

**EXH. EAB-16  
DOCKETS UE-220066/UG-220067  
2022 PSE GENERAL RATE CASE  
WITNESS: ED BURGESS**

**BEFORE THE  
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

**WASHINGTON UTILITIES AND  
TRANSPORTATION COMMISSION,**

**Complainant,**

**v.**

**PUGET SOUND ENERGY,**

**Respondent.**

**Docket UE-220066  
Docket UG-220067**

**FIFTEENTH EXHIBIT (NONCONFIDENTIAL) TO  
THE PREFILED RESPONSE TESTIMONY OF**

**ED BURGESS**

**ON BEHALF OF NW ENERGY COALITION, FRONT AND CENTERED, AND  
SIERRA CLUB**

**JULY 28, 2022**

# PROGRAMS TO ELECTRIFY SPACE HEATING IN HOMES AND BUILDINGS

BY STEVEN NADEL



**ACEEE Topic Brief**  
**June 2020**

**ACEEE**   
American Council for an Energy-Efficient Economy

## Key Findings

- Programs to promote the electrification of space heating in homes and buildings, primarily using high-efficiency heat pumps, are rapidly growing. Current year budgets are nearly \$110 million, up 70% from the prior year.
- These programs are early in their evolution. Many programs are refining their approaches, adjusting incentives, adding components, and piloting new or complementary approaches such as all-electric new construction.
- Programs are most extensive on the West Coast and in the Northeast but are beginning in other regions as well. Many of these programs are run by utilities (investor-owned, municipal, and cooperative), but some are run by states, cities, and independent organizations designated by states.
- Many of the programs target the use of heat pumps to displace both fossil fuels (an electrification measure) and electric resistance heat (an electric efficiency measure), but some programs target mostly one or the other.
- The bulk of program participants use heat pumps alongside existing fossil fuel systems. A growing number of programs are looking to encourage heat pumps as primary heating systems. In regions with growing use of air-conditioning, ductless heat pumps can be a popular way to add both supplemental heat and efficient air-conditioning to homes that are difficult to retrofit with central air-conditioning.
- Most programs encourage weatherization to reduce loads in conjunction with purchasing a new heat pump. About one-third of programs require weatherization. A few programs are exploring approaches to improve weatherization uptake before or at the time of heat pump installation (e.g., the Massachusetts Market Value Performance [MVP] program).
- In areas with high use of delivered fuels (fuel oil and propane), many programs target customers using these fuels because the economics of electrification in these situations are often better than when displacing natural gas. Likewise, a few programs are encouraging all-electric new construction.
- Several programs offer upstream incentives to contractors or distributors, finding that such an approach increases participation. High incentives, such as those enabled by giving credit for fossil fuel savings and not just electric savings, and/or by putting value on greenhouse gas emissions reductions, also increase participation.
- Existing programs emphasize the residential sector. While commercial applications are often eligible, they are usually not targeted, and where targeted, the emphasis is on smaller buildings. Analysts and programs are just starting to consider electrification opportunities in the commercial sector.

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## Introduction

A variety of studies have found that to meet long-term goals for reducing greenhouse gas emissions, we should dramatically reduce the burning of fossil fuels to heat homes and buildings. One way to do this is to use high-efficiency electric heat pumps, as long as the electricity produced is from renewable energy or other no-/low-carbon-generating sources (Greenblatt and Long 2011; Howland et al. 2014; Williams et al. 2015). To pursue this strategy, several states have embraced electrification as a policy objective. For example, in 2018, the California legislature adopted Senate Bill (SB) 1477 to fund efforts to promote low-emissions buildings and adopt sources of heat energy; the use of heat pumps is a central component of this initiative (California Legislature 2018). And in New York State, the Public Service Commission recently ordered a substantial increase in energy efficiency efforts, including a significant focus on heat pumps (Wilt 2020; New York PSC 2020). Likewise, leading cities – such as the eight cities in the building electrification initiative – have also embraced decarbonization and electrification.<sup>1</sup>

As a result of these studies and policy pronouncements, utilities, states, and program administrators have begun offering programs to encourage home and building owners to install high-efficiency heat pumps, typically at the time existing equipment fails and needs to be replaced. In 2018, the American Council for an Energy-Efficient Economy (ACEEE) profiled many of these initial programs and policies (Nadel 2018). However, the data from that report are now dated, and many additional programs and policies have since been introduced. This brief provides an updated review of electrification programs. It focuses on space heating, which is the largest use of fossil fuels in buildings (EIA 2020). Other electrification opportunities in buildings include converting water heaters, stoves/ovens, and dryers, but those are outside the scope of our review. We focus on space heating while still noting where programs cover other end uses.<sup>2</sup> We recognize that this field is changing quickly, and we intend to periodically update this brief with new data and additional information on programs.

For this paper, we requested updated information from all of the programs included in the 2018 report. We also consulted a variety of program and electrification experts for recommendations on additional programs we might highlight. Thus, while we included many programs currently underway in the United States, we almost certainly missed some. For both the prior and additional programs, we then reached out to program managers, asking for a set of specific data on their programs as well as for

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<sup>1</sup> [www.beicities.org/cities-participating](http://www.beicities.org/cities-participating).

<sup>2</sup> For a more extensive discussion of programs for heat pump water heaters, see York et al. (2015).

information we could use to develop program descriptions. As part of the review process for this Topic Brief, we reached out to each of these program managers, asking them to review and comment on the program descriptions we prepared.

In the next section, we summarize the program data collected. We then provide descriptions of the programs, program experience to date, and lessons learned. We end with a brief discussion and conclusions.

## Program Data

We requested eight pieces of information from each program, and 22 programs provided data. The data provided are listed in the appendix. In this section, we summarize the results. Locations of these programs are shown in figure 1. Note that different program implementers included different types of programs under the heading “electrification.” Virtually all of the programs include heat pumps for space heating, some include heat pump water heaters (HPWHs), some include associated weatherization, and a few include other measures such as induction stoves and even electric vehicles (EVs) and lawn mowers. The appendix provides information on the scope of each program. Due to these differences among programs, care should be used when comparing their data.

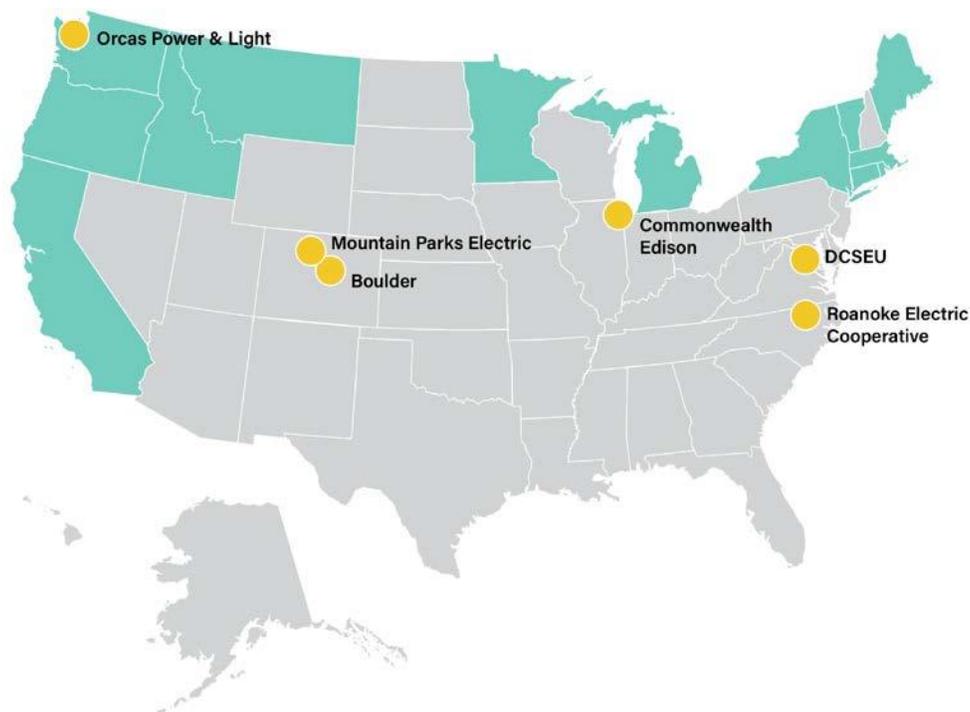


Figure 1. States and programs profiled in this brief. States that are shaded green have multiple programs that are discussed in this paper. Yellow dots indicate programs operated by individual program administrators that are not discussed in the sections on the shaded states and regions.

## ANNUAL BUDGET

We asked for programs’ annual budgets for the current and prior years. These budgets ranged from \$45,000 (City of Boulder) to \$36.6 million for the multi-utility New York State Clean Heat: Statewide Heat Pump Program (and this does not include the budget for the New York State Energy Research and Development Authority [NYSERDA], whose budget is still pending). Across the programs in our study, budgets totaled about \$109 million for the current year, up substantially from the \$64 million

these same programs reported for their prior years. The increase reflects rising interest in electrification and is due to new programs (such as in New York and at Southern California Edison) and to increases in some program budgets (e.g., the Sacramento Municipal Utility District [SMUD] budget was \$4.5 million last year and \$12.5 million this year). Budgets by program are summarized in table 1. These budgets reflect information from just prior to the coronavirus pandemic and does not reflect adjustments due to the pandemic and resulting economic recession.

### **NUMBER OF REBATES AND CUSTOMERS**

Programs report collectively providing nearly 80,000 rebates and serving nearly 24,000 customers in the most recent year. Some customers received more than one rebate. Both of these numbers are conservative as some programs report number of rebates but not number of customers and vice versa. The largest programs in terms of rebates were operated by Energize Connecticut (CT; 28,535), Efficiency Maine (nearly 18,000), and NYSERDA (nearly 13,000). The Vermont Tier III program reports serving nearly 9,000 customers. Participation by program for the most recent year is summarized in table 1.

### **SOURCE OF FUNDS**

Of the 22 programs, 19 are funded by utility ratepayers. Six programs use cap-and-trade funds. Several New England programs use funds from the regional forward capacity market. SMUD complements ratepayer funds with some shareholder funds. The Massachusetts Market Value Performance (MVP) Program is funded out of the state budget, the Eugene program is funded in part by a state program, and the Boulder program is funded in part from a small tax on electricity sales

### **TECHNOLOGIES INCLUDED**

Of the 23 programs, 22 include ductless heat pumps, 21 include ducted heat pumps, and 20 include HPWHs. In addition, 12 include variable refrigerant flow heat pumps (used primarily in commercial buildings), and 6 include induction stoves. In colder climates, many of the programs specifically require “cold climate” heat pumps, meaning heat pumps that can work well at low temperatures, often as defined by a specification developed by Northeast Energy Efficiency Partnerships (NEEP).<sup>3</sup>

### **SECTORS TARGETED**

All of the 23 programs target single-family homes. Seventeen programs target multifamily buildings, 12 target small commercial buildings, and 8 target large commercial buildings.

### **FUELS ELIGIBLE**

Oil and propane systems are eligible for replacement in 18 programs, and natural gas systems are eligible in 18 programs (many overlap, but some programs cover one or the other). Wood is eligible for replacement in 10 programs and “other fuels” in 10. Electric resistance heat was the primary “other” fuel mentioned. Some programs do not target oil and propane because use of these fuels is very limited in their territories. Some programs do not target natural gas due to questions about the economics of natural gas conversions, a desire to start with oil and propane, or not wanting or being able to pay for fuel switching (these programs will pay to replace electric resistance heat).<sup>4</sup>

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<sup>3</sup> [www.neep.org/ASHP-Specification](http://www.neep.org/ASHP-Specification).

<sup>4</sup> For a discussion on state regulations on fuel switching, see Berg, Cooper, and Cortez (2020).

**Table 1. Budgets and participation by program**

Program implementer	Annual budget		Participation in most recent year	
	Prior year	Current year	Rebates	Customers
SMUD	\$4,500,000	\$12,500,000	2,500	
Palo Alto	\$150,000	\$300,000	43	
SCE CLEAR	\$425,000	\$1,600,000		
SCE plug-load and appliance		\$17,000,000		
NYSERDA	\$22,800,000		12,778	6,520
NYS Electric Utilities	Just started	\$36,600,000	Just started	Just started
Efficiency Maine	\$12,118,849		17,776	
Mass Save	\$4,875,000	\$9,705,000	2,530	
MassCEC		\$500,000	27	
Massachusetts DOER	\$1,333,333	\$1,333,333	350	250
Vermont Department of Public Service		\$5,942,339		8,993
Efficiency Vermont	\$3,600,000	\$4,100,000	5,291	
Burlington Electric Department	\$627,905	\$277,469	356	390
Building Performance Professionals Assoc. of VT	\$10,000	\$300,000		
Energize CT (Avangrid)	\$6,853,734	\$6,766,340	9,050	6,909
Energize CT (Eversource)	\$5,846,348	\$10,676,893	19,485	
Energize CT Optimization Pilot		\$300,000		
National Grid Rhode Island	\$190,000		490	378
Bonneville Power Administration			8,350	
City of Ashland, Oregon			225	
Eugene Water and Energy Board	\$500,000	\$500,000	288	268
City of Boulder, Colorado	\$45,000	\$45,000		40
DC Sustainable Energy Utility		\$440,000		Just starting
<b>Total</b>	<b>\$63,875,169</b>	<b>\$108,886,374</b>	<b>79,539</b>	<b>23,748</b>

Blank cells indicate no data provided.

### ***MOST COMMON MEASURES AND THEIR INCENTIVES***

We asked administrators which measures were most common in their programs and what incentives were provided for these measures. The largest number of responses cited ductless and ducted heat pumps and HPWHs. Other measures with multiple responses were ground-source heat pumps, weatherization, and all-electric new construction (included in many new-construction programs). Incentives vary widely among programs, both in dollar amount and in how they are expressed (e.g.,

dollars per unit or dollars per ton of cooling capacity<sup>5</sup>). Incentives for each measure and program are summarized in table 2.

Table 2. Incentives provided for the top-three measures in each program

Program	Incentive	Program	Incentive
<b>Ductless heat pumps (often cold climate)</b>		<b>Ground-source heat pumps</b>	
NYSERDA 2019	\$500/outdoor unit	NYSERDA 2019	\$1,500/ton
NY utilities 2020	\$500–800/outdoor unit	NY utilities 2020	\$1,500–2,850/ton
SCE	\$300–600/ton	Massachusetts MVP	\$6,000–20,000 per home
Energize CT	\$500 per unit*	<b>HPWHs</b>	
Mass Save	\$1,250/ton	SMUD	\$3,000
Vermont Tier III	\$500–800 per system	Palo Alto	\$1,200–1,500
Efficiency Vermont	\$350–450 per system	SCE	\$1,000
Burlington Electric Dept.	\$1,200–1,650 per system	Energize CT	\$750
National Grid Rhode Island	\$1,000/ton	Efficiency Vermont	\$600
City of Ashland	\$88–1,200 per system	Boulder	\$1,450
EWEB	\$1,000 per system	<b>Residential new construction</b>	
Boulder	\$1,050 per system	SCE	\$12,500 all electric
<b>Ducted heat pump (sometimes cold climate)</b>		SCE	\$7,500 dual fuel
SMUD	\$4,500 per system	Energize CT	\$1,000/apt., \$2,500/home
SCE	\$300–600/ton	<b>Weatherization</b>	
NYSERDA 2019	\$1,000/ton	Massachusetts MVP	\$1,000–9,000
NY utilities 2020	\$1,000–2,000/ton	Vermont ZEN	\$10,000
Energize CT	\$500 per system	DCSEU low-income pilot	\$5,000–6,500 (projection)
Mass Save	\$1,250/ton		
MassCEC	\$2,500 (convert from NG)		
Massachusetts MVP	\$2,000–12,000 per system		
Vermont Tier III	\$500–800 per system		
Efficiency Vermont	\$800/ton		
Vermont ZEN	\$15,000 per home		
National Grid Rhode Island	\$1,000/ton		
EWEB	\$800 per system		
Boulder	\$1,450 per system		

\* Connecticut incentives will increase to match the Massachusetts incentives as of mid-2020.

### **IS WEATHERIZATION ENCOURAGED OR REQUIRED?**

Weatherization reduces heating loads, allowing a smaller system to be installed and making it easier for a heat pump to serve all or most of the heating load, even on cold days. Eight of the programs

<sup>5</sup> A ton of cooling capacity is 12,000 Btus/hour. This is based on the fact that cooling was historically expressed in tons of ice equivalent: a ton of ice provides about 12,000 Btus of cooling. A typical ductless heat pump might be 1–2 tons; a typical ducted residential heat pump might be 3–5 tons.

require weatherization as part of heat pump projects, and 15 encourage but do not require weatherization (some programs require weatherization for some but not all customers). The programs requiring weatherization are the Vermont Zero Energy Now (ZEN) and Tier III programs, an Energize Connecticut program (which requires weatherization when displacing oil and propane but only encourages weatherization for other fuels), the National Grid Rhode Island HVAC Program (which requires weatherization to be eligible for a higher tier of incentives), and two low-income programs (SMUD and District of Columbia Sustainable Energy Utility [DCSEU]) where weatherization is required but paid for by the program. The two new-construction programs in our database require that participants take beyond-code efficiency measures to be eligible for incentives. In addition, several programs (e.g., the Massachusetts MVP program) that do not require weatherization encourage participants to weatherize through the use of extra incentives for doing both weatherization and a heat pump.

## Program Descriptions and Experience

In the following sections, we describe programs by state and region, starting with the most extensive efforts in terms of budget and breadth of effort (e.g., California, New York, and some of the New England states) and proceed to medium-sized and then smaller efforts (some of which are pilots).

### **CALIFORNIA**

As noted, the California Legislature passed SB 1477, funding efforts to promote “low-emissions buildings and sources of heat energy.” The California Public Utilities Commission (CPUC) has revised its cost-effectiveness procedures for accessing many fuel substitution<sup>6</sup> programs with energy efficiency funding. Several municipal utilities have operated electrification programs for a few years, and investor-owned utilities are starting their own programs. Note also that more than 30 local jurisdictions have enacted restrictions on use of fossil fuels, primarily in new buildings through local building codes. We discuss these efforts in the paragraphs that follow.

#### **Statewide Efforts**

SB 1477 established two new statewide programs: Technology and Equipment for Clean Heating (TECH) and Building Initiative for Low Emissions Development (BUILD).

TECH aims to jumpstart the market for low-emissions space and water-heating technologies such as heat pumps by working “upstream” with manufacturers, distributors, and vendors and through consumer education and contractor training. TECH will be run by a statewide third-party implementer, to be selected through a competitive process.

BUILD is dedicated to new all-electric housing that has lower emissions than buildings fueled with conventional natural gas. The program can incentivize any combination of measures, including heat pumps, energy efficiency, demand response, storage, and solar, beyond what is required by code. BUILD will be primarily focused on housing for low-income families, with a minimum of 75% of these funds set aside for low-income projects and active technical assistance provided to low-income housing developers. The California Energy Commission will administer BUILD.

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<sup>6</sup> California uses *substitution* to describe replacement of two different regulated fuels and *switching* for replacement of unregulated with regulated fuels.

Over the next four years, TECH will receive \$120 million and BUILD will receive \$80 million from natural gas utility carbon-allowance proceeds in the state's cap-and-trade program (Borgeson 2020; Gerdes 2019). Planning for both programs is under way, and implementation is scheduled to begin in 2021.

For many years, the CPUC had a policy to nominally allow fuel switching in the portfolio of energy efficiency programs when a fuel-switching measure met a so-called “three-prong test”: fuel switching must (1) save energy, (2) reduce emissions, and (3) save consumers money. But many details of this policy were unclear, and as a result, little fuel-switching activity took place. In August 2019, the CPUC issued a revised policy. It clarified a variety of issues and enabled energy efficiency program administrators to more readily include fuel-switching measures in their programs (Borgeson 2019; CPUC 2019). Since then, they have also approved \$45 million of expenditures for utility HPWH programs outside of the energy efficiency funding through the Self-Generation Incentive Program (Delforge and Borgeson 2020).

### **Municipal Utility Programs**

In California, municipal utilities are not subject to CPUC regulation and thus were not affected by ambiguities in the three-prong test. Therefore, several municipal utilities have operated electrification programs for several years. The largest set of programs is operated by SMUD, an electric-only utility that is implementing a portfolio of programs aimed at zeroing out its carbon footprint by eliminating natural gas from buildings in its territory. Since SMUD’s electricity is over 50% carbon free and heat pumps are typically more efficient than gas units, SMUD finds that the largest carbon savings come from the conversion of gas equipment to electric. SMUD is the first U.S. utility to shift measurement of energy efficiency from avoided kilowatt-hours (kWh) to avoided carbon (SMUD 2020), which the utility refers to as “electrification efficiency.”

SMUD’s current program strategy began in June of 2018 with the rollout of electrification programs aimed at residential space and water heating as well as cooking. When converting gas equipment to electric in existing homes, the incentives are set at \$3,000 for water heating, \$4,500 for space heating, and \$500 for induction cooking. Customers can also receive up to an additional \$2,500 incentive for panel and wiring upgrades necessary to convert the home to all electric. When electric equipment is replaced with new, more-efficient electric devices, incentives change to \$1,000, \$2,000, and \$100, respectively.<sup>7</sup>

SMUD also has rebates for new all-electric homes (\$5,000 for single-family homes, \$1,500 for multifamily). For new single-family homes, SMUD also has incentives for builders who are not yet ready to go all electric: they provide smaller incentives for a new home that is all-electric ready, meaning it has the electric service, breakers, wiring, and plugs required for easy conversion to all electric. For existing multifamily buildings, the maximum incentive is \$3,000 per apartment plus an additional 25% of the incentive if the property is low-income qualified. As of August 2019, all SMUD low-income programs have incorporated electrification into their offerings. In January of 2020, SMUD introduced commercial building electrification programs, which include incentives for equipment replacement and new construction (S. Blunk, electrification strategist, SMUD, pers. comm., April 10, 2020).

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<sup>7</sup> The incentives noted here were reduced as of June 1, 2020, due to the COVID pandemic and its impact on SMUD’s revenues.

For several years, the City of Palo Alto's municipal utility offered rebates for the use of HPWHs in new construction and for the conversion of gas water heaters. However, the new construction rebate was discontinued as of April 1, 2020 because the city passed an all-electric mandate for residential new construction, eliminating the need to incentivize HPWHs for those projects. Palo Alto continues to offer rebates of \$1,200–1,500 for the replacement of a gas water heater with an HPWH; the amount varies with tank size. Since June 2019, an induction cooktop loaner program has invited residents to borrow a portable induction unit for up to three weeks for free. The city has a pilot program to retrofit gas wall furnaces at an apartment complex with air-source heat pumps; the pilot will identify the technical and logistical hurdles of retrofitting gas wall furnaces in apartment units with heat pump equipment and will serve as a case study for future projects. The city has also created a number of resources to encourage an all-electric lifestyle with a home electrification web page and information on electric panel upgrades. To promote electrification among homeowners and contractors, the city hosted an Electrification Expo in October 2019 to showcase equipment, with presentations by industry experts; over 260 people attended (S. Mellberg, program manager, City of Palo Alto, pers. comm., April 9, 2020).

### **Investor-Owned Utility Programs**

Now that the new CPUC decision has clarified the three-prong test, California's investor-owned utilities are preparing program plans. To start, Southern California Edison (SCE) is now offering one program – the Clean Energy and Resiliency Rebuild (CLEAR) Program – and proposing a set of low-income programs. CLEAR offers incentives to build efficient homes in areas where homes were destroyed in recent wildfires. Under CLEAR, incentives of up to \$12,500 are available for efficient all-electric homes and \$7,500 for efficient dual-fuel homes. In addition, up to \$5,000 is available for installing solar systems and backup batteries (SCE 2019). Pacific Gas and Electric (PG&E) has a similar program called Advanced Energy Rebuild. SCE has also proposed to the CPUC that under its low-income programs, it should be allowed to offer two pilot programs, one for existing homes and one for new construction. The proposed retrofit program is for homes that have high cooling loads or use propane or wood for space heating. The program would provide direct installation of space and water heat pumps as well as induction-cooking equipment. The new construction program would provide technical assistance and incentives to affordable housing developers for construction of affordable all-electric new homes. It would also include a new tenant education program (Buendia 2020). A decision on the program is still pending at the CPUC.

Another effort worth noting is legislation on the San Joaquin Valley passed in 2014. Its goal is to increase access to affordable energy for disadvantaged communities in the Valley, an area where many homes are presently heated with propane and/or wood. In response, Southern California Gas proposed to extend natural-gas lines to these homes so they can be heated with natural gas while PG&E and SCE proposed to promote high-efficiency heat pumps. In late 2018, the CPUC decided to implement largely heat pumps and one gas-line extension pilot. The electrification pilots will serve over 1,500 homes and have a \$50 million budget that will cover new equipment, energy efficiency improvements, and other upgrades. To date, the pilot communities and program contractors have been selected; community outreach and customer enrollment are beginning (CPUC 2020; M. Thomas, principal manager, Building Electrification, SCE, pers. comm., April 7, 2020).

### **Community Policies**

Finally, 30 California communities have instituted some restrictions on the use of fossil fuels in homes or buildings. The restrictions come in many "flavors" ranging from restrictions on new natural gas infrastructure to restrictions on installing new fossil fuel space-heating, water-heating, or cooking equipment (Building Decarbonization Coalition 2020).

## **NEW YORK**

New York's Climate Leadership and Community Protection Act codifies the state's ambitious clean energy targets, which include the commitment to reduce greenhouse gas emissions throughout the state by 85% from 1990 levels by 2050 (Morris and Farmer 2019; New York State Assembly 2019). The New York Public Service Commission recently approved a major expansion of program savings targets and budgets, with the main target expressed in British thermal units (Btus) of total energy savings across fuels. Approximately 84% of homes in New York use natural gas, fuel oil, or propane for heating (EIA 2019d). In 2020, New York initiated a statewide heat pump framework designed to support customers in transitioning to energy-efficient electrified space- and water-heating technologies, with incentives offered through the NYS Clean Heat: Statewide Heat Pump Program. This program is led by the state's electric utilities and replaces programs previously run by NYSERDA.

Under NYS Clean Heat, the state's electric utilities administer incentives for air-source heat pumps, ground-source heat pumps, and HPWHs via a consistent statewide program. All customer sectors, regardless of existing heating fuel, are eligible. The common program structure provides for both customer and contractor incentives, with specific incentive amounts varying by utility territory. The NYS Clean Heat Program supports the installation of heat pumps that are optimized to heat efficiently in cold climates. Under the program, participating contractors need to follow best practices related to sizing, selecting, and installing heat pumps for cold climates. The program also promotes consumer education to maximize the benefits of heating with heat pumps. (Heat pumps that are used primarily for space cooling are ineligible for incentives.)

The NYS Clean Heat incentive program will invest \$454 million through 2025 to support customer adoption of heat pumps. In addition, NYSERDA will invest approximately \$230 million in coordinated market development initiatives for building electrification funded through their Clean Energy Fund (CEF), including for workforce development and training, consumer education and technical assistance, technology innovation and demonstrations, and advancing solutions for low- and moderate-income consumers (this budget is proposed but not approved yet). The electric utilities and NYSERDA plan to collaborate on developing and maintaining the statewide program design for NYS Clean Heat, in consultation with the Department of Public Service, the Long Island Power Authority, and gas utilities in gas supply-constrained areas, with additional input from market participants and other stakeholders (New York Electric Utilities and NYSERDA 2020; V. Ulmer, senior advisor, NYSERDA, pers. comm., April 13, 2020).

Previously, NYSERDA administered statewide air-source and ground-source heat pump incentive programs (which began in mid-to-late 2017), and multiple utilities offered heat pump rebates that could be combined with the NYSERDA incentives. Results were promising, leading to initiation of the statewide program. The contractor industry has grown substantially in New York State since 2017, with 112 ground-source heat pump installers and more than 350 air-source heat pump contractors participating in NYSERDA's heat pump programs as of March 2020. Through 2019, nearly 11,000 program participants received incentives and services under NYSERDA's programs, supporting approximately 21,500 heat pump installations (V. Ulmer, NYSERDA, pers. comm., April 13, 2020).

One interesting geothermal example is Dandelion Energy, a geothermal heat pump company that offers to install a new geothermal system for zero down payment and a monthly payment less than current energy bills. To do this, they package state and utility incentives and federal tax credits and

select homes where the monthly savings and system costs make this deal feasible. They have done hundreds of homes.<sup>8</sup>

## **NEW ENGLAND**

We start with the most extensive programs, those in Maine, Massachusetts, and Vermont, and then proceed to the still-substantial programs in Connecticut and Rhode Island. There is also coordination on these efforts across the region, facilitated by NEEP.<sup>9</sup>

### **Maine**

Maine has committed in legislation to reducing greenhouse gas emissions 45% by 2030, and 80% by 2050, below 1990 levels.<sup>10</sup> Electrification helps to achieve greenhouse gas emissions goals because 81% of households use oil, natural gas, or propane for heating, including 62% who use fuel oil, the highest of any U.S. state (EIA 2019b). In addition, the legislature has defined “beneficial electrification” and directed the Public Service Commission and the Efficiency Maine Trust (EMT, the state’s third-party energy efficiency program administrator) to conduct studies, pilots, and full-scale programs to advance beneficial electrification in buildings and transportation (Cushman et al. 2020).

EMT is leading several initiatives to facilitate the shift to electrification, alongside its long-standing energy efficiency efforts. The first is a ductless heat pump program for both residential and commercial customers (Energy Main Trust 2019). Residential customers can receive up to a \$1,000 rebate for the first indoor unit and \$500 for a second one, with incentives tied to efficiency ratings. Enhanced rebates are available for eligible low-income customers. Commercial customers can receive up to \$1,250 in rebates for multizone units; the first zone qualifies for a \$500 rebate and subsequent zones qualify for additional increments of \$250. The residential and commercial programs are funded by a combination of revenues from the Independent System Operator – New England (ISO-NE) Forward Capacity Market, funds from allowance sales in the Regional Greenhouse Gas Initiative, and a systems benefit charge on each kWh of electricity sold in the state.

Since 2011, more than 50,000 units have been installed through the program (I. Burnes, director of strategic initiatives, EMT, pers. comm., May 11, 2020), making this perhaps the largest program in the United States. In 2019, Maine enacted a goal of adding 100,000 more heat pumps by 2025.<sup>11</sup> EMT attributes the high adoption rate to Mainers’ sensitivity to volatile prices for delivered fuels and familiarity with hybrid heating systems (I. Barnes, EMT, personal communication, April 21, 2020). The high rebates have also contributed, according to one review (VEIC 2018). Not only is EMT aggressively promoting HPWHs through its residential and low-income programs, it is also promoting EV charging infrastructure and the purchase of new EVs.

### **Massachusetts**

Massachusetts has some of the highest energy savings goals in the nation, with very extensive programs for essentially all customer segments. The state views electrification as a key strategy to meet its long-term climate mitigation commitments as well as to meet grid flexibility and modernization

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<sup>8</sup> [www.dandelionenergy.com/](http://www.dandelionenergy.com/).

<sup>9</sup> [www.neep.org/initiatives/building-decarbonization/strategic-electrification](http://www.neep.org/initiatives/building-decarbonization/strategic-electrification).

<sup>10</sup> 38 MRSA §576-A. [www.mainelegislature.org/legis/statutes/38/title38sec576-A.html](http://www.mainelegislature.org/legis/statutes/38/title38sec576-A.html).

<sup>11</sup> 35-A MRSA §10119(2)(A)(2). [www.mainelegislature.org/legis/statutes/35-A/title35-Asec10119.html](http://www.mainelegislature.org/legis/statutes/35-A/title35-Asec10119.html).

goals. Massachusetts has added primary energy savings goals (measured on a Btu basis) to its framework of multiple goals, in addition to goals for electricity and natural gas savings, net benefits, and greenhouse gas emissions abated. Residential heating presents a large electrification opportunity; approximately 81% of households use natural gas, fuel oil, or propane (EIA 2019c). The state mainly provides incentives for heat pumps through Mass Save, although the Massachusetts Clean Energy Center (MassCEC) has previously supported the heat pump industry and continues targeted pilot programs on key electrification topics such as whole-home heat pump systems. In addition, a few pilot programs are offered by the Department of Energy Resources (DOER, the state energy office).

Mass Save is a collaborative effort led by the state's investor-owned utilities and the Cape Light Compact. It operates a comprehensive set of statewide programs, including providing rebates for ductless heat pumps and ducted heat pumps. Mass Save has two tiers of incentives for residential heat pumps: standard incentives (for customers who want to cool their home, want to heat and/or cool a part of their home, or heat with gas) and fuel optimization incentives. The latter, which began in 2019, are for customers who install heat pumps to displace or replace their delivered fuel or electric resistance central heating system. Mass Save recommends that customers displace, not replace, their central heating systems; however, the decision is ultimately up to the customer. To qualify for the higher fuel optimization incentive (not including displacing electric resistance heating), customers who choose to displace their delivered fuel central heating system must install integrated controls, which – according to a preselected outdoor temperature – allow the system to automatically switch from heating with a heat pump to a conventional heating system. Standard rebates are \$250 per ton of capacity; optimization rebates are \$1,250 per ton. Incentive levels for both standard and fuel optimization heat pump measures were standardized in 2020. Mass Save also offers integrated controls as a standalone measure for customers who already have heat pumps installed. Incentives are also available for business customers, but these are treated as custom measures at present (Mass Save 2018, 2020). They are starting to develop a small-business fuel optimization program (M. Coan, senior analyst, National Grid, pers. comm., May 11, 2020).

Controls were added to the program after performance studies showed lower run times (and less savings) than expected. Frequently, the furnace was turning on too quickly before the heat pump had an opportunity to satisfy the need for heat (Korn et al. 2016). Integrated controls that operate both the heat pump and the backup system can address this problem. Short of integrated controls, NEEP recommends that the central system's thermostat should be set about 4° below the ductless unit so it only comes on when the ductless cannot keep up. Programs have also explored the use of remote thermostats to sense temperature further away from the ductless unit (ductless heat pumps typically sense temperature on the indoor unit, which can be 7 feet up on a wall). This can ensure that remote rooms are not getting colder than the homeowner wants (D. Lis, director of technology and market solutions, NEEP, pers. comm., May 11, 2020).

Mass Save also offers heat pump and integrated control training opportunities. Beyond system design, installers are trained to teach customers to optimally heat their entire homes by using their thermostats to adjust the set points for each standard heat pump unit. For fuel optimization heat pumps, installers are trained to teach customers to “set it and forget it,” letting the heat pumps and the central heating system work with each other via the integrated control. Program administrators also send out post-installation consumer education pieces, which remind customers how to maintain and operate their new equipment to ensure maximum savings.

MassCEC previously offered incentives for residential and commercial air-source and ground-source heat pumps. The residential air-source heat pump incentive ran from November 2014 through March 2019 and supported over 20,000 projects. MassCEC is currently running a whole-home air-source heat pump pilot, offering \$2,500 per residential unit (or \$3,750 or \$5,000 for income-qualified customers) that converts from natural-gas heating to a whole-home heat pump system. The program began recently and had limited participation last year. MassCEC is also currently offering a residential ground-source heat pump incentive of \$2,000 per ton (or \$3,000–3,500 per ton for income-qualified customers) up to 5 tons, although remaining funds for this program are limited. MassCEC no longer offers commercial air-source heat pump or ground-source heat pump incentives (M. Howard, program manager, Building Decarbonization, Massachusetts Clean Energy Center, pers. comm., April 15, 2020).

DOER has two policy tools that work to promote heat pump adoption: the Alternative Portfolio Standard (APS) and a three-year residential retrofit pilot program called Home MVP.

The APS offers renewable thermal “alternative energy certificates” (AECs) to both residential and commercial customers. They are based on actual energy usage for larger heat pump systems and modeled energy usage for small and residential heat pump systems. A typical home retrofit with 90% or greater space heating from heat pumps qualifies for an upfront AEC incentive of around \$2,000–3,000. Larger commercial installations receive AECs based on metered performance each year; AECs are minted in a similar fashion to renewable energy credits (RECs) (I. Finlayson, deputy director, Energy Efficiency Division, DOER, pers. comm., April 16, 2020).

Home MVP was developed through a 12-month contractor-driven working group and is offered statewide, enabling participation by customers of municipal utilities in Massachusetts who are not eligible for either Mass Save or MassCEC programs. Home MVP innovations include fuel-neutral performance-based savings based on whole-house site savings (measured in millions of Btus), home audit modeling calibrated to customer bill data, no reliance on lighting savings, zero-interest loans only for non-fossil fuel measures, integrated multifuel home energy scorecards, and tracking of metered savings for two years with bonus incentives for contractors. As of April 2020, Home MVP had completed just over 300 home retrofits. The majority are electrification conversions using either air-source or ground-source heat pumps. Average energy savings are 50 million Btus per year, and average rebates were reduced in February 2020 from around \$7,000/home to around \$5,000/home due to high program demand (I. Finlayson, Energy Efficiency Division, DOER, pers. comm., April 16, 2020).

In our 2018 report, the MassCEC program was central to the state’s efforts, complemented by Mass Save programs. Now the Mass Save programs are ramping up, with supplementary programs operated by MassCEC and DOER. Whereas the earlier MassCEC and Mass Save programs emphasized partial-home heating and cooling, and Mass Save still has this orientation, the current MassCEC and DOER programs are emphasizing the displacement of oil and propane through whole-home solutions.

## **Vermont**

In 2015, a renewable energy standard (RES) became law in Vermont. The law establishes three categories of required resources to meet the requirements of the RES: (1) total renewable energy, (2) distributed renewable generation, and (3) energy transformation. The third category, energy transformation (or “Tier III”), encourages Vermont retail electricity providers to support projects that reduce both the amount of fossil fuel consumed by their customers and the emission of greenhouse gases attributable to that consumption. Examples of energy transformation projects include home weatherization or other thermal energy efficiency measures, air-source or geothermal heat pumps,

high-efficiency heating systems, increased use of biofuels, biomass heating systems, support for transportation demand management strategies, support for EVs or related infrastructure, and infrastructure for the storage of renewable energy on the electric grid. For the energy transformation category, the required amounts are 2% of each retail electricity provider's annual retail electric sales during the year beginning January 1, 2017, increasing by an additional 0.67% each subsequent January 1 until 12% is reached on January 1, 2032 (Vermont Department of Public Service 2020).

Vermont's retail electricity providers are meeting their RES Tier III requirements largely through building and transportation electrification measures. Approximately 77% of homes in Vermont use fuel oil, natural gas, or propane for heating (EIA 2019f). An analysis of utility plans for 2018 found that the most common Tier III measures are custom fuel-switching projects for commercial/industrial (C&I) customers, cold-climate heat pumps for residential customers, and EVs and chargers (Energy Futures Group 2018). Vermont established a technical reference manual to address residential high-volume "prescriptive" measures, including cold-climate residential heat pumps, HPWHs, EVs and chargers, as well as battery storage and woodstoves (Vermont Department of Public Service 2017). Most commercial/industrial activity within the program is considered custom, and these projects generally make up the bulk of obtained energy savings, due to both the potential greater depths of savings and the better overall energy yield per dollar expended (B. Murphy, energy efficiency program specialist, Vermont Department of Public Service, pers. comm., April 17, 2020).

In addition to the RES, Vermont's 2016 Comprehensive Energy Plan identifies cold-climate heat pumps as a strategy for meeting the state's goals to reduce fossil fuel consumption. Distinct from but complementary to the electricity retail providers' Tier III efforts, Efficiency Vermont (Vermont's statewide energy efficiency utility) has played an important role in electrification efficiency (i.e., promoting and supporting more-efficient electrification measures), which ensures that an installed electrification measure will also be the most electrically efficient measure available.

In 2014, Efficiency Vermont launched its first heat pump rebate program and has incentivized more than 19,600 heat pumps to date. Efficiency Vermont attributes this success to the combination of midstream program delivery and an aggressive supply chain strategy. Currently (2020), Efficiency Vermont provides a \$350- to \$450-per-unit midstream incentive to wholesale distributors who are, in turn, required to pass the cost savings on to contractors in the form of an instant discount at the point of purchase. Efficiency Vermont sends a letter to contractors' customers explaining that the contractor has received a discount on the equipment, which in turn motivates contractors to pass the cost savings on to the customer. In addition, customers may receive financial incentives from their electric retail provider,<sup>12</sup> and moderate-income (80-120% of area median income) customers are eligible for an additional \$200 rebate (M. Walker, regulatory project manager, Vermont Energy Investment Corp., pers. comm., April 14, 2020).

Going forward, Efficiency Vermont plans to continue providing midstream rebates, in collaboration with retail electric providers, while developing the supply chain through training, education, and promotion. Efficiency Vermont also provides electrification support services, such as facilitating the processing of cold-climate heat pump rebates for both Green Mountain Power (Vermont's largest

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<sup>12</sup> Vermont Electric Co-op offers a \$300 bill credit, Washington Electric Co-op offers a \$250 rebate, Stowe Electric offers a \$675 rebate, municipalities served by Vermont Public Power Supply Authority offer a \$300-400 rebate, Green Mountain Power offers a \$100 midstream discount plus a \$400 rebate, and BED offers an additional \$750-1,000 rebate. These incentives are generally associated with the Tier III program.

utility) and Efficiency Vermont. This enables participating distributors to engage in one seamless transaction rather than working with two separate programs (M. Walker, Vermont Energy Investment Corp., pers. comm., April 14, 2020).

The Burlington Electric Department (BED) is a municipal utility serving Vermont's largest city. BED also serves as Burlington's energy efficiency utility, providing a substantial set of efficiency programs for all customers. For the past two years, BED has also provided electrification incentives in support of Burlington's goal of becoming a net-zero-energy city and Vermont's RES. BED presently offers incentives for cold-climate heat pumps, both ductless (incentives of \$750–1,000 per unit) and ducted (\$1,650–2,200 per unit). They have established a network of preferred heat pump installers to ensure correct, high-quality installation and customer satisfaction (BED 2020a). And, as a temporary measure to help customers during the COVID crisis, BED has received regulatory approval to increase many of its financial incentives, including for weatherization and heat pumps (BED 2020b).

BED also has programs to encourage the uptake of EVs and electric lawn mowers. The popular lawn mower incentives have helped shrink the incremental cost difference between electric and gasoline models, making it easier for consumers to decide in favor of an electric mower.

Regarding heat pumps, BED has found that many people have unrealistically high expectations about ductless units fully heating or cooling their houses, making it important to manage customers' performance expectations. They are also seeing a controls conflict between the heat pump system and the existing central boiler or furnace (i.e., one system provides enough heat to satisfy the thermostat, causing the other system not to operate and leaving remote parts of the house too cold). To address this problem, BED is currently exploring automatic integrated control options. BED also noted that better-weatherized buildings can help heat pumps handle loads better, so they are looking into tiered incentives (and financing options) to encourage high-use homes to weatherize either before or at the same time they install a heat pump (C. Burns, director of energy services, BED, pers. comm., April 22, 2020).

Zero Energy Now is another program encouraging the adoption of cold-climate heat pumps in Vermont. The Building Performance Professionals Association of Vermont, in coordination with Green Mountain Power and Efficiency Vermont, launched the program in 2016 to move Vermont homes closer to zero net energy by providing a comprehensive package of services, including weatherization, heat pumps, and solar photovoltaic. Installing cold-climate heat pumps has been a key strategy for minimizing each home's energy consumption. In 2016–2017, 35 projects were completed through the program. A recent study (Stebbins, Perry, and Faesy 2020) found that actual savings for 24 of these projects resulted in 64% average electric grid and fossil fuel savings, for an average of \$1,861 savings per year. The program also encourages the installation of HPWHs to achieve deeper fuel savings.

Taken together, Vermont's efforts are extensive, with over 10,000 systems installed in the past year<sup>13</sup>—a high number for a state with a population of under one million.

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<sup>13</sup> As noted in the appendix, Tier III served nearly 9,000 customers and Efficiency Vermont provided over 5,000 rebates. Since "double dipping" is allowed, these two programs have substantial overlap.

## Connecticut

Some 80% of the housing stock in Connecticut uses natural gas, fuel oil, or propane for space heating (EIA 2019a). In 2018, the Connecticut Department of Energy and Environmental Protection implemented a Comprehensive Energy Strategy calling for residential building electrification (Connecticut DEEP 2018). The strategy asks utilities to promote the installation of ductless air-source heat pumps (DHPs), particularly by leveraging consumer demand for space cooling. The Energize CT program, which is spearheaded by Eversource and the United Illuminating Company (UI),<sup>14</sup> has primary responsibility for promoting DHPs.

The Energize CT program currently provides a \$300 incentive for single-zone ENERGY STAR® DHPs and a \$500 incentive for multizone ENERGY STAR DHPs that meet the program's required efficiency levels;<sup>15</sup> the program also offers financing at a 0.99% interest rate for qualifying products. The program employs an upstream approach. Incentives are given to wholesale distributors, who must pass the incentive along to customers. To ensure quality installation, incentives are offered at the distributor point of sale only to licensed contractors with a valid customer installation address. With respect to DHPs, Energize CT has found that upstream programs are more effective than downstream programs for several reasons. The first is that customers automatically see the rebated price and do not have to file paperwork for mail-in rebates. Second, wholesale distributors are motivated to receive and pass along the incentive to remain competitive with their counterparts. The program also provides rebates for commercial customers depending on equipment efficiency and size (VEIC 2018).

To significantly increase participation, Eversource and UI have recently received permission to increase incentives to \$250 per ton for ducted air-source heat pumps and \$750 per ton for ground-source heat pumps. They are also increasing incentives for installing insulation at the same time a new heat pump is installed. In addition, to help ramp up interest following COVID closures, they will provide a \$500 per ton incentive for ducted air-source heat pumps through the end of 2020 and a further increase in insulation incentives (Eversource Energy and Avangrid 2020). Regulators invited the utilities to propose higher incentives and approved the proposal in May 2020.

The state and utilities are also proactively encouraging new construction to adopt electric heat pumps for heating; an All-Electric Home Incentive is now offered that combines above-code levels of energy efficiency with high-efficiency heat pumps and HPWHs (Energize Connecticut 2020). In addition, the utilities have a pilot to encourage displacement of delivered fuels (e.g., fuel oil and propane) in existing homes. At the time of writing, neither pilot had had much activity (R. Faesy, principal, Energy Futures Group, pers. comm., May 8, 2020).

## Rhode Island

As part of National Grid's 2019 Energy Efficiency Program Plan (Rhode Island Public Utilities Commission, Docket No. 4888), an Air Source Heat Pump (ASHP) Delivered Fuels Displacement Program was proposed, approved, and offered. With 87.5% of households in Rhode Island utilizing natural gas, oil, or propane for space heating (EIA 2019e), this program was developed to accelerate the

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<sup>14</sup> These utilities work closely with the Connecticut Green Bank and Connecticut Department of Energy and Environment.

<sup>15</sup> Efficiency requirements are specified in terms of seasonal energy efficiency ratio for air-conditioning, high-temperature energy efficiency ratio for air-conditioning (a measure of efficiency at high outdoor temperatures), and heating season performance factor for heat pump seasonal heating performance.

electrification of Rhode Island's residential heating sector to keep pace with Rhode Island's long-term greenhouse gas emission reduction targets: 80% reduction below 1990 levels by 2050.

In 2019, National Grid delivered the ASHP Program with two tiers of downstream incentives: standard and enhanced. The standard high-efficiency ASHP incentive ranged from \$150 to \$350 per ton and was available to any customer provided that a licensed contractor installed the equipment. The enhanced high-efficiency ASHP incentive of \$1,000 per ton was available to customers who were partially or fully displacing oil, propane, or electric resistance forms of heating. To qualify for the enhanced incentive, customers were required to complete a home-energy assessment and weatherization work, using a program-approved contractor. In addition, 0% interest loans were offered to cover the remaining balance after deduction of the incentive. Furthermore, National Grid offered incentives for all-electric new homes through their Path to Zero Energy Ready program.<sup>16</sup> In 2019, 424 delivered-fuel customers and 109 electric-heat customers participated in the ASHP Program.

At the beginning of 2020, the Rhode Island Delivered Fuels Displacement (Electrification) Program was discontinued due to a decision by the Rhode Island Public Utilities Commission stating that while greenhouse gas reductions, such as those resulting from electrification, are important for achieving state objectives, the Rhode Island Least Cost Procurement Law does not permit such expenditures from energy efficiency funds.<sup>17</sup> The state energy office has since allocated \$2.7 million in Regional Greenhouse Gas Initiative (RGGI) funds to continue the program for 1–2 years. Longer term, state policymakers are considering other options to support electrification as well as other renewable thermal technologies (B. Trietch, energy policy and planning manager, Rhode Island Office of Energy Resources, pers. comm., April 22, 2020; Murphy and Weiss 2020).

### **PACIFIC NORTHWEST**

In 2010, the Northwest Energy Efficiency Alliance (NEEA) introduced the Ductless Heat Pump (DHP) Initiative to increase heat pump adoption throughout its region. The program targeted three housing types: single-family homes with zoned electric heating, single-family homes with electric forced-air furnaces, and manufactured homes with electric forced-air furnaces. Installing heat pumps in these homes could yield about 1,750 million kWh of savings (Storm et al. 2012).

NEEA worked with utilities to create and market robust rebate programs for DHPs. The program harnessed the power of installers to influence their clients' purchasing decisions by enlisting them to promote DHP technology and programs. It also created a Master Installer Certification to ensure high-quality work. Customers must hire a certified installer to qualify for a rebate, and both the utilities and NEEA maintain a list of master installers that customers may choose from. Installers are motivated to earn the certification by the free marketing and the additional revenue stream it provides. NEEA also facilitates collaborations between manufacturers and retailers to develop and deploy marketing campaigns (Conzemius and Kahl 2016).

As of 2016, the program saw DHP market penetration increase from 0% to 13% in the four northwestern states. NEEA also worked with contractors to decrease markups on DHP installations. Data have shown that the cost of DHP installations is increasing in the Pacific Northwest (Lee et al.

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<sup>16</sup> [www.nationalgridus.com/media/pdfs/resi-ways-to-save/ee6174\\_ri\\_newconsprogram.pdf](http://www.nationalgridus.com/media/pdfs/resi-ways-to-save/ee6174_ri_newconsprogram.pdf).

<sup>17</sup> Video of Rhode Island Public Service Commission session: [www.ustream.tv/recorded/125239926](http://www.ustream.tv/recorded/125239926) (at approximately minute 38:00).

2018). NEEA interviewed distributors and installers to understand this trend. Some suggested that since installers already experience low profit margins, they might see the introduction of new and complicated technologies as an opportunity to increase those margins. NEEA is working with manufacturers to potentially provide equipment at lower costs to installers to offset these rising prices (Lee et al. 2018).

A late-2019 evaluation updated some of these findings, estimating that about 17,700 DHPs were installed in the region in 2018, of which 80% received some type of incentive (108 utilities in the region offer incentives for DHPs). The evaluation estimates cumulative sales of about 101,000 units since 2008, with DHPs now installed in 18% of the target market for single-family homes with zonal heating, 15% for single-family homes with electric furnaces, and 6% for manufactured homes with electric furnaces. Prices for DHPs have not decreased since the evaluation cited in the previous paragraph and in fact, on average, increased by 14% (Lee et al. 2019).

At this point, NEEA has phased out its incentives but is continuing to monitor the DHP market. The Bonneville Power Administration (BPA) does provide payments to retail utilities for energy efficiency savings, and many of these utilities offer incentives and other assistance for DHP, although incentives and program details vary from utility to utility. Note that the BPA payments target electric savings and not fuel switching. While fuel switching is not an objective of their program, some fuel switching is probably taking place, such as reduced use of wood and other fuels. BPA reports that in calendar year 2019, their customer utilities provided rebates on more than 6,000 DHPs and more than 2,000 each for ducted heat pumps and HPWHs (B. Barclay, energy efficiency representative and policy strategist, BPA, pers. comm., April 22, 2020).

While BPA does not target fuel switching, a few local utilities in the region do.

For example, the City of Ashland (Oregon) municipal utility, in addition to long-running energy efficiency programs, has a variety of electrification and decarbonization programs, with an emphasis on vehicles and secondarily on buildings. Regarding buildings, they participate in an “Energize Rogue” (Rogue River Valley) DHP promotion, a limited-time group purchase campaign for homes and businesses in Josephine, Jackson, and Douglas Counties to install ductless heat pumps at a discounted rate and reduce utility bills (A. Hanks, interim city administrator, City of Ashland, pers. comm., April 30, 2020). They have also adopted an administrative policy on “future use of carbon-emitting fuels in municipal facilities” that calls for future installations to not use fossil fuels unless the city administrator grants a special exception that documents that “carbon fuel infrastructure is the only viable solution to meet the specific need” (Ashland 2018).

Likewise, the Eugene Water and Electric Board (EWEB) has a smart electrification effort to support their customers’ electrification efforts. Their building electrification efforts focus on heat pump technology to help customers make energy-efficient choices that also minimize increases in peak demand. They offer customers incentives or loans to purchase heat pumps. For ducted heat pumps, they offer incentives of up to \$1,000 per home or a 0% interest loan of up to \$12,000 per home. For ductless heat pumps, the incentives are \$800 per home or a 0% interest loan of up to \$4,000 for a single-head system (one indoor unit) plus \$1,500 more per head (each additional indoor unit). Higher rebates are available for income-qualified customers.<sup>18</sup> In addition, their transportation electrification

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<sup>18</sup> [www.eweb.org/residential-customers/rebates-loans-and-conservation](http://www.eweb.org/residential-customers/rebates-loans-and-conservation).

programs look to accelerate EV adoption, provide equitable access to EV technology, and offer education and programs to encourage charging when clean energy is available.

## **MIDWEST**

Efforts to expand use of heat pumps are beginning in Minnesota, Michigan, and Illinois.

### **Minnesota**

In Minnesota, the Center for Energy and the Environment (CEE) has conducted a number of field studies on cold-climate heat pumps, finding that even in Minnesota's very cold climate, heat pumps can supply about 60% of a home's heat over the course of a winter (Schoenbauer 2019). CEE is now working with a coalition of utilities and other interested parties to form a collaborative with a vision to "make cold-climate air-source heat pumps the first choice for contractors and homeowners that are replacing electric and delivered-fuel heating systems, or air-conditioners by 2030" (Nelson et al. 2019). The collaborative intends to work on technical guidance, installation quality, manufacturer and distributor engagement, installer support and training, data management and reporting, utility coordination, and marketing resources (Nelson et al. 2019).

One obstacle to electrification programs in Minnesota is that state law currently prohibits fuel-switching programs. Many of the affected parties have reached agreement on proposed changes to this law. Their proposal is now pending before the state legislature as part of an energy efficiency package.

### **Michigan**

In Michigan, the state's two largest utilities, Consumers Energy and Detroit Edison, have recently agreed to undertake pilot heat pump and all-electric new-home programs. Consumers Energy will offer two pilots, one focused on retrofitting propane-heated homes with cold-climate heat pumps and the other on all-electric residential new construction. Consumers Energy will also invest \$3-4 million in cold-climate heat pump retrofits for low-income housing, principally as an electric efficiency measure to displace resistance heat. And one of their shareholder incentive metrics will be the number of cold-climate heat pumps installed in low-income homes, with the max incentive earned at 500 units for 2020. These will primarily be retrofits of resistance-heat buildings (although low-income propane customers in the propane pilot could also count). Detroit Edison will also be undertaking an all-electric residential new-construction pilot. And they committed to spend \$1 million on heat pump retrofits in electric resistance-heated low-income housing. These programs are spelled out in settlement agreements in energy efficiency proceedings and were recently approved by the Michigan Public Service Commission.<sup>19, 20</sup>

### **Illinois**

In Illinois, Commonwealth Edison (Com Ed), the state's largest utility (serving the greater Chicago area) has recently begun an all-electric residential new-construction program. Program requirements are air tightness less than 2.5 air changes per hour (at 50 Pascals of pressure), an air-source heat pump with a seasonal energy efficiency ratio of at least 17.8 and a heating seasonal performance factor of at least 11.0, an HPWH with efficiency of at least 3.45 Uniform Energy Factor (UEF), ENERGY STAR certified lighting, appliances, and thermostats (including an electric dryer), low-flow water fixtures,

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<sup>19</sup>[mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000AGDjVAAX](https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000AGDjVAAX).

<sup>20</sup> [mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000AGDkOAAX](https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000AGDkOAAX).

and several comfort and indoor air quality requirements. An incentive of \$2,000 is provided per participating home. In addition, induction ranges are encouraged but not required, as are measures to make these new homes photovoltaic, EV, and battery-storage ready (e.g., installing electric service and wiring so that adding these systems later will be easy). Initial participants include townhomes, apartment flats, single-family homes, and accessory dwelling units (ComEd 2020). And under a 2018 settlement agreement, Com Ed retrofitted heat pumps in 80 multifamily apartments that used electric resistance heat. A report on this pilot is due shortly (C. Neme, principal, Energy Futures Group, pers. comm., May 6, 2020).

### **OTHER PARTS OF THE UNITED STATES**

Electrification programs have also begun in other parts of the United States.

#### **RURAL ELECTRIC COOPERATIVES**

The National Rural Electric Cooperative Association (NRECA) has worked with others to form the Beneficial Electrification League (BEL) to promote electrification that saves consumers money over time, benefits the environment and reduces greenhouse gas emissions, improves product quality or consumer quality of life, and fosters a more robust and resilient grid (in their view, electrification needs to do at least one of these without adversely affecting the others).<sup>21</sup> NRECA and BEL recently published a report on *Promoting Efficiency and Electrification in Home Heating and Water Heating* that includes several cases (Hight 2020). Examples include

- Mountain Parks Electric (Colorado), which has been field testing cold-climate heat pumps and is now considering on-bill financing for air-source heat pumps.
- Orcas Power & Light (Washington), which serves islands in Puget Sound. Their Switch It Up! program will install air-source heat pumps, HPWHs, and EV-charging systems in members' homes, with the member paying back the utility over time through a special voluntary tariff. Since this is a site-specific tariff, if ownership changes hands, the tariff stays with the meter and continues to be paid by the new owner. Orcas also provides a \$500 rebate for customers who switch from a gas or propane heating system. As of September 2019, 49 air-source heat pumps had been installed and another 35 were in the pipeline.
- Roanoke Electric Cooperative (North Carolina) offers its members an on-bill finance Upgrade to Save program for energy efficiency measures, including installation of air-source heat pumps. Roanoke received a low-interest loan from the U.S. Department of Agriculture's Energy Efficiency and Conservation Load Program. As of late 2019, Upgrade to Save had 740 participants, of which 325 had installed heat pumps (of these, about 100 converted from gas or propane systems).

#### **BOULDER, COLORADO**

The City of Boulder, Colorado, working with Boulder County's EnergySmart Program, started the Comfort365 program in the spring of 2017. Boulder is one of the founding cities in the Building Electrification Initiative. The program combines education and outreach, active marketing, and financial incentives to drive heat pump adoption. As much as \$1,750 in incentives is available for a resident who is replacing a gas furnace with a high-efficiency cold-climate heat pump, and up to \$1,450

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<sup>21</sup> [www.beneficialelectrification.com/](http://www.beneficialelectrification.com/).

in incentives is available for heat pump replacement of a gas water heater. Key elements of the program include a partnership with Mitsubishi, which helped engage its dealer and installer network, offered additional incentives, and conducted TV, radio, and digital marketing in the Denver metro area. Boulder has found it somewhat difficult to track the exact impact of the program due to some challenges with building permit data, but the city estimates that it saw at least a 200% increase in installations during the first year of the campaign. This is from a baseline of 20–30 units annually. A total of 80 rebates have now been given, but according to the available permit data, more than 100 units have been installed annually since the program launched. They now focus their marketing investments on the cooling season rather than the heating season because the heating season is a more difficult time to influence customer choice (decisions to replace appliances in the winter months are usually driven by emergency, so favor like-for-like decisions); they also continue to work on tactics to influence customer decisions beyond seasonal marketing.

Boulder is fairly cold (about 5,500 heating degree days on average), with an average single-family home size of close to 2,000 square feet, so a typical gas furnace is sized for home peak heating loads of 70,000 Btus per hour or more. They find that existing ducted cold-climate heat pumps do not have enough heating capacity to work properly with the existing ducting in the home; consequently, homeowners need to modify the ducting or select a ductless system, which results in a higher-cost system. A lower-cost alternative is an integrated dual-fuel gas furnace and heat pump, which reduces, but does not eliminate, gas use. In addition, in 2017, Boulder adopted more-stringent energy performance requirements for new construction and major renovations. Since then, at least half of new homes incorporated heat pumps (C. Elam, energy manager, City of Boulder, pers. comm. May 1, 2020; Terry and Stori 2019).

#### ***DISTRICT OF COLUMBIA SUSTAINABLE ENERGY UTILITY***

The DCSEU is the main implementor of energy efficiency programs in the District of Columbia. They offer programs for all sectors, including a significant concentration on low- and moderate-income households. They are about to launch a Low-Income Decarbonization Pilot (LIDP) that will provide deep energy retrofits and install solar photovoltaic systems on single-family homes owned or rented by low-income DC residents that utilize natural gas or fuel oil as the primary source of heating and cooling. LIDP is being designed and implemented to determine costs (materials, equipment, labor), before and after energy usage, greenhouse gas reductions, lifecycle savings, benefits to the consumer, and roadblocks encountered when removing fossil fuel-burning equipment, providing energy efficiency measures, and converting fossil-fueled appliances from the homes owned or rented by DC residents.

Households meeting DCSEU's low-income qualifications and residing in single-family homes will be eligible. The pilot will include 10–20 homes and a variety of heating system types. The program will include weatherization, air sealing, LED lights, smart thermostats, new heat pump systems (either whole home or several ductless units), and a solar system (either on the roof or through participation in a community system located in the District of Columbia). If feasible with available funding, remaining fossil-fueled appliances will be converted (starting with the water heater), and window and door replacements will be considered. Working with contractors and the system designer, DCSEU will develop education materials and/or a workshop for homeowners both before and after installation. The pilot will not be held to the DCSEU's normal cost-effectiveness standards and will conclude with the development of a set of lessons learned, to be published as a white paper that will help improve general understanding of the overall costs and other resources needed to implement the program at scale (P. Boyd, senior manager, Technology and Innovation, DCSEU, pers. comm. April 24, 2020).

## Discussion and Conclusions

While electrification programs are rapidly growing, they are still in an early stage of their evolution. Total current-year budgets across the United States are nearly \$110 million, up 70% from the prior year. In the most recent year, nearly 80,000 rebates were provided. Programs are refining their approaches, adjusting incentives, adding components, and piloting new or complementary approaches such as optimized whole-home retrofits and all-electric new construction. Programs are most extensive on the West Coast and in the Northeast but are beginning in other regions as well.

Many of the programs target the use of heat pumps to displace both fossil fuels and electric resistance heat, but some programs target mostly one or the other. Several programs offer upstream incentives to contractors or distributors, finding that such an approach increases participation (VEIC 2018). High incentives, such as those enabled by allowing credit for fossil fuel savings and not just electric savings, also increase participation (VEIC 2018). In areas with high use of delivered fuels (fuel oil and propane), many programs target customers who use these fuels because the economics of electrification in these situations are generally better than when displacing natural gas. Probably the majority of applications involve using heat pumps while keeping fossil fuel heating systems in place. Programs in New England have found that attention needs to be paid to integrating the two systems, such as using integrated controls and/or considering thermostat locations and setting the thermostat for the backup system a few degrees lower than the heat pump so that the backup functions only when the heat pump cannot serve the full load. In regions with growing use of air-conditioning, ductless heat pumps can be a popular way to add efficient air-conditioning to homes that are difficult to retrofit with central air-conditioning.

A few other issues arose in our research. For example, while all of the programs encourage weatherization to help reduce heating loads and costs, only about one-third of programs require it. However, quite a few programs are exploring approaches to improve weatherization uptake before or at the time of heat pump installation. Furthermore, a limited number of cold-climate ducted heat pump products with a large heating capacity are on the market, making it difficult to serve existing homes with high heating loads (e.g., inefficient homes in cold climates). Several programs noted that competition from natural gas programs can also present challenges; natural gas utilities do not want to lose large loads, and many of them are promoting high-efficiency natural gas furnaces. In a few cases, electrification supporters have advocated ending gas furnace incentives, but for the most part, these programs continue in order to promote condensing gas furnaces when they cost effectively save energy relative to less-efficient noncondensing furnaces.<sup>22</sup>

Programs to date emphasize the residential sector. While commercial applications are often eligible, they are usually not targeted; even where targeted, the emphasis is on smaller buildings. More can be done in the commercial sector, as will be discussed in an ACEEE report to be published in the fall of 2020. However, only very limited analyses on commercial-sector opportunities are available (e.g., see Kim et al. 2017), making it difficult for program implementers to identify and promote the best electrification opportunities in the commercial sector.

With programs still at an early stage of development, much work remains to be done. Additional information should be collected and analyzed on customer response to different program and incentive

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<sup>22</sup> For example, the New Jersey Board of Public Utilities proposed to scale back programs for natural gas equipment but, in response to concerns from contractors, decided not to proceed with the change (New Jersey BPU 2019).

approaches, on the costs, energy savings, and emissions impacts of heat pump retrofits, and on how to best package heat pumps and weatherization. On the basis of these analyses, best practice approaches can be identified and promoted. Program approaches also need to be developed for the commercial sector, in particular going beyond small buildings that are currently targeted by some programs.

Programs to promote electrification of homes and buildings appear to be off to a promising start. Given the increasing interest in electrification, we expect continued growth in the next few years, along with substantial refinement as lessons are learned and applied.

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## **Acknowledgments**

This report was made possible through the generous support of the Tilia Fund and another foundation wishing to be anonymous. The authors gratefully acknowledge reviewers, colleagues, program managers, sponsors, and other experts we consulted who supported and assisted with this brief. External expert reviewers included Merrian Borgeson from the Natural Resources Defense Council, Carolyn Elam from the City of Boulder, Richard Faisey and Chris Neme from the Energy Futures Group, Mark Kresowik from the Sierra Club, Emily Lewis O'Brien and Dylan Voorhees from the Vermont Energy Investment Corporation, David Lis from Northeast Energy Efficiency Partnerships, Jessica Shipley from the Regulatory Assistance Project, and Jenna Tatum from the Building Electrification Initiative. Internal reviewers were Rachel Gold and Maggie Molina. External review and support do not imply affiliation or endorsement.

## **Appendix: Data by Program**

The tables below provide the data provided to us by each program. While we have sought to collect the data in as standardized form as possible, programs differed somewhat in how they responded. Therefore, care should be used in comparing programs. These data are best seen as providing a broad picture. Furthermore, all of these programs are regularly changing. The data below capture a snapshot in time.

Program administrator	SMUD	Palo Alto	SCE	SCE	NYSERDA	NYS Electric Utilities	Efficiency Maine
Program name			Clean Energy and Resiliency (CLEAR)	Plug Load & Appliance (Residential Upstream Incentives for Space & Water Heat Pumps)	Air Source Heat Pump (ASHP) Rebate Program* Ground Source Heat Pump (GSHP) Rebate Program* Clean Heating and Cooling Community Campaigns Geothermal Clean Energy Challenge	NYS Clean Heat: Statewide Heat Pump Program	
Eligible technologies/end uses					2017-2019	2020	
Ductless heat pumps	X		X	X	X	X	X
Ducted heat pumps	X		X	X	X	X	X
VRF heat pumps	X		X			X	X
Heat pump water heaters	X	X	X	X		X	X
Induction ranges	X	Portable loaners	X				
Other:			Battery storage		X	X	EVs
Other:			Solar				
Other:							
Eligible fuels							
Natural gas	X	X	X	X	X	X	Through lost opportunity offerings, not retrofits
Oil and propane	X		X		X	X	X
Wood	Possibly				X	X	X
Other:	Possibly		All-electric preferred		Electric resistance	Electric resistance	
Sectors targeted							
Single-family residential	X	X	X	X	X	X	X
Multi-family residential	X	X		X	X	X	X
Small commercial (~<100 kW)	X				GSHP	X	X
Large commercial	X				GSHP	X	Do not target this sector
Other:					GSHP	X	
Budget							
Current year	\$12,500,000	\$300,000	\$1,600,000	\$17,000,000	2020 incentives are covered under the NYS Clean Heat budget; additional budget for NYSERDA CEF market development initiatives is pending approval	\$36,600,000	
Prior year	\$4,500,000	\$150,000	\$425,000	No incentives available last year for these fuel-sub technologies	\$22,800,000	Launched 2020	\$12,118,849
Funding source							
Utility ratepayers	X	X	X	X	X	X	X
Utility shareholders	X						
Cap and trade funds							X
State funds besides cap and trade							
Other:							Forward Capacity Revenue
Most common incentives							
Measure #1	HPWH	HPWH	Dual Fuel Home with EDR > 2	Central HVAC HP	ccASHP: partial load heating	ccASHP: partial load heating	Ductless heat pumps
Incentive for #1	\$3,000	\$1,200-\$1,500	Up to \$7,500	\$300/ton *	\$500 per outdoor ASHP unit	\$500-\$800 per outdoor unit	
Measure #2	HP-HVAC		All-electric home with EDR > 2	Mini-split HP	Whole-home ASHP systems	ccASHP: full load heating	HPWH
Incentive for #2	\$4,500		Up to \$12,500	\$300-\$600/ton*	\$1,000 per ton cooling capac.	\$1,000-\$2,000 per 10,000 BTUH of full load heating capacity	VRF
Measure #3	Induction stove		Solar + battery storage	HPWH	Small GSHP systems	GSHP: full load heating	
Incentive for #3	\$500		\$5,000	\$1,000/unit	\$1,500 per ton cooling capac.	\$1,500-\$2,850 per 10,000 BTUH of full load heating capacity	
				*\$100/per ton kicker for HP HVAC systems installed in multifamily properties			
Connection between weatherization and electrification measures?							
Weatherization required	X						
Weatherization encouraged			X	X	X	X	
Explain:	For low income only				Program Manual "highly recommends that site owners contact a home performance professional to assess and implement energy efficiency opportunities related to building envelope and HVAC distribution before, or in coordination with, installing a heat pump system, and refers to available incentives.	NYS Clean Program materials will promote weatherization to make homes and buildings "heat pump ready," which will include publicizing NYSERDA's Comfort Home Pilot. Expansion of weatherization programs offered in conjunction with heat pump programs will be explored as a potential program element to be added in the future.	
Participation in most recent year							
# customers			NA	NA	6,520	Just started	
# rebates	2,500	43	NA	NA	12,778	Just started	17,776
Notes		61 participants induction loaner (40 Palo Alto and 21 from other communities but 100% CPAU funded)	Goal: 400 residential projects, 20 nonresidential		21,500 cumulative		

Program administrator	Mass Save	Massachusetts Clean Energy Center	Massachusetts DOER	Public Service Department - VT	Efficiency Vermont	Burlington Electric Department (BED VT)	Energy Futures Group for the Building Performance Professionals Association of Vermont
Program name	Fuel optimization incentives are offered for heat pumps in the Residential Retail, Residential Coordinated Delivery, and Income-Eligible Coordinated Delivery Core Initiatives	Whole-Home Air-Source Heat Pump Pilot	Home MVP	Tier III	Cold Climate Heat Pumps (CCHP), Heat Pump Water Heaters (HPWH), Whole Building Heat Pumps (WBHP), Custom	Net Zero Energy City	Zero Energy Now
Eligible technologies/end uses							
Ductless heat pumps	X	X	X	X	X	X	X
Ducted heat pumps	X	X	X		X	X	X
VRF heat pumps	X	X	X		X	X	
Heat pump water heaters	X		X	X	X	X	X
Induction ranges			X	X		X	X
Other:					Ducted heat pumps (centrally	EVs & charging stations	Weatherization
Other:					Air to water heat pumps	Electric bikes	Solar PV
Other:						Electric lawn mowers	
						Electric public transit buses	
Eligible fuels							
Natural gas		X	X	X	X	X	X
Oil and propane	X		X	X	X	X	X
Wood			X		X	X	X
Other:	Electric		Electric/any		Electric resistance		
Sectors targeted							
Single-family residential	X	X	X	X	X	X	X
Multi-family residential	X		X	X	X	X	Eligible but not targeted
Small commercial (<100 kW)	X			X	X	X	Eligible but not targeted
Large commercial	X			X	X	X	
Other:					Low income (SF, MF)		
Budget							
Current year	\$9,705,000	\$500,000	\$1,333,333	\$5,942,339	\$4,100,000	\$277,469	\$300,000
Prior year	\$4,875,000	NA	\$1,333,333		\$3,600,000	\$627,905	\$10,000
	(budgets are incentives only)						
Funding source							
Utility ratepayers	X	X		X	X	X	
Utility shareholders							
Cap and trade funds	X				X		
State funds besides cap and trade			X				
Other:					Forward Capacity Market bids from EE		Energy Foundation and other
Most common incentives							
Measure #1	MSHP displacing oil	Switching from natural gas to a whole-home air-source heat pump system	Air-source heat pumps	ccHP	Ductless/compact ducted HP	Electric lawn mower	Weatherization
Incentive for #1	\$1,250/ton	\$2,500	\$2,000-\$12,000	\$500 - \$800	\$350-\$450	\$100	\$10,000
Measure #2	Central HP displacing oil		Insulation and air-sealing	PHEV - EV	HPWH	PHEVs and EVs	Heat pumps
Incentive for #2	\$1,250/ton		\$1,000-\$9,000	\$300-\$1,500	\$600	\$800-\$1,200	\$15,000
Measure #3	Ductless HP displacing electric resistance		Ground-source heat pumps	C&I custom measures	Centrally ducted HP	CC ductless heat pumps	Solar PV
Incentive for #3	\$1,250/ton		\$6,000-\$2,0000	\$650-\$225,000	\$800/ton	\$1,200-\$1,650	\$25,000
Connection between weatherization and electrification measures?							
Weatherization required				X			X
Weatherization encouraged	X	X	X	X	X	X	
Explain:	In MA, the program administrators do not require weatherization, but it is recommended.	The whole-home pilot requires that customers have had a home energy assessment and strongly encourages them to follow up on the recommended measures.	Performance-based incentive encourages a combination of heat-pumps, and weatherization. In addition there is an increased weatherization incentive when combined with heat pump electrification.	Only one utility requires weatherization for cCHP measures, the rest encourage it. The TRM offers greater credit for a cCHP installed in a weatherized home.	Midstream programs make weatherization qualification very challenging. Also, we believe that meeting customers where they are is important for engagement and reduced barriers to entry.	Dwellings using more than 50,000 BTUs/heated square foot are offered Wx incentives of 33% for owner occupied and 50% for rentals where tenants pays heating costs directly.	Homes must be weatherized in order to participate
Participation in most recent year							
# customers			250	8,993		390	
# rebates	2,530	27	350		5,291	356	
Notes							2016-2017 pilot yielded 35 participants. Recent study of 24 of these participants found 64% electric grid and fossil fuel savings. Based on this study, the Energy Foundation has funded a Vermont pilot program to resurrect Zero Energy Now in Vermont, and expand it to other Northeast states.

Program administrator	Energize Connecticut (Avangrid)	Energize Connecticut (Eversource)	Energize Connecticut	National Grid RI	Bonneville Power Administration	City of Ashland, OR	Eugene Water and Energy Board
Program name			Oil and propane fuel optimization heat pump pilot program	HVAC Program		Conservation Division Incentive programs	Smart Electrification
Eligible technologies/end uses							
Ductless heat pumps	X	X	X	X	X	X	X
Ducted heat pumps	X	X	X	X	X	X	X
VRF heat pumps	X				X		X
Heat pump water heaters	X	X		X	X	X	X
Induction ranges							
Other:			Integrated controls				GSHP with desuperheater
Other:							Transportation electrification
Other:							
Eligible fuels							
Natural gas	X	X				X	X
Oil and propane	X	X	X	X			X
Wood	X						X
Other:	Electric	Electric			Electric resistance		Gasoline (for transportation)
Sectors targeted							
Single-family residential	X	X	X	X	X	X	X
Multi-family residential	X	X		X	X	X	X
Small commercial (~<100 kW)	X			X	X	X	X
Large commercial	X						X
Other:				Low income			
Budget							
Current year	\$6,766,340	\$10,676,893	\$300,000				\$500,000
Prior year	\$6,853,734	\$5,846,348		\$190,000			\$500,000
Funding source						X	
Utility ratepayers	X	X	X	X			X
Utility shareholders							
Cap and trade funds	X	X	X				
State funds besides cap and trade							Oregon Clean Fuels Program
Other:					Program budget is collected via BPA's wholesale power charges to retail utilities who purchase firm power	Oregon Clean Fuels Program, BPA	
Most common incentives							
Measure #1	Heat pumps	Ductless single-zone HP	Ducted HP	Mini-split heat pump, non-ducted, without integrated controls, partial oil displacement		Ductless heat pumps	Ductless heat pump
Incentive for #1	\$500	\$300	\$1,250/ton	\$1,000/ton		\$4,500	\$1,000
Measure #2	HPWH	Ductless multizone HP	Ductless HP	Mini-split heat pump, non-ducted, full electric resistance heat displacement		Windows	Ducted heat pump
Incentive for #2	\$750	\$500	\$1,250/ton	\$1,000/ton		\$8,000	\$800
Measure #3		Heat pump water heater <55 gals.	Integrated controls	Mini-split heat pump, ducted, without integrated controls, partial oil displacement		Solar Electric	Heat pump water heater
Incentive for #3		\$750	\$500/controller	\$1,000/ton			\$800
Connection between weatherization and electrification measures?							
Weatherization required	X	X	X	X			
Weatherization encouraged	X	X		X		X	X
Explain:	Required for displacing delivered fuels. Recommended for HES participants.	Required for displacing delivered fuels. Recommended for HES participants.		Two separate tiers of incentives existed in 2019: - Standard Rebate: Encourages, but does not require weatherization - Enhanced Rebate (\$1,000/ton); Requires weatherization			Financial barriers, but customers tend to weatherize without it being required, either at time heat pump installed or at a later time
Participation in most recent year							
# customers	6,909		0	378			268
# rebates	9,050	19,485	0	490	8,350	225	288
Notes						Rebates include all weatherization measures and not just heat pumps	

Program administrator	City of Boulder, CO	DCSEU - DC Sustainable Energy Utility
Program name	Comfort365	Low-Income Decarbonization Pilot - LIDP
Eligible technologies/end uses		
Ductless heat pumps	X	X
Ducted heat pumps	X	X
VRF heat pumps		
Heat pump water heaters	X	X
Induction ranges		
Other:	GSHP with desuperheater	Electric range
Other:		LED lighting
Other:		Weatherization
		Solar (site or community)
Eligible fuels		
Natural gas	X	X
Oil and propane	X	X
Wood	X	
Other:	Electric resistance	
Sectors targeted		
Single-family residential	X	X
Multi-family residential	X	
Small commercial (<-100 kW)		
Large commercial		
Other:		
Budget		
Current year	\$45,000	\$440,000
Prior year	\$45,000	\$0
Funding source		
Utility ratepayers	X	X
Utility shareholders		
Cap and trade funds		
State funds besides cap and trade		
Other:	Tax on electricity use	
	Property & sales tax	
Most common incentives		
Measure #1	Mini-split system for zonal heating and cooling	HP & weatherization package
Incentive for #1	\$1,050	\$20,700-\$38,700
Measure #2	Unitary (dual fuel) ducted system displacing gas	
Incentive for #2	\$1,450	
Measure #3	HPWH replacing gas water heater	
Incentive for #3	\$1,450	
Connection between weatherization and electrification measures?		
Weatherization required		X
Weatherization encouraged	X	
Explain:	We also offer discounted energy audits and insulation and air sealing incentives to encourage weatherization in combination with electrification.	
Participation in most recent year		
# customers	40	Just starting
# rebates		
Notes		