Biomass Proposed Response to Governor's Emergency Proclamation

Detail of Calculations

The biomass energy industry has quantified the value for air emissions in its response. The memo below outlines the science and economics behind its quantification of these benefits.

Calculation of the Emissions Reductions

The values included are calculated by using source specific methods for each fuel source.

Agricultural biomass emissions reductions are quantified by calculating the emissions of open burning of agricultural residuals, and comparing it to typical permit limits for biomass generators. Emissions factors for Open Burning are based on a publicly available scientific study. Emissions factors are adjusted for variables such as moisture content and heat content in order to get comparisons on an equivalent basis. Emissions are translated into pounds of emissions per bone dry ton of biomass. A bone dry ton, or "BDT" is a widely used measurement in the biomass industry, and represents a ton of biomass fuel on a dry basis (excluding the weight of the moisture in the fuel). Emissions factors for each alternative are outlined below.

Emission	PM10	NO_x	VOC/Hydrocarbon	CO
Open Burning (lbs./BDT)	9.6	8.1	7.1	71.7
Biomass Facility (lbs/BDT)	0.5	1.8	0.8	4.7
Avoided Emissions (lbs/BDT)	9.1	6.3	6.3	67.0

In-forest biomass emissions reduction is calculated by quantifies the emissions benefit of avoiding burning of excess forest material in a controlled fashion, and also avoiding the burning of such material in wildfires. Calculations for in-forest fuel assume two alternatives for the fuel, if not used in a biomass generation facility.

The first alternative is that the in-forest biomass is disposed of through a controlled burning operation, whereby the material is piled together and deliberately burned in the forest, in order to reduce wildfire risk. As this method is similar in operation to agricultural burning, the emissions factors are assumed to be the same as the Open Burning factors. The analysis assigns an 80% probability to this scenario.

The second alternative is that this fuel is consumed in a wildfire. Emissions factors for forest fires are based on a publicly available scientific study. Similar to Open Burning, emissions factors are adjusted for variables such as moisture content and heat content in order to draw comparisons on a pounds of emissions per bone dry ton of biomass. Methane (CH_4) is a greenhouse gas, with a 20-25x impact of carbon dioxide. For quantification, a 21x multiple is used to achieve a CO_2 equivalent. Emissions factors for each alternative are outlined below.

Emission	PM10	NO_x	VOC/Hydrocarbon	CO	CH_4
Forest Fire (lbs./BDT)	33.2	11.7	22.2	316.6	12.6
Biomass Facility (lbs/BDT)	0.5	1.8	0.8	4.7	-
Avoided Emissions (lbs/BDT)	32.7	9.9	21.3	311.9	12.6
CO2 Equiv.					264.9

The avoided emissions from controlled burning or wildfire are then prorated based on the 80% and 20% assigned probabilities, respectively, to achieve a probability weighted emissions benefit.

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Urban Biomass The most likely alternative for urban biomass is the landfilling of such material. In a landfill, the carbon content of the material ultimately decomposes to create methane. Carbon represents approximately 50% of biomass by weight. This carbon will decompose into methane, a majority of which will be captured in the landfill's methane capture system. The California GHG registry uses a 75% assumption for methane capture, although this analysis assumes a higher 85% capture rate. Captured methane is combusted and in converted to carbon dioxide, while the remainder of the gas ultimately escapes into the atmosphere as methane. A 21x multiplier is applied to the methane to achieve a greenhouse gas equivalent. This is compared to complete combustion of the biomass, which generated only CO_2 from the carbon content of the wood.

(lbs./BDT)	**CH_4**	**CO_2**	**Total**
Landfilll Emissions Generated	200	3,117	N/A
CO_2 Equivalent	4,2000	3,117	7,317
Biomass Emissions Generated	-	3,667	N/A
CO_2 Equivalent	-	3,667	3,667
Avoided Emissions (CO_2 Equivalent)			3,650

Value of the Emissions Reductions

The emissions benefits calculated above are then translated into dollar values using current market rates for pollutants. For greenhouse gases such as carbon dioxide and methane, CO2 equivalents were priced based on the recent carbon auction settlement data under the California Cap and Trade Program. In the November 2015 auction, credits were priced at $12.73/ton. Slightly lower number of $12.29/ton from the May 2015 auction was used in this analysis.

For other pollutants (nitrous oxides, carbon monoxide, particulate matter, and other organics/hydrocarbons), pricing was upon recent transactions prices in California's Emission Reduction Offset markets. Although data is reported for other markets, San Joaquin Valley and South Coast air districts represent the most active trading markets for these credits. Where available, credit values for San Joaquin Valley were used, as they were generally more conservative (lower) than South Coast. For carbon monoxide, South Coast values were used because there was no 2014 data available from San Joaquin Valley. The values used are as follows:

Pollutant	PM 10	NOx	VOC/Hydrocarbon	CO
Credit Value ($/ton)	$14,726	$36,519	$3,877	$5,479

The value of these credits represents that right for a source to emit this amount annually for the life of the emissions source. Since the value we are seeking is the emissions allowed on a single amount, this value was used to imply an annual emissions value. An annual cost was calculated, assuming a twenty year average life of the emissions source and an 8% discount rate. The resulting value per unit of emissions is as follows:

Pollutant	PM 10	NOx	VOC/Hydrocarbon	CO
Credit Value ($/ton)	$1,500	$3,720	$395	$558

The dollar values per unit of credit are then multiplied by the avoided emissions to calculate the benefit of biomass generation by fuel type.

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Quantification of Emissions Reduction Benefits

In order to quantify the biomass funding amounts, this proposal calculates the benefits to air quality by calculating the avoidance of various pollutants and greenhouse gases and multiplying them by the appropriate emissions factors

Agricultural biomass

	PM10	NO_x	VOC/HC	CO	Total
Avoided Emissions (lbs/BDT)	9.1	6.3	6.3	67.0	
Conversion (ton/lb)	0.0005	0.0005	0.0005	0.0005	
Emissions Value ($/ton)	$1,500	$3,720	$395	$558	
Biomass Benefit ($/BDT)	$6.85	$11.76	$1.25	$18.70	**$38.55**

Forest fire biomass (a subset of In-forest biomass alternative outcome)

	PM10	NO_x	VOC/HC	CO	CH_4*	Total
Avoided Emissions (lbs/BDT)	32.7	9.9	21.3	311.9	264.9	
Conversion (ton/lb)	0.0005	0.0005	0.0005	0.0005	0.0005	
Emissions Value ($/ton)	$1,500	$3,720	$395	$558	$12,29	
Biomass Benefit ($/BDT)	$24.56	$18.43	$4.21	$87.03	$1.63	$135.86

In-forest biomass (a blended value of 80% controlled burn and 20% wildfire)

	$/BDT	**Probability**	**Weighted Average**
Forest Fire Biomass	$135.86	20%	$27.17
Controlled Burn Biomass	$38.55	80%	$30.84
Biomass Benefit ($/BDT)			**$58.01**

Urban biomass

	CO_2
Avoided Emissions (lbs/BDT)	3,650
Conversion (ton/lb)	0.0005
Emissions Value ($/ton)	$12.29
Biomass Benefit ($/BDT)	**$22.43**