# Forest Biomass and Air Emissions

WASHINGTON STATE DEPARTMENT OF
Natural Resources
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### *What is forest biomass?*

Forest biomass is the by-product of current forest management activities, current forest protection treatments authorized by DNR, or the by-product of forest health treatment prescribed or permitted under Washington's forest health law. Forest biomass does not include lumber products, or wood treated with preservatives. Forest biomass is not wood from old growth forests, wood required to be left on site under the state forest practices rules. Also, forest biomass does not include municipal solid waste.

## Forest Biomass and Greenhouse Gas Emissions

### *What are the climate impacts of biomass combustion for energy?*

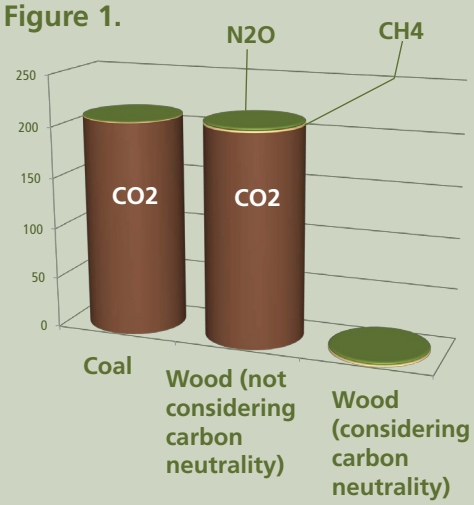
Emissions of carbon dioxide ($CO_2$) and other greenhouse gasses from combustion of forest biomass to produce energy are considered "carbon neutral." This is because these emissions contribute to the already cycling stock of carbon that is being exchanged between the biosphere and the atmosphere as part of the earth's carbon cycle. As $CO_2$ emissions from the combustion of forest biomass for energy production (or from slash burns, forest fires, tree respiration, and forest biomass decomposition) enter the atmosphere, $CO_2$ is simultaneously being reabsorbed by growing forests. Carbon neutrality, in this context, is dependent on maintaining the overall stock of forests. Currently in North America and specifically in Washington State, forest stocks are increasing in volume.

This natural cycling of carbon in the ecosystem is not present in the combustion of fossil fuel to produce energy. When fossil fuels, like coal or oil, are burned, the carbon is transferred from permanent storage in the earth's crust into the atmosphere as greenhouse gases (GHG's). This is not balanced by any countervailing withdrawal of carbon from the atmosphere. When forest biomass is used to generate energy, as a fossil fuels substitute, new $CO_2$ emissions from fossil fuels are replaced by emissions that are already part of the closed loop carbon cycle (See Figure 1).

## Greenhouse Gas Emissions of Coal and Wood

**lb-CO2e/MMBtu**

**Figure 1.**




(Source ORCAA, 2010)

**Definitions**

| | |
|---|---|
| **CH4** | Methane |
| **CO2** | Carbon dioxide |
| **GHG** | Greenhouse gas |
| **HCl** | Hydrogen chloride |
| **Hg** | Mercury |
| **lb-CO2e/ MMbtu** | Pounds of carbon dioxide equivalent per one million British Thermal Units |
| **Mn** | Manganese |
| **N2O** | Nitrous oxide |
| **NOX** | Nitrogen oxides |
| **PM** | Particulate matter |
| **SO2** | Sulfur dioxide |
| **VOC** | Volatile organic compounds |
| **ORCAA** | Olympic Region Clean Air Agency |

There can also be a short-term climate benefit from controlled forest biomass combustion compared to in-forest slash burning or uncontrolled wildfires (the likely alternative fate of forest biomass). In contrast to controlled combustion, open burning produces more methane (CH4), a greenhouse gas that's 25 times more potent than CO2. (Also see differences in air pollutant emissions, below.)

Finally, biomass is often produced when over-crowded forests are thinned in order to improve the productivity and fire resiliency of forests. In so doing, the forests are better able to absorb and store more carbon over time.

### *How do existing federal and state policies address GHG emissions from biomass combustion?*

In 2009, EPA adopted rules related to mandatory reporting of greenhouse gases from all sectors of the economy in the United States. The final rule applies to fossil fuel suppliers and industrial gas suppliers, direct GHG emitters and manufacturers of vehicles and engines outside of the light duty sector. Because forest biomass combustion, from an LCA standpoint, results in minimal emission, the rule does not require the control of GHGs from forest biomass combustion. Rather it requires only that sources above certain threshold levels monitor and report emissions. Based on the assumption that combustion of biomass is a carbon neutral activity, the rule exempts fuel combustion units that burn biomass from reporting.

In Washington state, facilities that emit 10,000 metric tons of carbon dioxide whether from biomass or a fossil based fuel must report their emissions to the Department of Ecology. Because state law considers the combustion of certain biomass as not being within the definition of greenhouse gas except for reporting purposes, carbon dioxide emissions from biomass are reported separately from other emissions.

**Table 1**

## Forest Biomass and Air Emissions

***Uncontrolled Emissions Comparison***

| Pollutant | WOOD LB pollutant/ LB/MMBtu | COAL LB/MMBtu | NATURAL GAS combined cycle turbine LB/MMBtu | WOOD slash burn LB/MMBtu |
|---|---|---|---|---|
| **NOX** | 0.220 | 0.510 | 0.0371 | 0.3 |
| **CO** | 0.600 | 0.025 | 0.0075 | 12.4 |
| **SO2** | 0.025 | 0.890 (coal sulfur content varies) | 0.0028 | Not available |
| **VOC** | 0.017 | 0.003 | 0.0043 | 0.8 |
| **PM** | 0.570 | 0.460 | 0.0083 | 1.3 (PM >10 microns only) |
| **CO2** | 206.94 | 214.04 | 116.97 | 206.94 |
| **HCl** | 1.900E-02 | 6.100E-02 | None | |
| **Hg** | 3.500E-06 | 1.600E-05 | None | |
| **Mn** | 1.600E-03 | 1.200E-03 | None | |

Source: ORCAA Assessment 2/3/2010, Ecology 2/24/2010

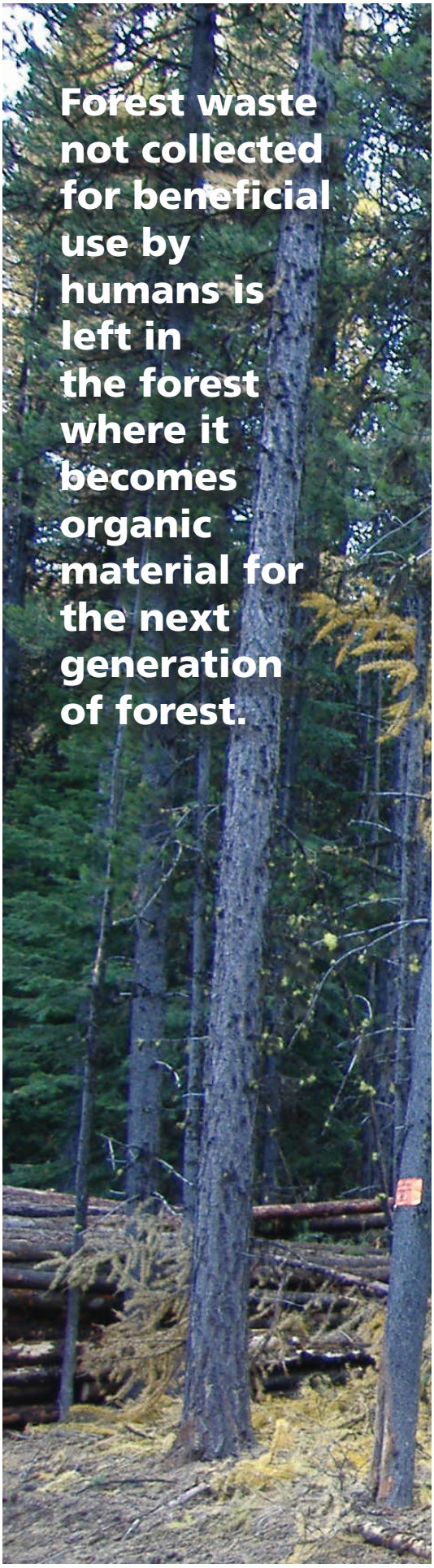



**Table 2**

## Forest Biomass and Air Emissions

***Controlled Emissions Comparison***

| Pollutant | WOOD, LB/MMBtu Spreader-stoker | COAL LB/MMBtu | NATURAL GAS combined cycle turbine, LB/MMBtu | WOOD slash burn LB/MMBtu |
|---|---|---|---|---|
| **NOX** | 0.1 | 0.07-0.38 | 0.0082 | 0.3 |
| **CO** | 0.35 | 0.025 | 0.0050 | 12.4 |
| **SO2** | 0.025 | 0.18-0.044 (varies based on control technology) | 0.0028 | Not available |
| **VOC** | 0.0052 | Not normally limited | 0.0014 | 0.8 |
| **PM** | 0.01-0.02 | 0.0009-0.02 (range of permitted values) | 0.0083 | 1.3 (PM >10 microns only) |
| **HCl** | Not normally limited | Not normally limited | Not normally limited | |
| **Hg** | Not normally limited | 0-90% reduction required, varies by state | Not normally limited | |
| **Mn** | Not normally limited | Not normally limited | Not normally limited | |
| **GHG emissions (CO2e)** | 211.39 (including CO2) 4.45 (excluding CO2 as carbon neutral)[1] | 214.91 | 117.76 | |
| **CO2** | 206.94 | 214.04 | 116.97 | 206.94 |
| **CH4** | 0.0200 | 0.0022 | 0.0084 | |
| **N2O** | 0.0130 | 0.0015 | 0.0020 | |

Source: Ecology 2/24/2010

[1]CO2 is one of three gases used to calculate CO2e, carbon dioxide equivalent, the primary unit of measure for greenhouse gases. In calculating carbon dioxide equivalent, the annual emissions of a chemical are multiplied by its respective global warming potential to determine the equivalent quantity of CO2 that they represent. The global warming potential for carbon dioxide is 1, methane is 21 and nitrous oxides is 310. For example, the CO2e calculation for wood combustion includes carbon dioxide (206.94 tons), methane (.02 x 21= .42 tons) and nitrous oxides ((.013 x 310 = 4.03 tons).

# Forest Biomass and Air Pollutants

### *How will burning forest biomass to create energy affect air emissions?*

Burning forest biomass as an energy feedstock in power production facilities will result in release of some air pollutants. In order to accurately assess these impacts, it is important to compare these emissions with more traditional energy feedstocks (natural gas and coal), and slash-burning (a common treatment for the woody residuals of logging).

Tables 1 and 2 compare emissions of common (and regulated) air pollutants from burning of wood (forest biomass), natural gas, and coal. There are more air pollutants emitted than those shown in these charts, however, these are considered the key air pollutants of concern. The first table shows emissions in the absence of pollution control technology. The second table assumes currently required pollution control technology.

Table 2 shows that differences in emissions depend on the specific pollutant. Burning coal generally results in higher emissions of SO2, mercury and HCl, while wood combustion has higher CO emis-

**Both prescribed burning and wildfires produce greater volumes of air pollution than carefully controlled biomass combustion in an energy facility.**

sions. Comparatively, natural gas combustion is significantly lower in all pollutants. The Olympic Region Clean Air Agency (ORCAA) predicts that differences in controlled levels of NOX and particulates (PM) from coal and wood combustion will be insignificant.

Forest waste not collected for beneficial use by humans is left in the forest where it may become organic material for the next generation of forest, may be burned on-site in a prescribed burn, or may dry out and contribute to an increased risk of uncontrolled forest fires. Outdoor burning releases carbon monoxide, particulate matter, and volatile organic compounds into the air. As the tables demonstrate, both prescribed burning and wildfires produce greater volumes of air pollution than carefully controlled biomass combustion in an energy facility. Industrial particulate control technologies can remove up to 99% of particulate matter from the combustion woody biomass.

### *Do all forest biomass-to-energy projects involve combustion and air emissions?*

Air emissions are associated with multiple stages of forest biomass collection and use. Forest biomass-to-energy projects, including DNR's current pilot projects, may include stand-alone power plants, combined heat and power plants, pellet production for wood pellet stoves and boiler fuel, and pyrolysis to produce bio-oil and bio-char. The latter two conversion processes do not involve significant biomass combustion, but result in products whose eventual use (e.g. as liquid fuel) will result in air emissions. What distinguishes forest biomass from other combustion feedstocks such as oil, coal, and natural gas is that biomass is renewable, carbon neutral, and produced in abundance in Washington State.

## More Information

If you would like to learn more about the Department of Natural Resource's Biomass Initiative, please contact **Craig Partridge** at craig.partridge@dnr.wa.gov or **Rachael Jamison** at rachael.jamison@dnr.wa.gov.