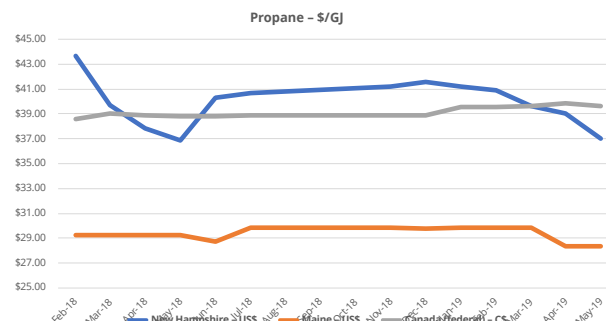
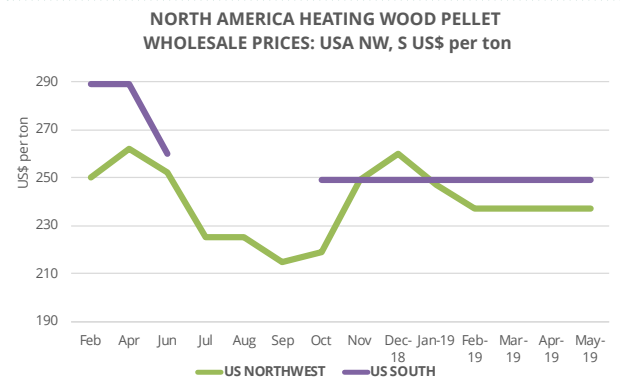
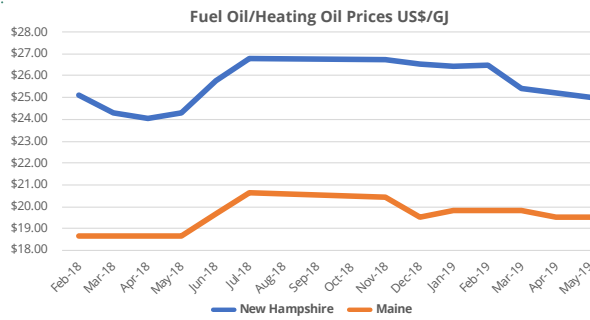
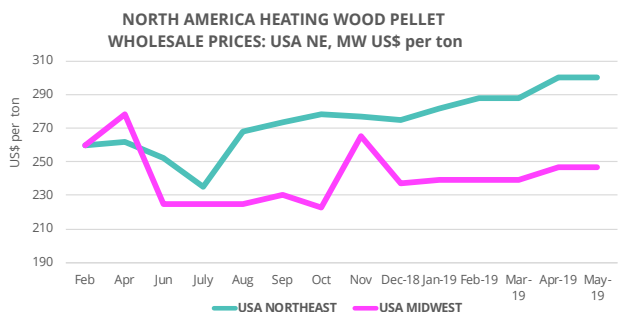
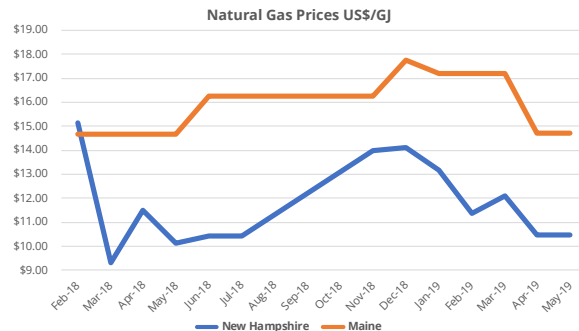
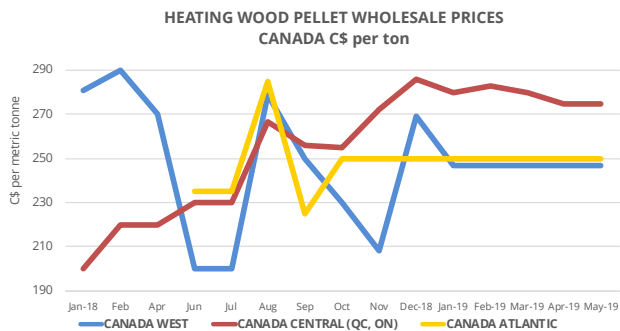


NORTH AMERICA HEATING WOOD PELLET PRICES Historical Perspective

www.madisonsreport.com	Wholesale (reseller)		7,800 to 8,700 BTUs			\$/ ton			Trend
	May 2019	Apr 2019	\$ change	% change	Trend	Last Year	\$ change	% change	
Canada West (BC, AB)	\$247	\$247	+0	+0.0%	-	\$250	-3	-1.2%	▼
Canada Central (MB, ON, QC)	\$275	\$275	+0	+0.0%	-	\$249	+27	+9.6%	▲
Canada East (NS, NB, PEI)	\$250	\$250	+0	+0.0%	-	\$225	+25	+10.0%	▲
USA Northeast	\$300	\$300	+0	+0.0%	-	\$274	+26	+8.7%	▲
USA Midwest	\$247	\$247	+0	+0.0%	-	\$230	+17	+6.8%	▲
USA Northwest	\$237	\$237	+0	+0.0%	-	\$215	+22	+9.3%	▲

All prices in Canada in CAD\$ - All prices in USA in US\$

PRICE HISTORY 2018 - May 2019



NORTH AMERICA HEATING WOOD PELLET PRICE AND MARKET GUIDE

May 2019

Regional Pricing of Residential Softwood Pellets • International Standard ISO 17225-2

7,800 to 8,700 BTUs	Wholesale (reseller) \$/ton		Retail / 40 lb bag		UNIT CONVERSIONS Wholesale and Retail			
	May	Apr	May	Apr	\$/ GJ	\$/ MWh	\$/ mmBTU	
WEST (mill gate/roadside)	BC	\$225	\$225	---	---	\$12.09	\$43.53	\$12.76
		---	---	\$4.00 - 7.29	\$7.29	\$19.59	\$70.51	\$20.67
	AB	\$269	\$269	---	---	\$14.46	\$52.04	\$15.25
CENTRAL (roadside) (St. Laurence)		---	---	\$6.49 - 7.29	\$7.29	\$19.59	\$70.51	\$20.67
	MB	\$280	\$280		\$5.60	\$15.05	\$54.17	\$15.87
				\$5.60 - 7.29		\$17.32	\$62.34	\$18.27
	ON	\$220 - 290	\$270	---	---	\$14.51	\$52.23	\$15.31
		---	---	\$5 - 7.29	\$5.60	\$16.51	\$59.44	\$17.46
ATLANTIC (delivered to hub)	QC	\$290	\$290	---	---	\$15.58	\$56.10	\$16.44
		---	---	\$5.50 - 7.29	\$5.99	\$17.18	\$61.86	\$18.13
	NS/NB	\$250	\$250	---	---	\$13.44	\$48.36	\$14.17
		---	---	\$5 - 7.29	\$6.15	\$16.51	\$59.44	\$17.42
NORTHEAST (warehouse/ wholesale yard)	PEI	---	---	---	---	---	---	---
		---	---	\$5.75 - 7.29	\$7.29	\$19.59	\$70.51	\$20.67
	ME	\$266 - 381	\$287	---	---	\$17.60	\$63.35	\$18.57
		---	---	\$6 - 8	\$7.00	\$18.81	\$67.71	\$19.84
	NH	\$278 - 345	\$275	---	---	\$14.94	\$53.78	\$15.76
		---	---	\$5.75 - 7.80	\$6.25	\$16.79	\$60.45	\$17.72
	VT	\$279 - 309	\$294	---	---	\$15.80	\$56.87	\$16.67
		---	---	\$5.49	---	\$14.75	\$53.10	\$15.56
	MD	\$225 - 290	\$283	---	---	\$15.18	\$54.65	\$16.02
	CT	\$279 - 371	\$298	---	---	\$16.79	\$60.45	\$17.72
		---	---	\$5.49	---	\$14.75	\$53.10	\$15.56
	MA	\$270 - 371	\$273	---	---	\$17.92	\$64.52	\$18.91
		---	---	\$5.81	\$6.13	\$16.69	\$60.07	\$17.60
	RI	\$279 - 371	\$290	---	---	\$17.12	\$61.61	\$18.06
		---	---	\$5.49 - 6.25	\$5.49	\$14.75	\$53.10	\$15.56
	NY	\$245 - 410	\$255	---	---	\$13.70	\$49.33	\$14.46
		---	---	\$6.00	\$6.00	\$16.12	\$58.03	\$17.01
	NJ	\$300 - 400	\$305	---	---	\$17.20	\$61.90	\$18.14
		---	---	\$6.25 - 6.99	\$5.49	\$14.75	\$53.10	\$15.56
VA	\$259 - 269	\$264	---	---	\$14.19	\$51.07	\$14.97	
			\$5.49	---	\$14.75	\$53.10	\$15.56	
PA	\$225 - 400	\$282	---	---	\$15.15	\$54.55	\$15.99	
	---	---	\$3.75 - 6.99	\$5.00	\$13.44	\$48.36	\$14.17	
IL	\$192	\$192		\$4.49	\$10.32	\$37.14	\$10.89	
			\$3.99 - 4.49		\$11.39	\$41.01	\$12.02	
MIDWEST (roadside)	WI	\$195 - 294	\$230	---	---	\$12.33	\$44.40	\$13.01
		---	---	\$3.99 - 6.99	\$4.87	\$13.09	\$47.10	\$13.81
	MO	\$249	\$249	---	---	\$13.38	\$48.17	\$14.12
	---	---	\$3.99 - 4.99	\$4.49	\$12.06	\$43.43	\$12.73	
NORTHWEST (delivered to hub)	ID	\$245	\$245		\$4.74	\$13.17	\$47.40	\$13.89
				\$3.99 - 5.49		\$12.74	\$45.85	\$13.44
	WA	\$209 - 249	\$249	---	---	\$12.31	\$44.30	\$12.98
	---	---	\$5.18 - 5.49	\$5.34	\$14.34	\$51.60	\$15.12	
SOUTH (delivered to hub)	CA/TN	\$249	\$249	\$5.49 - 5.69	\$5.59	\$13.38	\$48.17	\$14.12
					\$15.02	\$54.07	\$15.85	

All prices in Canada in CAD\$ - All prices in USA in US\$

NORTH AMERICA FOREST FIBRE FLOW UPDATE: 1H 2019

Robust US home building activity and North America timber harvest belie incredibly weak construction framing softwood lumber prices in the first half of this year. There were serious supply chain issues, mostly due to severe weather, in the winter. As well, the US government shutdown put a particularly bad crimp in the movement of goods, and at the border stopped it completely. Indeed, for products subject to duty, there was a total delay of transportation until the full-time people came back to the job.

Some say the lumber supply-demand balance appears well-stocked in June 2019, as inventories are replete and delivery times are down to same-week. Most decry tragically low prices as incomprehensible.

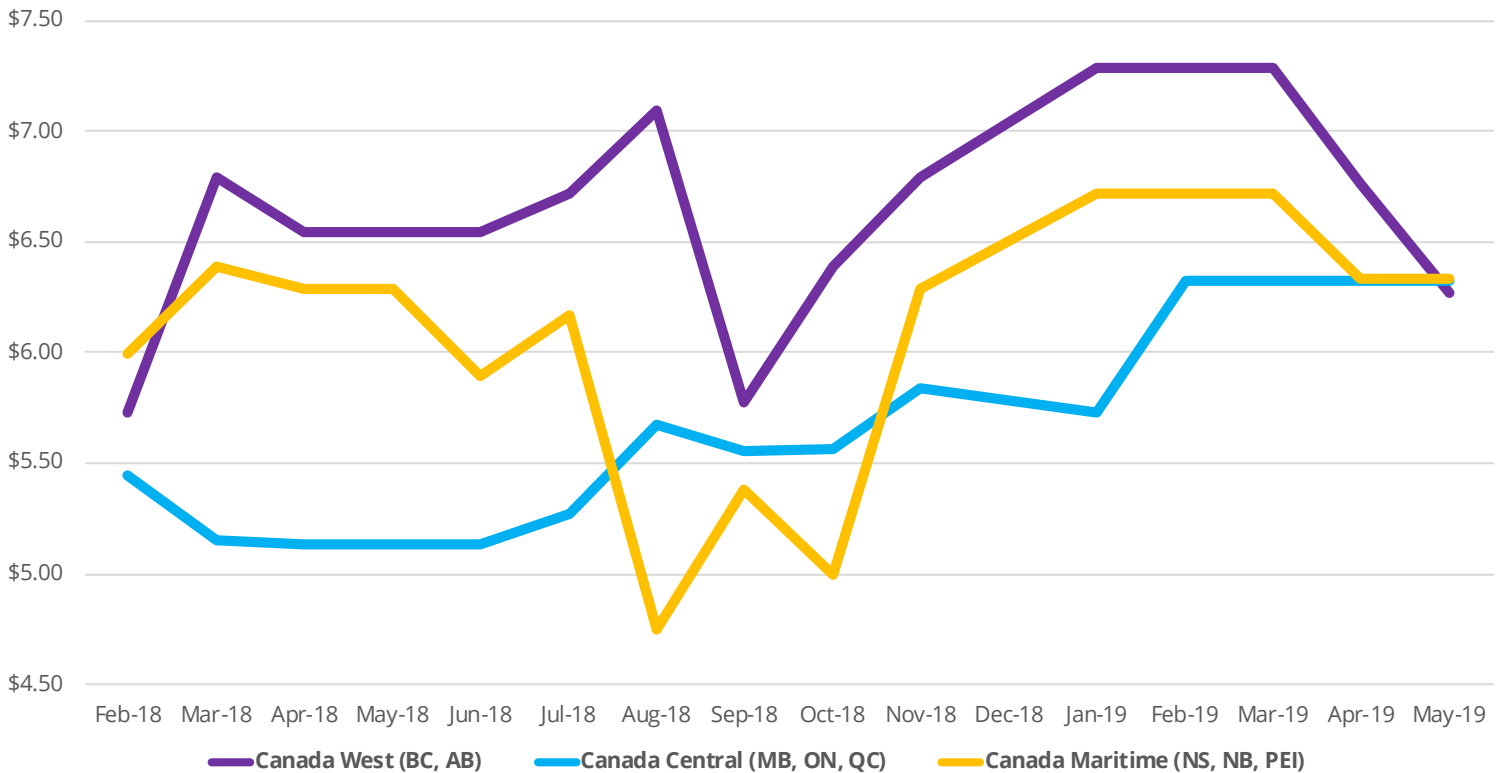
Minuscule, especially for the season, order files at sawmills across all regions brought lumber prices crashing down from the soaring highs of this time last year. Indeed, after languishing for most of 4Q 2018, wholesaler prices of solid wood commodities started falling right from the beginning of this

year until they flatlined at dangerous lows for most of May. Producers went off-the-market (refusing to quote prices) while secondary suppliers weren't sure at what levels to set their existing inventory.

This all, of course, affects the price of sawmill residue as lumber manufacturers adjust production volumes in an effort to buoy prices. Indeed, significant manufacturing curtailments at so many of the major sawmills in British Columbia over March and April, then again in June, as well as several announcements of permanent closures, took enough capacity offline for lumber prices in early June to jump up +20%. This is, however, still only a partial recovery from the drops since the admittedly record-highs of this time last year.

US housing starts for May are fairly stable at approximately 1.2 million units annualized, with permits up +6% from April. Housing supply is tight at a few months for-sale, and prices of both new and existing homes have been rising for almost a year. Lending, while still tight, is becoming more flexible.

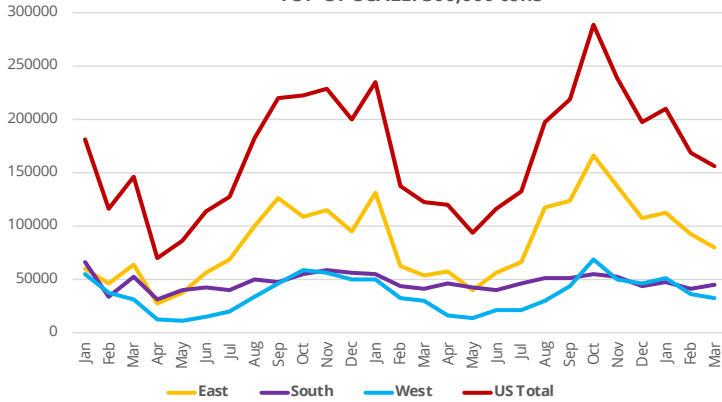
Canada Wood Pellets Retail Price - per 40 lb bag



US REGIONAL PELLET SALES AND PRICES

March 2019

US Domestic Sales Densified Biomass Fuel - Jan '17 - Mar '19
TOP OF SCALE: 300,000 tons



Densified biomass fuel consists primarily of compressed wood pellets, briquettes, and logs. The manufacture of wood pellets utilizes **wood residues** from sustainably managed forests as well as high-quality **wood waste** from a variety of industrial activities such as construction and logging. Wood pellet combustion has a high efficiency level and extremely low particulate emissions. Additionally, wood pellets are a renewable energy source.

Densified biomass fuel is used for heating in wood pellet stoves or furnaces in residential settings and in large-scale boilers in commercial buildings. Industry uses utility-grade wood pellets in processes that require thermal energy, such as generating electricity.

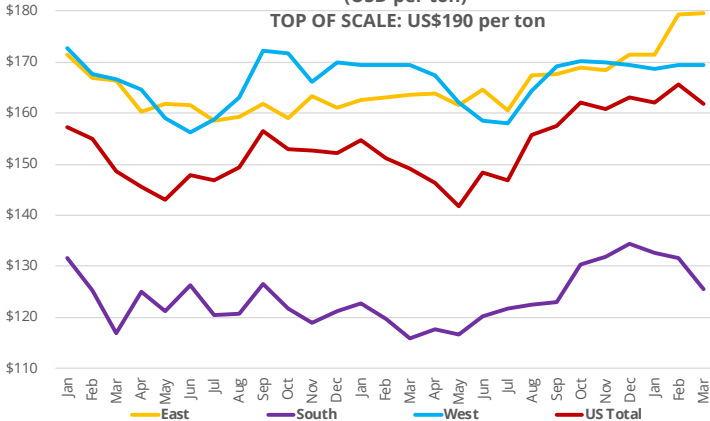
US Domestic Densified Biomass Fuel Sales

Month	East	South	West	US Total
Dec-17	94,251	55,467	49,852	199,570
Full Year 2017	898,880	568,490	424,652	1,892,022
Jan-18	130,745	54,657	49,818	235,220
Feb-18	61,651	42,834	32,717	137,202
Mar-18	52,918	40,622	29,187	122,727
Apr-18	57,436	46,196	16,004	119,636
May-18	39,482	41,651	12,885	94,018
Jun-18	55,719	39,144	21,183	116,046
Jul-18	66,080	45,365	21,241	132,686
Aug-18	117,729	50,261	29,260	197,250
Sep-18	123,112	50,983	43,913	218,008
Oct-18	165,862	53,060	68,767	287,689
Nov-18	137,509	51,727	49,657	238,893
Dec-18	107,594	43,133	46,204	196,931
Full Year 2018	1,115,837	559,633	420,836	2,096,306
Jan-19	111,971	47,081	50,383	209,435
Feb-19	91,915	41,185	35,315	168,415
Mar-19	79,384	45,232	31,900	156,516

Average Price US Densified Biomass Fuel

Month	East	South	West	US Total
Dec-17	\$161.05	\$121.24	\$170.00	\$152.22
Avg 2017	\$162.64	\$122.94	\$165.71	\$150.68
Jan-18	\$162.61	\$122.62	\$169.43	\$154.76
Feb-18	\$163.19	\$119.65	\$169.33	\$151.06
Mar-18	\$163.69	\$115.76	\$169.56	\$149.22
Apr-18	\$163.76	\$117.58	\$167.49	\$146.43
May-18	\$161.47	\$116.69	\$162.13	\$141.72
Jun-18	\$164.57	\$120.15	\$158.46	\$148.47
Jul-18	\$160.44	\$121.81	\$157.95	\$146.83
Aug-18	\$167.53	\$122.56	\$164.48	\$155.62
Sep-18	\$167.77	\$122.86	\$169.22	\$157.56
Oct-18	\$168.87	\$130.00	\$170.28	\$162.04
Nov-18	\$168.51	\$132.01	\$169.88	\$160.89
Dec-18	\$171.61	\$134.45	\$169.54	\$162.98
Avg 2018	\$165.34	\$123.01	\$166.48	\$153.13
Jan-19	\$171.54	\$132.75	\$168.82	\$162.17
Feb-19	\$179.36	\$131.65	\$169.41	\$165.61
Mar-19	\$179.68	\$125.50	\$169.49	\$161.93

Average Price Densified Biomass Fuel - Jan 17 - Mar 19
(USD per ton)
TOP OF SCALE: US\$190 per ton



Shows sales (tons) and average price (revenue per ton) of **primarily wood pellets** in the US domestic heating market for

the reporting month. Sales and average revenue per ton include **both retail and wholesale sales**.

SOURCE: U.S. Energy Information Administration Form EIA-63C, Densified Biomass Fuel Report

Export Volume and Average Price of Densified Biomass Fuel
Jan '17 to Mar '19



EXPORT VOLUME AND AVERAGE PRICE OF US WOOD PELLETS

March 2019

US export sales and average price (revenue per ton) of primarily **utility-grade pellets** to global markets.

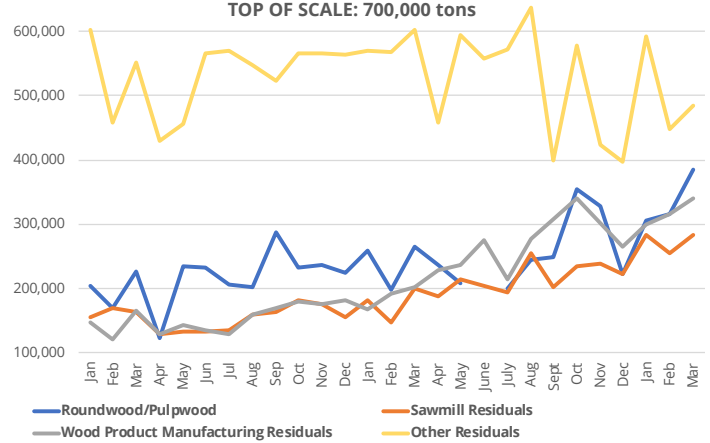
US BIOMASS FEEDSTOCK VOLUMES AND PRICES

March 2019

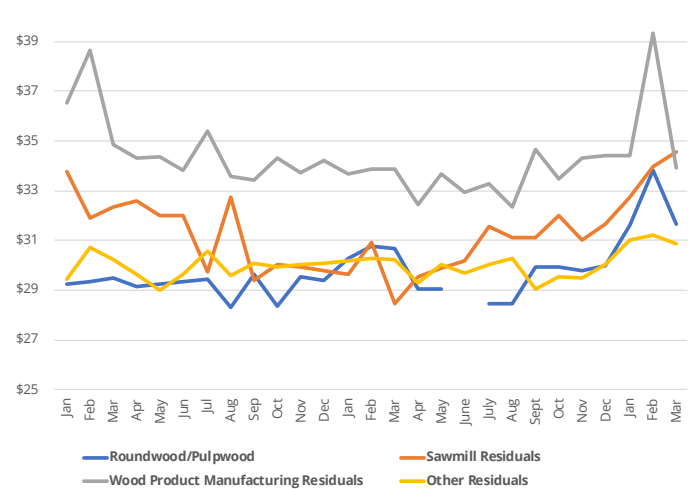
US Biomass Feedstock Volumes

Month	Roundwood/ Pulpwood	Sawmill Residuals	Wood Product Manufacturing Residuals	Other Residuals
Dec-17	223,932	156,219	181,645	563,963
Full Year 2017	2,581,271	1,860,717	1,836,938	6,399,323
Jan-18	259,705	181,471	168,427	569,367
Feb-18	198,400	147,497	191,406	567,836
Mar-18	266,155	200,928	203,328	603,329
Apr-18	236,396	187,520	228,479	458,389
May-18	208,029	205,039	236,239	594,663
Jun-18	-	195,977	275,486	557,412
Jul-18	200,926	181,498	215,122	572,826
Aug-18	245,730	255,340	277,670	636,205
Sep-18	248,150	188,941	320,465	398,551
Oct-18	354,141	234,600	336,712	577,959
Nov-18	328,940	239,303	298,144	423,519
Dec-18	223,481	223,160	266,110	397,483
Full Year 2018	2,770,053	2,441,274	3,017,588	6,357,539
Jan-19	306,407	283,494	299,831	593,160
Feb-19	315,780	254,604	254,604	448,674
Mar-19	386,012	283,540	340,964	484,608

US Biomass Feedstock Purchase Volumes, Jan 17 - Mar 19 (tons)



US Biomass Feedstock Cost, Jan 17 - Mar 19 (USD per ton)



US Biomass Feedstock Cost

Month	Roundwood/ Pulpwood	Sawmill Residuals	Wood Product Manufacturing Residuals	Other Residuals
Dec-17	\$29.41	\$29.77	\$34.24	\$30.09
Avg 2017	\$29.21	\$31.35	\$34.77	\$29.91
Jan-18	\$30.29	\$29.66	\$33.67	\$30.20
Feb-18	\$30.75	\$30.91	\$33.89	\$30.30
Mar-18	\$30.69	\$28.44	\$33.88	\$30.24
Apr-18	\$29.06	\$29.55	\$32.44	\$29.30
May-18	\$29.06	\$29.88	\$33.67	\$30.01
Jun-18	-	\$30.19	\$32.96	\$29.69
Jul-18	\$28.46	\$31.56	\$33.29	\$30.02
Aug-18	\$28.46	\$31.11	\$32.33	\$30.27
Sep-18	\$29.92	\$31.10	\$34.66	\$29.03
Oct-18	\$29.96	\$32.02	\$33.50	\$29.54
Nov-18	\$29.79	\$31.04	\$34.31	\$29.49
Dec-18	\$29.98	\$31.66	\$34.42	\$30.02
Avg 2018	\$29.67	\$30.59	\$33.59	\$29.84
Jan-19	\$31.63	\$32.78	\$34.41	\$31.00
Feb-19	\$33.83	\$33.97	\$39.32	\$31.20
Mar-19	\$31.65	\$34.57	\$33.90	\$30.87

Shows the feedstock purchases (tons) and average weighted cost (USD per ton) for four categories of raw materials:

roundwood timber, sawmill residue, wood product manufacturing residue, and other residuals.

Other residuals includes:

bark, logging residues, wood chips, post-consumer wood, unmerchantable wood, and other.

SOURCE: U.S. Energy Information Administration Form EIA-63C, Densified Biomass Fuel Report

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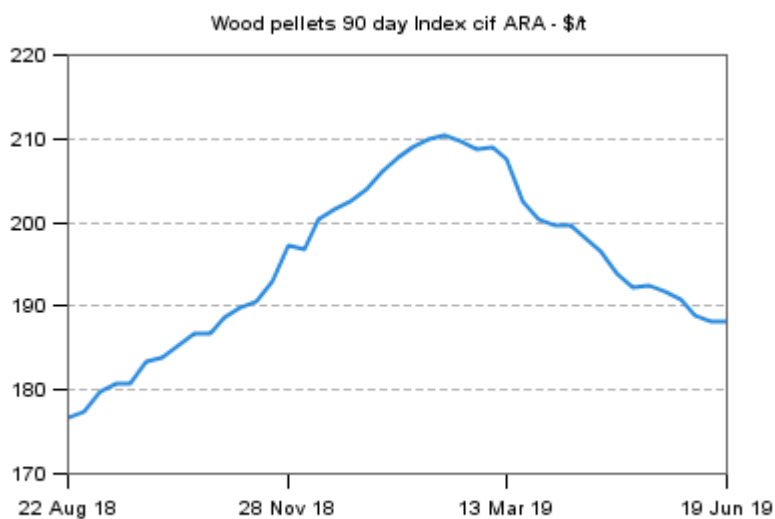
COMPETING HEATING FUEL PRICES USA AND CANADA

April 2018 – June 2019

	Fuel Type	US\$/GJ	US\$/MWh	Date
NEW HAMPSHIRE	Natural Gas 1st tier	\$10.48	\$37.74	June 6, 2019
	Fuel Oil (#2)	\$24.99	\$89.98	
	Propane	\$37.04	\$133.35	
	Kerosene	\$30.38	\$109.36	
	Electricity - Resistance Heat	\$47.57	\$171.26	
	Electricity - Air Source Heat Pump	\$19.03	\$68.52	
	Heating Pellets NH	\$20.78	\$74.83	
MAINE	Cord Wood	\$11.85	\$42.65	May 6, 2019
	Natural Gas (Avg)	\$14.73	\$53.02	
	Heating Oil	\$19.54	\$70.35	
	Propane	\$28.33	\$101.98	
	Kerosene	\$24.29	\$87.44	
	Wood Pellets	\$15.39	\$55.41	
BOSTON, MA	Electricity (Residential)	\$87.56	\$315.20	April 2018; tax not incl
NASHVILLE, TN	Electricity (Residential)	\$43.14	\$155.30	
MIAMI, FL	Electricity (Residential)	\$34.75	\$125.10	
HOUSTON, TX	Electricity (Residential)	\$38.20	\$137.50	
PORTLAND, OR	Electricity (Residential)	\$38.86	\$139.90	
	Fuel Type	C\$/GJ	C\$/MWh	Date
CANADA (Federal)	Furnace Oil	\$34.37	\$123.72	June 18, 2019; incl tax
	Diesel	\$40.41	\$145.46	
	Auto Propane	\$41.25	\$148.47	April 2018; tax not incl
	Electricity (Residential - Avg of 12 Major Canadian Cities)	\$36.54	\$131.53	
QUEBEC	Furnace Oil	\$32.41	\$116.66	June 18, 2019; incl tax
	Diesel	\$42.79	\$154.02	
	Auto Propane	\$37.13	\$133.67	April 2018; tax not incl
	Electricity (Residential)	\$19.81	\$71.30	
VANCOUVER, BC	Furnace Oil	\$40.17	\$144.60	May 14, 2019; incl tax
	Diesel	\$46.79	\$168.45	
	Auto Propane	\$40.54	\$145.93	April 2018; tax not incl
	Electricity (Residential)	\$31.72	\$114.20	

ARGUS WOOD PELLET INDEX: JUNE 2019

Argus® Wood Pellets cif ARA Index



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EIA REPORT FORECASTS FURTHER GROWTH IN BIOMASS POWER

MADISON'S PELLET REPORT



Publisher **KetaDesign Productions**
 Editor and Market Analyst **Earl Heath**
 Production **Pauline Petit**



Annual Subscription **US\$989**

Discounts for multiple subscriptions
 Published 11 times a year



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 ISSN pending

Published in Canada ©2019

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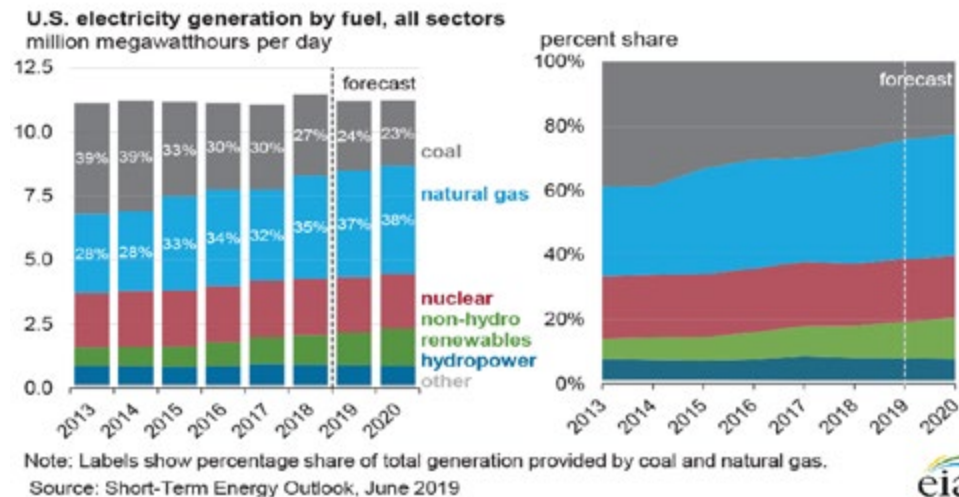


The latest Short-Term Energy Outlook from the US Energy Information Administration (EIA) predicts energy provided by nonhydropower renewable sources will continue to increase in the remainder of 2019 and into 2020. Non-hydropower renewables, including biomass, provided 10 per cent of electricity generation in the US in 2018, with that proportion expected to rise to 11 per cent in 2019 and 13 per cent in 2020.

While the vast majority of pellets produced in the US are exported to energy markets in the United Kingdom and other European countries, in 2018 wood biomass was used to generate 113,000 MWh of electricity per day in the US. Electricity production from wood biomass is expected to be flat this year at 113,000 MWh per day before increasing in 2020 to 115,000 MWh per

day. Wood biomass consumption appears to be in a downward trend, decreasing from 2.357 quadrillion Btu (quad) in 2018 to an anticipated 2.238 quad in 2019 and 2.205 quad next year. Biomass capacity in the electric power sector is expected to follow a similarly decreasing pattern in the near future, with capacity dropping from 7,151 MW in 2018 to a projected 7,071 MW in 2019 before falling further to 7,052 MW in 2020. Biomass electricity generation in the electric power sector has a more stable forecast for the next two years. After producing 86,000 MWh per day in 2018, biomass is anticipated to decrease to 85,000 MWh per day in 2019 before climbing back up to 86,000 MWh per day in 2020. The EIA Short-Term Energy Outlook report can be found [here](#).

By Earl Heath



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Former Sawmill in BC to Become Pellet Plant

A former sawmill in McBride, BC, is expected to be converted into a wood pellet plant by Boreal BioEnergy, a BC-based forestry company. Boreal purchased the site, on which a shuttered sawmill has sat for 13 years, and began building the new biomass facility, with the company now into the engineering and civil works phase of the plan. Construction is slated to start in early 2020 and production should begin late next year. Projected production capacity is expected to be 250,000 tonnes of black pellets per year, with the operation creating 50 to 60 jobs in the region. Production is destined for export to the Japanese market, with the first shipment scheduled to arrive in 2021. Boreal BioEnergy is also looking at developing more pellet facilities at old sawmill sites in Fort Nelson, BC, and Fort St. John, BC, with pre-engineering phases anticipated to be underway at both of those plants by this fall.

Pellet Mill Plans for Port Alice

Alberta-based Arterran Renewables expressed interest in putting a modular pellet plant on the site of a shuttered pulp mill in Port Alice, BC. The site, near Port Alice's deep water port on Vancouver Island, will allow Arterran to use existing buildings for storage and conveyor belts and docks for transport. Feedstock in the form of logging residuals is plentiful in the region, and the location provides ready access to countries such as Japan and China looking to replace coal and nuclear energy with densified biomass. Arterran uses a low temperature, low pressure catalytic process resulting in biomass with a higher mass and energy potential than coal, effectively making it cleaner burning. The product has been validated by multiple third party testing labs, while the company has received the Startup Canada Award for sustainable development and been nominated for the Governor General's Innovation Award. Arterran is still in the early stages of planning and development for this project and is optimistic about using their own

equity to start a modular pilot plant at Port Alice when all the necessary stakeholders are satisfied.

Sawmill to Provide More Feedstock for Pellet Plant

A new LaSalle Lumber Co. LLC sawmill in Urania, LA, commenced full commercial operations on May 29th, and will begin providing residual wood waste from its operations to Drax's adjacent LaSalle Bioenergy pellet plant. The new facility is a joint venture between Louisiana-based Hunt Forest Products and British Columbia-based Tolko Industries. Roughly 850,000 tons of wood will be consumed by the mill annually, with yearly production capacity expected to reach 200 million board feet. Wood waste from lumber manufacturing will be densified into wood pellets at the adjacent Drax Biomass facility, which will then be transported to the Port of Greater Baton Rouge to be shipped to Drax's biomass power facilities in the United Kingdom.

Terrace Pellet Plant Damaged by Fire

An early morning fire on May 25th has prompted an investigation at the new Skeena BioEnergy pellet plant in Terrace, BC. Safety monitoring equipment detected a small fire in the mill's flatted dryer at 2:12 a.m. that was quickly extinguished. Damages to the dryer area are expected to delay production for an estimated three weeks while the required parts are delivered and replaced. One employee was taken to hospital for observation but was discharged and returned to work. The adjacent Skeena Sawmills facility was not impacted by the blaze and continued regular operations.

Amended Biomass-Friendly Bill Passed in New Hampshire

New Hampshire's six biomass power plants will receive support from a bill amendment recently passed in the state's Senate. The bill, initially passed last year before

being vetoed, requires electrical power distribution companies to purchase energy from the state's biomass and waste-to-energy facilities via mandated, three-year contracts. New Hampshire's legislature overrode the veto last September, but implementation of the law has been delayed by litigation at the Federal Energy Regulatory Commission and by challenges from the state's Public Utilities Commission. To avoid economic shutdowns of biomass energy plants that could cripple the industry, a bipartisan coalition of state senators offered an amendment to the bill that creates a baseload renewable energy credit to benefit biomass energy producers. The aim is to get the plants back on-line with alacrity, providing 100 MW of energy to New Hampshire's power grid, creating and preserving jobs in the sector, and providing the state's forest industry with a welcome stream by which to dispose of forest- and mill-waste residuals.

Coal Ban Will Require Finland to Import Biomass

In February of this year Finland approved a measure to ban the use of coal to produce energy by May 2029. As coal currently provides roughly 20 per cent of the country's energy for residential heating, the anticipated 70 per cent rise in demand for biomass fuel as Finland transitions cannot be met by waste residues produced by local forest operations alone. Estimates indicate that biomass energy production will rise from the current level of 38 TWh to 64 TWh in 2030, while domestic supply of biomass is expected to grow by only 8 TWh in the interim. That gap in supply will likely be filled by import volumes of wood pellets, most of which currently come from Russia. According to Statistics Canada the two countries have no established trading history in biomass.

ENVIVA REFINES FEEDSTOCK POLICY

Maryland-based Enviva, the largest industrial wood pellet manufacturer in the world, recently launched a refined global sourcing policy for its biomass feedstock. Following a two-year partnership with Earthworm Foundation, a non-profit company that helps businesses reform their supply chains, Enviva has committed to a number of modifications to its sourcing policy that aim to enhance sustainability and improve environmental performance.

Enviva currently owns and operates seven pellet facilities in the Southeastern United States which source feedstock from a variety of regional forestlands, much of which is a mix of hardwoods and softwoods that critics claim are critical for wildlife habitat and as carbon sinks. The company's updated policy commits to reforestation not only at the tract level but at the landscape level as well. Enviva also added to their pledge to avoid harvesting trees from high conservation value (HCV) bottomland forests a provision to avoid harvesting in certain upland HCV forests too. The company is also developing a satellite-based monitoring system to help third-party auditors collect and verify harvest data submitted by

¹ [Source](#)

landowners. These initiatives are in addition to Enviva partnering with the Alabama-based non-profit Longleaf Alliance to restore longleaf pine forest areas surrounding its pellet plants. Through this partnership the company can provide a crucial market for landowners attempting to restore longleaf savannah forestlands, paying them to clear hardwood undergrowth that can cost a landowner hundreds of dollars per acre to try and control with herbicide, fire, or by mulching and leaving the fibre on site¹.

Critics continue to question the legitimacy of Enviva's statement of carbon neutrality as it manufactures more than 3 million metric tons of wood pellets per year and offsets the burning of this biomass for energy by reforesting vast areas of the Southeastern United States. While the debate rages on, increasing numbers of coal-fired power plants in Europe and Asia are being converted to biomass under the assumption that the cradle-to-gate carbon output of burning wood pellets is less environmentally damaging than extracting and burning coal.

By Earl Heath



[Source](#)

US PRODUCTION OF WOOD PELLETS, VOLUMES: MAR 2019

Wood Pellets, Premium/Standard

Month	East	South	West	US Total
Full 2017	790,012	267,559	405,218	1,462,787
May-18	81,480	21,488	29,464	132,432
Jun-18	90,151	21,529	33,588	145,268
Jul-18	82,500	13,573	30,137	126,210
Aug-18	97,558	28,095	35,859	161,512
Sep-18	93,055	27,453	31,677	152,185
Oct-18	110,045	27,397	37,863	174,077
Nov-18	93,476	19,687	35,990	146,968
Dec-18	83,554	19,273	33,422	136,249
Full 2018	1,017,592	252,558	392,751	1,659,488
Jan-19	94,063	25,889	33,476	153,428
Feb-19	88,803	20,008	29,275	138,086
Mar-19	86,497	19,941	35,008	141,446

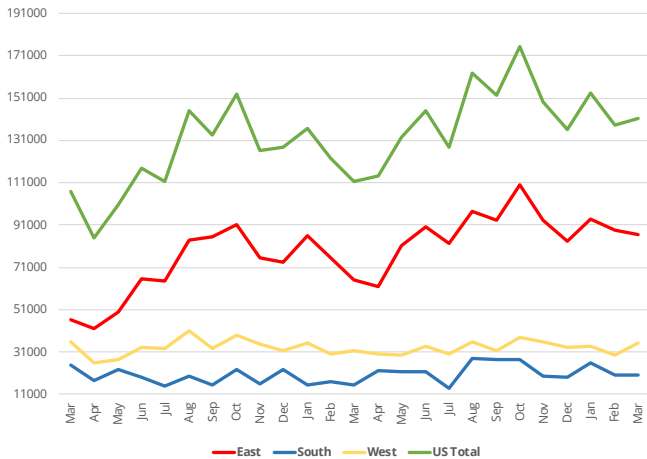
Tons of wood fuel products manufactured in each region during the reporting month for three categories: **wood pellets, PFI certified; wood pellets, not certified; and wood pellets, utility.** (Non-certified pellets are those that did not have the official PFI certification)
Included in wood pellets: PFI certified and not certified categories are premium, super-premium, and standard pellets. These pellet types are primarily used for heating residences and schools. Utility-grade pellets are generally used for electrical power generation and include both those with and without certifications.

SOURCE: [US Energy Information Administration](#)

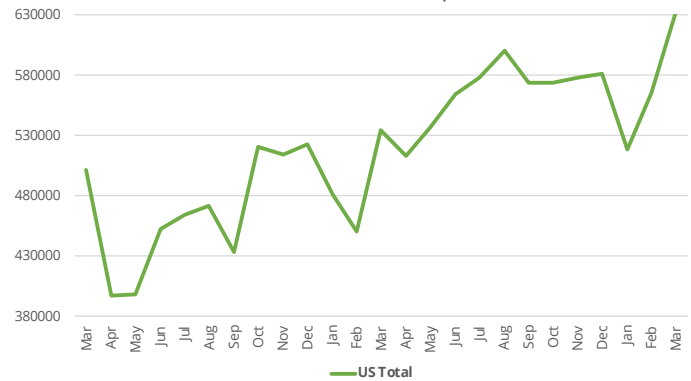
Wood Pellets Utility

Month	South	US Total
Full 2017	5,539,954	5,539,954
May-18	534,145	534,145
Jun-18	558,903	558,903
Jul-18	574,155	574,155
Aug-18	601,728	601,728
Sep-18	573,954	573,954
Oct-18	571,430	571,430
Nov-18	578,295	578,295
Dec-18	580,898	580,898
Full 2018	6,552,588	6,552,588
Jan-19	519,060	519,060
Feb-19	565,496	565,496
Mar-19	631,166	631,166

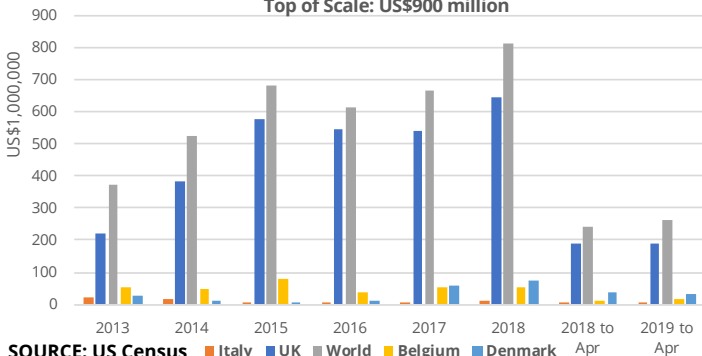
US Production of Wood Pellets, Premium/Standard Mar '17 - Mar '19
TOP OF SCALE: 191,000 tons



US Production of Wood Pellets, Utility: Jan '17 - Mar '19 (tons)
TOP OF SCALE: 630,000 tons

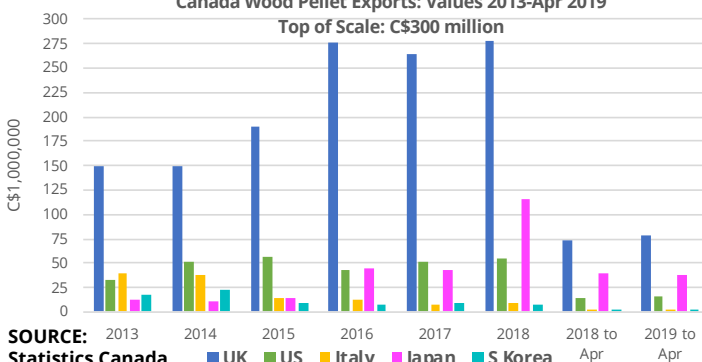


US Wood Pellet Exports: Values 2013-Apr 2019
Top of Scale: US\$900 million



SOURCE: US Census

Canada Wood Pellet Exports: Values 2013-Apr 2019
Top of Scale: C\$300 million



SOURCE: Statistics Canada

NORTH AMERICA VALUES OF WOOD PELLET EXPORTS Apr 2019

US Wood Pellet Exports: Values 2013 to APR 2018

US\$1,000,000	China	Italy	Belgium	UK	World
2014	0.00	18.36	50.53	384.89	522.41
2015	0.05	0.36	78.00	578.77	682.98
2016	0.02	0.01	37.69	546.77	612.47
2017		5.63	51.15	539.21	666.54
2018		10.87	51.41	645.96	811.87
2018 to Apr		1.33	11.46	187.56	243.40
2019 to Apr		7.17	17.08	192.10	263.17
		Apr 2019/2018	2%	8%	

Canada Wood Pellet Exports: Values 2013 to APR 2018

C\$1,000,000	S Korea	US	Italy	Japan	UK	World
2014	22	51	39	11	150	276
2015	8.34	57.20	14.71	13.76	190.29	284.70
2016	7.967	43.41	12.62	45.43	276.16	409.56
2017	9.47	51.06	7.36	42.67	265.09	396.68
2018	8.27	54.07	9.28	115.63	277.84	489.50
2018 to Apr	1.96	13.53	1.83	40.03	72.55	130.09
2019 to Apr	0.86	16.62	1.95	37.64	79.29	138.87
Apr 2019/'18	-127%	19%	6%	-6%	9%	6%

Domestic exports - Wood and articles of wood; wood charcoal
HS 440131 Wood pellets, agglomerated

UNIT CONVERSIONS

Typical Heat Values and Densities of Certain Fuels

Fuel	Unit of Measurement	GJ	MWh	toe	t/m ³ (or t/m ^{3l} v)
Crude oil	tonne	41,868	11.63	1.00	0.855
Heavy fuel oil normal/low sulphur	tonne	40.60/41.10	11,278/11,417	0.970/0.982	0.955
Light fuel oil	tonne	42.50	11,806	1.015	0.845
Diesel oil	tonne	41.50	11,528	0.991	0.845
Liquid oils	tonne	46.30	12,861	1.106	0.580
Coal	tonne	25,211	7,003	0.602	0.800
Coke	tonne	29.30	8,139	0.700	0.750
Natural gas (OoC)	1,000 m ³	36.00	10,00	0.860	0.732
Blast furnace gas	1,000 m ³	3.79	1,053	0.091	
Coke oven gas	1,000 m ³	16.70	4,639	0.399	
Black liquor	DT	11.70	3,250	0.279	1.415
Birch chip (log)	m ^{3st}	5.40	1.50	0.129	0.400
Mixed chip (log)	m ^{3st}	4.51	1.25	0.107	0.350
Fuel chip	m ^{3l} v	2.88	0.80	0.069	0.300
Saw dust	m ^{3l} v	2.16	0.60	0.052	0.300
Wood shavings	m ^{3l} v	1.80	0.50	0.043	0.100
Conifer bark	m ^{3l} v	2.16	0.60	0.052	0.300
Birch bark	m ^{3l} v	2.52	0.70	0.060	0.350
Wood pellet	tonne	16.92	4.70	0.404	0.690
Sod peat	m ^{3l} v	5.04	1.40	0.120	0.380
Milled peat	m ^{3l} v	3.24	0.90	0.077	0.320
Biogas	m ³ gas	14.4 - 28.8	4 - 8	0.344 - 0.688	

SOURCE: Energy statistics (KTM) and VTT Energia <http://www.bioenergyadvice.com/facts/conversion-factors/>

	toe	MWh	GJ	Gcal
toe	1	11,630	41,868	10.0
MWh	0.08598	1	3.6	0.86
GJ	0.02388	0.2778	1	0.2388
Gcal	0.1	1.1630	4,1868	1

Feature	Chips from lopped poles	Wood pellet	Wood briquette	Sod peat	Oat	Fuel oil
Moisture content %	25-30	8-10	8-10	25-40	14	
Bulk density (kg/m ³ v)	250-320	600-650	600-650	350-400	520-590	0.845
Energy density (kWh/m ³ v)	700-900	2,900-3,900	2,900-3400	1,400	2,200-2,500	10,000 (kWh/m ³)
Ash content	0.5-2.0	0.5	0.5	4.0-6.0	5.0-7.0	+/-0

Comparison of key specifications of properties for selected woody solid biofuels and fossil fuels

Fuel Type	Density* (kg/m ³)	Density* (lb/ft ³)	High heating value by mass (MJ/kg)	High heating value by mass (Btu/lb)	Solid Biofuels	Amount of Fuel (metric tonnes/year)
Wood chips (about 45% moisture, loosely packed)	300-400	19-25	10-11	4,300-4,700	Boiler efficiency	70% 85%
Firewood (stacked; air dry to about 25% moisture)	300-500	19-31	14-15	6,200-6,500	Wood pellets (A2 - M10)	280 230
Wood pellets (≤10% moisture) density about 650-700 kg/m ³	550-800	34-50	18-20	7,700-8,500	Wood chips (A2 - M35)	395 325
Heating oil (No.2)	850	53	42	18,000	Wood chips (B1 - M50)	500 410
Propane Liquid Petroleum Gas	1.7	0.12	50	21,500	annual fuel amounts as a function of solid biofuels, moisture content and boiler efficiency	
Natural Gas	0.7-0.9	0.04-0.06	43	19,500		

* Bulk density is typically used for solid biofuels while density is used for gaseous and liquid fossil fuel

UNIT CONVERSIONS

Conversion Factors for Different Energy Sources

Comparing and understanding the energy content of different fuels is difficult, but converting them into kilowatt-hours makes the process easier. It is wide to compare different fuels, because comparing makes you understand the heating value of firewood and its potential as a source of energy. Biofuels are potential replacements for oil because of their cost - and energy - efficiency.

In the table below, biofuels are compared with other energy sources. The conversion factors are approximate average numbers, since the energy-efficiency of biofuels varies along with the quality of the biomass.

1,000 litres fuel oil / 10,000 kWh

2,100 kg pellet

12.5 m³ wood chips

6 stacked cubic metres of birch

Using the table above, it can be calculated that, for example, the energy of one stacked cubic metre of dry birch chips equals approximately the energy of 170 litres of fuel oil. That is 1,700 kWh

[SOURCE](#)

Btu Content of Common Energy Units

1 barrel (42 gallons) of crude oil = 5,800,00 Btu

1 gallon of gasoline = 124,000 Btu (based on US consumption, 2008)

1 gallon of diesel fuel = 139,000 Btu

1 gallon of heating oil = 139,000 Btu

1 barrel of residual fuel oil = 6,287,000 Btu

1 cubic foot of natural gas = 1,028 Btu (based on US consumption, 2008)

1 gallon of propane = 91,000 Btu

1 short ton of coal = 19,988,000 Btu (based on US consumption, 2008)

1 kilowatthour of electricity = 3,412 Btu

[SOURCE](#)

1 \$/MWh, \$ per megawatthour

1 \$/MWh = 2.77777×10^{-10} \$/J

1 \$/MWh = 2.77777×10^{-7} \$/kJ

1 \$/MWh = 0.00027777777777778 \$/MJ

1 \$/MWh = 0.2777777777778 \$/GJ

1 \$/MWh = 2.93071×10^{-7} \$/BTU

1 \$/MWh = 1.16222×10^{-9} \$/cal

1 \$/MWh = 1.16222×10^{-6} \$/kcal

1 \$/MWh = 4.45053×10^{-29} \$/eV

1 \$/MWh = 1×10^{-6} \$/Wh

1 \$/MWh = 0.001 \$/kWh

[SOURCE](#)

Volume

1 full cord = 128 ft³

1 cubic metre = 35.3 cubic feet

1,000 litre (lt) = 1 m³

Fuel Equivalents

1,000 litre (lt) heating oil equivalent (in energy basis)

~ **5-8 m³** dry stacked firewood (M 20%)

10-12 m³ wood chips (M 45%, loosely stored)

~ **2 metric tonne** (or ~ 3 m³) wood pellet

Weight

Metric ton (t) = tonne = 1,000 kilograms = 2,205 lb

Imperial or Long ton (lt) = 1,016 kilograms = 2,240 lb

Short (US) ton (st) = 907 kilograms = 2,000 lb

From **long ton** to **metric ton** multiply by 1.016

From **short ton** to **metric ton** multiply by 0.9072

Energy and Density

From **MJ/kg** to **kWh/kg** multiply MJ/kg by 0.2778

From **MJ/kg** to **BTU/lb** multiply MJ/kg by 430

From **BTU/lb** to **MJ/kg** multiply Btu/lb by 0.002326

From **MJ/m³** to **BTU/ft³** multiply MJ/m³ by 26.84

From **BTU/ft³** to **MJ/m³** multiply Btu/ft³ by 0.0373

Common energy units (Scientific notation)

British thermal unit (Btu) 1.0

Millions of Btu 1.0E+06 Btu

Therm 1.0E+05 Btu

Billions of Btu 1.0E+09 Btu

Quad 1.0E+15 Btu

Calorie 1.0 Calorie

Kilocalorie 1.0E+03 Calories

Food calorie 1.0E+03 Calories

Thermie 1.0E+05 Calories

Teracalorie 1.0E+12 Calories

Megajoule 1.0E+06 Joule

Joule 1.0 Joule

Gigajoule 1.0E+09 Joule

Terajoule 1.0E+12 Joule

Watthour 1.0

Kilowatthour (kWh) 1.0E+03 watthour

Megawatthour (MWh) 1.0E+06 watthour

Gigawatthour (GWh) 1.0E+09 watthour

Terawatthour (tWh) 1.0E+12 watthour

[SOURCE](#)

UNITS AND CONVERSIONS FOR VARIOUS ENERGY MASSES AND DENSITIES