Memo

To: VT Public Utility Commission
Fr: Rick Weston, Chair, Clean Heat Standard Technical Advisory Group
Re: Statement of the Technical Advisory Group (TAG) on the definition of "advanced wood heat"
Dt: 18 November 2024

Proposed Definition of "Advanced Wood Heat": Two Options

The characteristics of advanced wood heating include appliances that have verifiable high efficiency and low emissions of criteria and air toxic emissions. Technologies that could be included are wood stoves, furnaces, and boilers certified for use inside homes (defined by safety testing for indoor installation). Common features of "Advanced Wood Heating" appliances include automatic fuel feeding systems, combustion controls that modulate air to fuel ratios for optimum burn conditions, and other controls that ensure optimal performance when installed. In the case of central heating units, advanced wood heating appliances also utilize external thermal storage to minimize the impacts of cyclic operation.

In 2023, the US EPA Inspector General determined that the federal certification program for residential wood heaters cannot be relied on by agencies to identify clean appliances. Given the lack of verifiable data and lack of test methods that provide data on installed performance, the TAG recommends **excluding cordwood appliances as an eligible clean heat measure at this time**. Cordwood appliances might be reassessed for Clean Heat Standard eligibility if their emissions performance can be verified to meet defined criteria based on duty-cycle test methods promulgated by the US Environmental Protection Agency (EPA), and issues with the federal certification program have been resolved. Inclusion of cordwood appliances could be revisited in three years, in tandem with other TRM updates.

The TAG recommends establishing efficiency and emissions performance standards up front for eligible "advanced wood heat" measures under the CHS, to provide clarity. The TAG also suggests that Efficiency Vermont and other in-state incentive programs consider adjusting their eligibility criteria to align with the below criteria, to the extent possible.

We considered two options for performance standards for residential advanced wood heat. They differ only in their minimum standards for combustion efficiency and emission rates of particulate matter.

Proposed Performance Standards:

- Stoves:
  - Pellet stoves only, revisit cordwood units after January 2028
  - Efficiency
    - **Option 1**: 80% or higher as certified by US EPA wood heater database
    - **Option 2**: 75% or higher as certified by US EPA wood heater database
  - PM emissions
    - **Option 1**: 1.0 g/hr per EPA certification test

    - **Option 2**: 2.0 g/hr per EPA certification test
  - Must be professionally installed by certified installers
  - Only primary residences eligible

  Note: 14 of the 101 certified pellet stoves meet these criteria (EPA-certified pellet stove list with PM emissions and efficiency included in Attachment 3)

- Central heating systems:
  - Pellet central heaters only, revisit cordwood and chip units after January 2028
  - Must be professionally installed by an Efficiency Vermont qualified installer for pellet boiler installation
  - Only primary residences eligible
  - Units certified by US EPA using thermal storage and duty cycle test methods do not need to meet a performance specification
  - Units certified without thermal storage (identified by using the EPA wood heater database, any unit listed as "no" in the thermal storage column):
    - PM emissions per the EPA wood heater database ≤0.07 lb/MMBtu
    - Efficiency **greater than** 80% as certified by US EPA wood heater database
    - Appliance must have safety certification test (UL) for indoor installation only

    Note: 13 of the 16 EPA certified indoor pellet boilers meet these criteria (EPA certified pellet boiler list with PM emissions and efficiency included in Attachment 3)
  - No recommendations for non-residential units at this time; developing a recommendation requires additional data to support development of a performance standard.

Background: Performance Specifications

The TAG discussed recommending detailed performance specifications for wood heating appliances rather than limiting technology options. The following sections provide background on the topic based on the 11/5/2024 subgroup meeting. Additional background information can be found in Attachment 2.

Eligibility criteria considerations for advanced wood heating measures:

- **Wood Heating Background**
  - The EPA Inspector General recommends that states not rely on the EPA certification program to identify clean appliances (see Attachment 2 for more information)
  - New test methods
    - The target date for new federal test methods for residential wood stoves is December 2026.
    - The target date for new federal test methods for residential wood central heaters is December 2027
  - New federal emission standards for residential wood heaters would be set per a court consent decree:
    - Stoves by December 2027.
    - Central heaters by December 2028.

- Criteria and air toxic emissions from home heating will increase if wood heating replaces/displaces liquid fuel, such as home heating oil, natural gas, and propane.[1]
- Pellet central heating particles are less toxic than cordwood boilers by two orders of magnitude.[2]
- Assuming all wood fuel used in Vermont has been harvested in Vermont may not be accurate. ANR data only reflects Vermont forestry practices.[3] Pellet fuels, especially bagged pellets used for stoves, have the highest likelihood of out-of-state manufacturing, and may not use wood waste as a feedstock.
- All residential installations, regardless of size, must be certified under federal regulations.
- Federal incentives require 75% efficiency per the EPA database.
- For residential central heaters that require the use of thermal storage, EPA uses a duty-cycle test which is not equivalent to the steady state method used to assess heaters without thermal storage.
- For commercial units:
    - Vermont allows use of a test method to certify performance that EPA has deemed insufficient for US test methods.[4]
    - New York State requires commercial and institutional wood heaters larger than 1 MMBtu meet a particulate matter (PM) emission limit of 0.10 lb/MMBtu using an *in situ* stack test (EPA Method 5) for all non-residential installations. This is a state regulatory requirement, not a threshold for incentives.
    - Vermont Air Pollution Control Agency Best Available Control Technology (BACT) PM limit for units over 3 MMBtu is 0.03 lb/MMBtu.

- **Efficiency Vermont Wood Heating incentives as of 11/7/2024:**
    - Wood stoves
        - Eligible technologies
            - Incentives for new, high-efficiency stoves.
            - Qualifying stoves are EPA-certified, meet <2.0 grams per hour emissions rating and are >75% efficient as measured by the Higher Heating Value (HHV) per EPA data.
            - Efficiency Vermont discount cannot be combined with any other point-of-purchase discounts (including offers from the Clean Energy Development Fund (CEDF) and Windham & Windsor Housing Trust).
        - Other requirements
            - Stoves must be installed in Vermont.
            - Self-installed stoves are not eligible for this offer.
            - Efficiency Vermont has a list of approved installers

    - Wood central heating
        - Eligible entities

[1] Based on US EPA AP-42 emission factors.
[2] Orashche, J., et al., 2012. Comparison of Emissions from Wood Combustion. Part 1: Emission Factors and Characteristics from Different Small-Scale Residential Heating Appliances Considering Particulate Matter and Polycyclic Aromatic Hydrocarbon (PAH)-Related Toxicological Potential of Particle-Bound Organic Species. Energy Fuels 2012, 26, 11, 6695–6704
[3] ANR Forestry program comment at 11/5/2024 meeting (recorded).
[4] EPA letter from Steffan Johnson, US EPA dated May 14, 2019.

        - Residential and commercial (up to 5,000 sq ft); larger units requires additional work with Efficiency Vermont to determine if incentives apply.
        - Customers of Burlington Electric Department and VGS are **not eligible** for this rebate.
        - Commercial new construction projects are not eligible for this rebate but may be eligible for custom incentives.
    - Eligible technologies
        - High-efficiency wood pellet boilers or furnaces only as verified by US EPA certification program.
    - Other requirements
        - Must be installed by an Efficiency Excellence Network - HVAC Central Wood Pellet Heating Systems contractor.
        - Systems must have at least 1 ton of fuel storage and automated on/off and fuel feed.

- **Other Northeast Incentive Programs**
    - Wood stoves
        - Other programs: Only Vermont provides financial incentives for stoves, pellets, or cordwood.
    - Central heaters
        - Other programs
            - New Hampshire provides incentives for pellet boilers. The program requires a minimum of 80% efficiency per EPA certification testing.
            - Maine provides incentives for cordwood and pellet boilers. The program requires a minimum of 70% efficiency per EPA certification testing.

The vote of the TAG members present was:

OPTION 1: Residential pellet stoves that meet the performance standards for PM emission rate of 1.0 g/hr or lower and 80% efficiency or higher

6 – approve
6 – do not approve
2 - abstain

OPTION 2: Residential pellet stoves that meet the performance standards for PM emission rate 2.0 gr/hr or lower and 75% efficiency or higher

8 - approve
4 – do not approve
2 – abstain

Submitted by:
Frederick Weston, Chair

Attachment 1
10/16/24 – Proposed Options for Definition of "Advanced Wood Heat" (Original)

OPTION 1: The Clean Energy Development Fund and Efficiency Vermont provide incentive payments to installers of automated heating systems that largely replace other, fossil fueled whole home heating systems. One possible definition of Advanced Wood Heat is to **restrict the installed measures to those automated systems that are designed as whole building heating systems.**

OPTION 2: As another option, the term "Advanced Wood Heat" can have a broader definition. Emma Hanson, the former wood fuels coordinator at the Agency of Natural Resources, communicated the following with respect to the range of wood heating options included as "Advanced Wood Heat" in the Clean Heat Standard:

> The whitepaper behind the Clean Heat Standard states, "Vermont has a long history of relying on wood for heat, and, more recently, significant experience in more efficient, lower-emitting advanced wood heat systems. Options today include efficient pellet stoves, automated pellet or chip boilers or furnaces, and efficient cordwood stoves."

And there is a federal tax credit for a wider range of wood burning appliances:

- All wood heating appliances (pellet stoves, pellet boilers, pellet furnaces, wood stoves, and wood boilers) with 75% or greater efficiency are eligible for a 26% federal tax credit. The tax credit may be claimed on the appliance itself as well as the sales tax, labor and installation costs, and any parts essential to the operation of the appliance, ex a hearth pad under a stove.

For this reason, it is possible for the PUC **to define "Advanced Wood Heat" credits for installations of wood burning appliances that qualify for the federal tax credit**. Furthermore, Efficiency Vermont provides incentive payments for the installation of certain wood burning stoves. This makes at least some of the installations of wood stoves that occurred after January 1, 2023 available for early action credits.

OPTION 3: A third possibility exists as envisioned in the early work of Opinion Dynamics. **The delivery of wood fuel with an assigned carbon intensity value could be eligible for credits as delivered fuel credits.** In this case, the clean heat credit would be for the fuel itself, not for the installed measure. This has not been a topic of discussion, and it may not be what Act 18 envisioned for Advanced Wood Heat.

Attachment 2
TAG Discussion of New Proposed Option

The term "Advanced Wood Heat" can have a broader definition than just the consideration of automated, whole home pellet boilers and furnaces. Emma Hanson, the former wood fuels coordinator at the Agency of Natural Resources communicated the following with respect to the range of wood heating options included as "Advanced Wood Heat" in the Clean Heat Standard: The whitepaper behind the Clean Heat Standard states, "Vermont has a long history of relying on wood for heat, and, more recently, significant experience in more efficient, lower-emitting advanced wood heat systems. Options today include efficient pellet stoves, automated pellet or chip boilers or furnaces, and efficient cordwood stoves."

This option would base eligibility for advanced wood heating measures on criteria for equipment efficiency and emissions performance. The intent is not to limit market choice of fuel (cordwood, pellets or chips) or appliance type (stove, boiler or furnace), but to set standards to encourage the market toward systems and fuels that have outcomes that obtain real and measurable greenhouse gas reductions without increasing public health risks.

The approach of basing eligibility on efficiency and emissions criteria generally aligns with the approaches used in current Vermont incentive programs, including Efficiency Vermont and the Small-Scale Renewable Energy Incentive Program (SSREIP). Therefore, under this option, at least some installations of advanced wood heating clean heat measures meeting the eligibility criteria that occurred after January 1, 2023, would be available for early action credits. Additionally, including stoves as an eligible measure provides for a clean heat measure that is more affordable and accessible to low- and moderate-income (LMI) Vermonters.

This option would exclude cordwood appliances from eligibility as a clean heat measure until such time as their emissions performance can be verified to meet defined criteria based on duty-cycle test methods promulgated by the EPA. Industry and environmental agencies alike acknowledge that current test methods do not provide data that can predict the efficacy of in-use performance.[5] Currently there is no reliable dataset available to determine which cordwood appliances (stoves or boilers) have acceptable levels of PM emissions and efficiency ratings. Per a 2023 EPA Inspector General report assessing the effectiveness of EPA's residential wood heater program,[6] stove certification testing data under EPA's program cannot be relied on to identify high-efficiency, low-emitting appliances. The EPA Inspector General report concluded that the federal program cannot be fixed without development of new and improved test methods along with a rule revision.[7]

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[5] "The current testing process simply cannot consistently distinguish emissions performance differences of less than 3 to 6 grams per hour. The process is certainly capable of reliably distinguishing between good and bad performance, but it cannot reliably distinguish between "good, better and best" performance." P 71 HPBA NSPS comments available at https://downloads.regulations.gov/EPA-HQ-OAR-2009-0734-1643/attachment_2.pdf and P 6 from technical consultant available at https://downloads.regulations.gov/EPA-HQ-OAR-2009-0734-1643/attachment_3.pdf

[6] EPA Inspector General Report, 2023. https://www.epaoig.gov/sites/default/files/reports/2024-04/_epaoig_20230228-23-e-0012_2.pdf

[7] The EPA Inspector General Report states, "state regulators and the public cannot rely on the EPA's wood heater program to ensure that only compliant appliances reach homes, and the EPA and states may be wasting millions of dollars on changeout programs by subsidizing new appliances that may not be

The largest and most referenced environmental and public health concerns focus on high PM2.5 emissions. Recent studies indicate that residential wood heating also emits air toxics and metals such as lead at concerning levels.[8] Wood heat is one of the largest sources of benzene, formaldehyde, and formaldehyde emissions nationwide. As previously noted, EPA's Inspector General reported that current EPA certification data for all appliances are suspect and cannot be used to support state and local programs.[9] Independent testing found that pellet stove emissions values are less variable than cordwood testing, based on Northeast States for Coordinated Air Use Management (NESCAUM) testing data published in the Journal of the Air & Waste Management Association.[10]

Eligibility of cordwood appliances as a clean heat measure should be reevaluated in a few years, when an accepted testing method is widely applied that can more accurately determine the levels of PM emissions for these appliances. EPA plans to promulgate new test methods for wood heaters by late 2027. NESCAUM recently received a $9 million grant from EPA to test new wood-burning appliances and create an independent data set using new/improved test methods. NESCAUM is currently testing all types of wood heaters (central heaters and stoves, pellet and cordwood), but it will take several years and additional funds to get 300+ commercially available appliances tested. This dataset is intended to provide state, local, and Tribal agencies information to inform their efforts to address air pollution from residential wood heating while EPA works on new federal requirements (anticipated 2029-33 timeframe for rule implementation if EPA maintains compliance with the current schedule).

Like cordwood stoves, EPA will be proposing new test methods for central heating appliances in the next two years. However, field studies have shown that PM emissions are clearly higher for cordwood appliances, followed by chip fuel and then pellet central heating systems.[11,12] Cordwood appliance performance is dependent on wood quality and how the appliance is operated to a greater extent than appliances that use pellets or chips.

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substantially cleaner in real-world conditions." It also notes, "The EPA's 2015 New Source Performance Standards for residential wood heaters is flawed, and the EPA has approved methods that lack clarity and allow too much flexibility. As a result, certification tests may not be accurate, do not reflect real-world conditions, and may result in some wood heaters being certified for sale that emit too much particulate-matter pollution. In fact, data from an EPA-approved testing lab indicate that some certified wood heaters do not meet emission standards."

[8] Traviss et al., Criteria, Greenhouse Gas, and Hazardous Air Pollutant Emissions Factors from Residential Cordwood and Pellet Stoves Using an Integrated Duty Cycle Test Protocol, August 12, 2024. Available at: https://pubs.acs.org/doi/full/10.1021/acsestair.4c00135

[9] EPA Inspector General Report, 2023. https://www.epaoig.gov/sites/default/files/reports/2024-04/_epaoig_20230228-23-e-0012_2.pdf

[10] Traviss et al., https://pubs.acs.org/doi/full/10.1021/acsestair.4c00135

[11] Kinsey, John, et al., 2012. Emissions Characterization of Residential Wood-fired Hydronic Heater Technologies. Atmospheric Environment. https://doi.org/10.1016/j.atmosenv.2012.08.064

[12] Hopke, Phil, et al., 2012. Evaluation of the Performance and Emissions from Commercial Scale Advanced Wood Combustion Systems.

Attachment 3

List of EPA Certified Pellet Stoves (as listed by EPA on 11/7/2024)

Manufacturer	Model	PM (grams/hr)	Efficiency
Aduro AS	H1 Hybrid, H2 Hybrid, H3 Hybrid	0.4	80
APR Industries Ltd.	BayWin Free Standing, BayWin Insert, BWS-BD, BW	0.83	76
ARDISAM, Inc.	Castle Serenity 41278	1	78
Dielle SpA	FBX S, FBX S+, FBX T, FBX R, FBX BUMP, ZEFIRO	1.9	79
Dielle SpA	Grecale, Grecale Glass, Round, Round Glass, Ethesia	1	75
Enerco Group, Inc.	PS130W Model Line: C130W, N130WTS, H140XL, C1	1.6	77
Enerco Group, Inc.	PS20W Model Line: PS20W, PS20WTS, C30XL, H30X	1.2	85
Enerco Group, Inc.	PS60W Model Line: C60W, N60WTS, H80XL, C80XL,	1.3	84
Enerco Group, Inc.	PSBF66W Model Line: CBF66W, NBF66WTS, H3W8(	1.1	80
FlamPoint EnerG	Europa 75a, Rafael 55a	0.08	83
Freedom Stoves, LLC	Independence PS21	1.6	78
Gruppo Piazzetta S.P.A.	P158, P158 D, and P158 T	0.79	83
Gruppo Piazzetta S.P.A.	P163, P163 D, and P163 T	0.89	82
Gruppo Piazzetta S.P.A.	Sahara	1.3	83
Hearth and Home Technologies	Frontier II	1.6	78
Hearth and Home Technologies	Harman Absolute 43-C	0.99	77
Hearth and Home Technologies	Harman Absolute 63	1.4	77
Hearth and Home Technologies	Harman Accentra 52i-TC	1.1	76
Hearth and Home Technologies	Harman Allure 50	1.5	75
Hearth and Home Technologies	Harman P43-C	1.8	77
Hearth and Home Technologies	Harman P61-C	1.5	79
Hearth and Home Technologies	Harman P68-C	1.4	79
Hearth and Home Technologies	P40i-C	0.69	82
Hearth and Home Technologies	P42i-TC	1	79
Hearth and Home Technologies	PelPro PP130-B, Quadra-Fire Outfitter II, PelPro PP15	0.53	82
Hearth and Home Technologies	Pel-Pro PP60-B, Pleasant Hearth PH35PS-B, Quadra	0.74	75
Hearth and Home Technologies	PelPro PP70	0.5	83
Hearth and Home Technologies	PelPro PPC90, PelPro TSC90, Pleasant Hearth PHC9	1.1	82
Hearth and Home Technologies	Quadra-Fire TREKKER-MBK, TREKKER-PMH, TREKI	0.7	78
Laminox	Giulia Air, Valentina Air N	1.6	84
Laminox	Phenix Air, Lydia Natural	1.3	79
Ravelli SRL	Francesca 2015 (01-US-001A), Nicole (2005ERU1), RV	1	81
Ravelli SRL	Roma (034-00-001A)	0.74	76
Ravelli SRL	RV100 Classic	0.7	80
Ravelli SRL	RV120 Touch, Atena V, Vitoria V	0.62	79
Sherwood Industries, Ltd.	EF2-1, Chatham-1, Davenport-1, Kinderhook-1	1.4	77
Sherwood Industries, Ltd.	Enviro – Maxx-1	1.5	77
Sherwood Industries, Ltd.	Enviro - Meridian-2, Meridian FPI-2, Meridian Cast Iron	1.8	75
Sherwood Industries, Ltd.	Enviro M55-FS-2, Enviro M55C-FS-2, Enviro M55C-FPI	1.9	78
Sherwood Industries, Ltd.	Enviro Mini 2, Enviro P3-2 Regency Greenfire GF40-2	0.54	80
SMG Hearth and Home, LLC	ComfortBilt HP22N, HP22, and HP22i Insert	1	81
SMG Hearth and Home, LLC	ComfortBilt HP50S	1.7	80
SMG Hearth and Home, LLC	HP 21	1.5	76
SMG Hearth and Home, LLC	HP 40	0.74	81
SMG Hearth and Home, LLC	HP 61	1.2	80
SMG Hearth and Home, LLC	HP41 - Alpine	1.6	80
SMG Hearth and Home, LLC	HP42-Alpine	1.1	86
SMG Hearth and Home, LLC	HP75C	1.4	81
St. Croix Stoves (Johnson Gas Appl	Ashby-P II	1.3	80
St. Croix Stoves (Johnson Gas Appl	Eclipse-P II	1.9	77
St. Croix Stoves (Johnson Gas Appl	Element-P II	1.1	79
St. Croix Stoves (Johnson Gas Appl	Hastings II	1.2	79
St. Croix Stoves (Johnson Gas Appl	Prescott II EXP, Prescott II EXL	0.7	81
Stove Builder International, Inc.	55-SHPCB120, 55-TRPCB120, and 25-CB120	1.4	76
Stove Builder International, Inc.	65R Series: Eco-65R, Blue Ridge P120	0.77	77
Stove Builder International, Inc.	Cambridge II, 3000C	0.96	76
Thelin Company Inc.	Echo-Comstock II	0.88	75
Thelin Company Inc.	Thelin Gnome	0.98	75
Thelin Company Inc.	Thelin Parlour 3000	0.92	81
Travis Industries, Inc	AGP Insert	0.98	76
Travis Industries, Inc	AGP PS	1.8	76
Travis Industries, Inc	Deerfield	1.2	77
United States Stove Company	5780-E, AP5780-E, VG5780-E, SP5780-E, SP58-E	1.1	76
United States Stove Company	Breckwell SP2047 (Traverse), GW7400, ARGO500	0.41	75
United States Stove Company	KP5513, KP5513-P, KP5513-L, US5513, US5513-P, U	1.5	76
United States Stove Company	KP5517, KP5517-P, KP5517-L,KP5517-W,US5517, U	1.6	77
United States Stove Company	KP5522, KP5522-P, KP5522-L, KP5522-W, US5522, (	1.5	76
United States Stove Company	SP1000E, KP1000E, AP1000E, US1000E	1	75

List of EPA Certified Pellet Boilers (as listed by EPA on 11/7/2024)

Manufacturer	Model	Emission Rate Annual Average (lb/mmBTU)	Efficiency	Type	Thermal Storage	Outdoor unit
Central Boiler Inc.- WoodMaster Inc.	Maxim M255 PE	0.03	89	Hydronic Heater	no	yes
Fröling Heizkessel und Behälterbau Ges.m.b.H	P4 Pellet 60	0.07	81	Hydronic Heater	yes	no
Fröling Heizkessel und Behälterbau Ges.m.b.H	PE1 Pellet 20	0.05	78	Hydronic Heater	no	no
Fröling Heizkessel und Behälterbau Ges.m.b.H	PE1 Pellet 35	0.05	80	Hydronic Heater	no	no
Hargassner GmbH	ECO-HK 120 Multifuel	0.04	88	Hydronic Heater	no	no
Hargassner GmbH	ECO-HK 70 Multifuel	0.07	87	Hydronic Heater	no	no
Hargassner GmbH	Smart PK32, Nano PK32	0.05	87	Hydronic Heater	no	no
Heatmaster Furnaces Inc. (SteelTech Inc.)	P7000	0.07	78	Hydronic Heater	no	yes
Maine Energy Systems, LLC	AutoPellet Air 28kW	0.06	89	Forced Air Furnace	no	no
Maine Energy Systems, LLC	Pellematic 20	0.02	77	Hydronic Heater	no	no
Maine Energy Systems, LLC	Pellematic 22	0.05	82	Hydronic Heater	no	no
Maine Energy Systems, LLC	Pellematic 32	0.02	77	Hydronic Heater	no	no
Maine Energy Systems, LLC	Pellematic 56	0.05	86	Hydronic Heater	no	no
Maine Energy Systems, LLC	Pellematic Smart XS (Condensing Mode)	0.05	90	Hydronic Heater	no	no
Windhager Zentralheizung Technik GmbH	BioWIN 152	0.04	65	Hydronic Heater	yes	no
Windhager Zentralheizung Technik GmbH	BioWIN 212	0.06	58	Hydronic Heater	yes	no
Windhager Zentralheizung Technik GmbH	BioWIN 262	0.04	71	Hydronic Heater	yes	no
Windhager Zentralheizung Technik GmbH	BioWIN 332	0.04	71	Hydronic Heater	yes	no