

**Economic Contribution of the Biomass Electric Power Generation Industry in New Hampshire**

Calendar Year 2016

Prepared for New Hampshire Timberland Owners Association

by

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## I. EXECUTIVE SUMMARY

Based on industry survey data for the calendar year of 2016, it was estimated with a customized IMPLAN model:

- The New Hampshire's six independent biomass electric power plants provide 121 jobs (\$11.6 million in payroll). This is referred to as the "direct effect" economic activity.
- They also support 583 jobs (\$28.1 million in payroll) in its supply industries such as the logging industry. This is referred to as the "indirect effect" economic activity.
- The jobs in the six independent biomass electric power plants and its supply industries combine to support another 228 jobs (\$11.2 million in payroll) in service sectors such as schools, grocery stores, hospitals, and restaurants. This is referred to as the "induced effect" economic activity.
- The grand total of the direct effect (the six independent biomass electric power plants), indirect effect (supply industries), and induced effect (service sector) economic activities is 932 jobs (\$50.9 million in payroll). And the total economic output to the state's economy is \$254.5 million each year.
- They contribute \$7.3 million of tax revenues to the state and local governments from all sources (direct, indirect and induced effect).

Note that this study focused on economic contribution tracing inter-industry purchases through its backward linkages. Other economic and environmental benefits of biomass energy, which are documented in other studies but not within the scope of this study, include:

- Increase in forest productivity: with forest thinning and removal of low-grade timber (e.g. biomass and pulpwood) forest productivity is enhanced and along with it sawlog values.
- Increase in property value: The value of forest land suited for biomass production is likely to rise as the demand for wood feedstock increases in response to a growing biomass energy. An increase in property value of forest land should also increase the tax base for rural communities.
- Biomass electric power plants are an important link in the state's other timber processing industries (e.g. sawmills) as they provide an outlet for sawmill waste (e.g. sawdust and chipped slabs).
- Biomass power plants are a primary alternative to open burning and leaving forest waste to decay and release methane gas to the environment or the landfilling of urban tree waste. Open pile burning releases criteria air pollutants (fine particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOC), and nitrogen oxides (NO<sub>x</sub>)), greenhouse gases (carbon dioxide (CO<sub>2</sub>)). In the near term, the lack of biomass plants will undo much of the progress that has been made in reducing the levels of harmful air pollutants in the air we breathe. And, because biomass power plants provide markets for low-grade timber this helps keep land in a forested state by providing revenue to landowners in the form of biomass chip purchases. This forest land retention helps to reduce atmospheric carbon through forest uptake of carbon dioxide.

## II. PROJECT DESCRIPTION

The College of Business Administration at Plymouth State University was contracted by the New Hampshire Timberland Owners Associations (NHTOA) to estimate economic contribution of the 25 MW capacity or less biomass electric power generation industry to New Hampshire's economy. Unlike fossil fuel that must be imported from outside New Hampshire and transported long-distance, biomass feedstock is supplied locally so it can help maintain or create jobs in the state. An input-output IMPLAN model was created to trace economic contributions in a variety of sectors along the entire supply chain of the biomass electric power plants (foresters, loggers, truckers, and mills). Biomass electric power plants make a significant contribution to the state's economy given that they purchase their biomass wood fuel supply and other supplies and services from local businesses. In addition, spending by workers in the biomass electric power plant industry and its supply industries provides a boost to the region's economy. The industry data was collected by NHTOA from the six independent biomass electric power plants in the state for the calendar year of 2016. This industry survey was used to customize and improve the baseline IMPLAN model and data.

The six biomass electric power plants are located in Alexandria, Bethlehem, Bridgewater, Springfield, Tamworth and Whitefield. Generally, these biomass plants have been in operation and a source of employment since the mid-1980s. Commercial logging to provide the biomass/wood fuel supply for the facilities occurs state-wide. A sense of the state-wide nature of such harvesting can be gleaned from Table 1 which shows 2014 biomass chip harvesting.

**Table 1: Biomass Volumes Summary, report of cut data April 2014 - March 2015**

County	Volume (tons)
Belknap	148,046
Carroll	102,415
Cheshire	78,303
Coos	151,346
Grafton	199,985
Hillsborough	163,472
Merrimack	261,910
Rockingham	96,311
Strafford	55,646
Sullivan	91,886
<b>Total</b>	<b>1,349,320</b>

Source: NH Depart of Revenue Administration

### III. DEFINITIONS OF KEY MEASURES

1. **Employment:** means the annual average number of jobs, including both full- and part-time jobs; for example, 10 jobs for the first half of the year and 20 jobs in the second half results in 15 average jobs for the year.
2. **Labor income:** means employee compensation (wages and salaries plus other compensations) and proprietor income.
3. **Value added:** means labor income, other types of property income (such as dividends, interest income, rent income, and profits), taxes on production and imports.
4. **Output:** means the total value of production, which is the sum of value added and the cost of all the inter-industry purchases required for production.
5. **Multiplier effect:** means the cumulative economic activity arising from the fact that the biomass electric power generation industry's direct effect contribution spreads across the state's economy by creating and supporting jobs, incomes, and taxes. The biomass electric power generation industry supports its supply industries in the region by making purchases from them (indirect effect). These supply industries include commercial logging, marketing research, truck transportation, and maintenance and repair construction. In addition, workers in the biomass electric power generation industry and its supply industries spend their earnings in the region's services industries (induced effect), such as restaurants, medical services, grocery stores, real estate, and retail stores.
6. **Direct effect:** means jobs, incomes, and taxes directly created by the biomass facility or biomass industry.
7. **Indirect effect:** means the economic effects of local inter-industry (supply industries, such as commercial logging) spending due to the existence of the biomass facilities.
8. **Induced effect:** means the economic effects of local spending (usually in service industries) of employee's wages and salaries of the directly and indirectly affected industries.

#### IV. LITERATURE REVIEW

An input-output model has been widely used in economic contribution studies of the biomass electric power generation industry. Studies measured economic contributions on the following measures – employment, labor income, value added and output. IMPLAN has been the most popular economic impact estimation tool in the literature of forestry-related industries. IMPLAN has a client list of more than 500 entities, including numerous federal and state government agencies.

IMPLAN econometrically estimates multipliers using various federal government data. These default multipliers slightly decreased after customization (see Section Survey Results and Model Adjustments for discussion regarding the customization). All multipliers are within or close to the range of multipliers that were found for other states in the literature, with the exception of employment multiplier. The large employment multiplier reflects the biomass electric power plants’ strong indirect effect in New Hampshire’s logging industry, which is largely due to a relationship between the local availability of logs and the logging industry’s output per worker.

In addition, the output per worker for the logging industry is \$82,995 (compared to median output per worker of \$238,043 among all 422 IMPLAN sectors existing in New Hampshire). Therefore, the biomass electric power generation industry demands a significant amount of output from the logging industry, which requires a high level of employment to meet that demand. The summary of the findings is reported in Table 2 below.

**Table 2: Multipliers for Sector 47: Electric power generation - Biomass**

State	Year	Employment	Labor Income	Value Added	Output	Model
New Hampshire	2014	7.8	3.9	1.8	1.6	IMPLAN
New Hampshire*	2014	8.3	4.2	1.8	1.7	IMPLAN
Maine	2014	4.5	3.8	1.5	1.6	IMPLAN
Vermont		3.1				RIMS II
Mississippi	2010	2.3	2.4	2.3	1.6	IMPLAN

\* The default model for New Hampshire before customization

Cells were left blank when they were not reported in the literature.

## V. IMPLAN MODEL AND DATA

The model used in this analysis was built by customizing the Impact Analysis for Planning (IMPLAN) regional input-output software. The first input-output model was developed by Dr. Wassily Leontieff to help the United States mobilize to meet the demand of the World War II. For this work in input-output models, he won the Nobel Prize in Economic Science in 1973.

The input-output model was later applied to regional economies. With the enactment of the National Forest Management Act in 1976, the U.S. National Forest Services needed a systematic tool for evaluating the national forest management plans on local residents and businesses. Hence, the creation of the IMPLAN. The advancement of computer technologies made it possible to extrapolate, extend, and convert existing data to regional economies using non-survey methods, without the cost of onsite data collection.

Today, IMPLAN is widely used for evaluating economic impacts beyond the forest and logging sector. It traces impacts through direct, indirect and induced economic effects. Direct effect is the initial expenditures, or production, made by the industry experiencing the economic change; indirect effect represents the effects of local inter-industry spending through the backward linkages; and induced effect is the results of local spending of employee's wages and salaries for both employees of the directly affected industry, and the employees of the indirectly affected industries. "Backward linkages" are the tracking of industry purchases backward through the supply chain to the direct effect industry.

IMPLAN data is constructed primarily from federal government data, including:

- U.S. Bureau of Economic Analysis Benchmark I/O Accounts of the U.S.
- U.S. Bureau of Economic Analysis Output estimates
- U.S. Bureau of Economic Analysis REIS Program
- U.S. Bureau of Labor Statistics Covered Employment and Wages Program
- U.S. Bureau of Labor Statistics Consumer Expenditure Survey
- U.S. Census Bureau County Business Patterns program
- U.S. Census Bureau Decennial Census and Population Surveys
- U.S. Census Bureau Economic Censuses and Surveys
- U.S. Department of Agriculture Crop and Livestock Statistics
- U.S. Geological Survey

## **VI. ASSUMPTIONS OF THE MODEL**

All usual assumptions of the input-output model apply in this study. The model incorporates the following:

- Constant returns to scale
  - As all inputs increase by a factor, output increases by the same factor. For example, output doubles if all inputs double.
- National production coefficients and margins
  - An industry is assumed to have identical production functions and margins in all regions in the country.
- No substitution among inputs
  - No substitution among inputs is assumed for simplicity. In practice, firms may look for an alternative for an input that becomes increasingly more expensive, which may happen if its demand increases and/or its supply falls.
- No constraints to the supply of commodity

## VII. DEFINITION OF INDUSTRIES

Table 3 describes the biomass electric power generation industry used in this study, along with its IMPLAN and the North American Industry Classification System (NAICS) code. It also describes a few of its primary supply industries.

**Table 3: Biomass electric power generation industry and its primary supporting industries**

IMPLAN Sector ID	Description	Examples	NAICS Code
<b>47</b>	<b>Electric power generation - Biomass</b>		<b>221117</b>
<i>Supply industries</i>			
16	Commercial logging	Cutting and transporting timber, stump removing in the field, timber piling, tree chipping in the field	1133
460	Marketing research and all other miscellaneous professional, scientific, and technical services	Boiler testing services, Pipeline or power line inspection (i.e., visual) services, Appraisal (except real estate) services, Arbitration and conciliation services (except by lawyer, attorney, or paralegal offices), Marketing analysis or research services	541910, 541930, 541990
19	Support activities for agriculture and forestry	Cruising timber, estimating timber, forest fire prevention, forest firefighting, forest management plans and preparation, pest control services	1153
501	Full-service restaurants		722511
564	Employment services	Employment placement agencies, Executive search services, Temporary help services	5613
62	Maintenance and repair construction of nonresidential structures	Maintenance and repair of power plants, Maintenance and repair of power and communication transmission lines	2371

## VIII. ECONOMIC CONTRIBUTION ESTIMATES Based on the IMPLAN model with actual data from the biomass electric power plants

The six independent biomass electric power plants' contribution spreads across the state's economy by creating and supporting jobs, incomes, and taxes. They support their supply industries in the region by making purchases from them (indirect effect). In addition, workers in the biomass power plants and their supply industries spend their earnings in the region's services industries (induced effect). For example, Table 4 shows that there are 121 jobs in these biomass electric power plants. These 121 biomass electric power plant jobs support an additional 583 jobs in supporting industries, such as logging. These 121 biomass electric power plant jobs and 583 jobs in the supporting industries together support an additional 228 jobs in services sectors, such as grocery stores, hospitals, gas station, utility, restaurants, etc.

**Table 4. Summary of Economic Contribution, Year 2016**

<b>Impact Type</b>	<b>Employment</b>	<b>Labor Income</b>	<b>Value Added (includes Labor Income)</b>	<b>Output (includes Value Added)</b>
<b>Direct Effect</b>	121	\$11.6	\$68.1	\$158.9
<b>Indirect Effect</b>	583	\$28.1	\$34.7	\$64.5
<b>Induced Effect</b>	228	\$11.2	\$18.7	\$31.1
<b>Total Effect</b>	932	\$50.9	\$121.5	\$254.5

The dollars are expressed in millions of 2016 dollars.

Value added is defined as labor income, other types of property income (such as dividends, interest income, rent income, and profits), taxes on production and imports.

Output is the sum of value added and the cost of all the inter-industry purchases required for production.

Table 5 shows the top 25 industries in terms of employment supported by the six independent biomass electric power plants. Their largest employment contribution was to “Commercial logging” with 200 jobs, followed by its own biomass electric power generation industry with 121. It’s notable that their indirect employment in “Commercial logging” (200 jobs) is larger than direct employment (121 jobs). It stresses the importance of biomass electric power plants to the logging industry.

In 2012 the Plymouth State University Center for Rural Partnerships conducted an economic analysis for timber harvesting using the IMPLAN model. At that time, the IMPLAN model estimated there are 0.34 commercial logging jobs and 0.09 indirect jobs (e.g. supply businesses serving commercial loggers) for every 1,000 tons of wood harvested. This statewide average considers all tree species harvested and timber products produced (e.g. pulp wood, biomass wood chips, and sawlogs). In 2016 the six independent biomass electric power plants are estimated to consume 1,489,574 tons of biomass wood chips, which based on the 2012 timber harvesting economic study would support 509 commercial logging jobs and 140 timber harvesting indirect jobs. The majority of the wood supply for these plants comes from New Hampshire forests. While some wood supply may originate in the state’s boarder areas with Vermont and Maine from time to time, such supply may also be harvested, brokered, and delivered by New Hampshire businesses, and produce an economic benefit in New Hampshire.

**Table 5: Top 25 Industries Affected, Employment**

Sector	Description	Direct	Indirect	Induced	Total
0	Total	121	583	228	932
16	Commercial logging	0	200	0	200
47	Electric power generation - Biomass	121	0	0	121
460	Marketing research and all other miscellaneous professional, scientific, and technical services	0	46	1	46
501	Full-service restaurants	0	26	13	40
19	Support activities for agriculture and forestry	0	36	0	36
62	Maintenance and repair construction of nonresidential structures	0	34	1	35
464	Employment services	0	24	3	26
440	Real estate	0	13	11	23
395	Wholesale trade	0	17	7	23
414	Trucking	0	20	1	20
482	Hospitals	0	0	14	14
447	Legal services	0	12	2	13
502	Limited-service restaurants	0	2	11	13
433	Monetary authorities and depository credit intermediation	0	9	3	12
400	Retail - Food and beverage stores	0	1	9	10
448	Accounting, tax preparation, bookkeeping, and payroll services	0	8	2	10
405	Retail - General merchandise stores	0	2	7	9
10	All other crop farming	0	9	0	9

<b>523</b>	Other state government enterprises	0	8	1	9
<b>465</b>	Business support services	0	6	1	7
<b>468</b>	Services to buildings	0	4	3	7
<b>475</b>	Offices of physicians	0	0	7	7
<b>503</b>	All other food and drinking places	0	1	6	7
<b>436</b>	Other financial investment activities	0	3	4	6

Table 6 shows the top 25 industries in terms of labor income supported by the six independent biomass electric power plants. Their largest labor income contribution was to employment and benefits in the biomass electric power generation industry with \$11.6 million, followed by “Commercial logging” with \$8.8 million.

**Table 6: Top 25 Industries Affected, Labor Income (in \$1,000)**

Sector	Description	Direct	Indirect	Induced	Total
0	Total	\$11,568	\$28,116	\$11,217	\$50,901
47	Electric power generation - Biomass	\$11,568	\$12	\$4	\$11,585
16	Commercial logging	\$0	\$8,807	\$4	\$8,811
395	Wholesale trade	\$0	\$1,645	\$673	\$2,319
62	Maintenance and repair construction of nonresidential structures	\$0	\$1,955	\$78	\$2,033
460	Marketing research and all other miscellaneous professional, scientific, and technical services	\$0	\$1,947	\$36	\$1,983
464	Employment services	\$0	\$1,090	\$127	\$1,217
414	Trucking	\$0	\$1,030	\$24	\$1,054
447	Legal services	\$0	\$871	\$147	\$1,018
482	Hospitals	\$0	\$0	\$997	\$997
501	Full-service restaurants	\$0	\$654	\$332	\$986
19	Support activities for agriculture and forestry	\$0	\$925	\$2	\$927
475	Offices of physicians	\$0	\$0	\$822	\$822
433	Monetary authorities and depository credit intermediation	\$0	\$604	\$169	\$773
435	Securities and commodity contracts intermediation and brokerage	\$0	\$497	\$258	\$755
448	Accounting, tax preparation, bookkeeping, and payroll services	\$0	\$531	\$113	\$644
440	Real estate	\$0	\$325	\$264	\$589
449	Architectural, engineering, and related services	\$0	\$365	\$64	\$429
437	Insurance carriers	\$0	\$115	\$285	\$401
461	Management of companies and enterprises	\$0	\$229	\$164	\$393
523	Other state government enterprises	\$0	\$346	\$43	\$390
504	Automotive repair and maintenance, except car washes	\$0	\$65	\$265	\$330
454	Management consulting services	\$0	\$232	\$98	\$330
465	Business support services	\$0	\$289	\$39	\$328
430	Data processing, hosting, and related services	\$0	\$299	\$28	\$328

Table 7 shows the state and local government taxes and receipts the six independent electric biomass power plants contributed. They collectively generated \$7.3 million of tax revenues to New Hampshire’s state and local governments from all sources (direct, indirect and induced effect).

**Table 7: Tax Contribution (in \$1,000) from Direct, Indirect and Induced Economic Effect Sources**

Description	Employee Compensation	Proprietor Income	Tax on Production and Imports	Households	Corporations
Dividends					\$39
Social Ins Tax- Employee Contribution	\$30	\$0			
Social Ins Tax- Employer Contribution	\$60				
Tax on Production and Imports: Sales Tax			\$588		
Tax on Production and Imports: Property Tax			\$2,938		
Tax on Production and Imports: Motor Vehicle Lic			\$130		
Tax on Production and Imports: Other Taxes			\$891		
Tax on Production and Imports: S/L NonTaxes			\$719		
Corporate Profits Tax					\$1,595
Personal Tax: Income Tax				\$59	
Personal Tax: NonTaxes (Fines- Fees				\$117	
Personal Tax: Motor Vehicle License				\$44	
Personal Tax: Property Taxes				\$36	
Personal Tax: Other Tax (Fish/Hunt)				\$35	
<b>Total State and Local Tax</b>	<b>\$90</b>	<b>\$0</b>	<b>\$5,266</b>	<b>\$292</b>	<b>\$1,634</b>

## IX. SURVEY RESULTS AND MODEL ADJUSTMENTS

In New Hampshire, there are 8 electric utility-style biomass electric power plants - 6 independent power plants each of 25 MWs capacity or less, Eversource’s Schiller Station located in Portsmouth, and the privately-owned Burgess Biomass Power Plant in Berlin. This study focuses solely on the 6 independent power plants. Table 8 shows six plant survey data compared to IMPLAN and Census data.

**Table 8 Survey Statistics in Comparison to IMPLAN and Economic Census (\$1,000)**

	Survey 2016	IMPLAN 2014	U.S. Census 2014
<b>Employment</b>	121	107	98
<b>Employee Compensation</b>	\$11,568	\$11,586	\$7,532
<b>Establishments</b>	6		5

Note that the U.S. Census Bureau numbers (County Business Patterns) are not complete reporting only five establishments. This is not uncommon at granular industry levels due to industry classification issues. The reliability of the Census data heavily relies on the reports that companies voluntarily submit. “Companies engaged in distinctly different lines of activity at one location are requested to submit separate reports, if the business records permit such a separation, and if the activities are substantial in size”, writes the U.S. Census Bureau. Economic models such as IMPLAN are often revised with the local information that is available to analysts so that they better reflect the status of the industry.

Hence, the default model was revised so that the industry’s total employment was increased to 191, which is a rough estimate based on multitude of sources, including an industry survey of the six independent power plants, interviews with industry officials, and government data. This customization did not inflate the outcome, but slightly reduced multipliers thus leading to more conservative total effect estimates. 121 jobs and \$11.6 million in payroll collected from the six biomass power plants were entered into the customized model to generate contribution estimates. Comparison of the multipliers before and after customization is reported in Literature Review.

## **X. REFERENCES**

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