

# Clean Heat Standard – Wood Fuel Carbon Intensities/Emission Factors and Other Issues

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This issue briefing has been prepared in response to the question posed by the Clean Heat Standard Technical Advisory Group (TAG), “What is the appropriate methodology for evaluating the greenhouse emissions and determining of credit values for wood biofuels and advanced wood heat?” and other related issues that have been raised around wood fuels. For ease of reading, this memo is divided into 5 sections:

1. Vermont Greenhouse Gas Inventory and Forecast: Background, Methodology, and Biogenic CO<sub>2</sub>
2. Use of Global Warming Potential Biogenic (GWPbio) and the Biogenic Carbon Footprint Calculator for Wood Fuels
3. Installed Measure Characterization and Advanced Wood Heating
4. Carbon Intensity Threshold & Emissions Tables
5. Northeast States for Coordinated Air Use Management (NESAUM) Emissions Factors

Act 18 of 2022, the Affordable Heat Act, establishes the Clean Heat Standard. §8127 (c) states that “clean heat credits shall be based on the accurate and verifiable CO<sub>2</sub>e emission reductions in Vermont’s thermal sector that result from the delivery of eligible clean heat measures to existing or new end-use customer locations into or in Vermont.” §8127(g) states that emission rates for heating fuels “shall be based on transparent, verifiable, and accurate emissions accounting adapting the Argonne National Laboratory GREET model, Intergovernmental Panel on Climate Change (IPCC) modeling, or an alternative of comparable analytical rigor to fit the Vermont thermal sector.”

## **1. Vermont Greenhouse Gas Inventory and Forecast: Background, Methodology, and Biogenic CO<sub>2</sub>**

The Vermont Greenhouse Gas Emissions Inventory and Forecast reports (the Inventory) are required by 10 V.S.A. §5823. The Inventory estimates historic 1990 and 2005 baseline anthropogenic greenhouse gas (GHG) emission levels and tracks changes in those emissions over time to determine progress toward meeting the state’s GHG reduction requirements in 10 V.S.A. §5784, which were updated with the passage of the Global Warming Solutions Act (GWSA) (Act 153) in 2020.

The Inventory uses a methodology that is consistent with the Intergovernmental Panel on Climate Change (IPCC) guidelines for governmental greenhouse gas accounting. Emissions totals in the Inventory are reported on a gross basis for the seven economic sectors with emission reduction requirements in the GWSA: agriculture, electricity, industrial processes, fossil fuel industries, residential/commercial/industrial, transportation, and waste. Sequestration of carbon dioxide (CO<sub>2</sub>) from the atmosphere is not accounted for in these individual economic sectors.

Emissions of biogenic CO<sub>2</sub> related to the combustion or decomposition of biologically based materials are accounted for in the net flux (transfer from one pool to another over time) of carbon within the Land Use, Land Use Change, and Forestry (LULUCF) sector. While the Inventory includes estimates of biogenic CO<sub>2</sub> emissions for several economic sectors (including from wood used for energy) for informational purposes, these emissions are excluded from the sector totals in accordance with the IPCC guidelines and the EPA accounting

framework for biogenic CO<sub>2</sub> emissions.<sup>1</sup> The 2024<sup>2</sup> Inventory report notes that “how to appropriately account for biogenic CO<sub>2</sub> is not an easy question to answer given the complexity of the systems involved and there is currently no consensus even within scientific literature as to the best approach.”

## **2. Use of Global Warming Potential Biogenic (GWPbio) and the Biogenic Carbon Footprint Calculator for Wood Fuels**

Global Warming Potential Biogenic (GWPbio) has been proposed as an indicator of the net potential warming impact of CO<sub>2</sub> released by the combustion of biomass, taking into account how the regrowth of harvested biomass recaptures the CO<sub>2</sub> released by combustion.<sup>3</sup> The 2024 Inventory report describes the use of GWPbio and the Biogenic Carbon Footprint Calculator (the Calculator), developed by the World Wildlife Fund and Quantis,<sup>4</sup> as “one additional framework for understanding emissions from biogenic carbon dioxide *that could be explored in more detail* which acknowledges that CO<sub>2</sub> emissions from the combustion of wood are real and impactful while providing some credit for the renewability of the resource” (*emphasis added*). As the 2024 Inventory report notes, the use of GWPbio is one possible method, but there are no commonly accepted methods to account for biogenic CO<sub>2</sub> emissions and removals in a life cycle assessment framework.

In the Approach to Lifecycle Analysis for Wood Products memorandum dated October 9, 2024, the Public Utility Commission’s (PUC) contractor Opinion Dynamics (OD) proposed revisions to its assumptions for estimating the lifecycle emissions of wood fuels used for heating. OD uses these assumptions as inputs to the Calculator to estimate the GWPbio for the three wood fuel products evaluated (wood chips, wood pellets, and firewood).

For clarity, it is important to define some general terms used when discussing wood products and timber classification:<sup>5, 6</sup>

- Residue – a substance that is not the primary end product that a production process directly seeks to produce.
- Logging residue – the unused portions of trees cut or destroyed during logging operations and left in the woods.
- Mill residue – wood material from mills or other primary manufacturing plants that is not used for the mill’s or plant’s primary products. Examples are slabs, edgings, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and pulp screenings. Includes bark residues and wood residues (both coarse and fine materials) but excludes logging residues.

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<sup>1</sup> *Accounting Framework for Biogenic CO<sub>2</sub> Emissions from Stationary Sources*. US EPA, Office of Atmospheric Programs, 2011, <https://www.epa.gov/sites/default/files/2016-08/documents/biogenic-co2-accounting-framework-report-sept-2011.pdf>

<sup>2</sup> Vermont Agency of Natural Resources. *Vermont Greenhouse Gas Inventory and Forecast: 1990-2021*. State of Vermont, Agency of Natural Resources, 2024, <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>

<sup>3</sup> Cherubini, Francesco, et al. “CO<sub>2</sub> Emissions from Biomass Combustion for Bioenergy: Atmospheric Decay and Contribution to Global Warming.” *GCB Bioenergy*, vol. 3, no. 5, 2011, pp. 413-26. <https://doi.org/10.1111/j.1757-1707.2011.01102.x>

<sup>4</sup> <https://www.worldwildlife.org/projects/biogenic-carbon-footprint-calculator-for-harvested-wood-products>

<sup>5</sup> *Forest Inventory and Analysis Glossary*. USDA, Forest Service, Forest Inventory and Analysis, 2023. [https://research.fs.usda.gov/sites/default/files/2024-01/wo-fia\\_glossary\\_standardterms20231211.pdf](https://research.fs.usda.gov/sites/default/files/2024-01/wo-fia_glossary_standardterms20231211.pdf)

<sup>6</sup> Siol, Christoph, et al. “Utilizing Residual Biomasses from Agriculture and Forestry: Different Approaches to Set System Boundaries in Environmental and Economic Life-Cycle Assessments.” *Biomass and Bioenergy*, vol. 174, 2023, <https://doi.org/10.1016/j.biombioe.2023.106839>.

- By-product – a residue that also satisfies the following conditions: (a) further use is certain, (b) can be used directly without further processing other than normal industrial practice, (c) is produced as an integral part of the production process, and (d) further use is lawful.
- Waste – a substance or object which the holder discards, intends to discard, or is required to discard.
- Pulpwood – roundwood, whole-tree chips, or wood residues that are used for the production of wood pulp.
- Sawtimber – a live tree of commercial species containing at least a 12' sawlog or two noncontiguous sawlogs 8' or longer and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0" diameter at breast height (dbh). Hardwoods must be at least 11" dbh.
- Pole timber – For trees measured at breast height, softwoods 5.0-8.9" diameter and hardwoods 5.0-10.9" diameter.
- Bolt – a short piece of pulpwood; a short log.
- Roundwood – logs, bolts, or other round sections cut from trees.

#### *Wood chips and pellets*

In the draft Fuel Measure Characterization dated September 9, 2024, OD described its feedstock assumptions for wood fuels: "lumber mill wastes" for chips and a "blend of lumber wood, lumber mill residues, and lumber mill wastes" for pellets. Two points of feedback were provided to OD: (1) the inputs used in the Calculator to estimate GWPbio for wood chips did not reflect the assumptions in the September 9 document, and instead treated the feedstock as coming entirely from purpose-grown and harvested roundwood, and (2) wood pellets are primarily made from logging and mill residues.<sup>7, 8</sup>

In response to this feedback and additional questions, OD has proposed revising the feedstock assumption for pellets to residues (OD also uses the term lumber mill wastes) from the processing of roundwood into other merchantable wood products.<sup>9</sup> ANR agrees with this revised approach, which treats wood pellets and chips consistently.

#### *Commercial firewood*

In the Approach to Lifecycle Analysis for Wood Products memorandum dated October 9, 2024, OD also proposed revising its assumptions for the feedstock for commercial firewood. Using the most recent report on the economic contributions of Vermont's forest products sector,<sup>10</sup> OD determined that the feedstock is a 70%/7% ratio of hardwood (maple/beech/birch) and softwood (spruce/fir), resulting in a GWPbio factor of 0.75 for commercial firewood when the species ratio is normalized to 100% for two species available in the Calculator, cool temperate beech and pine. This new assumption raises two questions: (1) whether OD's use of purpose-grown and harvested feedstock inputs in the calculator is appropriate, and (2) whether the species mix/ratio chosen by OD is correct for firewood production.

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<sup>7</sup> Rodriguez Franco, Carlos. "Forest Biomass Potential for Wood Pellets Production in the United States of America for Exportation." *Biofuels*, vol. 13, no. 8, 2022, pp. 983-94, <https://doi.org/10.1080.17597269.2022.2059951>.

<sup>8</sup> Spelter, Henry, et al. *North America's Wood Pellet Sector*. USDA, Forest Service, Forest Products Laboratory, 2009, <https://purl.fdlip.gov/GPO/LPS126684>.

<sup>9</sup> Opinion Dynamics memorandum "Approach to Lifecycle Analysis for Wood Products" dated October 9, 2024.

<sup>10</sup> Public Sector Consultants and Paul Frederick. *Forest Products Industries' Economic Contributions: Vermont*. Public Sector Consultants, 2020, <https://fpr.vermont.gov/sites/fpr/files/documents/2017%20Forest%20and%20Wood%20Products%20Industries%20Economic%20Contributions.pdf>

- (1) Firewood feedstock: The majority of firewood is produced as a by-product of harvests that primarily produce higher value wood products.<sup>11</sup> Firewood is produced from small-diameter roundwood, branches, logging residues, and wood from lower economic value or lower quality species. Larger diameter, higher quality logs of commercial species are used to produce high-value wood products such as lumber, structural beams, furniture, and veneer. The non-sawlog portions of sawtimber trees and small-diameter roundwood from forest thinnings are used for the highest economic use that is locally available with market demand, either as pulpwood for the production of paper, paperboard, and packaging, or as fuelwood, with pulp markets generally being preferred. With the exception of firewood collected for personal use, there are significant economic and market barriers to harvesting forest biomass for fuel only, including the high cost of transportation, the low market value, low financial returns, and high cost of harvesting.<sup>12</sup>
- (2) Species mix/ratio: The report cited by Opinion Dynamics is an economic analysis, not an inventory analysis. The hardwood/softwood ratio appears to have been determined from Exhibit 5, Forest Land Area by Forest Type Group (2017). This table reports forest composition by land area, not by volume. Forest Inventory & Analysis (FIA) data is available from the US Forest Service. We recommend that OD use Vermont-specific FIA data for this assessment. FPR is happy to facilitate access to FIA data upon request.

Should the TAG and OD move forward with the use of GWPbio for wood fuels, we recommend that the decision process to use it, and the evidence supporting that decision, be adequately explained in the technical and supporting documentation submitted to the PUC and/or used in the CHS. We also recommend that any use of the Calculator to estimate GWPbio factors be based on the available data for Vermont's forests, forest management, and wood utilization, and that any GWPbio estimates derived from the Calculator and used in the CHS be appropriately contextualized with respect to the limitations of the Calculator to account for Vermont-specific data.

### 3. Installed Measure Characterizations and Advanced Wood Heating

In the draft TRM Installed Measure Characterizations dated September 17, 2024, the following measures appear:

- 2.4.2/3.4.2 Advanced Wood Heating, Central Pellet Systems (Commercial/Industrial and Residential): The baseline is either a new central pellet system with a full load efficiency rating of 75% HHV or an existing wood heating system with a full load efficiency rating of 65% HHV.
- 2.4.3/3.4.3 Advanced Wood Heating, Pellet and Cordwood Stoves (Commercial/Industrial and Residential): The baseline is assumed to be an existing, less efficient wood stove supplementing an existing heating system.

Advanced wood heating systems are installed to replace various existing heating systems, including fossil fuel, electric, and wood systems.<sup>13</sup> The appropriate baseline condition for advanced wood heating systems should

<sup>11</sup> Goho, Curtis D., et al. *A Study of Logging Residue at Woods Landings in Appalachia*. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, 1976.

<sup>12</sup> Nielson-Pincus, Max, et al. *Woody Biomass Utilization Trends, Barriers, and Strategies: A Survey of USDA Forest Service Managers*. Ecosystem Workforce Program, Institute for a Sustainable Environment, University of Oregon, 2012, <https://digital.osl.state.or.us/islandora/object/osl%3A22736>.

<sup>13</sup> VEIC, personal communication with Molly Willard, October 25, 2024.

be the same as the baseline condition for air source heat pumps. While the measure description for the air source heat pump states that it is replacing a fossil fuel system, option #1 for the baseline condition includes a mix of fossil fuels, electricity, and wood. In addition, we note that if the existing system is known and is not a fossil fuel system (e.g. electricity or wood), there is no algorithm for these fuels as a baseline.

In Version 2 (dated October 16, 2024) of the Definition of “Advanced Wood Heat” for the Clean Heat Standard document, the authors state that the Vermont Clean Energy Development Fund and Efficiency Vermont provide incentives to automated wood heating systems, a subset of advanced wood heating systems in the discussion and justification for the Option 1 definition of Advanced Wood Heat for the CHS. This is incorrect – incentives are provided for advanced wood heating systems, some automated and some not.<sup>14</sup> The 2022 Update: Advanced Wood Heat Sector in Vermont report<sup>15</sup> defines advanced wood heating as including “all wood fuels (cordwood, pellets, and chips) and all high-efficiency heating appliance (stoves, furnaces, and boilers) installed indoors.” The 2022 Update report further states that advanced wood heating is generally representative of all new appliances incentivized by the State of Vermont programs.

We recommend that the TAG adopt a definition of Advanced Wood Heat that is consistent with existing programs. If the TAG decides to limit the definition of Advanced Wood Heat to automated systems, we recommend that the TAG does not also limit these automated systems to only pellet and chip systems. There are commercially available cordwood systems with automated and semi-automated operation.<sup>16</sup>

#### 4. Carbon Intensity Threshold & Emissions Tables

10 V.S.A. §8123 defines carbon intensity value as “the amount of lifecycle greenhouse gas emissions per unit of energy of fuel expressed in grams of carbon dioxide equivalent per megajoule (gCO<sub>2</sub>e/MJ).” §8127(f) establishes a timeline with a declining carbon intensity value threshold for liquid or gaseous clean heat measures, where “...the carbon intensity values shall be understood relative to No. 2 fuel oil delivered into or in Vermont in 2023 having a carbon intensity value of 100. Carbon intensity values shall be measured based on fuel pathways.”<sup>17</sup> §8127(g) establishes a schedule of lifecycle emission rates for heating fuels, any fuel that is used in a clean heat measure, and any fuel that is itself a clean heat measure.

Currently, the Technical Reference Manual (TRM) presents a single table that includes the carbon intensity values, the carbon intensity threshold timeline for liquid and gaseous fuels, and the lifecycle emission rate schedule. For clarity and public understanding, we recommend that the TRM include one table for liquid and gaseous fuels only with the proposed carbon intensity timeline from §8127(f) and a second table with the lifecycle emission rates from §8127(g).

<sup>14</sup> “Available Rebates: Wood Heating.” *Efficiency Vermont*.

<https://www.efficiencyvermont.com/rebates/list?cat=Heating%2C+Cooling+%26+Ventilation&hvacfilter=Wood+Heating&type=>. Accessed October 29, 2024.

<sup>15</sup> Sherman, Adam, et al. 2022 *Update: Advanced Wood Heat Sector in Vermont*. VEIC, 2024.

[https://publicservice.vermont.gov/sites/dps/files/documents/2022%20Update%20-%20Advanced%20Wood%20Heat%20Sector%20-%20Final%20Report%203.19.24\\_0.pdf](https://publicservice.vermont.gov/sites/dps/files/documents/2022%20Update%20-%20Advanced%20Wood%20Heat%20Sector%20-%20Final%20Report%203.19.24_0.pdf)

<sup>16</sup> “Firewood boilers and firewood heating systems.” *Froeling*. <https://www.froeling.com/en-us/products/firewood-boiler/>. Accessed October 29, 2024.

<sup>17</sup> 10 V.S.A. §8127(f)(3).

## **5. Northeast States for Coordinated Air Use Management (NESCAUM) Emission Factors**

In their Draft Vermont Clean Heat Standard Lifecycle Emissions Rate Schedule dated August 29, 2014, OD used combustion emission rates for CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O from wood fuels from the US EPA Emission Factors Hub, with CO<sub>2</sub> emission rates adjusted by a GWP<sub>bio</sub> factor as discussed above. In response, The NESCAUM shared “Criteria, Greenhouse Gas, and Hazardous Air Pollutant Emission Factors from Residential Cordwood and Pellet Stoves Using and Integrated Duty Cycle Test Protocol”<sup>18</sup> with the TAG and submitted the study as a comment to the record for the Clean Heat Standard. This study illustrates the variability in pollutant emissions, including greenhouse gases, that can occur depending on the heating appliance and the fuel type. While the emission factors for CO<sub>2</sub> and CH<sub>4</sub> are similar in the two approaches, they are not identical. It is unclear what alternative emission factors, if any, NESCAUM is proposing for consideration in this submission. A recommendation on this issue will require additional information on the rationale for considering an alternative.

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<sup>18</sup> Traviss et al, “Criteria, Greenhouse Gas, and Hazardous Air Pollutant Emission Factors from Residential Cordwood and Pellet Stoves Using and Integrated Duty Cycle Test Protocol” accessed at <https://epuc.vermont.gov/?q=downloadfile/735374/190907>