen / birch group	15,241,156	9%
Elm / ash / cottonwood group	12,627,818	7%
White / red / jack pine group	9,626,093	6%
Oak / pine group	5,774,755	3%
Others	7,331,740	4%
Total	174,277,773	100%

The merchantable bole volume of live trees on timberlands in the Northeast and Midwest are estimated to be 336.03 billion cubic feet (Table 3). The average annual net growth is 6.62 billion cubic feet, annual removals are 3.01 billion cubic feet, and annual mortality is 3.03 billion cubic feet. Annual growth in the timberlands exceeded the removals by a ratio of 2.2, meaning that for each cubic foot of timber harvested in the region, about 2.2 cubic feet of timber grew in the timberlands. However, this ratio varies by ownership type. The growth to removals ratio in national forests is 4.4. In private forests, it is 2.5, 2.0 in the case of forests under state and local government, and 1.5 in forests under other federal ownership (Table 3). This suggests variation in management focus on timberlands owned by different forest ownership types. Across the region, the annual removals are close to 1% of the standing volume and annual mortality in the timberlands are greater than annual removals (Table 3).

Table 3. Characteristics of regional growing stock in 2023 (million cubic feet) (Source: USDA Forest Service, Evalidator 2023).

Ownership	Net Volume	Annual Net Growth	Annual Removals	Annual Mortality	Growth/Removals
Total	336,028	6,622	3,010	3,031	2.2
National Forest	24,926	397	90	240	4.4
Other federal	2,719	43	29	29	1.5
State and local	49,975	950	481	478	2.0
Private	258,409	5,226	2,118	2,265	2.5
Not available		6	292	19	0.0

Methods

The analysis was conducted using IMPLAN (Impact Analysis for Planning) software and 2022 IMPLAN data, using the detailed impact analysis activity type in IMPLAN online which is analogous to employing the Analysis-by-Parts (ABP) technique in earlier versions of IMPLAN. This method was selected because it enables the creation of a customized industry sector based on detailed information about the sector's budgetary spending patterns and labor income (Lucas, 2022).

IMPLAN does not currently offer a distinct sector for wood-based biomass power generation. Instead, this activity is included within the broader "Electric Power Generation using Biomass" sector, which encompasses power generation from a variety of biomass sources, including agricultural byproducts, landfill gas, municipal solid waste, black liquor, sludge waste, and woody biomass. To isolate the economic contributions of wood-based power generation specifically, the detailed impact analysis technique was applied. The estimated economic contributions are reported in terms of full- and part-time employment, industry output, value-added, and labor income. Industry spending patterns for the woody biomass power generation sector were primarily obtained from Dahal et al. (2020) and, where applicable, corroborated or supplemented with data collected through a mail survey of biomass power generation facilities located within the study region.

In Fall 2024, the Michigan Department of Natural Resources (MDNR) conducted a mail survey targeting all known (120) biomass power facilities located in the 20-state study region, as well as in California, Georgia, and Virginia, to collect financial and resource utilization data for the year 2022. A total of 5 responses were received (4.2% response rate). The low response rate is likely attributable to the reluctance of facilities to disclose proprietary business information.

The survey asked respondents to report on several key metrics, including the number of employees, whether they produced electricity using woody biomass in 2022, the amount of electricity generated from woody biomass, the volume of wood consumed (in tons), fuel costs, employee compensation, and total production costs.

Each of the respondent biomass power generating industries in the study region employed on average 22 employees and generated on average 143,021 MWH of electricity in 2022. The range of power produced by the respondents spanned from a high of 175,974 MWH to a low of 109,170 MWH. The respondents consumed on average 237,302 tons of woody biomass per business at an average cost of $21.8 per ton of wood. Fuel cost as a percentage of the total cost reported by the respondents ranged from a low of 23% to a high of 56%, with an average of 41% when weighed by the size of production. Similarly, employee compensation as a percentage of total cost ranged from a high of 26% to a low of 16%, with an average of 21% when weighed by the size of production. Total cost per MWH of electricity produced ranged from a high of $93/MWH to a low of $79/MWH with the average of $87/MWH when weighed by the size of production. 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 study.

Since the data obtained from our 2024 mail survey did not provide sufficient information to update the production function for wood-based power generating industry in the study region, we relied on the same production function as used in our 2017 analysis (Please refer to 2017 regional report for more information on production function used for estimating the economic contribution of wood-based biomass power generating industry in the Northeast Midwest region).

The average operation and maintenance expenditure for the wood-based biomass power generation industry used for the economic contribution analysis for the twenty-state study region is listed in Table 4. 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 (2025). Fourteen out of the twenty states in the study region produced electricity using wood and wood-derived fuels in 2022 which amounted to a total of 7.13 million Megawatt hours (MWh). This is 29% less compared to the amount of electricity generated using woody biomass across the region in 2017. As in 2017, Delaware, Illinois, Indiana, New Jersey, Rhode Island, and West Virginia did not produce any electricity from woody biomass in 2022.

For 2017 analysis, we obtained cost information per MWh of electricity produced using wood and wood derived fuel from the survey of biomass power facilities located in the study region conducted by Michigan DNR in Fall 2022. Likewise, for 2022 analysis, we obtained similar cost information from the mail survey of biomass power facilities located in the region conducted by MI DNR in Fall 2024. It was estimated to be $87/MWh. Direct output from the wood-based biomass power-generating industry in the study region was then obtained by multiplying the total electricity produced from woody biomass in the region by the cost per unit of electricity produced using woody biomass. It was estimated to be $620.7 million in 2022. Approximately 58.4% of this output was used for intermediate inputs by the biomass power generation industry and 41.6% was value-added. Value added can further be broken into employee compensation (11.2%), proprietor income (2.4%), other property type income (19.0%), and taxes on production and imports (9.1%). Gross absorption and value-added percentages for the biomass power generation industry (IMPLAN sector 45 in 2022 IMPLAN data) were adopted for our analysis. In comparison, gross absorption percentage for electric power generation industry in 2017 IMPLAN data was 61.7% and value-added was 38.3%. The direct employee number for wood-based biomass power generation industry in the region for 2022 was obtained by dividing the direct output from wood-based biomass power generation industry in 2022 in the region by output per employee for sector 45 for the twenty-state region. In total, 443 people were found to be directly employed in the wood-based biomass power generation industry in the study region in 2022.

When estimating the economic contribution of the biomass power generation industry in IMPLAN using the ABP technique (or detailed industry impact analysis 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 70miles 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 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 $11.5 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 region.

Table 4. 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%

Results

Across the twenty Northeast and Midwest states, wood-based biomass power generation in 2022 was unevenly distributed, with production and economic activity concentrated in a handful of forest-rich states (Table 5). Maine and Michigan dominated the sector, together accounting for the largest share of regional output, followed by Minnesota, Wisconsin, and New Hampshire. Collectively, these five states produced 78% of all electricity generated from wood and wood-derived fuels in the region. Maine led with 1.7 million MWh and over $150 million in direct output, while Michigan followed closely with 1.47 million MWh and $128 million in direct industry output. In contrast, states such as Connecticut, Missouri, Iowa, Maryland, and Massachusetts hosted much smaller biomass sectors, and several Mid-Atlantic and Midwest states including Delaware, Illinois, Indiana, New Jersey, Rhode Island, and West Virginia reported no utility-scale wood-based biopower generation in 2022.

Table 5. Electricity generation, direct economic output, and direct employment associated with wood and wood-derived biomass power generation across Northeast and Midwest states in 2022.

State	Electricity generated (Thousand Megawatt Hours)	Direct Output (2017 Dollars)	Direct Employment
Connecticut	105	$9,135,000	6
Iowa	7	$609,000	0
Massachusetts	45	$3,915,000	
Maryland	7	$609,000	0
Maine	1,733	$150,771,000	113
Michigan	1,474	$128,238,000	107
Minnesota	888	$77,256,000	64
Missouri	43	$3,741,000	3
New Hampshire	711	$61,857,000	45
New York	423	$36,801,000	22
Ohio	222	$19,314,000	14
Pennsylvania	338	$29,406,000	17
Vermont	367	$31,929,000	26
Wisconsin	771	$67,077,000	54

Results from the IMPLAN economic contribution analysis show that, across the region, the wood-based biomass power industry directly employed 443 workers in 2022, generating $84 million in labor income, $258 million in value added, and $621 million in industry output (Table 6). When indirect and induced effects were included, the sector supported 5,487 total jobs, $411 million in labor income, $727 million in value added, and $1.41 billion in total economic output. The industries most affected in terms of employment were commercial logging, biomass electric power generation, and support activities for agriculture and forestry, reflecting the sector's tight integration with regional forest supply chains (Table 7).

Multiplier estimates further illustrate the industry's economic reach. The regional SAM output multiplier of 2.3 indicates that every $1 million of wood-based biopower production generated an additional $1.3 million in economic activity throughout the economy. Employment, labor income, and value-added multipliers were 12.4, 4.9, and 2.8, respectively. The comparatively high employment multiplier reflects the labor-intensive nature of upstream sectors, particularly commercial logging and forestry support services, which generate numerous jobs per dollar of spending, though often with modest wages. Induced effects in service industries such as retail, restaurants, and health care further expand job counts.

IMPLAN sector data confirm that the upstream industries supplying wood-based biopower are exceptionally labor intensive. In 2022, the commercial logging industry in the twenty-state Northeast Midwest region supported 33,914 jobs and $3.68 billion in output, or 9.2 jobs per $1 million of output. Labor intensity is even higher for support activities for agriculture and forestry, which supported 137,908 jobs and $6.49 billion in output, equivalent to 21.2 jobs per $1 million of output. These industries generate large numbers of jobs relative to their output because they rely heavily on manual labor, small firms, and seasonal or part-time workers, while producing relatively modest value added per employee. Consequently, when biomass power plants purchase fuel from these sectors, the indirect and induced employment effects increase substantially raising employment multipliers even though multipliers for labor income and output remain comparatively modest.

The wood based biopower industry in our study region contributed approximately $103 million in annual state and local taxes and $100 million in federal taxes in 2022 (Table 8)

Table 6. Economic contributions of wood-based biomass power generation industry in the Northeast and the Midwest in 2022 US dollars using IMPLAN software and 2022 IMPLAN data.

States Included	Economic Contributions of Wood-based Biomass Power Generation Industry	Employment (Jobs)	Labor Income ($MM 2022)	Value-added	Output
Twenty States (CT, DE, IL, IN, IA, ME, MD, MA, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WV, and WI)	Direct Contributions	443	$84	$258	$621
	Indirect Contributions	3,308	$210	$261	$439
	Induced Contributions	1,736	$117	$208	$351
	Total Contribution	5,487	$411	$727	$1,410
	SAM Multiplier	12.4	4.9	2.8	2.3

Table 7. The top five industries affected in terms of employment by wood-based biomass power generation industry in the twenty-state region in 2022

	Industry affected (IMPLAN Sector)	Impact			
		Direct	Indirect	Induced	Total
1	Commercial logging (16)	0	2375	0	2375
2	Electric power generation – Biomass (45)	443	0	0	443
3	Support activities for agriculture and forestry (19)	0	247	1	248
4	Commercial and industrial machinery and equipment repair and maintenance (515)	0	210	4	214
5	All other crop farming (10)	0	118	2	120

Table 8. Total tax contributions of wood-based biomass power generation industry in 2022 US dollars ($MM) using 2022 IMPLAN data.

Impact Type	Sub-county general	Sub-county special districts	County	State	Federal	Total
Direct	$13.0	$11.6	$5.7	$29.1	$25.2	$84.7
Indirect	$4.0	$3.0	$1.6	$13.2	$45.6	$67.3
Induced	$4.3	$3.5	$1.7	$12.0	$29.3	$50.7
Total	$21.3	$18.1	$9.0	$54.3	$100.0	$202.7

Summary

This study assessed the economic contributions of wood-based biomass power generation industry in the twenty-state Northeast and Midwest U.S. region 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 the region was found to directly support 443 jobs and contribute ~$621 million in output to the regional economy. Including indirect and induced effects, the industry contributed a total of 5,487 jobs and $1,410 million in output to the economies of the Northeast and Midwest U.S. states.

Compared to 2017, the direct employment in wood-based biomass power generation industry across the region declined by 39% (from 722 in 2017 to 443 in 2022) and direct output declined by 12% (from $701 million in 2017 to $621 million in 2022). Similarly, total employment declined by 34% and output declined by 19% in 2022 compared to 2017.

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