

---

## **Appendix B6**

### Additional Air Quality and Greenhouse Gas Emissions Considerations Supporting Calculations



**Table A. Emissions from Combustion of Wood Pellets**

**Emission Factors based on EPA AP-42 Emission Factors for Wood Residue Combustion in Boilers**

Wood Pellet Throughput	Wood Pellet Density <sup>a</sup>			Wood Pellet Heating Value <sup>b</sup>					
	(US Tons/yr)	(kg/m <sup>3</sup> )	(lb/kg)	(lb/m <sup>3</sup> )	(GJ/m <sup>3</sup> )	(J/GJ)	(J/Btu)	(Btu/lb)	(MMBtu/lb)
1,102,311	625	2.205	1378.13	11	1.00E+09	1055	7.57E+03	7.57E-03	15.13

  

Criteria Air Pollutants	Emission Factors (AP-42) <sup>c</sup>	100% Throughput	
		Criteria Air Pollutant Emissions (E=Fuel Throughput x HHV x EF)	
VOC	0.017 lb/MMBtu <sup>d</sup>	2.84E+05 lbs/year	<b>141.78</b> tons/yr
NOx	0.22 lb/MMBtu <sup>e</sup>	3.67E+06 lbs/year	<b>1,834.76</b> tons/yr
SO <sub>2</sub>	0.025 lb/MMBtu <sup>e</sup>	4.17E+05 lbs/year	<b>208.50</b> tons/yr
CO	0.75 lb/MMBtu <sup>e</sup>	1.25E+07 lbs/year	<b>6,254.85</b> tons/yr
PM <sub>10</sub>	0.27 lb/MMBtu <sup>f</sup>	4.50E+06 lbs/year	<b>2,251.75</b> tons/yr
PM <sub>2.5</sub>	0.16 lb/MMBtu <sup>f</sup>	2.67E+06 lbs/year	<b>1,334.37</b> tons/yr

  

GHG Constituents	Emission Factors (AP-42) <sup>c</sup>	GHG Emissions (E=Fuel Throughput x HHV x EF2)	
		CO <sub>2</sub>	195 lb/MMBtu <sup>g</sup>
CH <sub>4</sub> <sup>g</sup>	7.2 g/MMBtu	1.20E+08 g/year	1.20E+02 Metric Tons/yr
N <sub>2</sub> O <sup>g</sup>	3.6 g/MMBtu	6.00E+07 g/year	6.00E+01 Metric Tons/yr
		<b>CO<sub>2e</sub></b>	<b>1,495,920.34 Metric Tons/yr</b>

<sup>a</sup> Pellet Plant Handbook: The Physical Characteristics of Wood Pellet, <http://www.biomass-energy.org/blog/the-physical-characteristics-of-wood-pellet.html>

<sup>b</sup> What is a Biomass Wood Pellet, Drax, <https://www.drax.com/sustainable-bioenergy/what-is-a-biomass-wood-pellet/>

<sup>c</sup> EPA AP 42, Section 1.6 Wood Residue Combustion in Boilers [https://www.epa.gov/system/files/documents/2022-03/c1s6\\_final\\_0.pdf](https://www.epa.gov/system/files/documents/2022-03/c1s6_final_0.pdf)

<sup>d</sup> EPA AP 42, VOC Emission Factor from Table 1.6-3

<sup>e</sup> EPA AP 42, Emission Factors from Table 1.6-2 for Industrial wood-fired boilers

<sup>f</sup> EPA AP 42, Emission Factors from Table 1.6-1 for Dry wood with Mechanical Collector PM Control Device

<sup>g</sup> Based on GHG Emissions based on EPA Methodology and Wood Pellet Heat Content<sup>a</sup>

**Table B. Emissions from Combustion of Coal**

Wood Pellet Throughput (US Tons/yr)	Wood Pellet GJ/ton	Wood Pellet Energy GJ/year	Coal Energy GJ/ton	Coal Throughput Equivalent US Tons/year
1,102,311	17	18,739,286.92	19.00	986,278.26

**Emission Factors based on EPA AP-42 Emission Factors for Anthracite Coal Combustion**

100% Throughput (US Tons/yr)	10% throughput (US Tons/yr)	25% throughput (US Tons/yr)	50% throughput (US Tons/yr)
986,278	98,627.83	246,569.56	493,139.13

Criteria Air Pollutants	Emission Factors (AP-42) <sup>a</sup>	Criteria Air Pollutant Emissions
		100% Throughput
TOC	0.3 lb/ton	147.94 tons/yr
NOx	9 lb/ton	4,438.25 tons/yr
SO <sub>2</sub>	23.4 lb/ton <sup>b</sup>	11,539.46 tons/yr
CO	0.6 lb/ton	295.88 tons/yr
PM <sub>10</sub>	8 lb/ton <sup>c</sup>	3,945.11 tons/yr
PM <sub>2.5</sub>	8 lb/ton	3,945.11 tons/yr

GHG Constituents	Emission Factors (AP-42) <sup>a</sup>	GHG Emissions
CO <sub>2</sub>	5680 lb/ton	2,801,030.25 tons/yr
		2,541,051.90 MT CO <sub>2</sub> e/yr

<sup>a</sup> EPA AP-42, Emission Factors for Anthracite Coal Combustion, Stoker-fired boilers. [https://www.epa.gov/sites/default/files/2020-09/documents/1.2\\_anthracite\\_coal\\_combustion.pdf](https://www.epa.gov/sites/default/files/2020-09/documents/1.2_anthracite_coal_combustion.pdf)

<sup>b</sup> EPA AP-42, Assumes a 0.6% sulfur content

<sup>c</sup> EPA AP-42, Assumes a 10% ash content

**Table A. Emissions from Combustion of Wood Pellets**

**Criteria Air Pollutants based on Washington Department of Natural Resources**

Wood Pellet Throughput (US Tons/yr)	Wood Pellet Density <sup>a</sup>			Wood Pellet Heating Value <sup>b</sup>					
	(kg/m <sup>3</sup> )	(lb/kg)	(lb/m <sup>3</sup> )	(GJ/m <sup>3</sup> )	(J/GJ)	(J/Btu)	(Btu/lb)	(MMBtu/lb)	(MMBtu/US Tons)
1,102,311	625	2.205	1378.13	11	1.00E+09	1055	7.57E+03	7.57E-03	15.13

**Washington State Department of Natural Resources Emission Factors**

Criteria Air Pollutants	Emission Factors (Washington) <sup>c</sup>	100% Throughput	
		Criteria Air Pollutant Emissions (E=Fuel Throughput x HHV x EF)	
VOC	0.0052 lb/MMBtu	8.67E+04 lbs/year	<b>43.37</b> tons/yr
NOx	0.1 lb/MMBtu	1.67E+06 lbs/year	<b>833.98</b> tons/yr
SO <sub>2</sub>	0.025 lb/MMBtu	4.17E+05 lbs/year	<b>208.50</b> tons/yr
CO	0.35 lb/MMBtu	5.84E+06 lbs/year	<b>2,918.93</b> tons/yr
PM <sub>10</sub>	0.02 lb/MMBtu <sup>d</sup>	3.34E+05 lbs/year	<b>166.80</b> tons/yr
PM <sub>10</sub>	0.01 lb/MMBtu <sup>d</sup>	1.67E+05 lbs/year	<b>83.40</b> tons/yr
PM <sub>2.5</sub>	0.02 lb/MMBtu <sup>d</sup>	3.34E+05 lbs/year	<b>166.80</b> tons/yr
PM <sub>2.5</sub>	0.01 lb/MMBtu <sup>d</sup>	1.67E+05 lbs/year	<b>83.40</b> tons/yr
<b>GHGs</b>	<b>Emission Factors (Washington)<sup>c</sup></b>	<b>GHG Emissions (E=Fuel Throughput x HHV x EF)</b>	
CO <sub>2</sub> e	211.39 lb/MMBtu	3.53E+09 lbs/year	1,762,950.80 tons/yr
			<b>1,599,322.06</b> MT/year

<sup>a</sup> Pellet Plant Handbook: The Physical Characteristics of Wood Pellet, <http://www.biomass-energy.org/blog/the-physical-characteristics-of-wood-pellet.html>

<sup>b</sup> What is a Biomass Wood Pellet, Drax, <https://www.drax.com/sustainable-bioenergy/what-is-a-biomass-wood-pellet/>

<sup>c</sup> Washington State Department of Natural Resources, Forest Biomass and Air Emissions, Table 2 Controlled Emissions Comparison [https://www.dnr.wa.gov/Publications/em\\_forest\\_biomass\\_and\\_air\\_emissions\\_factsheet\\_7.pdf](https://www.dnr.wa.gov/Publications/em_forest_biomass_and_air_emissions_factsheet_7.pdf)

<sup>d</sup> Range of emission factors

**Table B. Emissions from Combustion of Coal**

Wood Pellet Throughput (US Tons/yr)	Wood Pellet GJ/ton	Wood Pellet Energy GJ/year	Coal Energy GJ/ton	Coal Energy MMBtu/ton	Coal Throughput Equivalent US Tons/year	1 GJ = 0.9478 MMBtu
1,102,311	17	18,739,286.92	19.00	20.05	986,278.26	

**Washington State Department of Natural Resources Emission Factors**

<u>100% Throughput</u> (US Tons/yr)	<u>10% throughput</u> (US Tons/yr)	<u>25% throughput</u> (US Tons/yr)	<u>50% throughput</u> (US Tons/yr)
986,278	98,627.83	246,569.56	493,139.13

Criteria Air Pollutants	Emission Factors (Washington) <sup>a</sup>	Criteria Air Pollutant Emissions	
		100% Throughput	
VOC	0.003 lb/MMBtu	29.66	tons/yr
NOx	0.07 lb/MMBtu <sup>b</sup>	691.98	tons/yr
NOx	0.38 lb/MMBtu <sup>b</sup>	3,756.49	tons/yr
SO <sub>2</sub>	0.044 lb/MMBtu <sup>b</sup>	434.96	tons/yr
SO <sub>2</sub>	0.18 lb/MMBtu <sup>b</sup>	1,779.39	tons/yr
CO	0.025 lb/MMBtu	247.14	tons/yr
PM <sub>10</sub>	0.0009 lb/MMBtu <sup>b</sup>	8.90	tons/yr
PM <sub>10</sub>	0.02 lb/MMBtu <sup>b</sup>	197.71	tons/yr
PM <sub>2.5</sub>	0.0009 lb/MMBtu <sup>b</sup>	8.90	tons/yr
PM <sub>2.5</sub>	0.02 lb/MMBtu <sup>b</sup>	197.71	tons/yr

GHGs	Emission Factors (Washington) <sup>c</sup>	GHG Emissions (E=Fuel Throughput x HHV x EF)	
CO <sub>2e</sub>	214.91 lb/MMBtu	2,374,432.76	tons/yr
			<b>2,154,049.16 MT/year</b>

<sup>a</sup> Washington State Department of Natural Resources, Forest Biomass and Air Emissions, Table 2 Controlled Emissions Comparison [https://www.dnr.wa.gov/Publications/em\\_forest\\_biomass\\_and\\_air\\_emissions\\_factsheet\\_7.pdf](https://www.dnr.wa.gov/Publications/em_forest_biomass_and_air_emissions_factsheet_7.pdf)

<sup>b</sup> Range of emission factors

**Coal v Wood Pellets**  
**Applying the Wang 2016 Lifecycle Calculations**

	Wood Pellet Throughput (US Tons/yr)	Wood Pellet GJ/ton	Wood Pellet Energy GJ/year	Coal Energy GJ/ton	Coal Throughput Equivalent US Tons/year	Estimated Emissions											Estimated Emissions														
	Throughput (Tons)					Emission Factors							Grams							MT			Tons								
						GHG	CO	NOx	SO2	PM	PM2.5	GHG	CO	NOx	SO2	PM	PM2.5	GHG	CO	NOx	SO2	PM	PM2.5	GHG	CO	NOx	SO2	PM	PM2.5		
	1,102,311	17	18,739,286.92	19.00	986,278.26																										
<b>Production</b>																															
Wood Pellet	1,102,311		137531	204								151,801,933,453	224,871,443	763,799,209	881,848,796	271,168,595	122,356,520							151,801.93	248	841	972	299	135		
Coal	986,278		866001	139								854,117,858,300	137,092,678	513,850,973	4,231,133,730	1,203,259,476	737,736,137							854,117.96	151	566	4,864	1,326	613		
<b>Net Change (Wood-Coal)</b>												(702,516,024,846)	87,778,765	248,948,236	(3,349,284,934)	(932,090,971)	(615,379,617)							(702,516.02)	97	274	(3,692)	(1,027)	(678)		
<b>Transportation</b>																															
Wood Pellet	1,102,311		15617	18								17,214,790,809	19,841,598	6,613,866	8,818,488	3,306,933	3,306,933							17,214.79	22	7	10	4	4		
Coal	986,278		60975	223								60,138,316,823	219,940,052	618,396,468	154,845,687	71,012,035	15,780,452							60,138.32	242	682	171	78	17		
<b>Net Change (Wood-Coal)</b>												(42,923,526,014)	(200,098,454)	(611,782,602)	(146,027,199)	(67,705,102)	(12,473,519)							(42,923.53)	(221)	(674)	(161)	(75)	(14)		
<b>Heat Generation</b>																															
Wood Pellet	1,102,311		1	120								1,102,311	132,277,319	97,003,368	3,306,933	78,264,081	36,376,263								1.10	146	107	4	86	40	
Coal	986,278		141	81								139,065,234	79,888,539	235,720,504	158,790,800	53,259,026	34,519,739								139.07	88	260	175	59	38	
<b>Net Change (Wood-Coal)</b>												(137,962,923)	52,388,780	(138,717,136)	(155,483,867)	25,005,055	1,856,524								(137.96)	58	(153)	(171)	28	2	
<b>Net Change (Wood-Coal)</b>												(745,577,513,784)	(59,930,908)	(501,551,503)	(3,650,795,999)	(974,791,018)	(625,996,612)								(745,577.51)	(66)	(553)	(4,024)	(1,075)	(690)	
<b>Wood Pellet</b>												168,817,826,573	376,990,360	866,416,442	893,974,217	352,739,518	162,039,716								168,817.83	416	955	965	389	179	
<b>Coal</b>												914,395,340,357	436,921,269	1,367,967,945	4,544,770,216	1,327,530,536	788,036,329								914,395.34	482	1,508	5,010	1,463	869	
<b>Reduction (Transitioning Coal to Wood)</b>													-82%	-14%	-37%	-80%	-73%	-79%								-82%	-14%	-37%	-80%	-73%	-79%

The amount of energy produced by wood pellets is based on the industry standard assumption that 17 GJ is produced per ton of wood pellets. The 17 GJ per ton estimate is conservative for this calculation because based on project-specific fiber testing, the wood pellets are anticipated to generate greater energy content closer to 18 GJ per ton (GSNR 2021).  
 1 tonne of coal equivalent = 21 MJ (19 GJ)

