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Policy Options and Qualitative Assessment for Vermont Thermal Analysis

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Introduction

The Vermont Agency of Natural Resources (ANR) has commissioned a study to identify and analyze both qualitatively and quantitatively policy options for reducing emissions from the buildings/thermal sector (or across Vermont's residential, commercial, and industrial (RCI) fuel use), as well as consider the benefits to an all-fuels approach. This document is part of a series of deliverables to be created by a team being led by Energy Futures Group, Inc., in collaboration with the Stockholm Environment Institute and the Cadmus Group.

The document begins with a summary of policy options, which will form the basis for the identification of five policy sets to be quantitatively modeled and studied in more detail during the remainder of the study. Each policy write up provides a brief description of the policy, examples of where these policies have been put in place, and citations and excerpts from key reference materials which are provided in the appendix.

Next is a qualitative assessment of policy options to reduce emissions from the RCI sector. The 12 policies that were assessed, as well as the five evaluation criteria, were determined in consultation with the Vermont ANR team, working in close collaboration with the Public Service Department (PSD). These policies will form the basis for the five policies and/or policy sets that will be quantitatively evaluated in the next phase of this project. As such, it is important to note that the policy sets ultimately selected by ANR may include policies that on their own do not perform best across all the criteria but when implemented in conjunction with other polices may be the best solution for meeting the Global Warming Solutions Act (GWSA) requirements for the buildings/thermal sector or more broadly across the transportation and buildings/thermal sectors.

Policy Option Summaries

Programs and Incentives

1) Expand existing programs and policies

Below is a list of programs and policies that could be expanded to address building sector emissions in Vermont. An expansion of one or more of these programs would require additional funding and would need to be implemented in combination with another revenue-generating policy or an external source of funds.

a. **Weatherization (OEO, Efficiency VT, Vermont Gas Systems)**
Weatherization efforts are conducted in the state by the Office of Economic Opportunity (OEO), Efficiency Vermont, and Vermont Gas Systems. The weatherization assistance

program of Vermont is offered through OEO and provides weatherization services to low-income households, improving the energy efficiency and comfort of their homes and reducing energy costs for these households.

Efficiency Vermont offers incentives for weatherization, including Home Performance with ENERGY STAR, a rebate to "work with an Efficiency Excellence Network contractor to improve your home's insulation and air sealing — ensuring occupants' comfort, health, and safety — and get 75% off project costs."[1]

Vermont Gas Systems also offers weatherization assistance, including Enhanced Income-Qualified Weatherization Rebate, which offers qualifying single-family homeowners an incentive to cover 75 percent of comprehensive weatherization project costs up to $5,000. They also offer Low Income Weatherization Assistance, which provides assistance with energy-efficiency improvements for low-income customers.[2]

Expanded weatherization efforts could include more funding dedicated to weatherizing buildings in Vermont, thus expanding the number of buildings weatherized. This expansion could be in line with the goals of the Weatherization at Scale Initiative. Expansion of weatherization in the state could take into account equity as a program and could focus on benefiting low- and moderate- income households. Important equity considerations include reducing paperwork to access weatherization rebates and for the rebates to be accessible to renters. A workforce development program is also necessary for such a policy to be successful. There needs to be a sufficient number of contractors to conduct the work, including contractors specialized in electrical, HVAC, plumbing and other general contracting needs, especially for old buildings.

b. Residential and commercial building energy codes (RBES and CBES) (PSD)

"Vermont's Building Energy Standards were established to set minimum efficiency requirements for new and renovated buildings. The standards are designed to provide more reductions in energy use and emissions over the life of a building, when compared with a similar building constructed prior to the standards going into effect."[3]

The residential and commercial building energy codes (RBES and CBES respectively) are being updated this year, with a target effective date of winter of 2023. While RBES and CBES

[1] https://www.efficiencyvermont.com/rebates/list/home-performance-with-energy-star

[2] https://vgsvt.com/savings/assistance-programs/

[3] https://publicservice.vermont.gov/efficiency/building-energy-standards

are being updated to include high energy performance standards, the opportunity to expand RBES and CBES in the state also includes increasing levels of code compliance in the state. Increasing compliance in the state would allow Vermont to achieve higher levels of energy savings and GHG emissions reductions from newly constructed buildings.

c. Appliance rebates and financing (Energy Efficiency Utilities)

Vermont's energy efficiency utilities (EEUs) - Efficiency Vermont, Vermont Gas Systems, and Burlington Electric Department – offer rebates on products and technologies, as well as financing for energy saving projects. Their services include rebates on insulation and air sealing; smart homes; heating, cooling and ventilation; appliances; refrigeration and commercial kitchens; renewable energy; lighting; electronics; transportation; agricultural equipment; and industrial and special equipment.[4] An expansion of Efficiency Vermont's rebates would be an increase in funding available for these programs to offer to customers and, with equity in mind, could be expanded particularly to lower-income customers.

Efficiency Vermont also offers financing to homeowners, businesses, and agricultural operations. Financing, including low-interest loans, can help building owners make energy improvements to their buildings. Expanding financing available through Efficiency Vermont could mean more building owners are able to access loans to facilitate building energy improvements.

d. Renewable Energy Standard (RES) Tier 3

Under Vermont's Renewable Energy Standard (RES), Vermont's distributed utilities (DUs) "must acquire and retire a minimum quantity of renewable energy attributes or Renewable Energy Credits (RECs), and to achieve fossil fuel savings from energy transformation projects. The requirements of the RES are broken down into three categories, or tiers."[5]

"Tier III requires DUs to achieve fossil fuel savings from energy transformation projects or retire Tier II RECs… Energy transformation projects include weatherizing buildings; installing air source or geothermal heat pumps, biomass heating systems, and other high-efficiency heating systems; switching industrial processes from fossil fuel to electric; increased use of biofuels; and deployment of electric vehicles or related charging infrastructure." If Tier 3 were expanded, a DU's Tier III obligation would be increased. For example, "for Tier III, the RES requires savings of 2% of a DU's annual retail sales in 2017, increasing to 12% by 2032."[6]

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[4] https://www.efficiencyvermont.com/products-technologies

[5] https://publicservice.vermont.gov/renewables/renewable-energy-standard

[6] https://publicservice.vermont.gov/renewables/renewable-energy-standard

The savings requirement as a percent of annual retail sales could be increased.

e. **Biofuels incentives through Clean Energy Development Fund (CEDF)**
"Vermont Clean Energy Development Fund (CEDF) offers incentives for qualified advanced wood heating equipment through the Small-Scale Renewable Energy Investment Program, managed by the Renewable Energy Resource Center."[7]

These incentives include Advanced Wood Heating Systems, Coal Change Out Adder (to swap out coal heating systems for pellet furnaces/boilers and cordwood/pellet stoves), Pellet Storage Voucher, Woodstove Change Out and Repairs (to replace inefficient wood stoves with advanced EPA certified wood and pellet stoves), and Wood Pellet or Chip Fired Evaporator.[8] An expansion of this program would be an increase in funding available for these programs to offer to customers.

f. **Weatherization Repayment Assistance Program (WRAP) through VHFA**
The Weatherization Repayment Assistance Program (WRAP) "uses on-bill payment model to help moderate-income Vermonters participate in comprehensive home energy projects." The program is funded by $9 million from the state and is overseen by the Vermont Housing Finance Agency (VHFA). "WRAP will allow Vermont households to pay for qualifying weatherization projects like insulation and air sealing as well as heat pumps and advanced wood heating systems through a monthly charge on their utility bill that can be paid back over time. Both homeowners and renters can participate in the program."[9]

g. **Direct technology/sector investments**
The Federal Infrastructure Investment and Jobs Act (IIJA) includes funding for modernization of the electric grid, and funding to promote the development of green hydrogen production. Investments and upgrades to the electric grid support the electrification of building loads and the increase of distributed and transmission level renewable resources.

Hydrogen production and use in the U.S. are mostly associated with chemical industries, and the production of ammonia and fertilizer, using steam reforming of gas. Green hydrogen uses renewable electricity and electrolysis to separate hydrogen from water. A recent partnership between Vermont Gas Systems, UVM, and Global Foundries is planning to use

[7] https://energysaver.vermont.gov/programs-incentives

[8] https://www.rerc-vt.org/

[9] https://vhfa.org/news/blog/new-weatherization-financing-program-available-vermonters

electrolysis to produce and use green hydrogen in the chip manufacturing process in Essex, VT.

Equity considerations: The existing programs and policies, including the many weatherization initiatives, appliance rebates and financing programs, and the biofuels heating and cooking incentive, all seek to lower the cost of energy efficient technologies for households and are therefore designed with equity in mind. Continued outreach to low- and moderate- income (LMI) households is needed to make them aware of these energy efficiency programs and policies, and the benefits they provide to reduce energy cost burdens. This also involves reducing the paperwork involved to access rebates and loans.

It is important to consider that while a quarter of all households in Vermont were built before the 1940s, more than a third of renters live in older houses. These older homes may not have the electrical capacity to handle higher electrical loads from heat pumps or heat pump water heaters, for example. If the home has knob-and-tube wiring, it may not be possible to weatherize the household (especially updating insulation) without upgrading the wiring first. These electrical upgrades may be cost-prohibitive, making it challenging to undertake energy efficiency improvements. However, the Inflation Reduction Act provides LMI households up to $4,000 for electrical panels and $2,500 for wiring upgrades, which can offset some costs.

It is also important to ensure rebates are accessible to renters. Landlords may not be incentivized to make energy improvements as they are not the ones paying the utility bills. However, greater energy efficiency not only reduces the cost burden on renters, but increases a building's property value, which is beneficial to a landlord or owner. It is important that if a landlord decides to make improvements, the cost of those improvements, if passed down to the consumer, does not increase the cost burdens of LMI tenants.

2) Feebates

Brief description of the policy and how it is implemented: A feebate is a policy that applies a fee to low-efficiency equipment and provides a rebate to high-efficiency equipment. This concept has been more widely discussed in its application to vehicles, where buyers purchasing a high-polluting vehicle would have to pay a fee and buyers purchasing low-polluting vehicles would receive a rebate on the purchase of the vehicle. In the context of the building sector, a feebate would apply to a building's heating appliances. The policy would apply to new equipment only. The feebate could apply to either an appliance's energy efficiency or its greenhouse gas emissions.

What is regulated and who the obligated entities are: Space and water heating appliances are regulated. The obligated entities are the retail providers of water and space heating equipment.

Revenue generating potential: The policy could be revenue-neutral or revenue-positive, depending on its design. A revenue-neutral approach would be designed such that the fee on the low-efficiency equipment would be used to cover the rebate of the high-efficiency equipment. A revenue-positive

approach would be designed in order to generate revenue from the policy, to be used by the state however it decides.

A feebate would have to be designed carefully, such that the fee does not impact the purchase of appliances so heavily as to reduce the revenue raised for the rebate, thus eliminating the ability of a feebate to pay for itself. Additionally, the design would need to ensure that it does not have a negative impact on the ability of low-income households to purchase heating appliances.

What other jurisdictions have implemented: We are not aware of other jurisdictions with feebates for space and water heating equipment in the building sector.

What data is required to implement: A feebate would require data on the costs and efficiencies of heating appliances in Vermont. Design would require estimates of the impact on fees and rebates on customer purchasing decisions, and whether the program is intended to be revenue neutral or to generate revenue.

Any features unique to the policy: The policy is an incentive-based approach that encourages individuals to purchase low-emitting appliances.

Equity considerations: A feebate on its own is not favorable to LMI households if the higher-efficiency equipment is more expensive than a lower-efficiency equipment after the rebate. However, if the amount of the rebate makes the higher-efficiency equipment less expensive than lower-efficiency equipment, a feebate could be favorable to LMI households. A feebate, if advertised with existing appliance rebates programs, could make this a viable option for LMI consumers or exceptions can be made to LMI households if they cannot purchase the lesser emitting appliance.

Pricing, Cap, and Credit Approaches

3) Direct carbon pollution pricing

Brief description of the policy and how it is implemented: Direct carbon pollution pricing (or carbon fees or taxes) places a cost on emissions that are otherwise borne by the common environment and general public, and not by the emitter. When emission costs are not borne by the emitter, those costs are externalized on society. With a direct price on the carbon pollution the emitter bears a direct cost for the pollution and the true cost of the activity becomes more reflected in its market price, in comparison to alternatives. If the price signal is strong enough, direct carbon pollution pricing/carbon taxes can lead to reduction in emissions. However, given the price inelasticity of demand for most fossil fuels, carbon pricing alone generally does not lead to significant pollution reduction.

What is regulated and who the obligated entities are: Fuels are regulated, requiring the addition of a carbon price based on the greenhouse gas emissions per unit of fuel. Obligated entities are the wholesale and/or retail level importers of fuels. For example, an individual fuel dealer or gasoline station that is supplied by an out of state wholesale distributor would be required to add and collect the carbon price for their retail sales. A Vermont based wholesale importer could place the carbon price on the fuel that they distribute to individual retail distributors.

Revenue generating potential: Revenues from a carbon tax can be refunded to consumers, directed to investments to equitable and just transitions to a decarbonized energy system, or a combination of these approaches.

What other jurisdictions have implemented: Hawaii's legislature has been actively considering a carbon tax, accompanied by an income-based tax-credit to help mitigate equity impacts. Direct carbon pricing has also been instituted at the national level in South Africa, Chile, Argentina, and Canada, and at the municipal level in Boulder, Colorado. Appendix 1 provides greater detail and references to these and other carbon pricing initiatives.

What data is required to implement: Analysis of the fuel supply chain to identify the full set of obligated entities at the wholesale and retail level. Analysis of market response to carbon price levels, based on elasticity of demand for fuels and costs of alternatives. Standard emissions factors for each fuel (likely from the Environmental Protection Agency) can be used to determine emissions per unit of fuel.

Any features unique to the policy: Direct carbon pollution pricing differs fundamentally from "cap" based systems in that it places a price on the pollution, leaving the level of emissions to be determined by the market response to the new price signal. While carbon tax revenues can be directed to mitigating equity impacts, it is likely to be difficult or impractical to account for income or environmental justice impacts at the time of purchase. For example, verifying household income at the time of gasoline or heating fuel purchase is likely to be impractical. Generally fossil fuel sales are also already taxed, with funds going to the general revenues or for targeted items such as road maintenance and construction. A carbon tax would be in addition to existing fuel taxes.

Equity considerations: A carbon tax will likely further increase the energy cost burden for LMI households both directly through increased fuel prices and indirectly if corporations pass down the increase in costs to consumers. If LMI households do not electrify at the same rate as high-income households, the carbon tax will be disproportionately borne by LMI earners. However, whether a carbon tax is, on net, equitable (or progressive or regressive) depends largely on how the resulting revenues are invested. For instance, the "invest" part of this policy can direct a portion of the tax revenues back to LMI households to not only offset additional costs, but to implement energy efficiency initiatives. LMI households can also be given credits before the policy is implemented.

To further improve equity, steps can be taken to align with the Federal Government's Justice40 initiative, where it recommends that 40 percent of the overall benefits go to disadvantaged communities that are marginalized, underserved, and overburdened by pollution. For example, an investment fund could be used to build out resiliency and jobs programs, provide direct support and job training to impacted workers, codify labor standards, direct grants to community organizations for grassroots-led energy planning, increase building efficiency, and help lower energy bills for LMI families.

4) Cap-and-invest

Brief description of the policy and how it is implemented: Cap-and-invest is one of the two "cap-based" policy options, with the other being cap-and-trade. Both systems are based on establishing a regulatory limit on emissions, either through emission allowances or requirements for clean credits. The key difference is whether revenues are generated through the auctioning of emission allowances (cap-and-invest) or allocated (as either emission allowances or credit requirements) without revenue generation (cap-and-trade). The two cap-based policies are closely related and there are examples where hybrid policies, containing features of both have been adopted. In this report, we analyze the cap-based policy options as they would apply either just to the building sector or across multiple sectors of the economy.

What is regulated and who the obligated entities are: Greenhouse gas emissions are regulated by establishing a declining number of emissions allowances for each year. Wholesale and/or retail fuel suppliers are the obligated entities and must have sufficient allowances to cover their fuel sales or face penalties. Some levels of carry-forward or banking of allowances for use in future years can be permitted. Emission allowances can be auctioned, allocated based on historic emissions, or a combination of the two.

Revenue generating potential: The revenue generated depends on how many emission allowances are auctioned versus allocated, and the auction clearing price. Revenues from a cap-and-invest system can be to augment other decarbonization policies and programs. Additionally, revenues could be invested in environmental justice initiatives to achieve equity goals.

What other jurisdictions have implemented: California, Quebec, New York, and Washington State have adopted some flavor of cap-and-invest, with California and Quebec having more than a decade of experience and policy evolution, while the other states are in early stages. The European Union also relies on auction of emission allowances and the EU Emissions Trading System (ETS) has been functioning for more than a decade. Appendix 1 provides additional details and references to experience in these jurisdictions.

What data is required to implement: Data on current and historic emissions of obligated entities is needed to set an appropriate level of initial emissions allowances. Analysis is also necessary to

determine the declining cap limit in future years, how many allowances are auctioned versus allocated, and the associated anticipated revenue.

Any features unique to the policy: The cap-based systems are an indirect form of carbon pricing, as they are expected to increase the consumer prices for conventional fossil fuels. However, whereas direct pricing, such as the carbon tax example discussed above, establishes a market price and allows the market to determine an optimal level of emissions based on the carbon price, the cap-based systems flip this relationship by creating a regulatory cap on emissions or a requirement for clean credits and depend on market forces to determine and maintain the price for meeting these requirements. The cap-based systems therefore provide a greater level of emission reduction certainty, but less clarity on price effects.

Equity considerations: Similar equity impacts and mitigation measures as direct carbon pollution pricing.

5) Cap-and-trade

Brief description of the policy and how it is implemented: As discussed above, cap-and-trade is closely related to cap-and-invest. Under a pure cap-and-trade, revenues are not generated through auction of allowances or purchase of clean credits. The distinctions are not always clear in the literature, for example the Regional Greenhouse Gas Initiative is often discussed and classified as a cap-and-trade system, although allowances are auctioned, with proceeds and revenues available to participating states for investment. For our discussion a cap-and-trade system sets emissions limits across the building sector or across multiple sectors and allocates free emission allowances (most typically based on historic or benchmarked performance for an emitter). The cap declines over time, and obligated entities therefore need to either purchase allowances from other parties or reduce their own emissions to remain in compliance.

What is regulated and who the obligated entities are: Greenhouse gas emissions are regulated by establishing a declining number of emissions allowances for each year. Wholesale and or retail fuel suppliers are the obligated entities and must have sufficient allowances to cover their fuel sales or to face penalties. Some levels of carry-forward or banking of allowances for use in future years can be permitted. Under cap-and-trade it is assumed that all allowances are allocated rather than auctioned.

Revenue generating potential: Non-compliance penalties are typically established and revenues from penalties can be used to promote equity or development of clean technologies.

What other jurisdictions have implemented: Oregon has enacted a cap-and-trade system with free allocation of compliance instruments to the obligated entities. Cap-and-trade policies have been used to reduce emissions from other pollutants including sulfur dioxide and nitrogen oxides. Appendix 1

provides further details and a reference to a literature review and retrospective analysis of three decades of cap-and-trade policies.

What data is required to implement: Data on current and historic emissions of obligated entities would be required to set an appropriate cap and number of emissions allowances.

Any features unique to the policy: Like cap-and-invest, this policy could be applied to the RCI sector only or to all fuels. A cap-and-trade system limited to RCI sector emissions would apply to fuel suppliers for heating fuels. A cap-and-trade system that applies to all fuels would expand the system to include transportation fuels. In this system, the emissions reductions would come from the easiest to abate sector, and allowances would be traded across sectors to meet the cap.

Equity considerations: Similar equity impacts as direct carbon pollution pricing, however there is less potential for revenue generation to offset additional costs passed down from firms to consumers.

6) Sector wide performance standards

Brief description of the policy and how it is implemented: A sector-wide performance standard is an obligation imposed on fossil fuel suppliers to reduce the carbon footprint associated with their products through investments in greenhouse gas emission reducing measures. The obligation is commonly articulated in terms of annual emission reduction "credits". Different measures have different credit values, with the values based on the amount of emission reduction each measure provides. The performance standard aspect of the policy means that fossil fuel suppliers can decide for themselves what mix of measures they want to use to meet each annual requirement. In order to reduce overall costs, credits can also typically be bought and sold. For the thermal or buildings sector, this type of policy is commonly called a Clean Heat Standard. The Affordable Heat Act (AHA), introduced in January 2023 as Vermont Senate Bill 5, is an example.

There are a range of important design decisions that need to be made in establishing a Clean Heat Standard. Some of the more important are:

- Obligated parties
- Size of the obligation
- Definition of emission reduction
- Eligible measures
- Equity for lower income households

A Clean Heat Standard is similar in many ways to a renewable portfolio standard for electric utilities. It also has similarities to energy efficiency savings obligations imposed on regulated electric and gas utilities – or comparable non-utility parties such as Efficiency Vermont.

What is regulated and who the obligated entities are: Credits for measures that reduce greenhouse gas emissions are regulated. Fuel suppliers are the obligated entities.

Revenue generating potential: While there may be trading of credits between obligated entities, and an entity that has excess credits could sell them to another party and gain revenue for their firm, this policy does not generate revenues for the state.

What other jurisdictions have implemented: We are not aware of any jurisdictions having implemented a clean heat standard for the entire building sector (though Colorado has a Clean Heat Standard applied to their pipeline gas sector),[10] but as noted the standard is similar to renewable portfolio standards or to energy efficiency portfolio obligations in place for many electric and gas utilities or for non-utility third party implementers.

What data is required to implement: Data and analysis to determine the schedule of credit requirements for each obligated entity and to establish standard protocols or deemed values of emissions reductions credits for various measures. These are likely to rely on existing calculations for savings and emissions reductions for measures such as weatherization, heat pump installation, and renewable fuels. Requires analysis and consideration of the lifecycle emissions profiles for renewable fuels.

Any features unique to the policy: The sector-wide performance standard is an indirect form of carbon pricing, as it is expected to increase the consumer prices for conventional fossil fuels. However, at the same time it is also expected to decrease consumer prices for cleaner fuels and other "clean heat" measures. This approach can encourage providers to examine and innovate in the ways in which they structure their business to create and/or procure clean heat credits. It may create a more dynamic approach than an emissions cap-based system, or carbon pricing. The performance standard provides a greater level of emission reduction certainty, but less clarity on price effects.

Equity considerations: A sector-wide performance standard has the potential to increase the energy cost burden for LMI households who use fossil fuels for heating to the extent that obligated entities pass down the increase in costs to their fossil fuel customers. On the other hand, LMI households can be prioritized for access to and benefits from clean heat measures, thereby lowering energy cost burdens for those customers.

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[10] Colorado General Assembly SB21-264, passed in 2021, requires gas distribution utilities with more than 90,000 retail customers to implement clean heat measures to reduce emissions by 4% from 2015 levels by 2025, and 22% from 2015 levels by 2030. https://leg.colorado.gov/bills/sb21-264.

7) Economy-wide performance standard – GHG standard

Brief description of the policy and how it is implemented: Setting emissions reduction credit requirements economy-wide expands upon the structure of performance standards to include obligated entities across all sectors. In theory, this allows entities in sectors with opportunities for lower cost and larger emission reductions to create emission reduction credits exceeding their allocated requirements and to provide (via market transactions) excess credits to sectors where emission reductions are more costly or limited by technical factors.

The structure of an economy-wide performance standard could be anticipated to help reduce the total costs for emissions reductions by allowing for higher levels of reductions from the sectors of the economy with the lowest cost opportunities. At the same time, this would mean that reductions would not necessarily be "proportional" to historic emissions across the sectors. The administrative and regulatory complexity of establishing an economy-wide emissions reduction credits is also more challenging than other sector focused policies.

What is regulated and who the obligated entities are: Greenhouse gas emissions are regulated. Defining obligated entities as far upstream in the supply chain as feasible will result in a smaller number of obligated entities and is desirable for administrative ease and compliance transparency. For example, rather than have emissions reduction credits for all end-users of a retail fuel, obligating wholesale fuel importers is more practical.

Revenue generating potential: While there may be trading of credits between obligated entities, and an entity that has excess credits could sell them to another party and gain revenue for their firm, this policy does not generate revenues for the state.

What other jurisdictions have implemented: We are not aware of any jurisdictions having implemented a policy based on requirements for economy wide emissions reduction credits.

What data is required to implement: A regulatory and rulemaking process for establishing the obligated entities, data and analysis to establish the schedule of credit requirements for each obligated entity and to establish standard protocols or deemed values of emissions reductions credits for various measures. If designed to include emissions from non-fuel/non-energy sectors would need to establish and maintain protocols and emission reduction values for each sector.

Any features unique to the policy: Applies a credit-based performance standard across all sectors.

Equity considerations: Similar equity impacts as sector-wide performance standard.

Direct Regulatory Approaches

8) Targeted performance standard for heating appliances

Brief description of the policy and how it is implemented: A targeted performance standard for heating appliances would establish emission standards for new heating appliances sold in the state. With this policy, the performance standard would apply to any new heating or hot water heating appliance sold within the state. Any appliance that does not meet the emission standard cannot be sold within the state. A targeted performance standard would be set in one year and could be revised to a more stringent target at a later date. In this way, the standard that appliances must meet could become more stringent over time as new standards are set. This policy could be paired with a complementary program or policy that provides rebates or subsidies to households in order to facilitate the purchase of new, lesser emitting heating appliances. Additionally, policymakers could make exceptions to the standard for low-income households if they cannot purchase the lesser emitting appliance.

What is regulated and who the obligated entities are: Space and water heating appliances are regulated. Regulations could include restrictions on fuel type, minimum efficiency, or estimated emissions. Heating appliance retailers are the obligated entities.

Revenue generating potential: This policy would not be expected to generate revenue.

What other jurisdictions have implemented: New York State has one example of a targeted performance standard for heating appliances. The New York State Climate Action Council Scoping Plan proposes adopting zero emissions standards that prohibit fossil fuel use in large burning equipment for heating and hot water in 2035.

What data is required to implement: Baseline data on the current mix of heating appliances sold in the state. Data and analysis on the availability of heating appliances meeting requirements. Analysis on what type of phase in is required and the type and level of heating appliance regulation.

Any features unique to the policy: A regulatory approach that applies directly to heating appliances.

Equity considerations: There is the potential for new efficient heating appliances to be of higher cost than existing, inefficient ones. There are existing appliance rebates and financing that are already available to LMI consumers and these rebates should ensure the cost of an appliance is of equal or lower cost compared to the more inefficient one. An exception can be made to LMI households if they cannot purchase the lesser emitting appliance.

9) Direct regulation of fuel emissions

Brief description of the policy and how it is implemented: Direct regulation of fuel emissions would establish a GHG emissions intensity standard for fuels used in buildings, otherwise known as a clean fuel standard or a low carbon fuel standard. A clean fuel standard is a credit-based program that encourages fuels with low emissions intensity. Emissions intensity is units of mass of emissions per unit of energy released during combustion of a fuel (e.g., grams CO2e per megajoule).

In this program, a fuel producer supplying fuels below the set fuel emissions intensity would generate credits, which can then be kept or sold. Producers of higher-emitting fuels would generate deficits, in which case, these producers must buy credits to meet the carbon intensity standard of a given year.

The fuel standard is then set lower in future years to reduce the allowable carbon intensity of fuels and would be the same across fuels. The goal of a clean fuel standard is to reduce the overall emissions intensity of fuels used in the state and would encourage the use of lower-emitting fuels, such as renewable natural gas (RNG) and liquid biofuels. A clean fuel standard can be included as a component of a sector-wide performance standard. As with the other market-based mechanisms, there are options for addressing equity concerns, including guaranteeing that the structure of the policy benefits low-income households and/or ensuring that complementary policies exist to maximize benefits to low-income households.

What is regulated and who the obligated entities are: Fuels for water and space heating are regulated, with an increasing requirement for fuels that have low greenhouse gas emissions. Fuel suppliers are obligated entities.

Revenue generating potential: While there may be trading of credits between obligated entities, and an entity that has excess credits could sell them to another party and gain revenue for their firm, this policy does not generate revenues for the state.

What other jurisdictions have implemented: Clean fuel standards exist in other jurisdictions, including Washington, Oregon, California (where it is called a low carbon fuel standard), and Canada but each of these policies are applied to transportation fuels. Each of these standards set their own emissions intensity target and each employ the market-based approach, generating credits for fuels under the set emissions standard. There are efforts to integrate these West Coast fuel standards together, under the Pacific Coast Collaborative, to create one combined market for low-carbon fuels.

What data is required to implement: Standard (EPA) data on the emissions intensity of various heating fuels would be necessary to implement a clean fuel standard. Data and analysis to establish a profile for clean fuel requirements. Data and analysis of the availability and cost for the clean fuels needed to meet the clean fuel standard.

Any features unique to the policy: This policy focuses on the GHG emissions intensity of fuels.

Equity considerations: A Clean Fuel Standard has the potential to affect LMI households that use gas if they are not transitioning away as fast as higher-income households. As wealthier households electrify and reduce gas consumption, gas infrastructure costs can end up being borne by a smaller customer base made up of mostly LMI households. Vermont has a much smaller set of households relying on utility gas, but even so, it's large enough to have large implications on the households that depend on it. Ensuring that a greater portion of lower-income households relying on gas have access to the Clean Fuel Standard first is important.

10) Fossil infrastructure moratorium

Brief description and how it is implemented: This policy entails limiting or eliminating investments in new fossil fuel infrastructure. Most typically, this relates to new gas distribution or transmission pipelines, but it can also encompass restricting new customer connections. Though we are not aware of any examples, in theory limitations or restrictions on new infrastructure for the delivery and distribution of propane, heating oil and other fossil fuels could also be included. The requirement to analyze, consider, and deploy non-pipe alternatives can also be placed in this policy group.

What is regulated and who the obligated entities are: Investment in new infrastructure to provide fossil fuel heating services are regulated. These could include new gas hook-ups, new distribution facilities for fuel oil or propane, or new gas distribution and transmission. Obligated entities are those that invest in or operate fossil fuel delivery infrastructure.

Revenue generating potential: None

What other jurisdictions they have been implemented: California and New Jersey have conducted studies on strategies for addressing the gas infrastructure transition and the ratepayer impacts of electrification on the gas and electric systems. The recent New York State Scoping Study includes recommendations to consider limitations on new gas service and possible modifications to statutory provisions to provide requested gas steam and electric services.

What data is required to implement: Analysis and data to determine timeline for phase in on moratorium. Determine the type of permits and project types that would be impacted. Analysis and consideration of how upgrades or maintenance to existing systems would be addressed.

Any features unique to the policy: The policy rationale is based on the consideration of the long life of new infrastructure investments, and the forward need to collect revenues as well as the impact of future emissions. As many decarbonization pathways and studies indicate that substantial reductions in gas consumption are required to meet emissions reduction targets, the questions of cost recovery for

gas infrastructure and how to provide a just transition as low-income customers may face barriers to electrification and be left facing increasing gas costs, are receiving greater attention.

Equity considerations: Similar equity considerations as the Clean Fuel Standard.

11) Building performance standards

Brief description and how it is implemented: "Building Performance Standards" (BPS) are policies that require commercial and multifamily buildings to meet certain performance levels, typically for energy use or greenhouse gas emissions. Each local or state government that implements a BPS customizes the requirements to fit its needs, but in general, a BPS contains:

- A performance target. For example, a jurisdiction may require buildings to meet a specific level of energy use per square foot and/or other level of performance.
- A timeframe by which all buildings must meet this target. For example, a jurisdiction may require that all buildings meet this target by December 2050, with interim goals in 2030 and 2040. Many laws include alternative paths to compliance, and there are penalties for buildings that fail to reach the target.[11]

A BPS policy is intended to address to energy use in existing buildings and is accompanied by benchmarking efforts. Similar to other policies that require or incent building energy efficiency, the availability of contractors to perform the work necessary is a critical component.

What is regulated and who the obligated entities are: The building performance, based on energy consumption or emissions is regulated. Which buildings (could be based on size or other factors) depends on the goals of the program. Obligated entities are owners of regulated buildings.

Revenue generating potential: None

What other jurisdictions have implemented: Several jurisdictions have a building performance standard in place, including Colorado, Maryland, Washington D.C., and Washington State.

An example of a related policy in Vermont is Burlington's Minimum Housing Code Weatherization Ordinance. "The purpose of the Weatherization Ordinance is to promote the wise and efficient use of energy in rental dwellings (including multi-family, single-family and condominiums) by mandating weatherization requirements (in high energy use buildings) through the Minimum Housing Code which is enforced by the Department of Permitting & Inspections (DPI)."[12]

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[11] https://www.energystar.gov/buildings/resources_topic/what_are_building_performance_standards

[12] https://www.burlingtonelectric.com/weatherization-ordinance/

"Once fully implemented, the Weatherization Ordinance only applies to high energy use rental buildings where the total space heating usage (all the apartments combined) is above 50,000 BTU/SF/YR (50,000 BTU/SF/YR). In mixed commercial/residential rental buildings, Weatherization Ordinance only applies to the residential rental portion of the building."[13]

What data is required to implement: Data on current and existing building energy use and emissions of buildings being regulated would be necessary to implement a building performance standard.

Any features unique to the policy: This policy regulates emissions from existing buildings.

Equity considerations: Targeted standards for rental properties and other housing can directly address building performance to reduce energy burden for lower income households. It is important if a landlord decides to make improvements that the costs of those improvements, if passed down to the consumer, does not increase the cost burdens of LMI tenants.

12) Emission limits on individual emitters

Brief description of the policy and how it is implemented: Emission limits on individual emitters would be a regulatory approach to limit the emissions produced by individual households and businesses in the state. Could be applied only to large industrial buildings – though this alone would not achieve necessary emissions reductions.

What is regulated and who the obligated entities are: Greenhouse gas emissions are regulated under this policy. Individual households and businesses are obligated entities. For administrative and enforcement feasibility it may be limited to entities above a threshold (e.g. >25,000 tons per year).

What other jurisdictions they have been implemented: We are not aware of any jurisdictions where this has been implemented.

What data is required to implement: Data on which buildings this policy would apply to and the baseline of emissions emitted by these buildings (based on fuel and energy use).

Any features unique to the policy: Unlike the other regulatory approaches, this regulation applies to individual households and businesses, as opposed to being applied to more upstream entities.

Equity considerations: If the responsibility of reducing emissions falls directly on households and businesses, this could create a major cost burden on LMI households who likely do not have the

[13] https://www.burlingtonelectric.com/weatherization-ordinance/

resources to invest in lower-emitting appliances. This policy could be paired with rebates to allow LMI households to reduce their emissions to meet the emissions limit.

Qualitative Assessment

Assessment Criteria

Confidently Attain Reductions – How strong is the confidence level that the policy will attain required emissions reductions with a focus on the 2030 GWSA requirements for the building thermal sector meeting its share proportionally? Policies that have a building sector specific cap on emissions or set credit requirements are rated as Best. Those that set a cap or credit requirements across additional sectors are rated as Better. Policies that do neither are ranked as Least Favorable as the assumption is that by themselves are not sufficient to meet 2030 building sector reduction requirements.

Cost per Metric Ton – Is the policy option likely to result in the lowest, middle, or highest category for the total cost per metric ton of reduced emissions? The policies enabling economy wide solutions are rated as Best. So are policies that have low costs but may not be able to reach required reduction levels on their own. Policies supporting market and technology solutions within the building sector are rated as Better. Policies in which the cost of reductions is expected to be high or where costs are uncertain are rated as Least Favorable. This assessment does not encompass the customer perspective or programmatic costs which will be addressed later in the study through quantitative modeling.

State Economic Impact – This criterion indicates ranking with respect to impacts on economic activity and jobs within Vermont. Those expected to expand and increase investments and jobs in the building sector, along with existing or new revenue sources, are ranked as Best. Those with a moderate ability to expand and increase investments and jobs in the building sector are rated as Better. Policies that may negatively impact investments and jobs are rated Least Favorable.

Health Impacts – This criterion considers the impact of policies on human health, particularly the impact on air quality and on building condition. The policies that directly reduce the combustion of fuels and support improved building performance are rated Best. Policies which are expected to reduce combustion and improve building performance to a somewhat lesser degree are rated Better. Policies which do not directly reduce combustion or address building shell improvements is rated Least Favorable. Quantitative estimates of reductions in criteria pollutants will be provided later in the study.

Implementation Feasibility – This criterion compares the policies in terms of administrative feasibility, complexity of design, ease of monitoring and enforcement, and availability of workforce. Policies which expand on existing efforts or are relatively straight-forward to implement are rated as Best. Policies which would require new administrative mechanisms and rules are rated Better. Policies which would be the most difficult to implement and administer or require significant increases in state workforce are rated Least Favorable.

Equity

The proposed policy options have the potential to benefit climate change efforts, but low- and moderate-income (LMI) households could face unintended consequences if these policies are not designed with equity considerations in mind. For example, some very low-income households have a very high energy burden of 24%, meaning that 24% of their income goes towards home energy costs.

While this criterion is an important lens through which to consider each policy, the team did not rank policies as Better, Best, or Least Favorable using this criterion. This is because the effective ability of a policy to address equity is not inherent to a policy and is rather influenced by the specific design of a policy.

Instead, policy summaries presented earlier included a description of the additional potential cost burdens LMI households could experience as a result of each policy and how to address these hardships during the transition away from fossil fuels. There will likely be a need for incentives to cover the full incremental costs for thermal shell improvements or electrification for income qualified customers along with targeted outreach and assistance to serve the hardest to reach customers. As this project proceeds, we will continue to identify and assess strategies for each policy can best elevate and address equity.

Qualitative Assessment

Confidently Attain 2030 GWSA Building Sector Proportional Reduction Requirements [14]

> **Best**- Cap and invest (building sector), Cap and trade (building sector), and Sector performance standard (4A, 5A, 6). Rationale is these are sector specific cap (or credit requirements) providing a higher level of regulatory certainty on proportional emission reductions within the sector. They are assumed to have complementary initiatives (be bundled with other policies) to support meeting target.
>
> **Better** – Expand existing programs (1) to meet the reduction target, Cap and invest (all fuels), Cap and trade (all fuels), Economy-wide GHG performance standard, and Limits on individual emitters (4B, 5B, 7, 12). These provide a level of certainty via an achievement, cap or credit requirement. However, with the exception of (1), they encompass broader sectors of the

[14] This criterion was specific to confidently attaining emissions reductions for the building sector. For various reasons, such as administration and cost-effectiveness, it may make sense to approach the state's emission reduction requirements across multiple sectors.

economy, thereby providing less certainty for proportional emissions reductions from the building sector.

Least Favorable – Feebates, Carbon pricing and invest (building sector), Carbon pricing and invest (all fuels), Targeted performance standards for heating appliances, Clean-fuel standard, Fossil infrastructure moratorium, Building performance standard, and Feebates (1, 2, 3A, 3B, 8, 9, 10, 11). These policies are expected to make significant contributions, but by themselves do not provide a level of reductions or confidence in meeting proportional building sector 2030 GWSA requirements.

Cost per Metric Ton –

Best- Expand existing programs and policies, Cap and Invest (all fuels), Cap and trade (all fuels), Economy-wide GHG performance standard (1, 4B, 5B, 7). Existing programs are generally providing savings and emissions reductions in a cost-effective manner and can be expanded to achieve deeper savings. The other three are caps or credit requirements that include non-building sector fuels, providing incentives and a structure for trading of credits or emissions allowances between sectors, thereby encouraging the least cost alternatives to reduce emissions.

Better – Feebates, Carbon pricing and invest (all fuels), Cap and invest (building sector), Cap and trade (building sector), and Sector performance standard, Targeted performance standards for heating appliances, and Fossil infrastructure moratorium, Building performance standards, and Emission limits on individual emitters. (2, 3B, 4A, 5A, 6, 8, 10, 11,12). These rely on technology and market solutions primarily within thermal sector. They do not provide for opportunities from other sectors to reduce emissions at a lower cost. Retrofits to existing equipment and buildings tend to be more costly than time of replacement measures.

Least Favorable – Carbon pricing and invest (building sector), and Clean-fuel standard, (3A, 9). Carbon pricing and a clean fuel standard rely on making the cost of the emitting fuel high enough that changes in consumer choices and behavior are induced. Market response is prone to lags due to energy price inelasticity and uptake. Uptake, consumer education and incentives could all be provided to improve the qualitative scoring.

State Economic Impact –

Best- Expand existing programs, Cap and invest (building sector), Cap and invest (all fuels), Sector performance standard, and Economy-wide GHG performance standard (1, 4A, 4B ,6 ,7). These are expected to result in the highest levels of investment in building sector improvements, and reductions in fossil fuel imports. There may be more local activity with

installation of heat pumps and weatherization, but importation of renewable fuels could come at a much lower up front (or even long term) cost. Each option could result in a positive economic impact but in two different ways (in-state job creation v. increased disposable income).

Better – Feebates, Carbon pricing and invest (building sector), Cap and trade (building sector), Cap and trade (all fuels), Targeted performance standards for heating appliances, Clean-fuel standard, and Building performance standard (2, 3A, 5A, 5B, 8, 9, 11). These rely on technology and market solutions within thermal sector but, with the exception of carbon pricing and invest, do not have revenue generation to increase investments. Most include efforts that expand on services requiring local labor. Most heating equipment and fossil fuels are imported to state.

Least Favorable – Carbon pricing and invest (all fuels), Fossil infrastructure moratorium, and Limits on individual emitters (3B, ,10, 12). Carbon pricing and invest for all fuels may cause higher levels of leakage with services or purchase of transportation fuels moving out of state. Moratorium on gas infrastructure would reduce potential economic activity and jobs.

Health Effects –

Best- Expand existing programs, Cap and invest (building sector), Cap and invest (all fuels), Cap and trade (building sector), Cap and trade (all fuels), Sector performance standard, Economy wide GHG standard, and Targeted performance standards for heating appliances (1, 4A, 4B, 5A, 5B, 6, 7, 8). These most directly reduce combustion emissions and will also improve performance of the built environment, reducing mold, moisture, and other issues.

Better- Feebates, Carbon pricing and invest (building sector), Carbon pricing and invest (all fuels), Fossil infrastructure moratorium, and Building performance standards, and Emissions limits on individual emitters (2, 3A, 3B, 10, 11, 12). These rely on technology and market solutions to prices within thermal sector leading to enhanced building performance and lower emissions from combustion.

Least Favorable – Clean Fuel Standard (9). Does not reduce existing combustion emissions or directly enhance building performance.

Implementation Feasibility -

Best- Expand existing programs, Carbon pricing and invest (building sector), Carbon pricing and invest (all fuels), and Targeted performance standards for heating appliances, (1, 3A, 3B, 8, 10). These expand on existing efforts or entail relatively direct and limited regulatory implementation.

Better – Feebates, Cap and invest (building sector), Cap and invest (all fuels), Cap and trade (building sector), Cap and trade (all fuels), Sector Performance Standard, Clean-fuel standard, and Building performance standard (2, 4A, 4B, 5A, 5B, 6, 9, 11). These require regulatory design and the development of new compliance and reporting structures.

Least Favorable- Economy wide GHG standard and Limits on individual emitters (7, 12). These are likely to be the most complicated and difficult to administer and monitor.

Table 1: Qualitative assessment of policy options.

	Attain2030 Building Sector Reductions	Cost per Metric Ton	State Economic Impact	Health Effects	Implementation Feasibility
Programs and Incentives					
1) Expand Existing Programs and policies	Better	Best	Best	Best	Best
2) Feebates	Least Favorable	Better	Better	Better	Better
Pricing, Cap, and Credit Approaches					
3) A. Carbon Pricing and Invest – **Building Sector**	Least Favorable	Least Favorable[15]	Better	Better	Best
B. Carbon Pricing and Invest – **All Fuels**	Least Favorable	Better	Least Favorable	Better	Best
4) A. Cap and invest – **Building Sector**	Best	Better	Best	Best	Better
B. Cap and invest -**All Fuels**	Better	Best	Best	Best	Better
5) A. Cap and trade – **Building Sector**	Best	Better	Better	Best	Better
B. Cap and trade – **All Fuels**	Better	Best	Better	Best	Better

[15] A low carbon price could be set that would rate more favorably, but this has least certainty of reducing emissions. Conversely, a high carbon price improves the certainty of meeting proportional sectoral emissions reductions.

	Attain2030 Building Sector Reductions	Cost per Metric Ton	State Economic Impact	Health Effects	Implementation Feasibility
6) Sector wide performance standards	Best	Better	Best	Best	Better
7) Economy-Wide GHG Performance Standard	Better	Best	Best	Best	Least Favorable
Direct Regulatory Approaches					
8) Targeted performance std for heating appliances	Least Favorable	Better	Better	Best	Best
9) Direct regulation of fuel - Clean Fuel Standard	Least Favorable	Least Favorable	Better	Least Favorable	Better
10) Fossil infrastructure moratorium	Least Favorable	Better	Least Favorable	Better	Best
11) Building performance standards	Least Favorable	Better	Better	Better	Better
12) Emissions limits on individual emitters	Better	Better	Least Favorable	Better	Least Favorable

Appendix: Additional References and Details on Policy Options

This Appendix includes additional details on the policy options, including deeper dives on the policies and where else they have been implemented. Additional reference materials are included for those wishing to learn more about the policies. The Appendix is a repository for our research and includes our notes and direct quotes from our sources and is not intended to be a part of the formal policy options write up.

1) Expand existing programs and policies

a. Weatherization (OEO, Efficiency VT, VGS)
- https://dcf.vermont.gov/benefits/weatherization
- https://www.efficiencyvermont.com/rebates/list/home-performance-with-energy-star
- https://vgsvt.com/savings/assistance-programs/

b. Residential and commercial building energy codes (RBES and CBES) (PSD)
https://publicservice.vermont.gov/efficiency/building-energy-standards

c. Appliance rebates and financing (Efficiency VT)
- https://www.efficiencyvermont.com/products-technologies
- https://www.efficiencyvermont.com/services/financing/homes

d. RES Tier 3 – electrification and weatherization
- https://publicservice.vermont.gov/renewables/renewable-energy-standard

e. Biofuels incentives through Clean Energy Development Fund (CEDF)
- https://energysaver.vermont.gov/programs-incentives)
- https://www.rerc-vt.org/

f. Weatherization Repayment Assistance Program (WRAP) through VHFA
- https://vhfa.org/news/blog/new-weatherization-financing-program-available-vermonters
- https://vgsvt.com/weatherization-repayment-assistance-program/

g. Direct technology/sector investments
Vermont's plans and proposals for accessing IIJA funds for electric grid infrastructure are summarized here: https://publicservice.vermont.gov/infrastructure-investment-and-jobs-act-grid-resiliency

The hydrogen technology investments from the Bipartisan Infrastructure Law are a major component of President Biden's plan to decarbonize the industrial sector, which accounts

for a third of domestic carbon emissions. Hydrogen energy has the potential to decarbonize multiple economic sectors, including heavy-duty transportation and steel manufacturing, create good paying jobs, and pave the way towards a grid powered by clean energy resources. Today, the U.S. produces about 10 million metric tons of hydrogen annually, compared to approximately 90 million tonnes produced per year globally. While most of the hydrogen produced in the U.S. comes from natural gas through steam methane reforming, electrolysis technology, which uses electricity to produce hydrogen from water, is an emerging pathway with dozens of installations across the U.S. This technology could allow for hydrogen production using clean electricity from renewable energy including solar, wind, and nuclear power.

The Bipartisan Infrastructure Law includes $8 billion for Regional Clean Hydrogen Hubs that will create jobs to expand use of clean hydrogen in the industrial sector and beyond; $1 billion for a Clean Hydrogen Electrolysis Program to reduce costs of hydrogen produced from clean electricity; and $500 million for Clean Hydrogen Manufacturing and Recycling Initiatives to support equipment manufacturing and strong domestic supply chains.

Information on the Vermont Gas System, UVM and Global Foundries Green Hydrogen Initiative: https://www.uvm.edu/news/story/vermont-partnership-advances-use-green-hydrogen-clean-fuel-future

2) Feebates

The resources below are helpful in understanding the application of a feebate in the building sector as applied to appliances.

Gabrielle Stebbins and Chris Neme, *A Heating Equipment Feebate*, prepared for the Energy Action Network, March 2022. https://www.eanvt.org/tracking-progress/research-and-reports/heating_feebate/.

- This resource is an in-depth report that explains the concept of a feebate in the context of Vermont.

Patrick Eilert, Amanda Stevens & Heidi Hauenstein, Jonathan McHugh
Innovative Approaches for Reducing GHG Emissions: Feebates for Appliances and Buildings
2010 ACEEE Summer Study on Energy Efficiency in Buildings
https://www.aceee.org/files/proceedings/2010/data/papers/2179.pdf

"A feebate is a market-based policy that can encourage greater energy efficiency and associated greenhouse gas emission reductions by levying surcharges on low-efficiency/high-emitting products and

refunding the revenue generated to purchasers of high-efficiency/low-emitting products through a rebate. Feebates, which can be designed to be revenue neutral, can be used to create incentives that shift markets toward lower emission products by influencing purchasing decisions. …

A significant energy savings opportunity exists in bridging existing voluntary and involuntary market interventions. Well-designed incentive programs are effective at motivating customers to purchase energy efficient products and services in a specific targeted market, but their effectiveness is usually limited to a small fraction of that market. Regulations for buildings and appliances are extremely cost effective at improving efficiency for an entire market, but codes and standards are blunt instruments that usually leave a lot of potential savings "on the table." Feebates can be used to bridge gaps between California's incentive programs and codes and standards as well as the gap between state and federal regulations. In particular, feebates could allow California to achieve additional energy and greenhouse gas emissions savings from appliances that are federally preempted from state-level codes and standards. From a policy perspective, federal regulations for buildings and appliances are effective at moving the entire nation towards a more sustainable future, but they are less effective than state policies at developing innovative regulations suitable for individual climate and economic conditions.

…Feebates for appliance and building could complement existing programs and regulations, enabling states to achieve even greater energy savings and associated emission reductions. A feebate is a market-based, technology-neutral policy that can be used to levy surcharges ("fee-") on less-efficient products and provide rebates ("-bate") for higher-efficient products. Through this system of surcharges and rebates, feebates create incentives that shift the market towards higher energy-efficiency and lower-emissions."

Additional references:
Nic Rivers, Jotham Peters*, "Switch Green": Analysis of Feebate for Major Household Appliances in Canada.* January 16, 2007. Published by David Suzuki Foundation.
https://davidsuzuki.wpenginepowered.com/wp-content/uploads/2019/02/switch-green-energy-star-appliance-feebate.pdf

- Analysis of the impacts that a revenue-neutral feebate for major house appliances would have on greenhouse gas emissions, pollutants, household energy consumption and costs, and other impacts in Canada
- Conducted in 2007
- Rebate for high efficiency appliances, coupled with a fee on low efficiency appliances
    - Efficiency ratings based on Energy Star qualifications
- Findings include:
    - Reducing greenhouse gas emissions by 275,000 tonnes per year
    - Reducing household energy costs by $80 million annually

    - Reducing annual household energy consumption by 1,440 gigawatt-hours — the equivalent of taking 120,000 homes off the electricity grid
- No consideration of impacts on low-income households

Natalie Mims and Heidi Hauenstein, February 2008, Rocky Mountain Institute.
Feebates: a Legislative Option to Encourage Continuous Improvements to Automobile Efficiency
https://rmi.org/insight/feebates-a-legislative-option-to-encourage-continuous-improvements-to-automobile-efficiency/

- Good overview of feebates but only in the context of their application to vehicles

3) Direct carbon pollution pricing

The Brookings Institute puts both cap and invest and tax and invest in the carbon pricing category. A carbon tax can be considered direct carbon pricing, while a cap-based system, which is likely to increase the price of the carbon fuel is indirect in that the market determines the price for allowances or credits.

The impact of a carbon tax on emissions levels will depend on the demand elasticity for fuels and the cost of alternative low-emitting options. The High Level Commission on Carbon Prices—drafted by the UN Framework Convention on Climate Change—estimated that achieving the Paris Agreement's goal of limiting warming to two degrees would require a universal carbon price of $40-80 per ton by 2020 and $50-100 by 2030 to achieve. Only 3.76% of global emissions are currently covered by a $40-80 price. Economists at the International Monetary Fund went even further, suggesting that major emitters would need a carbon price of $75 per ton to achieve sufficient emissions reductions.

In addition, any revenue earned from carbon pricing can be used to reduce the effects of climate change on the most vulnerable communities. Climate change has already disproportionately impacted vulnerable communities, and its impact is projected to worsen in the coming decades. Furthermore, the carbon pricing mechanisms and other environmental regulations needed to mitigate climate change can increase costs for consumers if costs are passed through by companies. Carbon pricing revenue should therefore be used to offset any potential increased energy costs for low-income households, as well as to build climate resilience in vulnerable communities.

Carbon Tax Center – a clearinghouse with information on efforts for carbon tax legislation at the state level. The references cited here are somewhat dated (in the 2017 timeframe) and it appears that none of the "promising" states have moved ahead with carbon taxes, though several have adopted alternative cap and invest. https://www.carbontax.org/states- -new/#:~:text=No%20U.S.%20state%20has%20a%20carbon%20tax.

Carbon taxes have been adopted in a handful of countries such including South Africa, Chile, Argentina, and Canada.

Canada has a federal carbon pricing system (fuel and output based) or provinces can pursue their own system. Quebec and Nova Scotia for example have adopted cap and invest under the WCI. Under the *Greenhouse Gas Pollution Pricing Act (GGPPA)*, adopted on June 21, 2018, the federal pricing system has two parts: a regulatory charge on fossil fuels like gasoline and natural gas, known as the fuel charge, and a performance-based system for industries, known as the Output-Based Pricing System. The fuel charge applies in Ontario, Manitoba, Yukon, Alberta, Saskatchewan and Nunavut. The Output-Based Pricing System applies in Manitoba, Prince Edward Island, the Yukon, Nunavut, and partially in Saskatchewan. All other provinces and territory are implementing their own pricing systems.

The Hawaii state senate has stated its intent to consider a carbon tax in 2022. https://citizensclimatelobby.org/blog/policy/how-economists-support-the-fight-for-a-carbon-fee-and-dividend-in-hawaii/

Boulder Colorado adopted a municipal carbon tax in 2007, and has since updated and renewed this effort. https://bouldercolorado.gov/projects/funding-city-climate-work.

4) Cap and invest

California: Air Resources Board. Program includes allocation of free allowances up to benchmark 90% for sector, and then auction. Note because of the auction for emissions allowances we classify California and Quebec as cap-and-invest, even if a substantial share of the allowances are free.

Auction joint with Quebec. 33rd joint auction in December 2021. https://ww2.arb.ca.gov/news/california-and-quebec-release-summary-results-33rd-joint-cap-and-trade-allowance-auction

California Cap and trade program update from CARB scoping study:

The Cap-and-Trade Program first came into effect in 2012, under AB 32, and included declining allowance caps through 2020. In 2017, AB 398196 was passed by a supermajority in the Legislature and included prescriptive direction on the design of the program from 2021 through 2030. The AB 398 Cap-and-Trade Program came into effect on January 1, 2021, and it included the following changes:

- Doubling of stringency with an annual cap decline of 4 percent per year from 2021– 2030
- AB 398 price ceiling
- AB 398 redesigned allowance price containment reserve with two tiers
- AB 398 100 percent leakage assistance factor for industry

- AB 398 lower offset limits: Usage limit cut from 8 percent to 4 percent, and half of offsets must provide direct benefits to California

As a result of achieving the 2020 target several years earlier than mandated by law, there are unused allowances in circulation. CARB estimated the amount to be approximately 310 million allowances after the conclusion of the third compliance period (2018–2020).201

AB 398 had also called for a similar analysis, which was completed in 2018.202 This bank represents approximately 5 percent of the total number of vintage 2013–2030 allowances issued within the joint market. This bank of allowances can only remain banked if year-over-year the covered emissions are declining by 14 MMT. If the annual decline in actual emissions is less than 14 MMT, regulated entities will need to use the banked allowances to cover their compliance obligations. It is likely that the existing bank of 310 million allowances will be needed over the early part of this decade and will be exhausted by the end of the decade. During the same period, prices for allowances will continue to increase at least 5 percent plus inflation year-over-year, sending a steadily increasing price signal to spur investment in onsite reductions for covered entities.

Since the original adoption of California's Cap-and-Trade regulation, the program has been amended eight times through a robust public process.

As the actual reductions from non-Cap-and-Trade Program measures increase, California will be less reliant on the Cap-and-Trade Program to "fill the gap" to meet an accelerated 2030 reduction target. For example, CARB is developing a proposal to increase the stringency of the LCFS program for 2030, the recently adopted Advanced Clean Cars ll regulation is more stringent than modeled for the 2030 40 percent target in the 2017 Scoping Plan, and SB 596 requires specific reductions in the cement sector over this decade and beyond.

Scoping Plan Table 3-11 includes estimated cost per metric ton for measures in the scoping plan scenario. Annual costs in 2035 and 2045 as well as average cost per ton over 2022 to each end point. These don't represent the estimated market price value for carbon mitigation for each measure.

Table 3-11: Estimated cost per metric ton of reduced CO_2e relative to the Reference Scenario for measures considered in the Scoping Plan Scenario (AB 32 GHG Inventory sectors)

Measure	Annual Cost, 2035 ($/ton)	Average Annual Cost, 2022–2035 ($/ton)	Annual Cost, 2045 ($/ton)	Average Annual Cost, 2022–2045 ($/ton)
Deploy ZEVs and reduce driving demand	-171	-99	-103	-122
Coordinate supply of liquid fossil fuels with declining CA fuel demand	60	109	-50	39
Generate clean electricity[a]	101	156	145	161
Decarbonize industrial energy supply	290	217	257	274
Decarbonize buildings	235	230	112	213
Reduce non-combustion emissions	93	94	106	99
Compensate for remaining emissions	745	823	236	485

[a] Note: The denominator of this calculation (2045) does not include GHG reductions occurring outside of California resulting from SB 100. If these reductions were included, this number would be lower.

Quebec: Established cap and trade in 2013 and joined Western Climate Initiative (WCI) in 2014. Quebec maintained partnership with California after Ontario withdrew from WCI in 2018.

Funds from allowance auctions go to the electrification and climate change fund, totaling more than $6.9 Billion since inception. https://www.environnement.gouv.qc.ca/changements/carbone/revenus-en.htm

Implementation plan (French) for 2022-2027.

New York State: New York's Climate Action Council released the Scoping Plan Full Report in December 2022, outlining options and strategies to meet the requirements of the 2019 Climate and Community Protection Act. Chapter 17 of the Scoping Study addresses Economywide strategies, and discusses the pros and cons of a carbon pricing versus a cap-and-invest policy.

New York State Scoping Plan includes investment portfolio[16] as well as overarching cap and invest structure. Draft plan and review with 35,000 public comments, and Climate Justices and Just Transition Working Groups. Climate Act requires disadvantaged communities receive a minimum of 35% with target of 40% of the benefits of spending on clean energy and efficiency programs. Methods for defining benefits underway. (page 6).

Jobs study conducted by Just Transitions Working Group. (p.8). Sector summaries include discussion of the cross-sector cap-and-invest program. The cap-and-invest program meets the need for assured emission reductions and allows for investments in technologies that help achieve emissions reductions and reduce the overall cost of this program. (p. 9 and 20).

Revenues generated by the program will leverage federal funding to implement the policies identified in the Scoping Plan. (p. 20). Design considerations to prioritize GHG and co-pollutant emission reductions in Disadvantaged Communities potentially include limits on trading allowances that preclude sources within or near Disadvantaged Communities from purchasing allowances from outside of Disadvantaged Communities, source-specific caps or other mechanisms designed to prioritize reduction of GHG or co-pollutant emissions from sources in or proximate to Disadvantaged Communities, and targeted air quality monitoring to ensure continued air quality improvement in Disadvantaged Communities. In addition, as required by the Climate Act, at least 35% of the investments made with program proceeds will benefit Disadvantaged Communities, with a goal of 40%. Offsets would have little, if any, role in a cap-and-invest program designed to comply with the Climate Act.

In addition, the strategy recommends rebates or other mechanisms to mitigate the program's financial impacts on LMI households so these households will benefit from program investments without bearing any additional energy costs due to the program's implementation. DEC will have until January 1, 2024 to promulgate enforceable regulations to ensure the State meets the Climate Act's statewide emissions limits. (p. 22).

Page 339: Narrowed policies to 2 choices, carbon tax and cap and invest. P. 342, auction of allowances and investments. P. 343 addressing affordability and equity. Evaluation criteria p. 345, certainty of emissions, and limited role for offsets. Consideration of energy intensive trade-exposed industries to avoid leakage, p. 344.

Discussion of price certainty, p. 346 – carbon tax has greater price certainty than cap and invest, the latter can use minimum allowance price and emission containment reserve and a soft price ceiling, to help narrow the range of potential price fluctuations.

Interaction with other regulatory programs – p. 347 cap and invest is well suited to providing complementary support to other standards and regulations – examples of RGGI and IRA. The cap

[16] Executive Summary page 1.

remains the same despite other initiatives, but the cost to attain will be reduced. Conversely, a carbon tax is set and is in addition to the impacts from other initiatives.

Washington State: In 2021, the Washington Legislature passed the Climate Commitment Act (or CCA) which establishes a comprehensive, market-based program to reduce carbon pollution and achieve the greenhouse gas limits set in state law. The program will start Jan. 2023, and the first emissions allowance auction will take place in the second half of Feb. 2023. In December, 2021 Washington joined the Western Climate Initiative, Inc. (WCI), the nonprofit that provides the auction platform for the linked programs in California and Québec, as well as the stand-alone program in Nova Scotia.

Washington has also adopted a clean fuel standard, and a hydrofluorocarbons management program.

Economic Analysis of impacts for Washington considers linking with California and Quebec markets and frontloading of compliance.

5) Cap and trade

Oregon: Legislation failed to pass, and cap-and-trade program implemented via executive order. After legislative efforts to pass a cap and trade bill shut down the Oregon legislature two years in a row, Oregon Governor Kate Brown signed Executive Order 20-04 in 2020, a sweeping administrative order aimed at reducing GHG emissions in Oregon by at least 80 percent below 1990 levels by 2050. A primary component of EO 20-04 was tasking the Department of Environmental Quality (DEQ) with developing and implementing rules to cap and reduce GHG emissions in order to meet the stated reduction goals. Late last year, the Oregon Environmental Quality Commission voted to adopt the CPP to fulfill that task.

Oregon DEQ freely distributes compliance instruments to covered entities for each year. A share 10-20% of compliance may be met by Community Climate Investments.

The EU Emissions Trading Scheme established in 2005 is the largest ETS. Other national initiatives include ETSs in Kazakhstan, New Zealand, Mexico, and (recently) China.

Cap and trade literature review: The seven emissions trading systems we examined were the US Environmental Protection Agency's (EPA's) phasedown of leaded gasoline in the 1980s; the US sulfur dioxide (SO2) allowance trading program under the Clean Air Act Amendments of 1990; the Regional Clean Air Incentives Market (RECLAIM) in Southern California; the trading of nitrogen oxides (NOx) in the eastern United States; RGGI in the northeastern United States; California's cap-and-trade system under Assembly Bill 32; and the European Union (EU) Emissions Trading System (ETS). https://www.resources.org/archives/learning-thirty-years-cap-trade/

6) Sector wide performance standards

No additional reference materials currently, refer to main text.

7) Economy-Wide Performance Standard – GHG Standard

No additional reference materials currently, refer to main text.

8) Targeted performance standard for heating appliances

- New York State Scoping Plan
    - PDF pages 189-190: "2035: DEC should adopt zero-emission standards that prohibit fossil fuel use in large fuel burning equipment for heating and domestic hot water. The standards should be enforced under a new emissions enforcement regime of large combustion equipment sized to typically heat buildings 50,000 sq. ft. or more in floor area, thereby requiring early retirement."

9) Direct regulation of fuel emissions

- Washington's Clean Fuel Standard: https://ecology.wa.gov/Air-Climate/Reducing-Emissions/Clean-Fuel-Standard
- Oregon's Clean Fuels Program: https://www.oregon.gov/deq/ghgp/cfp/Pages/CFP-Overview.aspx
- Canada's Clean Fuel Regulations: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations.html
- California's Low Carbon Fuel Standard: https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard
- Pacific Coast Collaborative: https://pacificcoastcollaborative.org/
- NYC biodiesel blending requirement subsequently followed by a statewide requirement (see: https://www.robisonoil.com/news/2021/december/heating-your-home-biofuel-blending-becomes-law-i/).

10) Fossil infrastructure moratorium

No additional reference materials currently, refer to main text.

11) Building performance standards

- BPS map highlights the current status of BPS adoption at the state and local level across the U.S.: https://www.energycodes.gov/BPS

- Information about Colorado's BPS: https://energyoffice.colorado.gov/climate-energy/energy-policy/building-performance-standards
- *Minimum housing code weatherization ordinance,* Burlington Electric Department https://www.burlingtonelectric.com/weatherization-ordinance/
- Benchmarking and Building Performance Standards Policy Toolkit: https://www.epa.gov/statelocalenergy/benchmarking-and-building-performance-standards-policy-toolkit

12) Emissions limits on individual emitters

No additional reference materials currently, refer to main text.