A Heating Equipment Feebate

Prepared for the Energy Action Network

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Abbreviations

ACEEE	American Council on an Energy Efficient Economy
BED	Burlington Electric Department
CEDF	Clean Energy Development Fund
CO_2	Carbon dioxide
CHS	Clean Heat Standard
DOE	Department of Energy
EAN	Energy Action Network
EFG	Energy Futures Group
EM&V	Evaluation, Measurement and Verification
EV	Electric vehicle
GHG	Greenhouse Gas
HOV	High-occupancy vehicle lane
HVAC	Heating, ventilation and air conditioning
LMI	Low-to-moderate income
LPG / LP	Liquid propane gas
PHEV	Plug-in hybrid electric vehicle
PSD	Department of Public Service
PUC	Public Utility Commission
RPS	Renewable Portfolio Standard
TCI	Transportation Climate Initiative
US	United States
VT	Vermont

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1. Executive Summary

Vermont has a number of energy policy goals and requirements related to reducing greenhouse gas emissions and increasing energy efficiency and renewable energy.[1] While headway towards these goals is being made in some areas, particularly in the electric sector, others have seen little progress or even backsliding. As shown in Figure 1, the thermal sector (mostly for space and water heating used in our buildings) produces more than a third of Vermont's greenhouse gas (GHG) emissions.

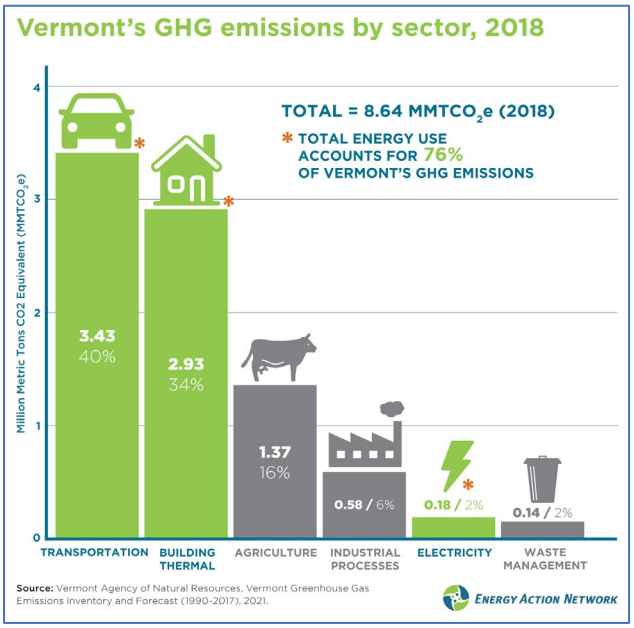

Figure 1. Vermont's GHG emissions by sector. Energy Action Network (EAN). 2021.[2]

This report focuses on one specific policy approach, often referred to as a "feebate"[3], that could assist in reducing the consumption of fossil fuels and related emissions from equipment used for space and water heating in our residential and small commercial buildings. For space heating, we use the U.S. Department of Energy classification of 300,000 Btu/h to separate residential from commercial boilers, and 225,000 Btu/h for furnaces.[4]

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[1] For example: 10 Vermont Statutes Annotated (V.S.A.) 578(a); 10 V.S.A. 580(1); 10 V.S.A. 581; 30 V.S.A. 8002 - 8005.

[2] "Annual Progress Report for Vermont 2020/2021." Energy Action Network. Montpelier, Vermont. 2021. https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf

[3] A feebate may also be referred to as an "efficiency price adjustment", "true cost pricing", or "switch and save".

[4] While the transportation sector produces the greatest emissions, significant attention has recently been focused on this sector. For example, in 2019, the Energy Action Network (EAN) commissioned the following report focused on "cap-and-invest" policies used to reduce emissions caused by transportation. "Cap-and-Invest: A review of policy, design and models and their applicability in Vermont." Prepared by Center for Sustainable Energy for Energy Action Network. April 2019. https://www.eanvt.org/tracking-progress/research-and-reports/cap-and-invest-a-review-of-policy-design-and-models-and-their-applicability-in-vermont/ Since then, the Vermont Agency of Natural Resources, Agency of Transportation and the Department of Public Service have held multiple public meetings to solicit feedback regarding the Transportation and Climate Initiative (TCI). More information is available here: https://anr.vermont.gov/content/transportation-and-climate-initiative. Further, Act 67 of 2021 requires significant investments and activities to reduce GHG emissions from the transportation sector such as: incentives

An equipment feebate program is a revenue-neutral approach to incentivize the purchase of products that are aligned with policy goals (e.g., more efficient and lower-GHG emitting products such as heat pumps, automated wood pellet systems and heat pump water heaters) with rebates, lower sales taxes and/or other financial incentives while discouraging purchases of products that are not aligned with policy goals (e.g., furnaces and boilers – particularly inefficient models – that use gas, kerosene, propane and fuel oil) through higher sales taxes and/or other fees.

There are multiple benefits resulting from implementation of a well-designed feebate.

- Depending on the design of the feebate, it can **significantly reduce GHG emissions**.
- Policy makers may support a feebate approach because it is considered **revenue-neutral**; the revenue from fees on the products that produce more pollution are then provided as incentives on the cleaner products.
- An equipment feebate can be designed to be **income sensitive,** and it can also help to **address economic inequity** by reducing lower-income Vermonters' "energy burden" through supporting equipment purchases that have lower operating costs. Both of these attributes advance the policy goal of addressing equity in GHG reduction.[5]
- A feebate can act as a form of **consumer protection** and **education** via clear and prominent product labeling shown at the time of sale. By discouraging inefficient equipment purchases and encouraging efficient purchases, a feebate sends a market signal to nudge consumers toward heating equipment that will save them money over time.
- Because the feebate squarely addresses purchases at the time of sale, it helps to **minimize fossil fuel "lock in"** associated with the purchase of new heating equipment, such as a furnace or boiler, which often have a 15 to 25 year life span.

While the feebate concept could be applied to a wide range of energy consuming and GHG-emitting equipment, appliances, vehicles, etc., there are a number of reasons for starting with a focus on just residential-sized space heating and water heating equipment (covering almost all residential applications, as well as many smaller commercial business applications).

First, initially focusing on relatively standardized residential equipment allows program administrators and policy makers an opportunity to gain knowledge and understanding regarding program implementation and market response. That will enable future refinements to the size of incentives and/or fees, as well as other aspects of policy design before the concept is extended to other products.[6]

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for electric vehicles (EV) and bicycles, grants for EV charging stations in multi-unit dwellings, a mandate for distribution utilities to offer EV rates in 2024, development of a public transportation electrification plan, improvements of high-use corridor segments for bicyclists, continuation of zero-fare public transit through fiscal year 2022, and implementation of coordinated intermodal connections. More information here: https://legislature.vermont.gov/Documents/2022/Docs/ACTS/ACT055/ACT055%20Act%20Summary.pdf. However, the thermal sector continues to not meet emission reduction targets; hence, the focus for this report.

[4] For example, residential and/or commercial cooking equipment, larger, non-specialized commercial and industrial equipment, as well as to other sectors such as transportation.

[5] Energy burden is "the ratio of energy spending expressed as a percentage of household income". https://www.efficiencyvermont.com/news-blog/whitepapers/vermont-energy-burden

[6] For example, residential and/or commercial cooking equipment, larger, non-specialized commercial and industrial equipment, as well as to other sectors such as transportation.

Second, phasing into an equipment feebate can allow program designers to understand the actual impacts of some potential concerns related to a feebate (e.g., how many sales are occurring in other states, with equipment then installed in Vermont, in order to avoid the feebate), and then course-correct to address those concerns.

Third, phasing into a feebate allows for better integration and alignment with other potential policies. For example, a feebate designed to directly target heating equipment purchase decisions can be coordinated with other policies being discussed in Vermont, such as the "Weatherization at Scale" initiative, which focuses on reducing energy losses through building envelopes. Further, while both a residential heating and water heating feebate and Weatherization at Scale have the potential to provide substantial GHG emission reductions, even together they will not be nearly enough to meet the thermal sector's portion of Vermont's GHG emission reduction goals. Thus, they need to be pursued within the context of a larger, umbrella policy for reducing emissions from the thermal sector, such as the "Clean Heat Standard" (CHS) recently proposed by the Vermont Climate Council.[7] Initial testing of how a residential heating and water heating equipment feebate contributes to meeting the CHS' sector-wide emission reduction requirements can inform future decisions on whether and how best to expand the concept to other energy consuming and GHG-emitting products.

In addition to focusing on residential-sized heating and water heating equipment, this report suggests that a Vermont feebate should be based on the Vermont sales tax, with the lowest GHG-emitting equipment being exempt from the sales tax and the highest GHG-emitting equipment paying 12%, or double the current 6% rate. Vermont has, actually, already taken a small step in this direction by making advanced wood heating systems sales tax exempt.[8] This paper proposes extending this exemption to other products and providing a slightly more nuanced application of the sales tax (e.g. five bands instead of just two "bands" – either the 6% sales tax or tax exempt), while making the overall feebate, revenue neutral.

While there are other ways to structure a feebate, tying it (at least initially) to the state sales tax would reduce administrative complexity by leveraging an existing state collection system and eliminating the need to actually draft and send rebates to customers. That would also ensure that customers purchasing low-GHG emitting equipment get the "rebate" – manifested as a lower or zero sales tax – instantaneously. That should improve its effectiveness by eliminating potential cash flow concerns for some customers who would have to wait for a rebate check in the mail under alternative systems.

There are obviously a variety of additional choices that need to be made in designing a feebate policy. This paper endeavors to address all of the following design issues:

- Which equipment should be covered,
- Which fuels should be covered,
- The feebate structure ("banded" versus "linear" approach),
- Price setting the fees/rebates,
- The mechanism used to apply the fee and rebate,

[7] A CHS is a performance standard that is applied to fossil fuel providers, requiring them to deliver a gradually-increasing percentage of low-emission heating services to their customers.
[8] Additionally, legislators and policy makers are currently discussing how and whether to implement a pilot feebate focused on water heating equipment.

- Program administration and delivery,
- Equity – including concerns about minimizing adverse impacts on low income customers,
- Evaluation, measurement and verification (EM&V), and transparency, and
- Coordination with other states.

The authors' recommendations for the conceptual structure of an equipment feebate program are summarized in Table 1 below. Each of our recommendations is discussed in more detail in Section 3 below. Note that this report presents a "first cut" at the design of a heating equipment feebate. Additional analysis and program design, detailed implementation planning, and significant stakeholder outreach and education, would be critical to moving this policy forward.

Table 1. Equipment feebate straw proposal – high level recommendations

Policy Element	Recommendation and Notes
Scope of equipment and sectors covered	●For the initial pilot phase of an equipment feebate, apply the feebate to: ●DOE equipment defined as residential-sized. This generally covers equipment used in residential and many small commercial settings. ●Equipment used for space and (domestic) water heating. Specifically: furnaces; boilers; electric resistance; air and ground source heat pumps; air-to-water heat pumps; traditional and tankless water heaters; heat pump water heaters; solar hot water heaters; and, indoor wood/pellet stoves, boilers, furnaces. ●For equipment that can use different fuels (e.g. fuel oil or biofuel), no different treatment should be used. For example, if a furnace using fuel oil is purchased and the customer intends to heat with biofuel, the furnace should receive the same feebate as other furnaces. To address the fee associated with a furnace that utilizes biofuels, the authors recommend an indirect incentive resulting from emission reduction credits via a Clean Heat Standard. ●After the initial phase of the feebate has been successfully completed with lessons learned and incorporated, consider expanding the range of equipment to non-specialized equipment used in residential, commercial and industrial buildings. ●Customized equipment that serves specific commercial and industrial applications and processes should be addressed through another complementary policy such as a Clean Heat Standard.
Scope of fuel covered	●All fuels should be covered with a fee or rebate: Fuel oil, propane, piped gas, kerosene, biofuels, wood, electricity.
Structure of feebate schedule; size of fees/rebates	●Use a "step function" approach incorporating bands (or, groupings of equipment). A 5-banded approach could be: **Band 1 (larger fee)** | **Band 2 (smaller fee)** | **Band 3 (no fee or rebate)** | **Band 4 (smaller rebate)** | **Band 5 (larger rebate)** ●Determine the bands primarily on emissions, but with some adjustments and simplifications based on other factors.
Price setting the fees/rebates	●Set fees and rebates high enough to significantly change purchasing behavior. ●The price setting process should include a variety of stakeholders, utilize up-to-date economic data, and be revisited annually for the first few years of the feebate program implementation. ●Consider establishing a reserve fund in the event that the feebate is not revenue neutral at all times. Consider a fee, rebate, and equipment classification structure that is likely to generate increased revenue in early years, with that increase used to create the reserve fund that allows continuity as market demand for low GHG-emitting products grows (and therefore the demand for rebates grow).
Mechanism to apply fee and rebate	●Apply the fee and rebate via a variable sales tax at point of sale, collected by the Department of Tax. ●A simplistic example of aligning a variable sales tax to the Band structure could be as presented below. This is for illustrative purposes only – a detailed analysis as to which rates to apply to which bands is needed. Note that current sales tax is 6%, so therefore it is essentially a "neutral" band – neither increasing nor lowering the tax: **Band 1 (12% tax)** | **Band 2 (9% tax)** | **Band 3 (current VT sales tax: 6%)** | **Band 4 (3% tax)** | **Band 5 (0% tax)** ●Ensure that the feebate is clearly, simply and prominently labeled on equipment.
Program administration and delivery	●Department of Tax processes taxes, collects program uptake data and provides to efficiency utilities. Efficiency utilities coordinate with the Department of Tax, review data, analyze program uptake, conduct follow-up surveys to gain customer feedback, interpret socio-economic impacts, perform quality assurance/quality control, propose program modifications, report on program impacts, and coordinate marketing and point-of-sale messaging. ●Department of Public Service provides oversight and review (see below), and presents program results via website. ●Periodic review by Public Utility Commission (see below) and Legislature. ●Clean Energy Development Fund provides startup funding and Program Reserve Funds in case fees do not cover rebates.
Equity	●Utilizing a variable sales tax that applies at point of sale helps to mitigate cash flow challenges that may result from waiting for a rebate, and also helps to incentivize landlords to invest in more efficient equipment that may utilize fuels with less fuel price volatility, as compared to other fuels (e.g. electricity costs resulting from a heat pump are historically more stable than oil or propane heating costs). ●Further analysis should be conducted to assess if additional mechanisms (tax refund, complementary cash rebate for efficient equipment, additional incentives) may be needed to ensure that lower income Vermonters are not overly impacted by the feebate structure. A clear, simple methodology should be developed to determine the appropriate levels for lower income Vermonters. ●Explore other complementary initiatives, such as prioritizing low income Vermonters with Weatherization at Scale, as equity may not be fully addressed by a feebate program alone. ●Marketing and on-going technical assistance should be provided to meet the specific needs of lower income Vermonters and renters.
EM&V and Transparency	●In keeping with current energy efficiency program structures in Vermont, the Department of Public Service provides oversight and review of Feebate program design and implementation, with periodic review by Public Utility Commission. ●Program website that provides dashboard and metrics.
Coordination with other states	●Partner with neighboring states to track how many out-of-state sales are occurring. ●Require customer zip code collection for sales in VT to track rebates on equipment that might migrate out of state. ●Analyze data results to determine the need for program modification via the phased implementation approach.

2. Report Context

For several decades, Vermont has enacted policies, goals, and requirements that promote a shift to a more sustainable energy sector. This has taken myriad forms: establishment of the first statewide energy efficiency utility (Efficiency Vermont), early adoption of net-metered renewable energy, the closure of Vermont's sole nuclear power plant, and the development of more than twenty energy-related goals and statutes culminating in Vermont's Global Warming Solution Act of 2020. However, as shown in Appendix 1, the policies that have seen the most progress to date occur in the electricity sector, through Vermont's various distribution and efficiency utilities.

Figure 2 shows a variety of policies that are needed to achieve Vermont's GHG emission reduction requirements. The three key actions needed to shift towards clean energy are (in green): i) maximizing efficiency; ii) decarbonizing our energy sources[9]; and iii) strategically electrifying. Policy tools currently deployed in Vermont to achieve these goals are shown in light yellow. Those currently being discussed are shown in light blue. The pink rectangle at the bottom represents technologies and policies that enable the transition to a decarbonized grid; some of these have been actively used in Vermont for some time, while others are just beginning to be utilized. Note that four of the six policies that are in place in Vermont pertain to the electric sector only, with one exception being incentives to electrify our transportation sector (which still has a relationship to the electricity sector) and the other exception being the "all cost-effective" efficiency mandate applying to electricity and piped gas, both of which are regulated.

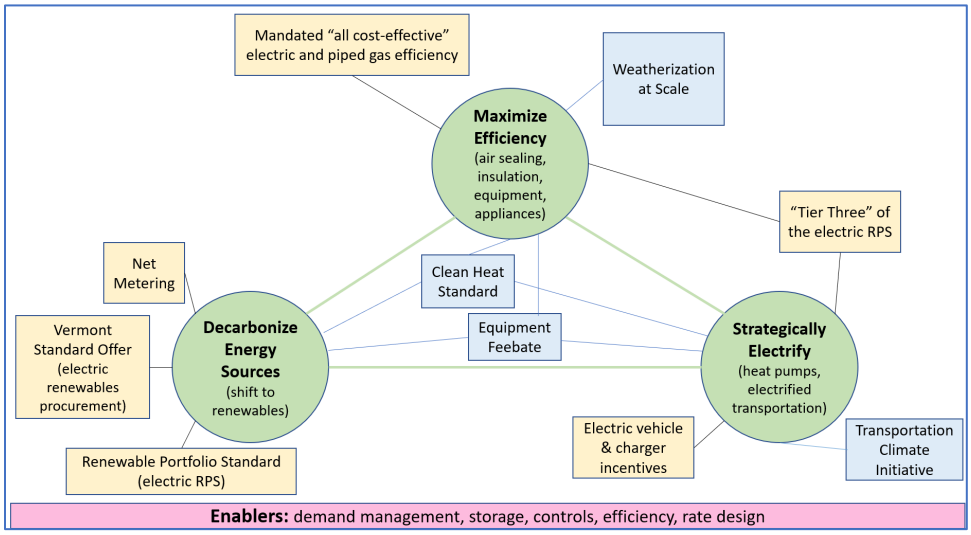

Figure 2. Select policy mechanisms to achieve a low-carbon future

As shown in Figure 3, the transportation and thermal sectors are the two leading producers of GHG emissions. These sectors have demonstrated little improvement over time in reducing GHG emissions in Vermont. In fact, from 1990 to 2018, thermal emissions increased by 16% and transportation emissions increased by 3%.

[9] Decarbonization must be applied to both the electric grid, by shifting to renewable electricity, as well as to piped gas and delivered fuels, for example through the use of B100 fuels and other sources.

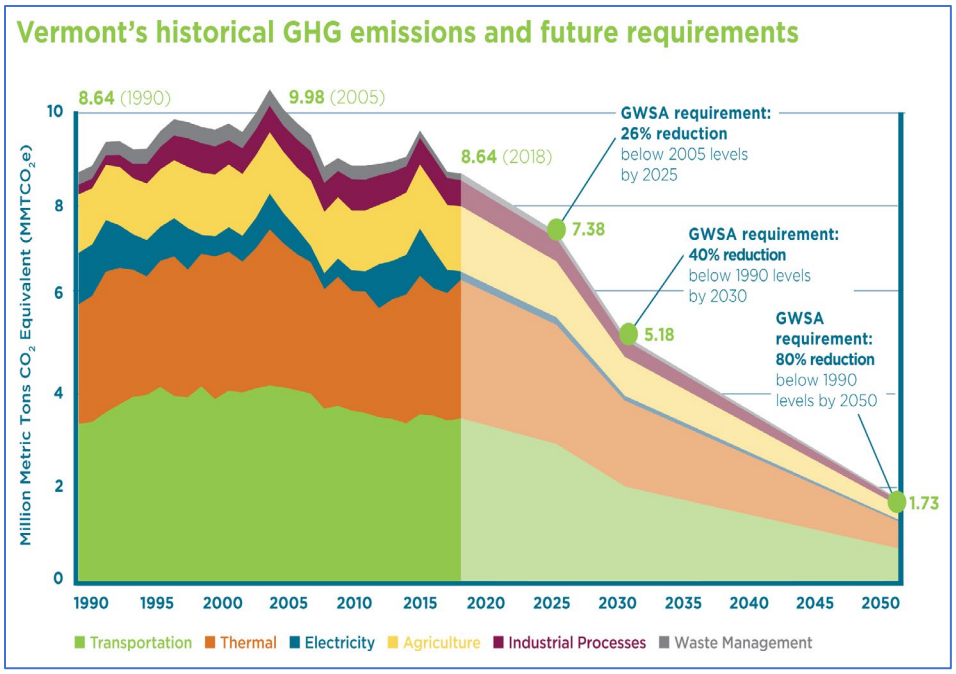

Figure 3. Vermont's historical GHG emissions and future requirements. EAN. 2021.[10]

As shown earlier in Figure 1, the thermal sector emits 34% of Vermont's greenhouse gases. This includes gases resulting from space and water heating. Fuels used for these activities include[11]:

- Fuel oil, also called "heating oil" and "oil" and referring to #2 distillate fuel oil;
- Propane, also referred to as liquid petroleum gas (LPG or LP gas);
- Various sources of bioenergy (wood such as cordwood/wood chips/pellets and biofuels);
- Natural gas, which this report refers to as "piped gas" (note that this should not be confused with propane gas, which is referred to as propane, or the "gas"oline that is used in internal combustion engine vehicles); and,
- Electricity.

As described earlier, this report focuses specifically on how to reduce the consumption of and emissions from equipment used for residential-sized space and water heating, which also captures the small commercial market segment.

The rationale for this is to provide program administrators and policy makers an opportunity to gain experience and understanding of the implementation process as well as the market response through a narrower, phased "roll out" approach. As technology advances and as experience with an equipment

[10] "Annual Progress Report for Vermont 2020/2021." Energy Action Network. Montpelier, Vermont. 2021. https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf

[11] Some Vermonters continue to use coal for heating their home, but this is rare in comparison to gas, propane and oil.

feebate progresses, policy makers could consider expanding the feebate to equipment other than that used for heating our spaces and domestic water.[12]

Additional reasons for phasing into an equipment feebate include the opportunity to allow program designers to understand the actual impacts of some concerns related to a feebate, and then course correct to address those concerns. One example of this is the concern that the fee may drive a portion of sales of high GHG-emitting equipment to bordering states.

Phasing into a feebate may also allow for better integration and alignment with other potential policies. For example, a feebate designed to directly target heating equipment can be coordinated with other policies being discussed in Vermont, such as the "Weatherization at Scale" initiative, which focuses on reducing energy losses through improvements to building envelopes. Further, these two policies – an equipment feebate and "Weatherization at Scale" - could be implemented under the kind of larger, umbrella policy necessary to meet the state's climate goals, such as the "Clean Heat Standard" (CHS) recently proposed by the Vermont Climate Council.[13]

The authors recognize that there are other policy tools that focus on heating equipment. For example, federal appliance and equipment standards[14] have improved the efficiency of various equipment, but these standards only establish a "floor" for efficiency. They also tend to consider the range of efficiency options available for each given fuel, rather than trade-offs in efficiency – let alone trade-offs in emissions – between equipment available for different fuels (e.g., switching from a propane furnace to an electric heat pump). These tools are insufficient to ensure Vermont's 2025, 2030 and 2050 energy mandates are met. If designed appropriately and implemented well, an equipment feebate sends a much-needed, additional market signal.

A key issue to address, as Vermont shifts away from fossil fuels, is how to ensure that this is done equitably and in a manner that protects the most vulnerable Vermonters. If appropriately designed, an equipment feebate can achieve this goal, as it can also serve to increase consumer protection, address energy burden, and lessen inequity. This is addressed in greater detail in Section 3.2.7.

Finally, it should be noted that an equipment feebate will not – unto itself – result in Vermont achieving its energy goals and requirements in the thermal sector in an affordable manner. First, turnover in equipment in buildings will not naturally occur at a quick enough pace to enable the state's 2025 and 2030 emissions reduction goals to be met through incentives designed to influence customer purchases at the time they are in the market for new equipment. Second, while incentives can help influence purchase decisions, they will not cause every customer to change to the least emitting heating system. Finally, simply shifting from an oil furnace to a ducted heat pump system in thousands of inefficient, leaky buildings, could result in overtaxing our electric grid if a significant increase in electric demand should occur. This could lead to other challenges, such as costly grid investments and building occupant discomfort. Thus, as discussed above, an equipment feebate must be designed and developed in coordination and alignment with other policies, for example, the Weatherization at Scale initiative and a

[12] For example, residential and/or commercial cooking equipment, larger, non-specialized commercial and industrial equipment, as well as to other sectors such as transportation.
[13] A CHS is a performance standard that is applied to fossil fuel providers, requiring them to deliver a gradually-increasing percentage of low-emission heating services to their customers.
[14] https://www.energy.gov/eere/buildings/appliance-and-equipment-standards-program

Clean Heat Standard. The Weatherization at Scale initiative can serve to address concerns about shifting to electrified heat in leaky buildings, while the Clean Heat Standard can provide the market-based, overarching GHG emissions reduction performance standards necessary to achieve the state's goals. These three policies complement one another, and can provide a framework for Vermont to achieve its multiple goals and requirements at the pace required.[15]

While greater progress is clearly needed in all sectors, significant progress has already been achieved in the electricity sector and there are active policy conversations regarding the transportation sector. Hence, many EAN members have turned their attention to addressing emissions from the thermal sector – a feebate applied to fossil fuel-based heating systems is one policy tool that can help in this area, in coordination with other policies and programs. For the above reasons, this paper focuses on residential-sized space and water-heating equipment.

3. Policy Focus: Equipment Feebate

3.1 What is a Feebate?

A feebate is a revenue-neutral approach to incentivize products that are aligned with policy goals while discouraging products that are not aligned with policy goals, as shown in Figure 4. This most commonly occurs at the time of sale or, in the case of automobile feebate programs, vehicle registration. While the concept of a feebate is not new, its use has been relatively limited to-date and has mostly focused on incentivizing vehicles with lower carbon emissions. In practice, this has often meant that both more efficient fossil fuel vehicles and those with a different fuel source (electricity) have been incentivized over less efficient fossil fuel vehicles. Our focus in this paper is on the thermal sector, specifically aimed at space and water heating equipment. A feebate is attractive from an economic point of view because it sends price signals to influence behavior aligned with policy goals in a way that does not require a new funding source. This "self-contained" aspect also increases interest in feebates among policymakers looking for options that will not require additional revenue.

A FEEBATE IS A REVENUE-NEUTRAL APPROACH TO INCENTIVIZING PRODUCTS THAT ARE ALIGNED WITH POLICY GOALS AND DISCOURAGING PRODUCTS THAT ARE NOT ALIGNED WITH POLICY GOALS, MOST COMMONLY AT THE TIME OF SALE OR, IN THE CASE OF AUTOMOBILE FEEBATE PROGRAMS, VEHICLE REGISTRATION.

[15] A Clean Heat Standard can be likened to Vermont's Renewable Energy Standard (RES), with other policies such as an equipment feebate and Weatherization at Scale, being likened to the various Tiers within Vermont's RES.

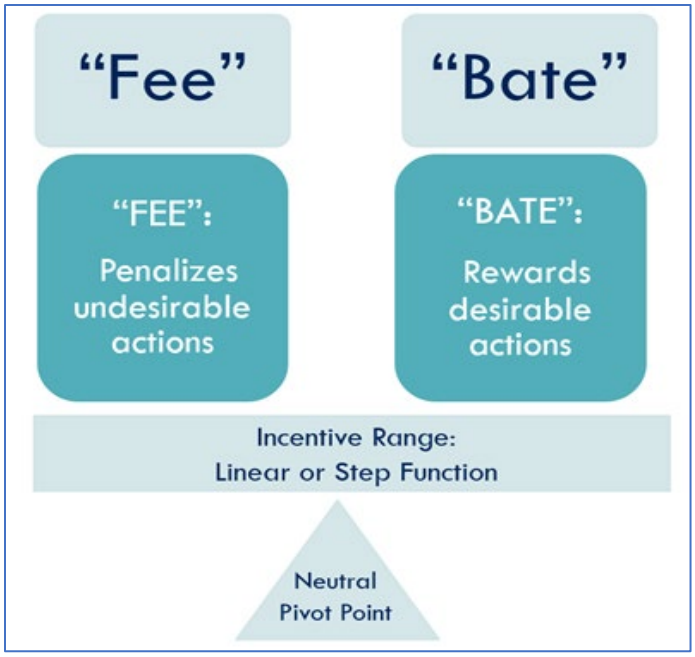

Figure 4. "Feebate" in graphic representation

As with any policy, there are many factors to consider; these are discussed more fully below. However, two key elements to the design of a feebate include the structure of the feebate "schedule" and the determination of the neutral "band" or "pivot point".

The structure of the feebate schedule can incorporate either a "linear" or a "step function" approach. With a linear approach, fees and rebates are based on a formula applied to every product, which then results in a different fee or rebate for each individual product. This more accurately matches program goals but can be more difficult to administer and be more confusing for consumers.

Alternatively, a "step function" creates a small set of rebates/fees for a limited number of "bands", or groupings of equipment. These are easier to understand for consumers but do not achieve quite the same degree of detailed refinement in aligning the environmental cost/benefit with the price signal. Regardless of the approach, the fees and rebates should be set at levels that will encourage changes in behavior, but there can be limits based on the funding provided by the fees and what is politically acceptable. An example of a "step function" or "band" approach is provided in Figure 5 below.

Band 1 (larger fee)	Band 2 (smaller fee)	Band 3 (no fee or rebate)	Band 4 (smaller rebate)	Band 5 (larger rebate)

Figure 5. Step Function Example

Policy makers must also determine where the pivot point, or "neutral band", rests. This is the band, or point at which, there is a minimum acceptable level of efficiency and emissions. Equipment that is not aligned with policy goals receives a fee and equipment that is most aligned with policy goals receives a

rebate. At the neutral band, or pivot point, there can be a group of products that are subject to no rebate or fee, if desired.

Ensuring the feebate is achieving the desired policy goals and maintaining transparency of information is key to providing trust in a new type of policy mechanism. Thus, states and countries that have implemented feebates, closely analyze the impact and outcome of the feebate on a regular basis, modifying as needed. Further, if the feebate has the intended effect in sales, then over time more people will have purchased the rebated products and fewer people will be purchasing the products that incur a fee. Thus, periodic (potentially annual) recalibration of the feebate design is necessary, including potentially shifting the "neutral band" and changing the fees and rebate levels, in order to keep the structure approximately revenue neutral. This ongoing analysis is usually coordinated closely with economists and public policy experts.

PERIODIC (POTENTIALLY ANNUAL) RECALIBRATION OF THE FEEBATE DESIGN IS CRITICALLY NECESSARY, INCLUDING POTENTIALLY RAISING THE PIVOT POINT AND CHANGING THE FEES AND REBATE LEVELS.

3.2 Equipment feebate policy considerations

Elements of a feebate policy for Vermont's residential space and water heating equipment should be considered in the context of the policy goals it should accomplish. Alignment with existing related policy goals is critical. Clearly, this includes existing energy programs such as: i) those offered by Vermont's energy efficiency utilities and distribution utilities; ii) energy-related goals such as the Paris Agreement, Vermont's new Global Warming Solutions Act including 2025, 2030 and 2050 emissions targets; and iii) statutory requirements such as Tier Three of the Renewable Portfolio Standard (see Figure 2 for a full list). However, it should also be considered in light of its interplay with other policy goals and requirements, such as economic and air quality policies, as well as the Vermont Department of Health's "Health in All Policies".[16] One example of this is with regard to how increases in wood heating interplays with local economic development, sustainable forestry management and air quality. The next subsections describe key design considerations when developing a heating equipment feebate.

3.2.1 Scope of equipment, sectors and fuels covered

Since the goal is to change purchasing behavior when a customer needs to replace a product, the program should seek to include all options available to a given customer. Otherwise, any product type not included essentially falls into the "neutral band" (or "pivot point") from the customer's point of view – which may not be the intent of the policy makers. This means that all fossil fuels, piped gas, and electric (heat pumps and resistance) options that have non-minimal sales should be considered for inclusion. Wood-burning products should also be considered and are discussed in more detail below.

The size and application of equipment also needs to be considered. Classifying equipment by market *sector* (residential, commercial, or industrial) is more difficult than by *fuel sales*, because smaller commercial buildings generally use the same equipment as homes. For an initial heating equipment feebate roll out, we recommend focusing on water heating used for domestic purposes, as well as space heating, with a prioritization on residential sized equipment. For example, a natural cutoff point could be the U.S. Department of Energy's (DoE) determination of 300,000 British thermal units per hour

[16] https://www.healthvermont.gov/about/performance/health-all-policies-scorecard

(Btu/h) to separate its classification of residential and commercial boilers, and 225,000 Btu/h for furnaces. These cutoff points would be appropriate for a feebate program that focused more on residential equipment and would also capture part of the commercial market.

Of course, there are additional uses of fuel burned on site in buildings, namely for cooking, drying, and for industrial process heat. We do not recommend initially including cooking, drying, or other smaller end uses. This equipment could be incorporated in a future feebate program, after experience has been gained from the initial feebate roll out.[17] We also do not recommend including equipment designed specifically for industrial processes during the initial phases of the feebate program. Such equipment is more specialized and low-carbon replacement options may not always be available yet. This market requires further study, and could also be addressed in part through some of the other complementary policies, such as a Clean Heat Standard, as shown previously in Figure 2.[18]

3.2.1.1 Approach to biofuels

Liquid biofuels, such as biodiesel and renewable gas, will likely play a role in Vermont's future low-carbon energy system. This is because biofuels are often considered to be cleaner, emitting fewer emissions than fossil fuels like piped gas, propane, oil and kerosene. Currently, only a very small amount of biofuel is mixed in with some fuel oil deliveries (less than 2% of total sales)[19]; Vermont Gas also sells a small amount of biogas. Generally, albeit with small modifications, biofuels use the same equipment as piped gas, propane and oil. Therefore, if sales of such biofuels increase substantially in the future (for example, in response to a CHS), it may be appropriate to reassess the application and/or design of the equipment feebate.

It is a challenge trying to exclude heating equipment that could consume biofuels because – at least in the case of delivered fuels – a customer buying biofuels today could switch back to fuel oil (the same could happen if the home is sold to a new occupant). For these reasons, we recommend that all equipment utilizing these fuels be treated the same within the design of the feebate, and that the approach to incentivizing a shift to biofuels is addressed through a biofuel incentive – ideally an indirect incentive resulting from emission reduction credits produced through a Clean Heat Standard. This is shown in Table 2.

3.2.1.2 Approach to wood

Unlike biofuels, most wood burning equipment is primarily suited to burning wood only. The net emissions from burning cordwood vary widely based on its source, condition and technology. Advanced wood stoves, pellet stoves, and central wood pellet boiler and furnace systems that have significantly lower emissions than traditional wood heating equipment may be the only equipment that should be

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[17] As mentioned earlier, once lessons have been learned through the initial phase of the feebate, expanding in other sectors (industrial, transportation) and including other technologies (cooking, clothes washing, small off road equipment, lawnmowers, snow/leaf blowers, chain saws) could be considered.

[18] A DFES is a policy or regulatory mechanism that ensures consistent annual progress on investments in cost-effective measures to reduce consumption of delivered fuels. A CHS is a performance standard that is applied to fossil fuel providers, requiring them to deliver a gradually-increasing percentage of low-emission heating services to their customers.

[19] https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Legislative_Reports/2021%20Annual%20Energy%20Report%20Final.pdf Page 37.

incentivized through a feebate program.[20] This would encourage the replacement of older wood heating equipment with cleaner burning, higher efficiency units. Coordination with other state policies, and particularly federal regulations, is critical when considering wood heat as there may be a need to consider air pollutants when determining a feebate level for a particular class of wood burning equipment.[21]

Table 2 presents the authors' proposed approach to addressing the scope of equipment, sectors and fuels covered by an initial, phased feebate.

Table 2. Proposed approach to addressing the scope of equipment, sectors and fuels covered

Policy Element	Recommendation and Notes
Scope of equipment and sectors covered	●For the initial pilot phase of an equipment feebate, apply the feebate to: ●DOE equipment defined as residential-sized. This generally covers equipment used in residential and many small commercial settings. ●Equipment used for space and (domestic) water heating. Specifically: furnaces; boilers; electric resistance; air and ground source heat pumps; air-to-water heat pumps; traditional and tankless water heaters; heat pump water heaters; solar hot water heaters; and, indoor wood/pellet stoves, boilers, furnaces. ●For equipment that can use different fuels (e.g. fuel oil or biofuel), no different treatment should be used. For example, if a furnace using fuel oil is purchased and the customer intends to heat with biofuel, the furnace should receive the same feebate as other furnaces. To address the fee associated with a furnace that utilizes biofuels, the authors recommend an indirect incentive resulting from emission reduction credits via a Clean Heat Standard. ●After the initial phase of the feebate has been successfully completed with lessons learned and incorporated, consider expanding the range of equipment to non-specialized equipment used in residential, commercial and industrial buildings. ●Customized equipment that serves specific commercial and industrial applications and processes should be addressed through another complementary policy such as a Distributed Fuels Efficiency Standard or a Clean Heat Standard.
Scope of fuel covered	●All fuels should be covered with a fee or rebate: Fuel oil, propane, piped gas, kerosene, biofuels, wood, electricity.

3.2.2 Structure of feebate schedule

Two key elements in the design of a feebate include the structure of the feebate schedule (i.e., "step function" or "linear" approach) and the determination of where the "pivot point" or "neutral band" occurs within the schedule. A "step function" creates a small set of rebates/fees for a limited number of "bands", or groupings of equipment. With a linear approach, fees and rebates are based on a formula applied to every product, which then results in a different fee or rebate for *each* product. This more accurately matches program goals but can be more difficult to administer and be more confusing for consumers. Because of its relative simplicity in program design and implementation, and therefore presumably a corresponding increase in consumer understanding of how the feebate works, we recommend using a "step function" approach, incorporating a series of bands of grouped equipment.

This report recommends five bands in total: two bands with fees of different amounts, one neutral band, and two bands with rebates of different amounts. A five-banded approach walks the "middle line"

[20]The authors recognize that the burning of wood does result in GHG emissions and that in many states, wood heat is not considered renewable. However, it is considered a renewable resource in Vermont and is currently a significant heating resource for Vermonters. This is unlikely to change – certainly not in the near future – given Vermont's culture of heading into one's own forest and chopping one's own trees. For these reasons, it is incorporated into the proposed equipment feebate structure for Vermont – but if this policy were to be implemented in other states, it may be deemed inappropriate to do so.

[21] For example, the EPA is currently reassessing wood heating equipment compliance with Clean Air Act standards, so the proposed equipment listed in Table 5 is likely to change in the near future.

between program precision and program simplicity. It provides for slightly more granularity in aligning products with policy intent as compared to a three-banded approach, while keeping the overall program design relatively streamlined. Further, as will be described in greater detail below, we recommend that bands be determined based on a blended approach that considers greenhouse gas emissions, fuel type, and equipment type and size. Table 3 presents suggestions pertaining to the general design of a step function schedule.

Table 3. Proposed approach to feebate structure

Policy Element	Recommendation and Notes
Structure of feebate schedule; size of fees/rebates	●Use a "step function" approach incorporating bands (or, groupings of equipment). A 5-banded approach could be: Band 1 (larger fee) | Band 2 (smaller fee) | Band 3 (no fee or rebate) | Band 4 (smaller rebate) | Band 5 (larger rebate) ●Determine the bands primarily on emissions, but with some adjustments and simplifications based on other factors.

Ideally, a heating equipment feebate program should have bands that are aligned with the goal of a quick, cost-effective transition to a low-carbon energy system and the associated GHG emissions reductions. However, determining where specific equipment should be placed within the bands quickly becomes complicated.

For example, consider a property that is well-sealed and insulated, is heated by cold climate air source heat pumps (ccASHPs), and is also located in a utility territory that obtains 100% of its power from renewable sources. In the event that the property owner wants to install electric baseboard heat as a "backup" for the heat pumps on the coldest winter days, should this equipment receive a fee (because most applications of electric baseboard in Vermont will not meet the criteria just described), be considered neutral (to recognize that there may be a need at times to have supplemental heat for ccASHPs, and the building shell is relatively "tight"), or receive a rebate (because the utility is 100% renewably sourced)?

Equipment size (heating capacity) and its emissions intensity are also factors to consider. Specifically, the overall impact to emissions of a heating system choice will be determined by both size (assuming it is properly sized for the load it will serve) and emissions efficiency. Fees/rebates that do not take size into account could also change purchasing decisions in ways to minimize the fees or maximize the rebate but without actually impacting emissions reductions. For example, a homeowner could choose to replace a dual oil boiler system with a single large oil boiler if the fees were much lower for that option. Fees and rebates based on a percentage of sales price could address this to some extent, as larger systems are generally more expensive than smaller ones.

These examples illustrate that bands can be defined by a variety of factors such as equipment type, size, efficiency, equipment fuel (and/or utility power source), as well as overall GHG emissions. Ultimately, we propose a blended approach to defining the bands within the step function schedule. The primary driver in determining which equipment falls within each band is GHG emissions, but this does require, at times, melding other factors such as equipment size, efficiency, and fuel source.

We suggest two separate band ranges – one for space heating and one for water heating. Generally, we recommend that equipment utilizing fossil fuels be assigned a fee[22], along with electric resistance heat.[23] We recommend that the neutral band include equipment that is generally considered efficient, but we place equipment with greater levels of efficiency in the two rebate bands.

Regardless of the initial program design, the placement of equipment within the bands should be reviewed frequently and updated as needed to reflect changing market conditions and new products.[24] An annual review, at least for the first few years, would be best to capture market changes and ensure program effectiveness. Table 4 presents an initial feebate structure straw proposal, placing equipment within the five "step function" bands.[25] This reflects the authors' intent to align feebate bands with equipment specifications determined by others, such as the Consortium for Energy Efficiency (CEE), Northwest Energy Efficiency Alliance (NEEA) and Northeast Energy Efficiency Partnerships (NEEP), to further simplify program implementation complexity and to leverage the work of others.[26] Table 4 is presented separately from Table 3 because the details regarding equipment specifications should be considered for illustrative purposes only, and should certainly be discussed in far greater detail with experts familiar with the technologies.

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[22] It will be important to address sending "mixed" market signals pertaining to gas. For example, subjecting efficient piped gas equipment to a fee while it is simultaneously being given a rebate by gas efficiency programs could lead to market confusion. This is a good example of the need for program and policy alignment between an equipment feebate with existing efficiency programs and with any potential new programs. One option to address this is to preclude equipment measures in the efficiency programs and to instead rely solely on the equipment feebate to address this equipment.

[23] Vermont's newly updated building energy code prohibits electric resistance heat except in specific circumstances, for example on the very coldest days or in bathrooms or colder rooms. Specifically, in a building with cold-climate heat pumps as the primary heating system, the supplemental electric resistance heat is controlled to prevent it from operating at an outside air temperature of 5° or more. The building must also have a tested air tightness of ≤2.0 ACH50. To ensure that new, electric baseboard equipment is only applied in the rarest of cases and to address the examples provided above, we recommend subjecting this equipment to a small fee. As the regional grid transitions to being predominantly renewably-powered, this could be reassessed. Vermont Residential Building Standards (RBES) Energy Code Handbook. Section 2.4b. September 1, 2020. https://publicservice.vermont.gov/sites/dps/files/documents/2020_VT_Energy_Code_Handbook_v6-DIGITAL_for_website.pdf

[24] As mentioned earlier, one example is that the EPA is currently reassessing wood heating equipment compliance with Clean Air Act standards, so the proposed equipment listed in Table 5 is likely to change in the near future.

[25] The authors recognize that there may not be perfect alignment between the DoE's definition of residential equipment for furnaces and boilers and what is proposed in Table 5 (for example, residential sized heat pumps are generally 65,000 Btu and smaller, which is not identical to the 300kBtu DoE demarcation). While not all of the available equipment will align perfectly, we nevertheless provide these directional recommendations as a "starting point" to the equipment feebate design discussion.

[26] The authors also recognize that refrigerant leakage from heat pumps result in GHG emissions. This does need to be considered within the larger context of strategically shifting to ccASHPs, but is not addressed in this paper.

Table 4. Feebate structure straw proposal – equipment bands

Water Heating (Domestic Hot Water, "DHW")				
Band 1 (larger fee)	**Band 2 (smaller fee)**	**Band 3 (no fee or rebate)**	**Band 4 (smaller rebate)**	**Band 5 (larger rebate)**
<.87 Uniform Efficiency Factor[1] (UEF) (fossil fuel)	.87 - .95 UEF (fossil fuel); ≤1 UEF (electric)	.95 – 1.0 UEF (fossil fuel)	>1.1 UEF[2]; Ground source heat pump (GSHP, also colloquially referred to as "geothermal") desuperheater	Cold climate air source heat pumps (ccASHPs) included in Northwest Energy Efficiency Alliance's (NEEA) Tier 3 or Tier 4 list[3]; Solar hot water; Dedicated GSHP DHW[4]; Efficient wood boiler with thermal storage

[1]UEF is the newest measure of water heater overall efficiency. The higher the UEF value is, the more efficient the water heater. UEF is determined by the Department of Energy's test method outlined in 10 CFR Part 430, Subpart B, Appendix E. https://www.energystar.gov/products/water_heaters/residential_water_heaters_key_product_criteria
[2]Based on CEE equipment specifications.
[3]https://neea.org/resources/hpwh-qualified-products-list
[4]Water-to-air heat pump with dedicated ("on demand") hot water cycle; OR water-to-water heat pump with storage tank for DHW.

Space Heating				
Band 1 (larger fee)	**Band 2 (smaller fee)**	**Band 3 (no fee or rebate)**	**Band 4 (smaller rebate)**	**Band 5 (larger rebate)**
<90% Annual Fuel Utilization Efficiency (AFUE) for fossil fuels	90 – 100% AFUE for fossil fuels; Electric resistance	Non-cold climate Air source heat pumps (ASHPs); EPA certified indoor wood heat appliance	Northeast Energy Efficiency Partnerships (NEEP) ccASHP specification 3.1[1]; GSHPs[2]; Best-in-class indoor pellet and wood stoves	ASHPs meeting ENERGY STAR V 6.1[3] criteria for cold climates; GSHPs meeting ENERGY STAR criteria[2,4]; Indoor centrally automated wood furnace or boiler

[1]https://neep.org/sites/default/files/media-files/cold_climate_air-source_heat_pump_specification-version_3.1_update.pdf (e.g. currently listed on NEEP's ccASHP page https://ashp.neep.org/. NEEP may modify this to utilize a "tiered" approach.
[2] Closed-loop or surface water source; no standing-column wells.
[3]https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%206.1%20Central%20Air%20Conditioner%20and%20Heat%20Pump%20Final%20Specification%20%28Rev.%20January%20%202022%29.Pdf
[4]https://energystar.gov/sites/default/files/asset/document/Geothermal%20Heat%20Pumps%20Version%203.2%20Final%20Specification.pdf
Note: The EPA is currently revising wood heat standards and requirements, hence the high level presentation of wood heating equipment in this Table.

3.2.3 Price setting the fees/rebates

The size of the incentive in relation to the fee must be analyzed to ensure that the feebate program, over time, is revenue neutral and sustainable until policy makers determine the goals have been achieved (i.e. only the desired equipment is purchased) and the feebate is no longer needed. Finding the "sweet spots" for the feebate incorporates multiple variables and will change over time. Generally, this process incorporates the input of a variety of stakeholders, including economists, policy makers, and others, utilizing the most up-to-date market and economic data.[27]

As an example, in 2018, Energy Futures Group conducted a high level analysis to determine how a feebate may be priced, such that it resulted in revenue neutrality. Data inputs for this analysis included 2016 National Sales data and system cost estimates from a Vermont installer. Feebate variables applied included: a 20% fee on inefficient fossil fuel based heating equipment, a 10% fee on efficient fossil fuel based heating equipment (increasing by 1% per year) from 2020 – 2030, and a flat 8% rebate applied to preferred equipment. The analysis assumed no change in pricing over the ten years and overall market growth at .5% (heat pumps at 9%, wood heat at 2% and fossil fuel systems at -15%). Rebates were provided for all wood technologies, and there was no assessment of whether the changed equipment was a full replacement or just a displacement of fossil fuel heating. This analysis is presented for illustrative purposes only. Figures 6 and 7 show the revenue impact and equipment sales, respectively.

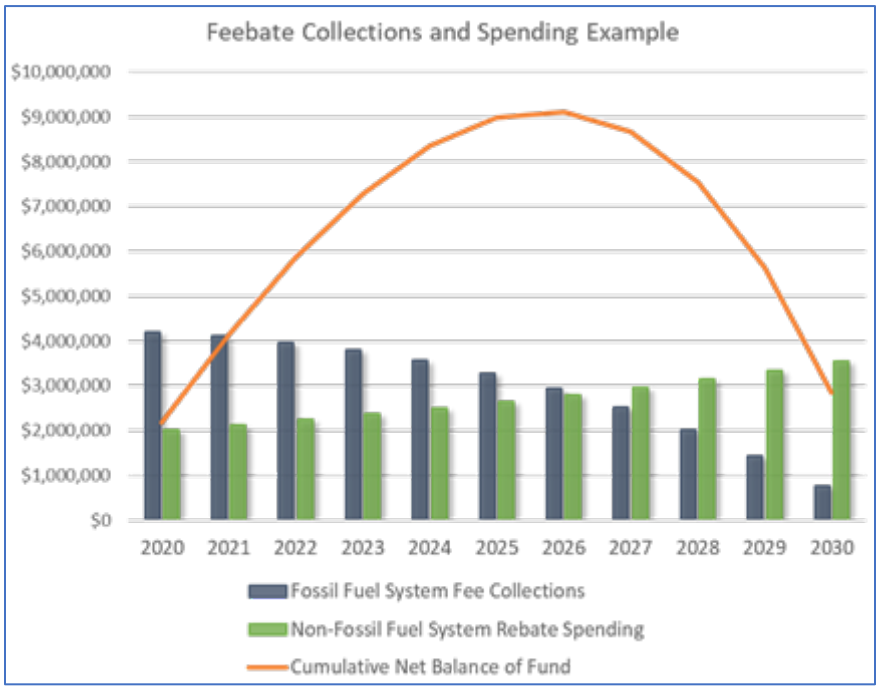

Figure 6. Feebate Collections and Spending Example

[27] Determining the size of the fees and rebates is outside the scope of this paper, but is a key next step to implementation.

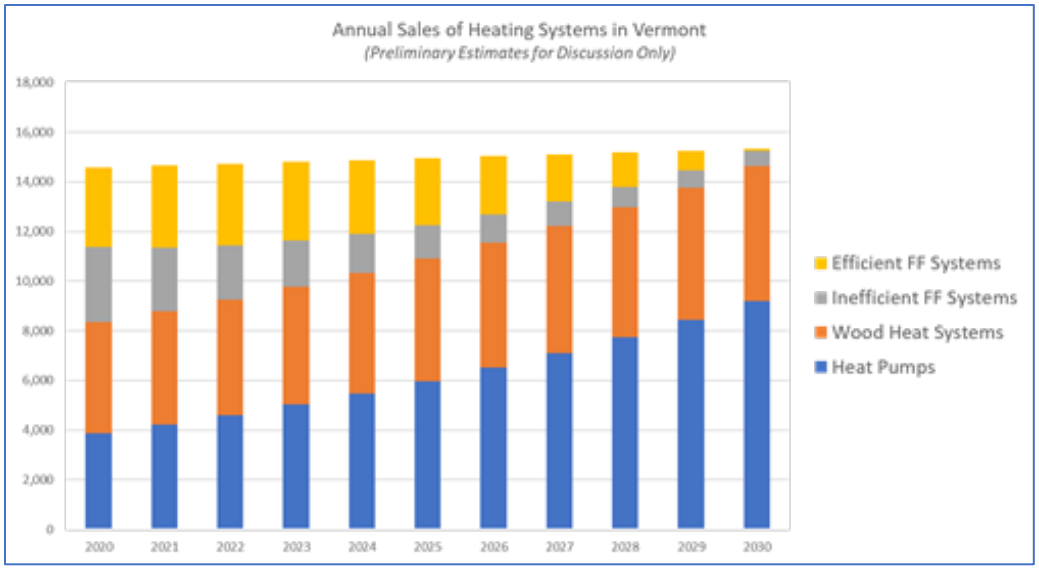

Figure 7. Annual Equipment Sales Example

Phasing in or starting small might seem attractive as a way to begin a feebate program to test how it works. However, if purchasing behavior is not significantly changed, then there is a high likelihood that the program could be ineffective, thereby delaying the intended outcome to reduce greenhouse gas emissions and undermining trust in the feebate as an effective policy tool. Additionally, the cost of a new furnace, boiler, or heat pump can be less than half of the total installation cost of a heating system replacement, because much of the total cost stems from the labor involved. Therefore, a feebate on just the equipment cost may need to be large in order to make a significant enough difference in the overall purchase price to change behavior. This is not to say that the fee must be excessively high (set at the price of elasticity) for it to work effectively. Rather, the fee must be set high enough that consumers notice and – in conjunction with other market factors (such as the ability to gain air conditioning via heat pumps, the establishment of a CHS, etc.) – influence the consumers' final purchase decision.

As with other feebate design factors, an annual review process of the pricing is critical to ensure that the overall feebate is achieving the policy goals intended, to provide an opportunity to "reset" the feebate to align with market and economic factors, to assess the level and impact of out-of-state sales, to monitor the potential for unintended consequences (such as increasing the energy burden for lower income Vermonters), and to, ultimately, provide an opportunity to make any necessary adjustments.

A feebate that is well-designed and properly calibrated to the market should result in a revenue neutral program to the state.[28] However, setting up a reserve fund (for example, within the Clean Energy Development Fund) may be warranted. Reserve funds could be used to address the lag time between incoming fees and outgoing rebates and to mitigate potential risk in the event that the fees do not balance out the incentives. As shown in the hypothetical example in Figure 7, the fees, rebates and equipment classifications can be set up so that the net effect in early years is a net increase in revenues, with that increase used to create the reserve fund that enables the program to continue as the market

[28] Note that, while an effective feebate is revenue neutral to the state, it is not for individual manufacturers and businesses. Some commercial outfits stand to lose money through a feebate, and therefore it is likely that a feebate will receive pushback from these entities.

transitions to a greater number of rebated low-GHG emitting equipment and fewer fees for higher GHG-emitting equipment. Table 5 below shows high-level recommendations regarding price setting for the feebate bands.

Table 5. Proposed approach to price setting

Policy Element	Recommendation and Notes
Price setting the fees/rebates	●Set fees and rebates high enough to significantly change purchasing behavior. ●The price setting process should include a variety of stakeholders, utilize up-to-date economic data, and be revisited annually for the first few years of the feebate program implementation. ●Consider establishing a reserve fund in the event that the feebate is not revenue neutral at all times. Consider a fee, rebate, and equipment classification structure that is likely to generate increased revenue in early years, with that increase used to create the reserve fund that allows continuity as market demand for low GHG-emitting products grows (and therefore the demand for rebates grow).

3.2.4 Mechanisms to apply fees and disburse rebates

The mechanism for and timing of fee collection and distribution can occur in a variety of ways. Below, we present benefits and challenges associated with different options. Ultimately, our suggested approach is to apply a variable sales tax that would be administered by the Vermont Department of Taxes.

3.2.4.1 Mechanisms to apply fees

Fees could be collected at the wholesale, retail, or installer level. Collection of fees at the wholesale level would simplify administration by requiring far fewer collection points than at the retail or installer level. Many existing energy efficiency programs already provide instant rebates at the wholesale level to encourage widespread adoption and increase the stock of efficient equipment by wholesalers. Collections at the wholesale level would, however, make it more difficult to handle out of state purchases, since an installer generally purchases the equipment from the wholesaler. This could have the unintended consequence of driving installers to use out of state wholesale distributors to avoid the fees. Efficiency programs have had success requiring contractors to identify the installation address in order to confirm eligibility for instant rebates, but there would be no incentive to provide it for a product that would be subject to a fee rather than a rebate.

Collection at the retail/installer level would involve many more collection points, but it could enable easier identification of Vermont installations. Even with collections at the retail/installer level, it would be difficult to collect for self-installed equipment purchased out of state either in person or via the internet. Self-install customers may already be using both of these avenues as a way to avoid sales taxes on a relatively expensive purchase. It should be noted that in-person retail outlets for heating equipment are fairly limited, as many distributors will only sell to installers. However, there are exceptions, such as big box stores, and there are now many internet sellers.

Ultimately, there may not be a way to ensure that no out-of-state purchases are made - internet or otherwise. This is one of the reasons why an annual review and recalibration process is recommended. Because this may or may not be a big issue, initial development and Year 1 of feebate implementation could initially ignore this issue, as long as it is reviewed during one of the regular program review and modification periods.

3.2.4.2 Mechanisms to disburse rebates

Similar to fee collection, rebate distribution can occur at multiple levels: via mail-in or online, at the wholesale, or at the retailer or installer level.

A relatively simple way to distribute the rebate for lower emitting equipment is via a mail in or on-line rebate. However, a separate rebate might make it more difficult for some customers to understand the true cost of the product and diminish its effectiveness. Education and awareness could be used to mitigate this issue, and installers would have an incentive to inform customers of their availability and provide the forms to them. A key issue with this approach, however, is the potential for increasing income inequity. Additional, post-purchase processes that require applications, as well as time lags between the initial purchase and arrival of the rebate check, can be hurdles for lower income Vermonters. This is another reason for the recommendation of a variable sales tax applied at the time of the sale.

Applying rebates at the wholesale level would require participation agreements with each wholesaler that serves the state. As described above, this has been accomplished by efficiency programs for heating, ventilation and air conditioning (HVAC) and other equipment, but in those cases participation is optional. While it is likely that all wholesalers serving Vermont installers would participate, since the rebates would be wanted by their wholesale customers, there could be no requirement to do so for out of state wholesalers.

Disbursing rebates at the installer/retailer level offers the benefit of ensuring it is captured in the sales price while making it easier to apply it to all Vermont installations. If the rebate were to be handled by the installer, prompt rebate fulfillment would be a critical requirement. Large rebates for heating equipment sold (in many cases) by very small businesses may be difficult for the business, particularly if the installer needs to give the discount to the customer up front and then wait for the reimbursement from the feebate program. Processing the rebate through the installer also presents the risk that the installer will not pass on some or all of the rebate to the customer if it is hidden from view. While this might not seem fair to customers, it is essentially transferring some of the incentive to sell the lower-carbon product to the installer, which could still help drive uptake of lower-carbon equipment. Finally, processing the incentive through the installer visibly signals to Vermont contractors and property owners where state policy makers intend to direct the heating equipment market.[29]

Lastly, rebates could be administered by a statewide program administrator such as Efficiency Vermont. If the fees are collected by the Department of Taxes, these could then be transferred to the statewide program administrator, along with other information such as the type of equipment purchased. This approach, however, still results in a time lag between when the purchase is made and when the rebate is received.

3.2.4.3 Recommended approach to applying fees and rebates

The approaches described above offer various benefits and challenges. Ultimately, we recommend applying the same mechanism – a sales tax administered by the Department of Taxes – via a variable

[29] Another alternative is to allow or require the customer to sign over the rebate to the installer. This approach ensures that the rebate appears on the invoice, but the customer does not have to go through the steps of submitting a rebate. This may still result in cash flow issues for smaller contracting businesses, as they await receipt of the rebate from the program administrator.

rate to equipment regardless of which Band it falls in because it is simple, immediate and clear. While not an easy "lift" for the Department of Taxes, the authors recommend this approach for a number of reasons including but not limited to the facts that: it is the most simplistic for manufacturers, retailers and consumers; it presents the full value of the feebate at the point of sale (both the penalty and reward); it minimizes the number of steps and entities needed to collect fees and disburse rebates; and it minimizes time lags that could impact cashflow for retailers, contractors and homeowners.

This approach can also help mitigate two equity challenges. First, it ensures that lower income Vermonters are not waiting for a rebate check (which could create cashflow challenges) but rather experience the benefits of the reduced tax immediately at the time of sale. Second, it provides further incentive to landlords to purchase more efficient equipment that (generally) utilizes fuels that experience less fuel price volatility.[30]

Specifically, the five bands could receive variable tax rates, such that Band 3 (the "neutral" Band, which does not receive a fee or an incentive) remains at the state tax rate, currently at 6%. Band 1 and 2 would be taxed more than the state sales tax level (e.g. Band 1 at 12% and Band 2 at 9%), with Bands 4 and 5 being taxed less than 6% (e.g. Band 4 at 3% and Band 5 at 0% tax).[31] Because current sales tax is 6%, applying a 6% sales tax to a piece of equipment is essentially treating the equipment neutrally, neither applying a fee nor providing a rebate – but rather, keeping with current market structure. Finally, this example is illustrative only, as the exact determinations would ultimately need to be thoroughly analyzed to ensure that they effectively influence purchasing choices while balancing overall revenues within the feebate design.

Critically, applying the feebate at the point of sale offers a unique opportunity to inform and educate consumers about the long term financial impacts of their purchase choice, resulting in the feebate acting as a form of consumer protection. To be most effective, the fee could be presented on all equipment with a color coded band approach, such as that used in the European Union for energy efficient equipment (Figure 8). It is recommended to show a simple, straightforward price tag including a statement such as "This high efficiency, cleaner heating product will save the typical consumer $200 a year in energy bills."

[30] In Vermont, electricity, piped gas and wood fuels have historically seen less volatility than propane and oil. The structure of Table 5 would direct landlords to selecting equipment utilizing electricity and wood more so than propane, oil and piped gas. A description of fuel price volatility is available at https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2003/10_23/Volatility%2010-22-03.htm

[31] Note that Vermont already has already enacted a portion of this tax structure as advanced wood heating systems are sales tax exempt.

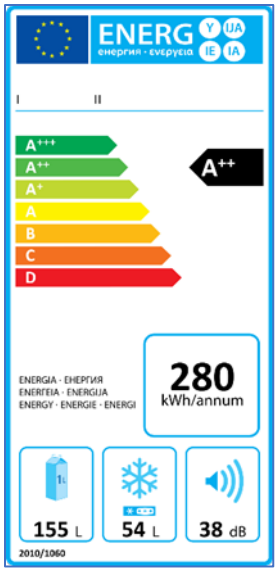

Figure 8. Sample product label[32]

Table 6 below presents the authors proposed approach to addressing the collection of fees.

Table 6. Proposed approach to applying fees and rebates

Policy Element	Recommendation and Notes
Mechanism to apply fee and rebate	●Apply the fee and rebate via a variable sales tax at point of sale, collected by the Department of Tax. ●A simplistic example of aligning a variable sales tax to the Band structure could be as presented below. This is for illustrative purposes only – a detailed analysis as to which rates to apply to which bands is needed. Note that current sales tax is 6%, so therefore it is essentially a "neutral" band – neither increasing nor lowering the tax: Band 1 (12% tax) | Band 2 (9% tax) | Band 3 (current VT sales tax: 6%) | Band 4 (3% tax) | Band 5 (0% tax) ●Ensure that the feebate is clearly, simply and prominently labeled on equipment.

3.2.5 Program administration and delivery

The scope of the role of an administrator can vary based on the program design that is chosen (e.g. the point at which the feebate is collected and disbursed). Because the feebate would deal in part with promoting more efficient equipment, some aspects of the role of administrator could be filled by an existing administrator, such as Efficiency Vermont, or a new energy efficiency administrator. If the feebate is applied via a sales tax as recommended in this paper, then there would be a role for the Department of Taxes as a partner in administration. Since part of the program requires the application of mandatory fees, the entity tasked with collecting the fees will need to have the appropriate authority (or new legal authority) to do so.

[32] https://en.wikipedia.org/wiki/European_Union_energy_label#/media/File:Energy_label_2010.svg

With a robust and statewide program, there could be substantial fees collected and rebates generated, even if the program is revenue neutral overall.[33] The simplicity in program design that is created by having the Department of Taxes oversee all feebate collection is highlighted in the previous section, which compares the number of entities that would need to be involved in the collection of fees, sharing of fee and equipment information, dispersal of payments, and review and modification of the feebate program, depending on the program design selected.

However, in the event that the recommended approach – to have the entire feebate collection processes be conducted by the Department of Taxes – is not selected, then it is unlikely that each point of purchase could do its own accounting and distribute rebates from the funds generated by the fees. In this alternative scenario, there could be separate streams for fees and rebates. For example, fees could be collected by the Department of Taxes, and rebates could be issued from the central program administrator. With proper policy design, the fact that there are two separate streams for revenue and disbursements would not be visible to customers. The program could still appear to customers as a simple fee or rebate that varies depending on the product they choose. However, this approach is not as simple and clear for the market as the authors' recommended approach.

Regardless of how the fees are collected and rebates are paid, other tasks also need to be completed, including reviewing data, analyzing program uptake, conducting follow-up surveys to gain customer feedback, interpreting socio-economic impacts, performing quality assurance/quality control, proposing program modifications, reporting on program impacts, and coordinating marketing and point-of-sale messaging. The authors recommend utilizing existing entities for these functions when possible, so as to leverage experience and expertise. Specifically, the authors recommend that the statewide program administrator be Efficiency Vermont, in coordination with other entities such as the Department of Tax (for the collection of fees). Table 7 below presents the authors' proposed approach to addressing program administration and delivery.

Table 7. Proposed approach to addressing program administration and delivery

Policy Element	Recommendation and Notes
Program administration and delivery	●Department of Tax processes taxes, collects program uptake data and provides to efficiency utilities. Efficiency utilities coordinate with the Department of Tax, review data, analyze program uptake, conduct follow-up surveys to gain customer feedback, interpret socio-economic impacts, perform quality assurance/quality control, propose program modifications, report on program impacts, and coordinate marketing and point-of-sale messaging. ●Department of Public Service provides oversight and review (see below), and presents program results via website. ●Periodic review by Public Utility Commission (see below) and Legislature. ●Clean Energy Development Fund provides startup funding and Program Reserve Funds in case fees do not cover rebates.

[33] An initial, "rough cut" analysis completed by EFG is shown in Appendix 4. In this analysis, there is a 20% fee applied to inefficient fossil fuel systems and a 10% fee on efficient fossil fuel systems (increasing by 1% per year over 10 years), with a flat 8% rebate applied to clean options. The analysis also assumes an overall market growth of .5% (heat pumps at 9%, wood heat at 2% and fossil fuel systems at -15%). In this analysis, the first year brings in $4 million in fees and pays out $2 million fees, with the cumulative net balance of the fund reaching $9 million in year 6, and closing in year 10 with $750,000 collected in fees and $3.5 million paid out in rebates. In Year 1, 43% of new sales are fossil fuel heated equipment while in Year 10, only 4% meet this definition.

3.2.6 Equity

Energy policy should be designed with equity considerations in mind. The authors present the policy elements that address equity at this late point in the paper because knowledge of fundamental feebate design elements, such as how the feebates are applied, is helpful in understanding the levers that can support an equitable outcome. The program design process should consider how it will impact disadvantaged communities and investigate ways to not just minimize any negative impacts, but to ensure that energy insecurity is being addressed in a meaningful way. While the term "disadvantaged communities" is broad, for this paper we focus on two sets of Vermonters: those with lower-incomes and renters. Compared to higher income individuals, lower-income Vermonters typically experience a higher energy burden, defined as "the percentage of gross household income spent on energy."[34] Meanwhile, renters often do not have direct control over their energy bills; the property owner typically owns the heating equipment (thereby determining the type and efficiency of the system, as well as the fuel that is used). Also, it is usually the owner who determines whether the property is properly weatherized.

As mentioned earlier, a feebate can be considered a form of consumer protection. By discouraging inefficient equipment purchases and encouraging efficient purchases, a feebate helps send a market signal to nudge consumers toward heating equipment that will save them money over time. This is critical, as behavioral economics literature has shown that people pay more attention to upfront costs than to lifetime costs (this has been shown from cell phones to vehicles), but that the cost impact that adds up most is the lifetime operating costs.[35] Clearly and prominently displaying the long-term financial costs and savings of the selected equipment via effective product labeling is critical to achieving the potential for consumer protection.

Use of a variable sales tax as the selected feebate approach requires that additional measures be taken to reach vulnerable Vermonters.[36] The setting of the feebate levels should involve an analysis to determine whether it will have additional upfront cost implications for lower income Vermonters; this information could then be used to develop an appropriate response. For example, income eligible purchasers could apply for a tax refund to address the incremental difference in the fee, and/or could apply for an additional incentive through, for example, entities such as Efficiency Vermont and the Clean Energy Development Fund. However, both of these approaches could result in further financial strain for lower income Vermonters, depending on the time lapse between receiving an incentive/tax rebate, and purchase of equipment. Therefore, a recommendation for program designers is to also consider requiring complementary cash rebates, provided through efficiency programs.

Income-qualifying participants should ideally receive technical and financial assistance to better understand how to weigh the potentially higher up-front costs of the technologies receiving rebates against the longer-term fuel costs of the technologies receiving the fee. While it is generally not recommended to promote financing to lower income customers, it may occasionally be appropriate for some moderate income Vermonters to access no-cost or very low-cost financing to "lock in" the long-

[34] https://www.energy.gov/eere/slsc/low-income-community-energy-solutions#:~:text=Energy%20burden%20is%20defined%20as,which%20is%20estimated%20at%203%25.
[35] https://ifs.org.uk/comms/comm125.pdf
[36] To further address income inequality, additional exploration could be undertaken as to the value of making the tax refundable.

term fuel savings.[37] Regardless, it is critical to ensure that the homeowner understands the financial choices at hand and to ensure that the program offering does not unintentionally make paying one's energy bills more, rather than less, challenging. Adequate protections should be incorporated into the feebate program to ensure that all financial support is received and that any potential debt is reasonable.

Clearly, additional consideration must be applied when designing and implementing a feebate, ideally coordinating additional rebates, for income-qualifying individuals. Ongoing technical assistance should be provided to these homeowners throughout the feebate implementation process to ensure the benign intent of the feebate (to shift Vermonters towards cleaner, more efficient heating sources that saves them money over the long-term) is achieved for all – especially those who can least afford high energy costs. Ultimately, even if the above considerations become part of the feebate program, the issue of equity may not be addressed in its entirety through a feebate alone. Therefore, other complementary initiatives, such as prioritizing low income homeowners via "Weatherization at Scale", should be explored.

With regards to renters, the challenge of the "split incentive" has often been discussed in the energy policy realm. Put simply, a "split incentive" market failure is said to exist when benefits of a transaction pass to someone other than the party paying the cost.[38] For example, when the landlord owns the heating equipment but the tenant pays the fuel bills, there is little incentive for the landlord to upgrade or invest in equipment that may cost more upfront but result in less overall operating costs. A feebate, interestingly, provides a positive impact by decreasing or potentially even eliminating the effects of the "split incentive" in that an equipment feebate could lead property owners to install equipment with lower operating costs that ultimately benefits tenants, if the "rebate" is set at a high enough level that it reduces the relative cost of installing the more efficient equipment as compared to the "fee" associated with the less efficient equipment. Table 8 below presents the authors proposed approach to addressing equity.

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[37] For example, Energy Futures Group implemented the Massachusetts' Solar Access Program, which provided access to low-cost financing that balanced the (monthly or annual) energy savings with the (monthly or annual) loan payment, resulting in no financial impact for the customer during the loan term, and savings after the loan has been paid off. This program, working with a local credit union, supported home owners who fell within 60-80% of the area median annual income, providing them with technical and financial support to ensure the loan would be financially favorable for the homeowner. The exact project size (e.g. the size of the solar array and heat pumps) was determined through an energy-financing tool that assessed how much the homeowner was spending on current fuel costs per year, and therefore what size project they could build to stay cash-flow neutral over the next ten years, so that by the end of the ten year period the homeowner owned the solar and heat pumps outright, having "locked in" to lower fuel costs for many more years to come.

[38] "Follow the Money: Overcoming the Split Incentive for Effective Energy Efficiency Program Design in Multi-family Buildings." Don Hynek, Megan Levy and Barbara Smith. Paper submitted for American Council on an Energy Efficient Economy (ACEEE) proceedings. https://www.aceee.org/files/proceedings/2012/data/papers/0193-000192.pdf

Table 8. Proposed approach to addressing equity

Policy Element	Recommendation and Notes
Equity	●Utilizing a variable sales tax that applies at point of sale helps to mitigate cash flow challenges that may result from waiting for a rebate, and also helps to incentivize landlords to invest in more efficient equipment that may utilize fuels with less fuel price volatility, as compared to other fuels (e.g. electricity costs resulting from a heat pump are historically more stable than oil or propane heating costs). ●However, further analysis should be conducted to assess if additional mechanisms (tax refund, complementary cash rebate for efficient equipment, additional incentives) may be needed to ensure that lower income Vermonters are not overly impacted by the feebate structure. A clear, simple methodology should be developed to determine the appropriate levels for lower income Vermonters. ●Explore other complementary initiatives, such as prioritizing low income Vermonters with Weatherization at Scale, as equity may not be fully addressed by a feebate program. ●Marketing and on-going technical assistance should be provided to meet the specific needs of lower income Vermonters and renters.

3.2.7 Evaluation, measurement and verification - and transparency

The role of evaluation, measurement and verification (EM&V) is a key one in energy efficiency program design. EM&V is the collection of methods and processes used to assess the performance of energy efficiency activities so that planned results can be achieved with greater certainty and future activities can be more effective.[39] Independent evaluators, with no role in program design or administration, should be used in order to maintain public trust. EM&V should follow established industry standard practices and be coordinated with existing efficiency programs when appropriate, including exploring opportunities for joint evaluation, which could reduce costs. In particular, some aspects of an equipment feebate program would be very similar to, and could interact with, existing or new Vermont Efficiency Utility incentives for cold climate heat pumps and efficient wood heating systems. Appropriate EM&V budgets should be set as an integral part of the program and provide adequate funding.

To ensure public trust, the program should have a website that tracks program performance near real-time and provides a dashboard of rebates and fees issued by geography and type of equipment, emissions reduced, LMI customers served, funding remaining, and other desired metrics. Transparent reporting provides policymakers and consumers' confidence in where and how their funds are being spent. Additionally, qualitative and quantitative data should be collected at time of purchase and one year post-purchase to provide insights into program design. Insights from these data should inform program design and be made publicly available on the program website. Evaluators could be placed under contract to provide services to the administrator. Table 9 below presents the authors proposed approach to addressing EM&V and transparency.

Table 9. Proposed approach to addressing EM&V and transparency

Policy Element	Recommendation and Notes
EM&V and Transparency	●In keeping with current energy efficiency program structures in Vermont, the Department of Public Service provides oversight and review of Feebate program design and implementation, with periodic review by Public Utility Commission. ●Program website that provides dashboard and metrics.

[39] https://www.energy.gov/sites/prod/files/2014/05/f16/what_is_emv.pdf

3.2.8 Coordination with neighboring States

Depending on the model chosen, coordination with other states may be helpful to minimize any adverse effects from situations where customers purchase the equipment from out of state in order to circumvent the fee or where customers travel to Vermont to purchase equipment receiving a rebate (especially in instances of self-installation). To answer the first concern, program administrators could replicate the efforts used to collect sales taxes on out of state purchases. To answer the second concern, customer zip codes could be required at the time of the purchase to monitor the potential of this issue. Both of these roles could likely be played by the administrator. Table 10 presents the authors' proposed approach to addressing coordination with other states.

Table 10. Proposed approach to addressing coordination with other states in an equipment feebate program

Policy Element	Recommendation and Notes
Coordination with other states	●Partner with neighboring states to track how many out-of-state sales are occurring. ●Require customer zip code collection for sales in VT to track rebates on equipment that might migrate out of state. ●Analyze data results to determine the need for program modification via the phased implementation approach.

4. Conclusion

Achieving our energy goals pertaining to our thermal sector is doable – but will take creativity and further detailed analysis, research, the will of Vermont policy makers, and the support of Vermonters. The policy explored in this paper offers significant promise, given the success of feebates in other jurisdictions as presented in Appendix 2. However, ongoing review of the policies would be necessary, both because a feebate has never been applied to heating equipment and to ensure that the feebate is achieving what is intended within an ever-changing marketplace.

This report presents the various key factors that should be considered when designing and implementing an equipment feebate. Some of the recommendations, such as who should be the administrator of a specific policy, are more defined than others. Other areas, such as how/whether to quantify carbon emissions within the wood heating sector likely warrant significantly more discussion (for the initial feebate design and implementation, the authors suggested to treat all wood heating systems with a rebate). In Table 11, below, the authors provide high-level recommendations to designing an equipment feebate, as well as a more detailed approach to placing equipment within five bands via a "step function" approach.

Regardless of the policy implemented, the founding point should be to ensure alignment with Vermont's overarching goals and to address how vulnerable Vermonters are impacted. Additionally, attention should be paid to ensure coordination with existing policies such as current Efficiency Vermont and VGS incentives, and leveraging with potential future policies, such as Weatherization at Scale and a Clean Heat Standard. Ultimately, if Vermont is to achieve the goals and requirements set thus far, significantly more headway must be made in the thermal sector.

APPENDIX 1. Vermont's emission requirements and targets-2020 status

Vermont statutory emissions requirements & administrative energy targets, 2020 status

OVERALL STATUS

- Undetermined
- Already met or on track to meet
- Not met or not on track to meet

CHANGE FROM LAST YEAR'S EAN REPORT

- Year-to-year progress flat
- Increasing rate of year-to-year progress
- Decreasing rate of year-to-year progress

	GOAL OR STATUTE	TARGET	TARGET DATE	STATUS 2019 EAN REPORT	STATUS 2020/1 EAN REPORT	TREND 2020
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 26% below 2005 levels by 2025.	-26%	2025	-9% (2016)	-13% (2018)	↑
	Act 153 (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 40% below 1990 levels by 2030.	-40%	2030	+5% (2016)	+0% (2018)	↑
	Act 153 (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions by 80% below 1990 by 2050.	-80%	2050	+5% (2016)	+0% (2018)	↑
TOTAL ENERGY	**CEP (2016):** Meet 90% of the state's energy needs through renewables — including thermal, transportation, and electric (Note: Energy sourced in-state and out-of-state)	90%	2050	24% (2016)	24% (2018)	→
	CEP (2016): Reduce total energy use (from 2010 levels) by over 30% by 2050 through efficiency and conservation, across thermal, transportation, and electric.	-30% 83 TBTU	2050	+1% 119 TBTU (2017)	+1% 120 TBTU (2018)	→
	30 V.S.A. 8002 (2015): RES Tier III - Require 2% of utility sales (BTU equivalency) in 2017 to reduce fossil fuel consumption, rising to 12% in 2032. Projects must be new, in-state, and in service in 2015 or later.	2% 12%	2017 2032	2.6% (2018)	3.3% (2019)	↑
	24 V.S.A. 4302(c)(7) (2016): Develop energy plans for regions and municipalities consistent with the CEP goals.	11 regions	2018 for RPCs Voluntary for towns	11 approved (regional) 38 approved (town) (2020)	11 approved (regional) 69 approved (town) (2021)	↑
TRANSPORTATION	**CEP (2016):** Reduce total transportation energy use by 20% from 2015 levels by 2025.	-20% 39.1 TBTU	2025	-2.6% 49.3 TBTU (2016)	-10% 45.3 TBTU (2018)	↑
	CEP (2016): Reduce transportation-emitted GHGs by 30% from 1990 levels by 2025.	-30% 2.32 $MMTCO_2e$	2025	+5% 3.49 $MMTCO_2e$ (2016)	+3% 3.43 $MMTCO_2e$ (2018)	→
	CEP (2016): Hold vehicle miles traveled (VMT) per capita to 2011 levels.	11,390	2030	11,888 (2017)	11,773 (2019)	↑
	CEP (2016): Reduce share of single- occupancy vehicle commute trips by 20% of 2011 levels (79.5%).	-20%	2030	+1.84 81.4% (2017)	+1.84 81.4% (2017)	N/A
	CEP (2016): Double the share of bicycle and pedestrian commute trips from 7.8% to 15.6%.	15.6%	2030	6.8% (2017)	7.7% (2018)	↑
	CEP (2016): Triple the number of state park-and-ride spaces from 1,142 to 3,426.	3,426	2030	1,639 (2019)	1,815 (2020)	↑
	CEP (2016): Increase public transit ridership by 110% to 8.7 million annual trips	8.7M	2030	4.74M (2018)	5.12M (2019)	↑
	CEP (2016): Increase Passenger Rail Trips: Quadruple Vermont-based passenger rail trips from 2011 levels (91,942) to 400,000 trips annually.	400,000	2030	96,696 (2018)	99,280 (2019)	↑
	CEP (2016): Increase the share of renewable energy in all transportation to 10% by 2025 and 80% by 2050.	10%	2025	6% (2018)	6% (2018)	N/A
	CEP (2016): Increase Renewably Powered Vehicles: Increase % of the vehicle fleet that are Electric Vehicles to 10% by 2025.	10%	2025	0.71% (2019)	0.8% (2020)	↑
THERMAL	**CEP (2016):** To reduce total fossil fuel consumption across all buildings by an additional one-half percent each year, leading to a total reduction of 6% by 2017 and 10% by 2025.	10%	2025	-6.1% 32.5 TBTU (2016)	+5.5% 36.5 TBTU (2018)	↓
	CEP (2016): Cold Climate Heat Pumps: Install 35,000 cold climate heat pump systems by 2025.	35,000	2025	16,255 (2018)	18,940 (2019)	↑
	CEP (2016): Increase wood's share of building heat to 35% by 2030.	35%	2030	26% (2016)	24.3% (2018)	↓
ELECTRICITY	**30 V.S.A. 8002 (2015):** RES Tier 1 - Total Renewable Electric - Obtain 55% of annual electric sales from renewables for each retail electricity provider in Vermont by 2017, and 75% by 2032. RECs retained (in-state and out-of-state).	55% 75%	2017 2032	62% (2018, site energy, post-REC)	64% (2019, post-REC)	↑
	30 V.S.A. 8002 (2015): RES Tier 2 - Distributed Generation - Require 1% of electric sales to come from distributed generation in 2017, rising to 10% by 2032. Projects starting in mid-2015 are eligible, and new NM and SO projects count if RECs are retired (in-state).	1% 10%	2017 2032	1.6% (2018)	2.20% (2019)	↑
	30 V.S.A. 8005a(c) (2011): Issue Standard Offer contracts to new SO plants until a cumulative capacity of 127.5 MW is reached (new plants 2.2MW or less commissioned on or after Sept 30, 2009) (in-state).	127.5 MW	2022	103.9 MW under contract 70.6 MW projects commissioned (2019)	112.97 MW under contract 69.86 MW projects commissioned (2020)	↑

"Annual Progress Report for Vermont 2020/2021." Energy Action Network. Montpelier, Vermont. 2021. https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf

APPENDIX 2. Feebate precedents – top performers

Norway

Norway's feebate program to encourage the purchase of electric vehicles has led the country to achieve the highest share of electric vehicle registrations in the world. The first electric vehicle (EV) incentives were implemented in the 1990s to promote local EV manufacturing, but they have since evolved into a set of policies designed to address transport emissions. Norway's program does not precisely follow the feebate model, as collections have exceeded incentives, but since it otherwise shares most of the same elements, it is a useful example.

The Norway program consists of a series of taxes and fees on vehicles, including value-added tax (sales tax), vehicle weight, carbon dioxide (CO_2) emissions and nitrogen oxide (NO_x) emissions. For CO_2 emissions, the program uses a formula-based approach with an inflection point at 120 g/km, after which the fees grow more steeply so that the fees rise more quickly for the most polluting fossil vehicles.[40] For electric vehicles, the taxes fall based on a stepwise function, essentially creating a single tax level for plug-in hybrid electric vehicles (PHEVs) and a full tax exemption for EVs. These vehicles are also fully exempt from the weight and value-added taxes. While some of the EV incentives in the past were in the form of rebates, the program has evolved to an approach that taxes polluting products very heavily and exempting either partially or fully the clean technologies. Hence the "rebates" are tax exemptions, but customers seem to understand their value as they have reported them as important, along with complementary benefits such as exemptions from tolls.[41]

The combined results of the evolving policy are dramatic. In 2019, EV/PHEV vehicles made up 56% of vehicle sales and were as high as 75% monthly in 2020.[42] The policy suite is supported by a target set by the Norwegian parliament that all vehicles sold by 2020 be non-emitting and that this should be achieved through economic incentives rather than bans. This demonstrates the dramatic shift in purchasing behavior that can be achieved in an environment where very high fees on polluting products can be implemented. Some pieces of the policy have been adjusted as uptake grows, such as the exemptions for tolls and parking fees. The tax structure itself is scheduled to be reviewed and revised in 2021. There was a proposal in 2017 to reduce the incentives based on weight, largely targeted at luxury EVs that were seen as receiving outsized benefits, but it was not implemented. However, this still serves as a lesson regarding the negative public response that can accompany incentives for high-end products, particularly when those incentives are greater than those received by the average consumer.

Singapore

Singapore's Carbon Emissions-based Vehicle Scheme evolved from an earlier green vehicle rebate program designed to encourage the purchase of lower emissions vehicles. It was implemented in 2013 and used a step function with four fee bands, four rebate bands, and a zero band set at 161-210 g/km that encompasses the pivot point.[43] The program is administered by the ministry of transport and is

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[40] Wappelhorst et al, Using vehicle taxation policy to lower transport emissions, https://theicct.org/sites/default/files/publications/EU_vehicle_taxation_Report_20181214_0.pdf

[41] Haugneland et al, Put a price on carbon to fund EV incentives –Norwegian EV policy success, https://elbil.no/wp-content/uploads/2016/08/EVS30-Norwegian-EV-policy-paper.pdf

[42] https://www.ev-volumes.com

[43] Singapore Ministry of Transport, https://www.lta.gov.sg

implemented at the time of registration. The emissions rate for electric vehicles is calculated using an emissions factor of 0.4 g CO_2/Watt as set by the ministry of transport. Rebates act as reductions to the relatively high registration fee, so to the consumer it appears very similar to Norway's program. The bands were revised in 2015, moving the zero band to 136-185 g/km and increasing the stringency of all bands. It also increased the fee/rebate for the top bands that encompass the most and least emitting vehicles.

The program was replaced in 2018 with the Vehicular Emissions Scheme that expanded it to include the local air pollutants hydrocarbons, carbon monoxide, NO_2, and particulate matter. The zero band was further strengthened to 125-160 g/km and the structure was simplified to include only two bands each for fees and rebates. Each of the five pollutants have bands, and a vehicle receives a rebate/fee based on its lowest band among these.

Adoption of plug-in and battery electric private passenger vehicles has not increased dramatically with the implementation of this program. Only 1593 of these vehicles were registered by 2019, out of a population of over 600,000. There are not additional incentives such as free tolls or access to high-occupancy vehicle (HOV) lanes, which may explain some of the differences with Norway's outcomes. In addition, this design illustrates the importance of the choice of emissions rate for electric technologies. Some fully electric vehicles were subject to a fee in Singapore due to the emissions rate calculation. For electric infrastructure with longer lifespans than vehicles, it is important to understand expected future electric emissions factors and how or if they should be incorporated in present-day incentive calculations.

APPENDIX 3. Sources for additional information

Best Practices for Feebate Program Design and Implementation, International Council on Clean Transportation, https://theicct.org/sites/default/files/publications/ICCT_feebates_may2010.pdf

Toolkit for Advanced Transportation Policies, M.J. Bradley and Associates, https://www.mjbradley.com/sites/default/files/mjba_transportation_toolkit.pdf