Vermont

Wood Fuel Price Report

A **Report** from:

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July 2024

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Introduction

This document serves as an independent assessment of factors influencing the price of biomass fuel, with a specific focus on a plant in Ryegate, Vermont. This report was authorized by Act 155, passed by the Vermont legislature in the 2022 session. This Act requested a study to "conduct analysis and calculate a minimum fair market price for wood fuel to be used by the plant used to satisfy the baseload renewable power portfolio requirement"[i]. The following report addresses Act 155's inquiry to look at fair market price for wood fuel.

Innovative Natural Resource Solutions LLC (INRS) was engaged by the Vermont Agency of Natural Resources - Department of Forests, Parks & Recreation to research and compile this report. INRS has substantial experience with the region's forest products industry and loggers, and has a strong working knowledge of existing and potential markets for low-grade wood.

> *INRS believes the information contained in this report to be correct, based upon information sources we deem reliable. Given the dynamic nature of wood markets and biomass, INRS does not warrant information in this report against all errors.*

Innovative Natural Resource Solutions LLC

Founded in 1994, Innovative Natural Resource Solutions LLC (INRS) is a full-service consulting firm specializing in forestry, the forest industry, natural resource conservation, and renewable energy.

INRS has worked with a number of private, non-profit and government parties in the development of new biomass and biofuel energy facilities around the country. The firm has recently worked with biomass or biofuel projects in Maine, New Hampshire, New York, Vermont, Washington, Georgia, and Virginia.

Executive Summary

Biomass fuel is one of several products that can be produced during a timber harvest. Generally speaking, loggers and landowners seek to maximize higher value products such as sawlogs and pulpwood during a timber harvesting operation, with biomass fuel produced from tops, branches, cull, and non-merchantable stems. Many timber harvesting operations elect not to produce biomass, and instead produce only roundwood products, leaving the low-value biomass material in the woods. Statewide, biomass fuel represents 11% to 15% of statewide harvest in recent years, with some counties recording no biomass fuel production and others approaching a third of the total timber harvest.

Biomass fuel is a commodity, with several plants in Vermont and New Hampshire purchasing the same product as the biomass electric facility in Ryegate. While there are enormous variations, so much so that any one price is near meaningless, most suppliers that INRS spoke to as part of this project indicated that, at current diesel prices, it costs somewhere in the low $30s per green ton to produce and deliver in-woods chips to a biomass plant. This is influenced by a number of variables, including but not limited to:

- Harvest type
- Equipment used
- Equipment up-time
- Wages paid to employees
- Cost of diesel
- Truck loading and unloading time
- Trucking distance
- Alternative market prices
- Landowner requirements

In the past several years, the price paid at Ryegate for biomass fuel has ranged from a little below $27 per green ton to over $40 per green ton.

Biomass fuel prices include a range of components, including stumpage (paid to the landowner), harvesting, chipping, and transportation from the site of harvest to the biomass electric facility. While understanding the input costs associated with biomass fuel, it is important to note that these influence but do not set market prices. Other factors include supply/demand dynamics, changes in competing markets, changes in end use market and weather. In the end, it is a dynamic market that sets the price.

Market Structure for Forest-Derived Wood

On timber harvesting operations, the loggers generally intend to harvest sawlogs (for lumber), pulpwood (for paper mills), bole chips (for pellet manufacturing and other applications), and firewood (for residential heating), all generally higher value products than in-woods chips (made from slash) used for large-scale energy production. However, when stems are harvested there are tops, branches, cull, and other slash material generated that can be utilized as biomass feedstock for a biorefinery. Timber harvesting is conducted to generate higher value products, and generally not driven by biomass markets.

In areas where there is a viable biomass or biofuel market, many loggers purchase portable whole tree chippers and chip vans (i.e., truck trailers designed to have chips blown in) in order to access this market.

In general, when a single tree is harvested, a number of products can be derived[ii].

- The bottom length (eight to sixteen feet) is often straight and has few defects, such as knots or branches. This section is generally a sawlog, and is sent to a sawmill for lumber production or, if extremely high quality, to a veneer mill. For some smaller stems, this can be utilized as pulpwood.
- The next lengths (again, often eight to sixteen feet) may become a variety of products. If it is straight and has few defects, it is a sawlog and will be sent to a sawmill. If it is smaller than the size sawmills require, or has a large number of defects (rot, knots, split, etc.), it will be sent to a pulp mill for paper manufacturing or to a pellet mill.
- The tops and branches (i.e., slash) can be chipped for biomass energy markets, chipped for mulch markets, or left in the woods.
    - Importantly, this material is generated any time there is a timber harvest, and relies upon other markets (e.g., sawlogs and pulpwood) to generate the tops and branches.

Figure 1 shows the sections of a single tree and the products derived[iii]; figures 2 through 5 show parts of a New England logging operation that will process slash for use in wood energy production.

Figure 1. Schematic of Products Derived from a Single Tree

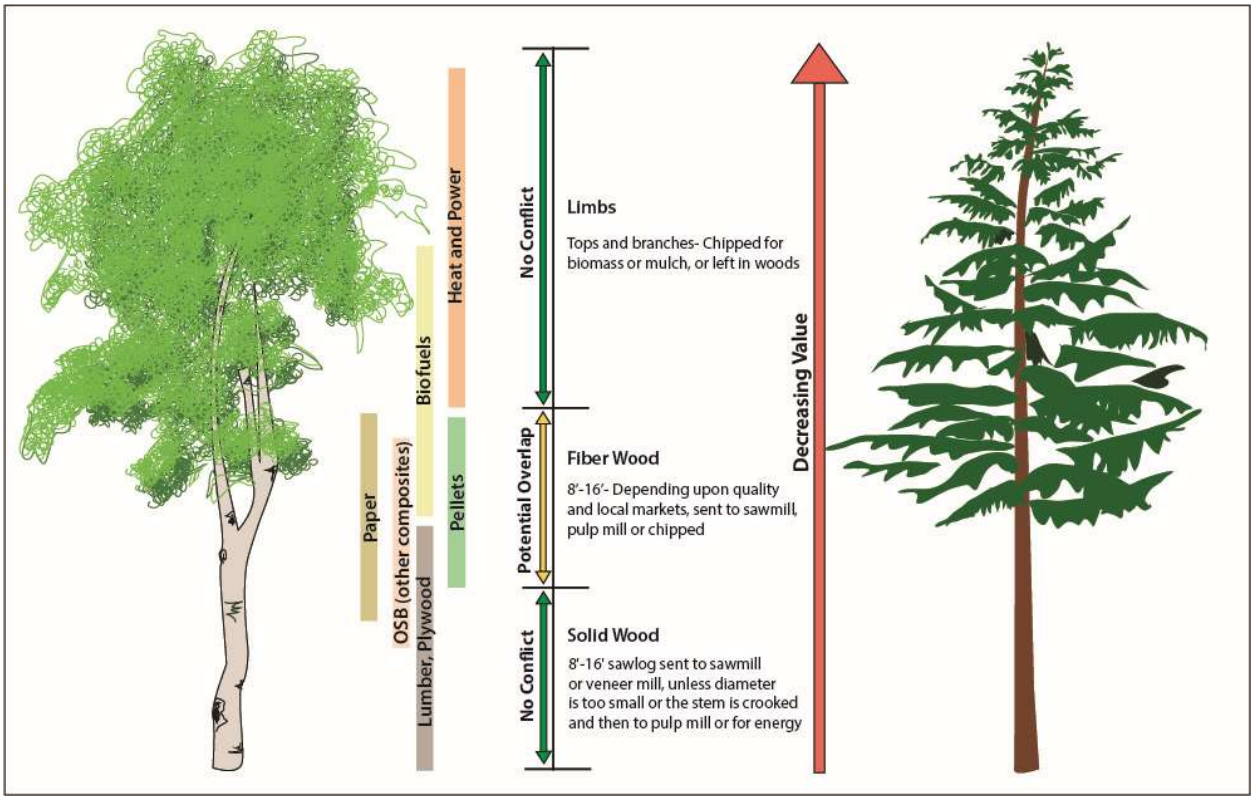


Figure 2. Log landing with slasher (left), chipper (right), and wood sorted by product.

Figure 3. Wood slash (in this case tops and branches) sorted for chipping.

Figure 4. Close-up of wood being chipped at landing, with higher value sawlogs in background.

Figure 5. Trailer for whole-tree chips, with opening for chipper to blow chips into.

Biomass Fuel as a Commodity

Biomass fuel, as used by the plant in Ryegate and a number of competing biomass electric plants in the Northeast, is a commodity. The American Heritage Dictionary of the English Language, 5th Edition, defines commodity as:

> *"A product or service that is indistinguishable from ones manufactured or provided by competing companies and that therefore sells primarily on the basis of price rather than quality or style."*

The market for biomass chips fuel at Ryegate is not an island, and interacts with other similar facilities across the region. It is likely that companies that sell biomass fuel to the facility in Ryegate, Vermont also sell to one or more of the following facilities (which operate currently or have in the past several years), depending upon the harvest location, price, and other factors:

Table 1. Other Biomass Electric Facilities and Distance to Ryegate, Vermont

Town	Size (MW)	Road Miles	Drive Time
Burlington	50	78	1 hour, 28 minutes
Whitefield, NH	20	36	52 minutes
Bethlehem, NH	20	31	38 minutes
Berlin, NH	75	68	1 hour, 29 minutes
Springfield, NH	20	74	1 hour, 14 minutes

The fact that many, if not all, suppliers to one facility have the ability to sell their biomass fuel to other competing buyers means that the price paid for biomass fuel at other facilities impacts what the Ryegate facility pays. This is common in commodity markets, and we see this for pulpwood and a range of agricultural products produced and purchased in New England.

Factors Influencing the Price of Biomass

The following factors influence the pricing and availability of biomass fuel, and changes in any of these factors can have an impact on biomass fuel prices:

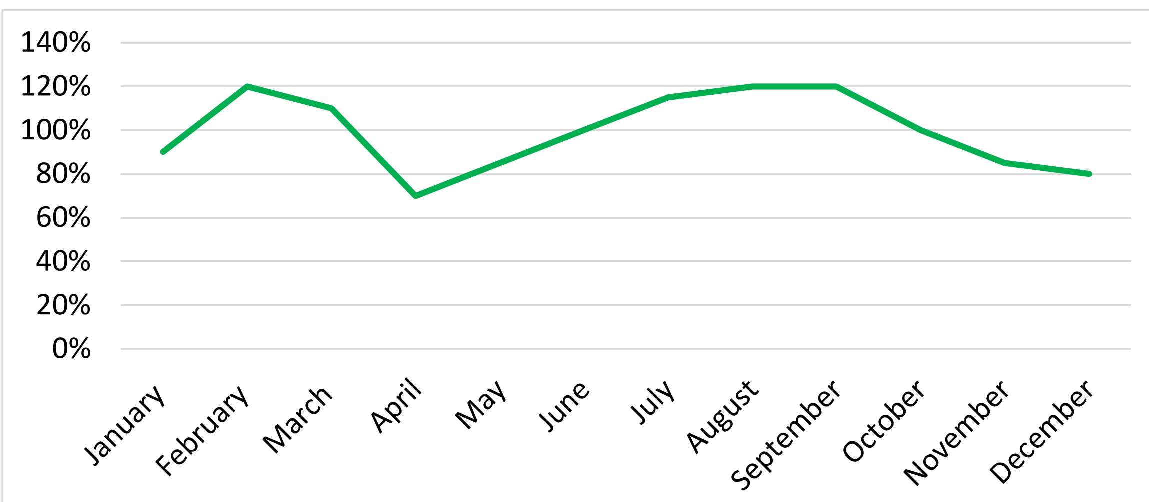
- Diesel costs are the most volatile single inputs to forest-derived wood. Every step of the process – felling, skidding, chipping, and transport – uses diesel to power machinery. As a general rule, it takes slightly over 2 gallons of diesel to harvest and transport 1 green ton of wood. (See discussion below.).

- Specific and localized weather events, such as much warmer than average winter temperatures in 2022-2023 or flooding across Vermont in the summer of 2023, can have a meaningful short-term impact on the price of biomass (and other forest products).

- In addition to the above generalized factors, plant-specific conditions such as truck turn-around time, traffic getting into and out of a facility, and hours of operation (accepting wood) can impact pricing.

- The following figure shows the generalized monthly production potential for Northern New England, as a percentage of total market demand. This shows the impact of spring and fall mud seasons, as well as the holidays, on biomass fuel production.

Figure 6. Biomass Production by Month (typical)



Cost Components of Biomass[iv]

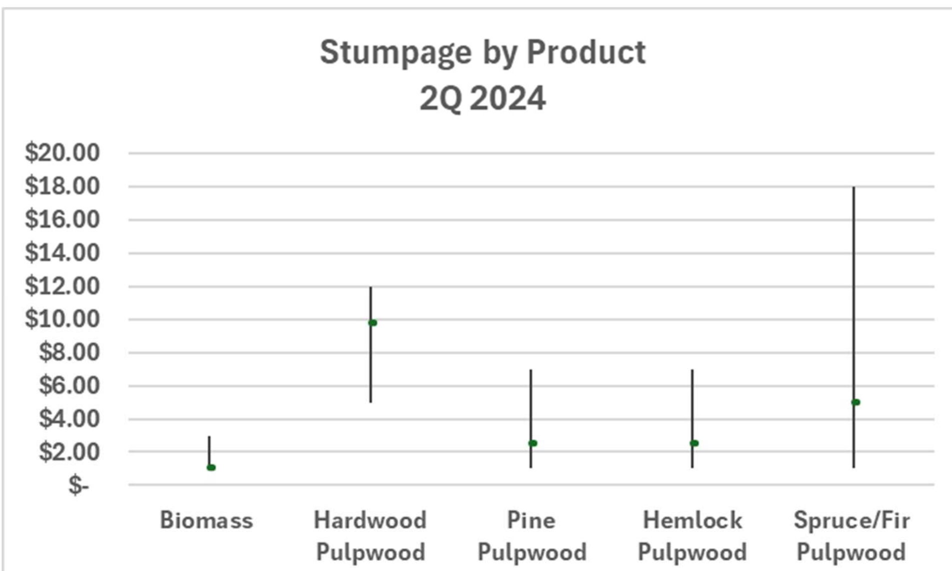
Biomass fuel has several cost components which can be evaluated separately. Each of these components is dynamic, and can vary based on multiple factors discussed below. While it can be helpful to understand each of these cost components, it is important to understand that biomass is priced as a delivered product ($ per green ton, delivered), and not as components.

Stumpage refers to the payment a landowner receives for wood 'on the stump,' or what the value of the wood is prior to harvesting. For most landowners, this is the sole source of revenue. Stumpage costs are used not only to realize a return on investment by the landowner, but also to pay for management costs (e.g., forestry), debt service, road costs (construction and maintenance), taxes and any other costs associated with owning land.

Biomass is a very low-value product, with the landowner receiving a nominal payment. Current stumpage value for slash in Northen New England is $0 to $5 per ton, compared to $3 to $15 per ton for pulpwood and as high as $80 per ton for sawlogs[v] (though there can be significant variations in stumpage price for pulpwood and sawlogs by species and grade).

The following chart shows the median, low and high stumpage reported by landowners and land managers operating in nearby Northern New Hampshire[vi]. As shown, landowner received the lowest payment for biomass used as fuel.

Figure 7. Stumpage for Low-Grade Forest Products ($/ton)



Harvesting (and yarding) of wood accounts for the single largest input component for the delivered price of biomass. In essence, this is payment to the logger, and accounts for all of the expenses associated with the felling, skidding (or forwarding) and processing necessary to move the wood from stump to truck.

Components of this cost include equipment (debt service and maintenance), non-diesel consumables (e.g., hydraulic fluid, skidder tires and chains, etc.), insurance and payroll. Almost all biomass harvesting is conducted by mechanized crews (feller-buncher, grapple skidder). The movement away from chainsaws and toward (much) more expensive equipment has been driven by a combination of factors: worker safety, productivity, and environmental stewardship. The average cost to establish a mechanized logging crew today is estimated at +/- $2 million (this can vary significantly by equipment type, age, and configuration).

Other variables include the harvest prescription (e.g., thinning, patch cut, etc.), distance from stump to landing, equipment age, travel costs to and from remote logging jobs (and in some instances lodging) and operating conditions. It is important to remember that while debt service for equipment is due every month, loggers in Northern New England have periods when they are unable to operate – generally mud season in the spring and again a (briefer) period in the fall, as well as sporadic periods of wet weather. The limitations on operating periods inevitably are reflected in delivered wood prices, though not in a transparent manner.

Harvesting costs (felling, skidding, yarding, and chipping) for slash are roughly $26 per green ton for biomass (slash and mortality). At the current diesel price of $4.06 per gallon, roughly $6.12 of this $26 is from the cost of diesel fuel to operate the feller, skidder, and chipper. It is important to note that in order for loggers to produce biomass for the price paid by biomass plants, they need sawlog and pulpwood markets to support the felling and skidding costs, in essence giving the tops and branches free (or discounted) felling and skidding from the point of harvest to the landing.

Figure 8. Grapple skidder brining roundwood and attached tops and branches to a landing

Trucking from the landing to the facility is estimated to cost roughly $8.60 per green ton (which can vary significantly by mileage and other factors). While individual trucking rates may vary, Innovative Natural Resource Solutions LLC (INRS) assumes $100 per hour for a truck and driver (no fuel). This cost is incurred not only for time of transportation, but also for loading and time at the facility waiting in line and unloading.

Figure 9. Trucks with Biomass Fuel Waiting to Unload

While understanding the input costs associated with biomass fuel, it is important to note that these influence but do not set market prices. Other factors include supply/demand dynamics, changes in competing markets, changes in end use market and weather. In the end, it is a dynamic market that sets the price.

Diesel as a Component of Biomass Production Costs

While understanding the cost components of the biomass supply chain, INRS has found that it is more relevant to understand the "wood" component of biomass fuel prices (stumpage, harvesting, processing, and trucking, absent diesel costs) and "diesel" as two independent cost centers.

The "wood" component of biomass pricing has been relatively price-stable, and is not prone to dramatic swings. Diesel fuel is a significant cost input to the price of biomass, and can be more volatile. Diesel is used in both in-wood operations (felling and skidding), operations at the log landing (handling and chipping), and transport to the facility.

Using actual fuel consumption from a number of logging companies across the Northeast, INRS has developed a formula for estimating the fuel used and diesel cost component of biomass fuel, based upon distance to market, payload size, and fuel cost. As a rule of thumb, a little over two gallons of diesel fuel are used in the production of a single green ton of biomass[vii]. However, this can vary considerably by the type and age of equipment, operator decisions, harvest prescription, skidding distance, distance to market, quality specified, and other variables.

The table below shows the estimated diesel cost component of production of biomass - both for wood operations (felling, skidding, handling, and chipping) and transportation – at a range of diesel fuel costs[viii].

Table 2. Diesel costs in biomass production (estimated)

$ per gallon	In-Woods Operation	Miles (one way) 10	20	30	40	50	60	70	80	90	100
$ 3.00	$ 3.81	$ 0.49	$ 0.99	$ 1.48	$ 1.98	$ 2.47	$ 2.96	$ 3.46	$ 3.95	$ 4.44	$ 4.94
$ 3.20	$ 4.06	$ 0.53	$ 1.05	$ 1.58	$ 2.11	$ 2.63	$ 3.16	$ 3.69	$ 4.21	$ 4.74	$ 5.27
$ 3.40	$ 4.32	$ 0.56	$ 1.12	$ 1.68	$ 2.24	$ 2.80	$ 3.36	$ 3.92	$ 4.48	$ 5.04	$ 5.60
$ 3.60	$ 4.57	$ 0.59	$ 1.19	$ 1.78	$ 2.37	$ 2.96	$ 3.56	$ 4.15	$ 4.74	$ 5.33	$ 5.93
$ 3.80	$ 4.83	$ 0.63	$ 1.25	$ 1.88	$ 2.50	$ 3.13	$ 3.75	$ 4.38	$ 5.00	$ 5.63	$ 6.26
$ 4.00	$ 5.08	$ 0.66	$ 1.32	$ 1.98	$ 2.63	$ 3.29	$ 3.95	$ 4.61	$ 5.27	$ 5.93	$ 6.58
$ 4.20	$ 5.33	$ 0.69	$ 1.38	$ 2.07	$ 2.77	$ 3.46	$ 4.15	$ 4.84	$ 5.53	$ 6.22	$ 6.91
$ 4.40	$ 5.59	$ 0.72	$ 1.45	$ 2.17	$ 2.90	$ 3.62	$ 4.35	$ 5.07	$ 5.79	$ 6.52	$ 7.24
$ 4.60	$ 5.84	$ 0.76	$ 1.51	$ 2.27	$ 3.03	$ 3.79	$ 4.54	$ 5.30	$ 6.06	$ 6.81	$ 7.57
$ 4.80	$ 6.10	$ 0.79	$ 1.58	$ 2.37	$ 3.16	$ 3.95	$ 4.74	$ 5.53	$ 6.32	$ 7.11	$ 7.90
$ 5.00	$ 6.35	$ 0.82	$ 1.65	$ 2.47	$ 3.29	$ 4.12	$ 4.94	$ 5.76	$ 6.58	$ 7.41	$ 8.23
$ 5.20	$ 6.60	$ 0.86	$ 1.71	$ 2.57	$ 3.42	$ 4.28	$ 5.14	$ 5.99	$ 6.85	$ 7.70	$ 8.56
$ 5.40	$ 6.86	$ 0.89	$ 1.78	$ 2.67	$ 3.56	$ 4.44	$ 5.33	$ 6.22	$ 7.11	$ 8.00	$ 8.89
$ 5.60	$ 7.11	$ 0.92	$ 1.84	$ 2.77	$ 3.69	$ 4.61	$ 5.53	$ 6.45	$ 7.37	$ 8.30	$ 9.22
$ 5.80	$ 7.37	$ 0.95	$ 1.91	$ 2.86	$ 3.82	$ 4.77	$ 5.73	$ 6.68	$ 7.64	$ 8.59	$ 9.55
$ 6.00	$ 7.62	$ 0.99	$ 1.98	$ 2.96	$ 3.95	$ 4.94	$ 5.93	$ 6.91	$ 7.90	$ 8.89	$ 9.88

In this table, the left column (blue) represents a range of diesel fuel prices, per gallon. The second column (yellow) shows the modeled in-woods diesel cost (diesel use associated with the felling, skidding, and processing of fuel from stump to truck), and the green columns show the diesel cost for round-trip transportation (loaded in one direction, empty on the return) for a 30-ton load at a variety of distances. For example, if diesel is $4.20 per gallon, the in-woods diesel cost is estimated to be $5.33 per ton and the diesel used in transportation at 60 miles is estimated to be $4.15 per ton. The total estimated cost for diesel per green ton of chips would thus be $9.48 in this scenario.

Total Price for Biomass Fuel

While it is tempting to sum the component costs of biomass (i.e., stumpage + harvesting + chipping + trucking) to get at what is the final price for biomass fuel, this is not how the market functions. Instead, biomass plants (including but not limited to Ryegate) set a price designed to get them the volume of wood fuel they need to operate, while allowing for continued economic operation of the facility.

Because nobody is obligated to produce biomass fuel (and it is, in fact, a product than many logging crews do not produce), the price established for fuel sends a signal to potential suppliers that they can use to determine if they are willing to supply fuel or not. Each supplier can then determine if the price being offered by the biomass plant justifies the expense associated with producing in-woods chips, and act accordingly.

As part of this project, INRS spoke with several suppliers who brought wood fuel to the facility when Ryegate was paying $38 or $40 per ton, but had stopped being suppliers when prices dropped. Some simply stopped producing chips – instead, returning tops and branches to the woods – while others sold to other markets that were paying a higher price. This is exactly how commodity markets work, with each consumer and each supplier able to act independently to make rational decisions based upon price and other factors.

While there are enormous variations, so much so that any one price is near meaningless, most suppliers that INRS spoke to indicated that, at current diesel prices, it costs somewhere in the low $30s per green ton to produce and deliver in-woods chips to a biomass plant. This relies upon healthy roundwood markets in order to get the tops and branches to the landing at a less-than-roundwood rate, and is influenced by a number of variables, including but not limited to:

- Harvest type
- Equipment used
- Equipment up-time
- Wages paid to employees
- Cost of diesel
- Truck loading and unloading time
- Trucking distance
- Alternative market prices
- Landowner requirements

The most recent prices being paid for biomass fuel in Northern New Hampshire and Northern Vermont are in the low $30s, and plants are getting the wood that they want at this pricing. This suggests that this is a workable price, and if plants do not get the volumes they need to operate they would be expected to raise the wood fuel pricing, constrained by other costs (e.g., operations and maintenance) and revenue (e.g., electricity sales and Renewable Energy Certificate sales).

Historic Biomass Fuel Pricing – Ryegate

As part of compliance with their Power Purchase Agreement, Ryegate reports its wood purchasing (total volume purchased and total amount paid), which can be used to calculate an average price per green tons of wood fuel purchased. This amount is then used in a formula to determine how much the facility is paid for electricity[ix]. The following chart and table show the delivered price for wood fuel at Ryegate, based upon this data. The most recent quarter (2Q 2024) has an average delivered price of $40.69 per green ton, and the last four quarters have an average price of $39.62 per green ton.

Figure 10. Ryegate Average Wood Fuel Price, $ per Green Ton

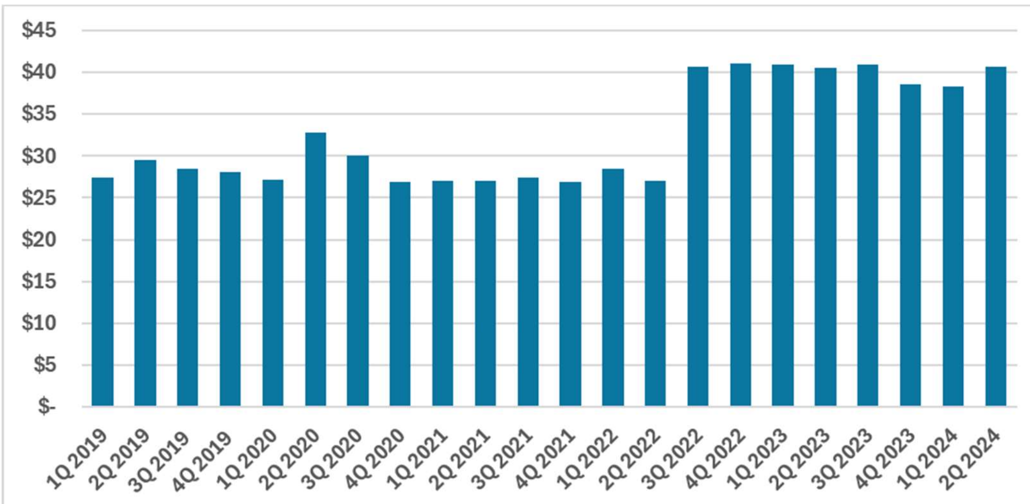


Table 3. Ryegate Average Wood Fuel Price, $ per Green Ton

	2019	2020	2021	2022	2023	2024
1Q	$ 27.38	$ 27.21	$ 27.00	$ 28.52	$ 40.92	$ 38.28
2Q	$ 29.56	$ 32.79	$ 27.00	$ 27.00	$ 40.49	$ 40.69
3Q	$ 28.42	$ 30.05	$ 27.43	$ 40.62	$ 40.93	
4Q	$ 28.06	$ 26.93	$ 26.95	$ 41.03	$ 38.59	

Historic Biomass Fuel Pricing – Regional

The average price paid by a plant for biomass chips can vary, based upon electricity pricing, demand for chips from competing mills, demand for other forest products, weather, operating costs, and other factors. While there is no reliable public historic pricing source for all of Vermont, the New Hampshire Timberland Owners Association publishes a quarterly price report[x] which includes a breakout for Northern New Hampshire (Coos, Grafton, and Carroll Counties). While Ryegate is obviously not in Northern New Hampshire, it is four road miles from the state line, and has historically competed for chips with biomass power plants in Bethlehem, Whitefield, and Berlin, NH. Given this location and market interaction, Northern New Hampshire is an excellent proxy for wood fuel prices at Ryegate.

The following shows average price for biomass fuel, per green ton delivered, in proximate Northern New Hampshire. The black section represents the price of 2.1 gallons of diesel fuel[xi], an estimate of the amount of diesel used to harvest, process and transport one ton of in-woods chips. The most recent quarter (1Q 2024) has an average delivered price of $40 per green ton, and the last four quarters have an average price of $38.50 per green ton. INRS notes that recent conversations with both suppliers and biomass plants in Northern New Hampshire and Vermont indicate that this price has dropped in 2Q 2024.

Figure 11. Biomass Fuel Price, $ per Green Ton (Delivered), 2016 - 2024

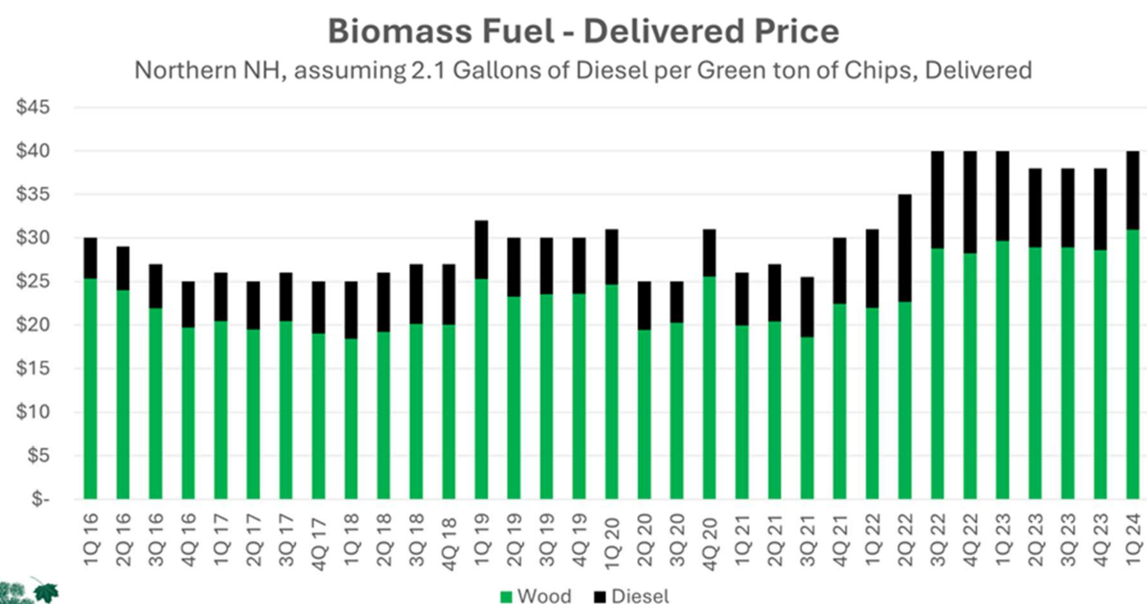


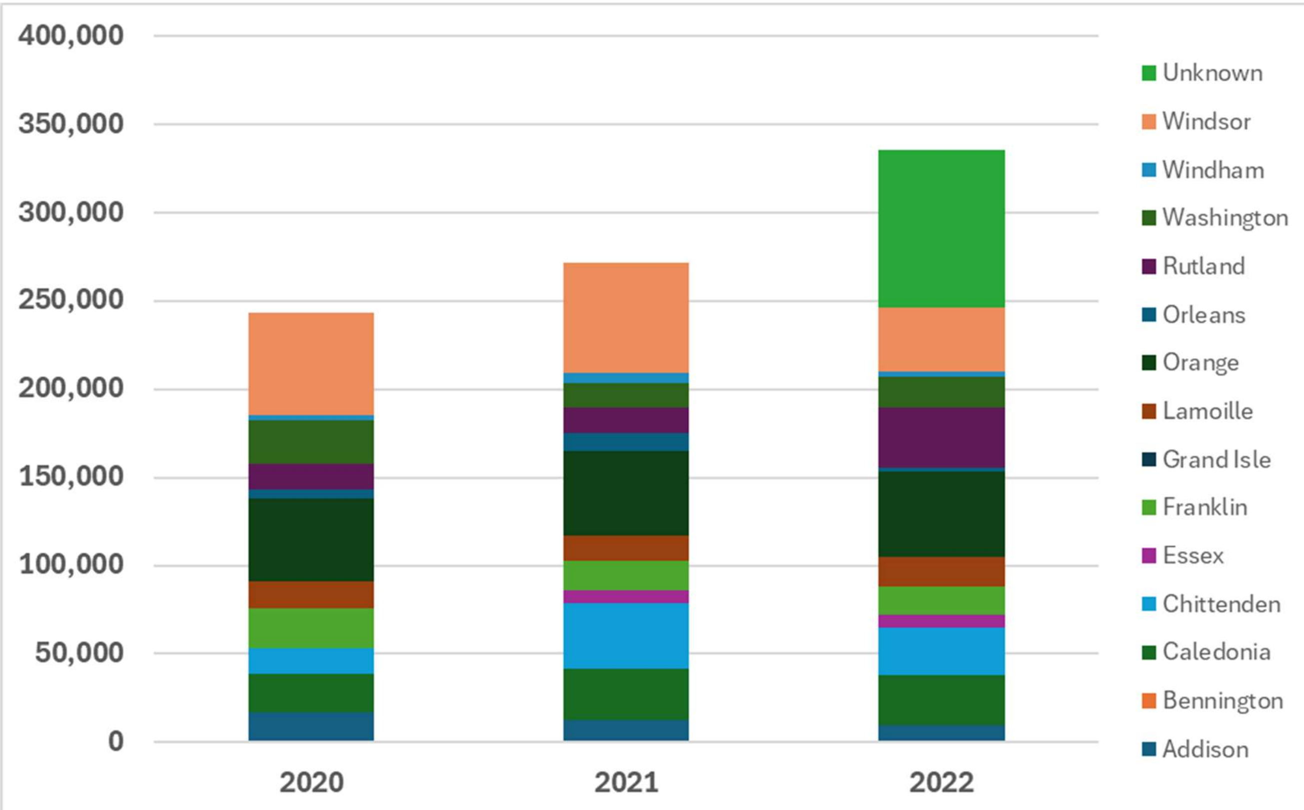
Table 4. Biomass Fuel Price, $ per Green Ton (Delivered), 2016 - 2024

		Price Components		
Quarter	Delivered Price	Wood	Diesel (2.1g)	Diesel ($/g)
1Q 16	$ 30.00	$ 25.32	$ 4.68	$ 2.23
2Q 16	$ 29.00	$ 24.01	$ 4.99	$ 2.38
3Q 16	$ 27.00	$ 21.92	$ 5.08	$ 2.42
4Q 16	$ 25.00	$ 19.74	$ 5.26	$ 2.51
1Q 17	$ 26.00	$ 20.44	$ 5.57	$ 2.65
2Q 17	$ 25.00	$ 19.50	$ 5.50	$ 2.62
3Q 17	$ 26.00	$ 20.44	$ 5.57	$ 2.65
4Q 17	$ 25.00	$ 19.05	$ 5.95	$ 2.84
1Q 18	$ 25.00	$ 18.45	$ 6.55	$ 3.12
2Q 18	$ 26.00	$ 19.20	$ 6.80	$ 3.24
3Q 18	$ 27.00	$ 20.13	$ 6.87	$ 3.27
4Q 18	$ 27.00	$ 20.03	$ 6.97	$ 3.32
1Q 19	$ 32.00	$ 25.30	$ 6.70	$ 3.19
2Q 19	$ 30.00	$ 23.26	$ 6.74	$ 3.21
3Q 19	$ 30.00	$ 23.54	$ 6.46	$ 3.08
4Q 19	$ 30.00	$ 23.57	$ 6.43	$ 3.06
1Q 20	$ 31.00	$ 24.62	$ 6.38	$ 3.04
2Q 20	$ 25.00	$ 19.42	$ 5.58	$ 2.66
3Q 20	$ 25.00	$ 20.28	$ 4.72	$ 2.25
4Q 20	$ 31.00	$ 25.56	$ 5.44	$ 2.59
1Q 21	$ 26.00	$ 19.93	$ 6.07	$ 2.89
2Q 21	$ 27.00	$ 20.41	$ 6.59	$ 3.14
3Q 21	$ 25.50	$ 18.63	$ 6.87	$ 3.27
4Q 21	$ 30.00	$ 22.44	$ 7.56	$ 3.60
1Q 22	$ 31.00	$ 21.99	$ 9.01	$ 4.29
2Q 22	$ 35.00	$ 22.67	$ 12.33	$ 5.87
3Q 22	$ 40.00	$ 28.77	$ 11.24	$ 5.35
4Q 22	$ 40.00	$ 28.25	$ 11.75	$ 5.60
1Q 23	$ 40.00	$ 29.65	$ 10.35	$ 4.93
2Q 23	$ 38.00	$ 28.93	$ 9.07	$ 4.32
3Q 23	$ 38.00	$ 28.90	$ 9.10	$ 4.33
4Q 23	$ 38.00	$ 28.59	$ 9.41	$ 4.48
1Q 24	$ 40.00	$ 30.95	$ 9.05	$ 4.31

Role of Chips in Vermont Forest Economy

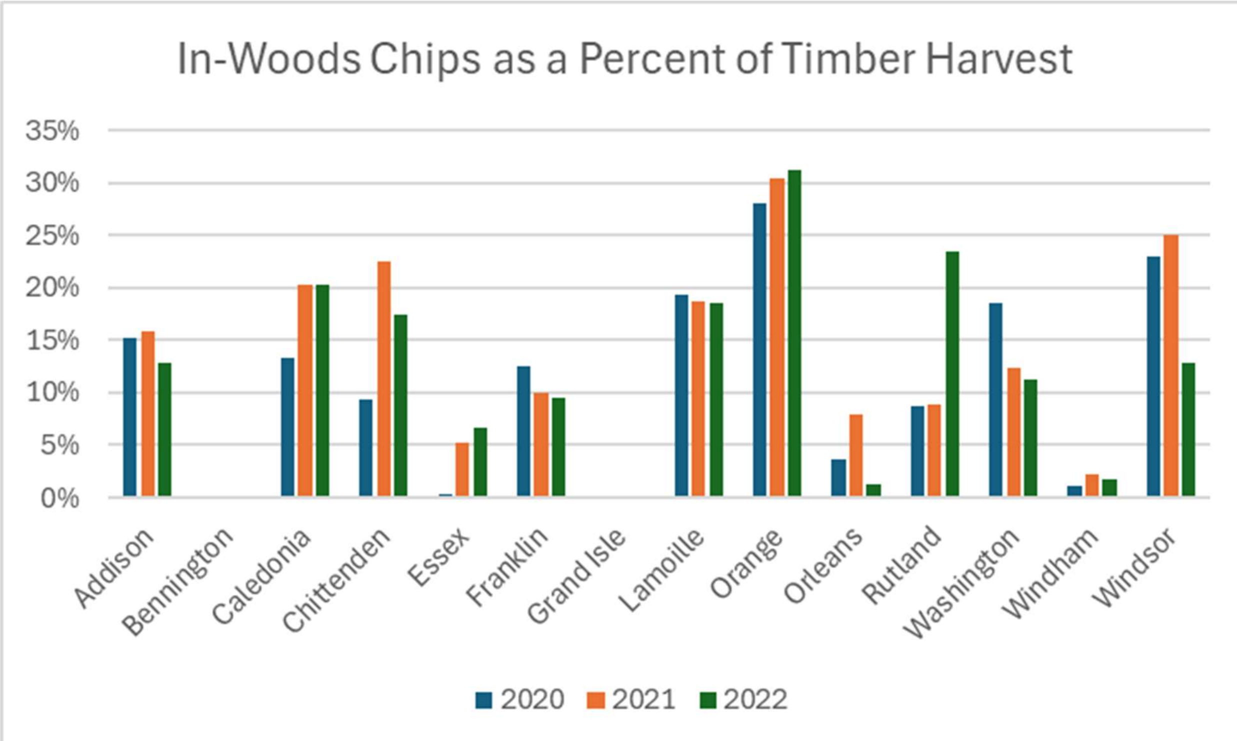
In-woods chips are an important Vermont forest product, and provide an important outlet for tops, limbs, cull, and other low-grade wood. Chips are produced in most counties of the state.

Figure 12. Annual Production of In-Woods Chips by County, 2020 - 2022[xii]



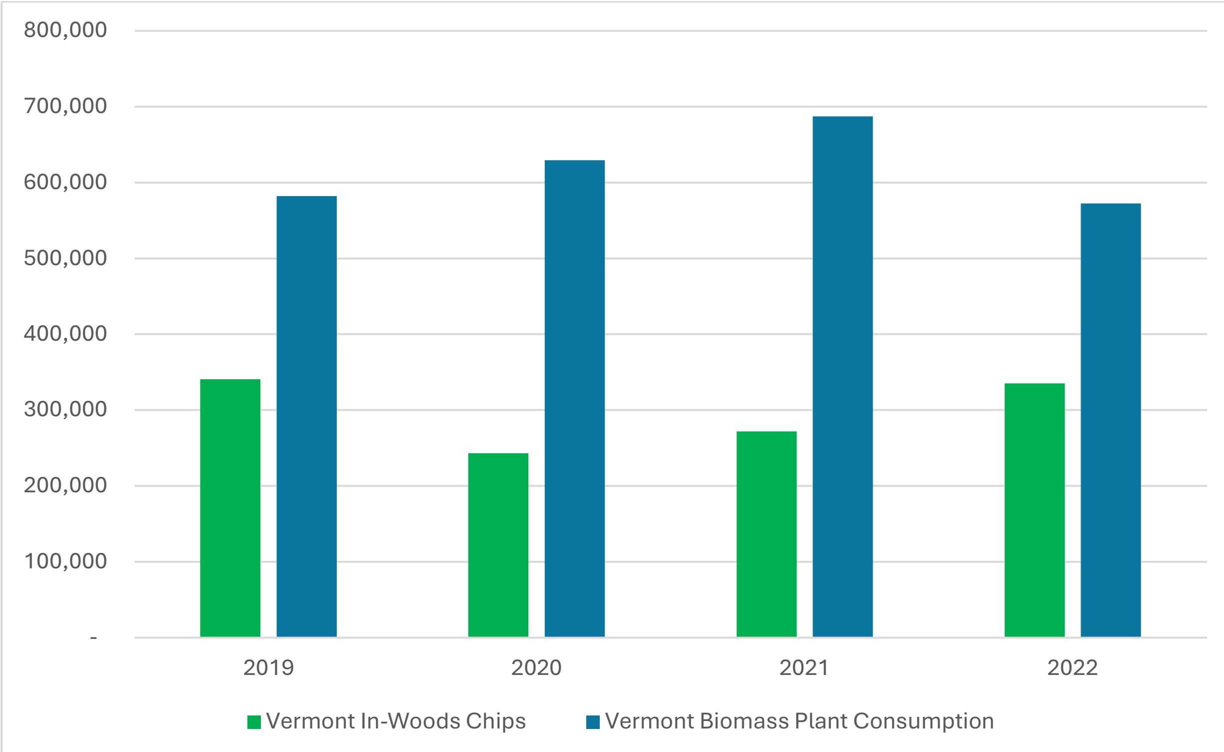
In-woods chips account for between 11% and 15% percent of statewide timber harvest in recent years, with significant regional variation[xiii]. In 2022, in-woods chips represented none of the timber harvest volume in Bennington County, and almost a third (31%) of the timber harvest in Orange County. This is likely explained by proximity to markets for in-woods chips, including but not limited to Ryegate Power in Ryegate and McNeil Generating Station in Burlington.

Figure 13. In-Woods Chips as a Percentage of Timber Harvest, by County 2020 - 2022



Vermont's biomass fuel use at the two wood-fired power plants (Ryegate and McNeil) exceeds the state's total in-woods chip production. This makes sense as both facilities are located proximate to other states (New Hampshire and New York, respectively), and purchase wood from forest operations around them. While the percent varies by year, during the time period 2019 – 2022 in-woods chips from Vermont timber harvests were about half of the total wood fuel used at the state's two biomass electric facilities.

Figure 14. In-Woods Chip Production and Vermont Biomass Plant Consumption, 2019 - 2022



It is important to note that while this information helps us understand in-state supply and demand for Vermont biomass at a high level, it is incomplete. Plants may purchase other wood as fuel (e.g., sawmill residuals or tree service waste), and some smaller biomass thermal facilities may use a modest volume of in-woods chips.

Wood Fuel Use

Biomass electric plants use between ~550,000 and ~700,000 green tons of wood fuel annually, depending upon electricity production. Ryegate represents roughly 40% of this wood fuel use, depending upon the year. Vermont's other biomass electric facility, Burling Electric Department's 50 MW McNeil Generating Station, uses the remainder.

Figure 15. Annual Wood Fuel Use, Vermont Biomass Electric Plants, 2019 - 2023

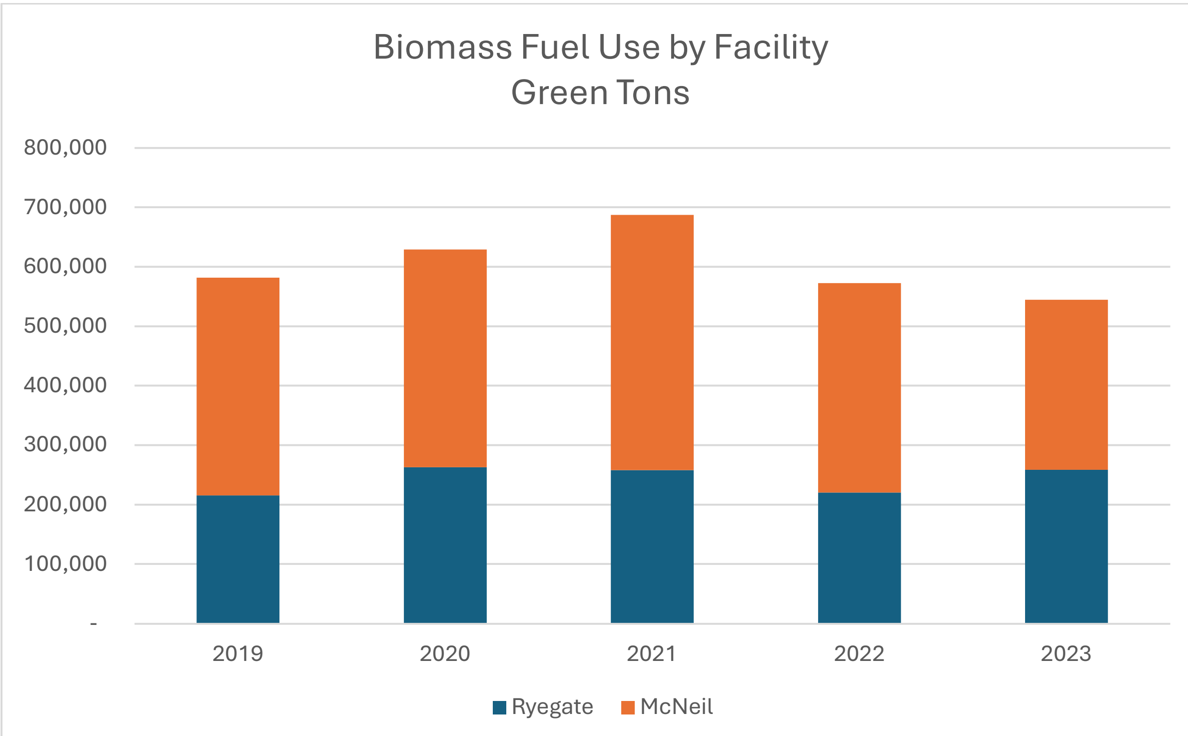


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Table 5. Annual Wood Fuel Use, Vermont Biomass Electric Plants, 2019 - 2023

	Ryegate	McNeil
2019	215,654	366,265
2020	262,941	366,465
2021	257,821	429,324
2022	220,223	352,264
2023	258,490	285,888

Energy Production at Ryegate

Ryegate has a capacity of 20 MW, and thus a maximum theoretical annual production of 175,200 MWh (20 MW x 24 hours x 365 days). Assuming that maintenance and other outages reduce the availability to 92 percent (meaning the plant is available to produce electricity 92 percent of the time), the maximum annual production is a little over 161,000 MWh. In three of the most recent five years, the plant operated at or near roughly full (92%) capacity.

Table 6. Annual Wood Fuel Use and Electric Generation, Ryegate

	Tons Used	MWh produced	Tons / MWh
2019	215,654	130,866	1.65
2020	262,941	161,634	1.63
2021	257,821	161,552	1.60
2022	220,223	137,184	1.61
2023	258,490	160,700	1.61
Total	1,215,129	751,936	1.62

When annual wood fuel use and electricity production are viewed together, it becomes clear that for each MWh of electricity produced, +/-1.6 green tons of wood fuel are utilized.

The plant does not currently make use of thermal energy produced (other than electricity production), but has plans to do so in the future.

The following table shows the historic monthly electricity production at Ryegate (1,000 kwh = 1 MWh), as well as electricity payments made to the plant. During the time period 2019 – 2024, the plant has received between $101.23 and $111.52 per MWh of electricity produced, with an average price of $103.40.

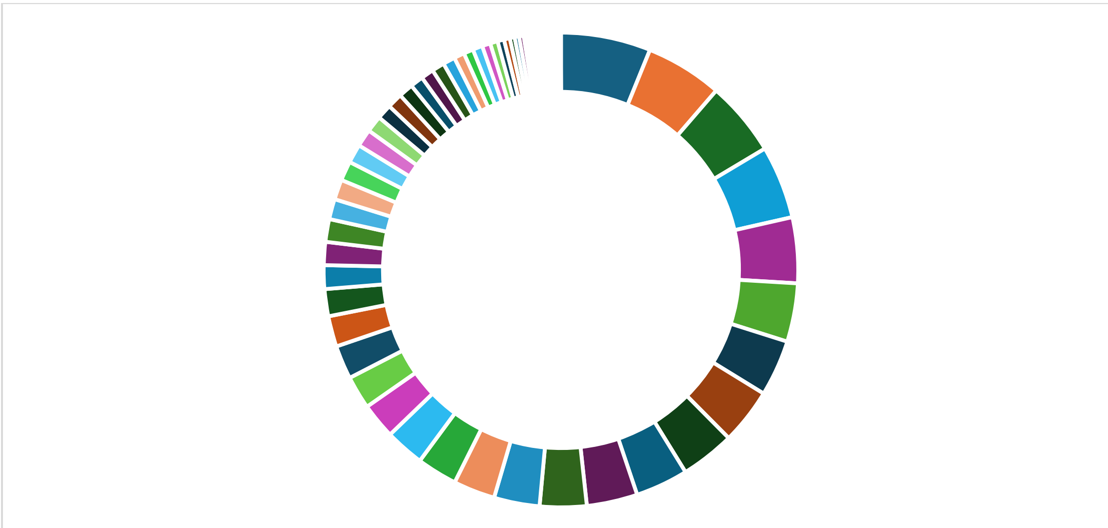
Table 7. Electric Generation and Energy Payments to Ryegate, 2019 - 2024[xv]

BASELOAD RENEWABLE POWER - RYEGATE PRODUCTION				
Month	kWh	Amount	Dispatch	Total
		2024		
MAY	11,449,810	$ 1,275,394.39		$ 1,275,394.39
APRIL	9,744,092	$ 1,085,394.35		$ 1,085,394.35
MARCH	14,495,532	$ 1,574,649.62		$ 1,574,649.62
FEBRUARY	13,702,182	$ 1,488,468.04		$ 1,488,468.04
JANUARY	13,151,121	$ 1,425,699.27		$ 1,425,699.27
		2023		
DECEMBER	13,145,191	$ 1,429,787.39		$ 1,429,787.39
NOVEMBER	14,276,478	$ 1,555,993.50		$ 1,555,993.50
OCTOBER	13,736,676	$ 1,495,649.30		$ 1,495,649.30
SEPTEMBER	9,415,444	$ 1,050,010.34		$ 1,050,010.34
AUGUST	14,255,828	$ 1,589,809.91		$ 1,589,809.91
JULY	14,145,436	$ 1,577,499.02		$ 1,577,499.02
JUNE	13,855,923	$ 1,538,284.62		$ 1,538,284.62
MAY	12,771,340	$ 1,417,874.17		$ 1,417,874.17
APRIL	13,926,580	$ 1,546,128.91		$ 1,546,128.91
MARCH	14,615,040	$ 1,629,576.96		$ 1,629,576.96
FEBRUARY	12,086,240	$ 1,347,615.76		$ 1,347,615.76
JANUARY	14,469,400	$ 1,613,338.10		$ 1,613,338.10
		2022		
DECEMBER	8,479,020	$ 946,428.21		$ 946,428.21
NOVEMBER	8,606,320	$ 960,637.44		$ 960,637.44
OCTOBER	6,362,220	$ 747,878.96		$ 747,878.96
SEPTEMBER	7,391,340	$ 865,525.91		$ 865,525.91
AUGUST	14,182,740	$ 1,660,798.85		$ 1,660,798.85
JULY	14,138,980	$ 1,655,674.56		$ 1,655,674.56
JUNE	12,430,220	$ 1,333,389.70		$ 1,333,389.70
MAY	11,634,320	$ 1,248,013.51		$ 1,248,013.51
APRIL	11,786,340	$ 1,264,320.69		$ 1,264,320.69
MARCH	14,532,660	$ 1,537,119.45		$ 1,537,119.45
FEBRUARY	13,156,480	$ 1,391,560.89		$ 1,391,560.89
JANUARY	14,483,800	$ 1,531,951.53		$ 1,531,951.53
		2021		
DECEMBER	13,122,360	$ 1,377,979.02		$ 1,377,979.02
NOVEMBER	14,319,580	$ 1,503,699.10		$ 1,503,699.10
OCTOBER	14,474,540	$ 1,505,786.40		$ 1,505,786.40
SEPTEMBER	9,521,360	$ 992,696.99		$ 992,696.99
AUGUST	14,408,580	$ 1,502,238.55		$ 1,502,238.55
JULY	14,541,000	$ 1,516,044.66		$ 1,516,044.66
JUNE	12,091,700	$ 1,258,141.39		$ 1,258,141.39
MAY	13,945,880	$ 1,451,068.81		$ 1,451,068.81
APRIL	13,963,000	$ 1,452,850.15		$ 1,452,850.15
MARCH	14,428,060	$ 1,501,239.64		$ 1,501,239.64
FEBRUARY	13,151,560	$ 1,368,419.82		$ 1,368,419.82
JANUARY	13,584,440	$ 1,413,460.98		$ 1,413,460.98
		2020		
DECEMBER	12,202,060	$ 1,269,258.28		$ 1,269,258.28
NOVEMBER	13,989,000	$ 1,455,135.78		$ 1,455,135.78
OCTOBER	14,728,320	$ 1,501,994.07		$ 1,501,994.07
SEPTEMBER	9,946,860	$ 1,029,698.95		$ 1,029,698.95
AUGUST	14,508,580	$ 1,501,928.20		$ 1,501,928.20
JULY	14,286,680	$ 1,478,957.11		$ 1,478,957.11
JUNE	14,146,800	$ 1,490,931.25		$ 1,490,931.25
MAY	14,079,580	$ 1,483,846.94		$ 1,483,846.94
APRIL	10,277,140	$ 1,083,107.78		$ 1,083,107.78
MARCH	14,708,640	$ 1,502,046.23		$ 1,502,046.23
FEBRUARY	13,833,020	$ 1,412,628.00		$ 1,412,628.00
JANUARY	14,926,980	$ 1,524,343.20		$ 1,524,343.20
		2019		
DECEMBER	11,086,480	$ 1,136,807.66		$ 1,136,807.66
NOVEMBER	0	$ -		$ -
OCTOBER	0	$ -		$ -
SEPTEMBER	10,478,180	$ 1,065,945.25		$ 1,065,945.25
AUGUST	14,040,720	$ 1,428,362.45		$ 1,428,362.45
JULY	14,744,100	$ 1,499,917.29		$ 1,499,917.29
JUNE	10,878,280	$ 1,112,412.91		$ 1,112,412.91
MAY	14,532,700	$ 1,486,113.90		$ 1,486,113.90
APRIL	14,138,720	$ 1,445,825.51		$ 1,445,825.51
MARCH	14,964,340	$ 1,514,840.14		$ 1,514,840.14
FEBRUARY	12,717,120	$ 1,287,354.06		$ 1,287,354.06
JANUARY	13,285,760	$ 1,344,917.48		$ 1,344,917.48

Number of Contractors Suppling Ryegate

In the time period June 2022 – May 2023, the facility had a total of 72 suppliers[xvi]. No single supplier provided more than 6% of the facility's fuel, so there is a wide depth of supply.

Figure 16. Distribution of Suppliers by Percentage of Biomass Fuel, Ryegate



In the past months Ryegate has changed how they procure wood, and are reportedly now purchasing all fuel through a single entity, which then manages procurement from a large number of loggers, mills, and other suppliers.

Endnotes

[i] Vermont Act 155 (2022), An act relating to extending the baseload renewable power portfolio requirement.
[ii] While this is a general description of the variety of products that can be derived from a single tree, it is important to note that the characteristics of an individual tree, combined with local markets, may make all or most of it unsuitable for lumber manufacturing, and in such case all of the tree would be used for pulp and chip markets or left in the woods.
[iii] *Note:* This tree is used for illustration purposes only. Forest-grown trees look significantly different than this diagram, with longer trunks and less "crown" or leafy top.
[iv] Informed by: Innovative Natural Resource Solutions LLC. *Components Prices for Delivered Pulpwood*, prepared for the Maine Department of Economic & Community Development. October 2015
[v] Market Pulse. *Timber Crier – The Newsletter of the New Hampshire Timberland Owners Association*. Fall 2022. Conversion of sawlog prices from MBF to green tons by INRS, using 2 cords per MBF and sawlog weights from the Maine Forest Service.
[vi] New Hampshire Timberland Owners Association. *Market Pulse* feature in the quarterly membership publication *The Timber Crier*.
[vii] This assumes a mechanized harvesting system using a feller buncher and a grapple skidder, the equipment configuration that accounts for the vast majority of in-woods chip production.
[viii] This analysis uses the reported price for on-road diesel, and does not account for the ability of in-woods equipment to operate using lower cost off-road diesel.
[ix] VEPP Inc., Ryegate Program, Monthly Production, Quarterly Fuel Adjustment. https://vermontstandardoffer.com/ryegate/monthly-production/
[x] New Hampshire Timberland Owners Association. *Market Pulse* feature in the quarterly membership publication *The Timber Crier*.
[xi] Diesel prices an average of monthly prices found in U.S. Energy Information Agency, *Gasoline and Diesel Fuel Update*, https://www.eia.gov/petroleum/gasdiesel/
[xii] Vermont Forest Resource Harvest Summary, 2020, 2021 and 2022
[xiii] Calculated from data in Vermont Forest Resource Harvest Summary, 2020, 2021 and 2022
[xiv] Personal communication. John Wakefield, AQCD Compliance Section, Vermont Agency of Natural Resources, April 9, 2024.
[xv] VEPP Inc., Ryegate Program, Monthly Production, Baseload Renewable Power Production, Ryegate. https://vermontstandardoffer.com/ryegate/monthly-production/
[xvi] Ryegate Annual Fuel Summary: 6-1-22 through 5-31-23