Appendix H:

Midstream HVAC Potential Study

10/19/2018

MichaelsEnergy

Memo

Date: September 13, 2018

To: Nat Blackford, Efficiency Maine Trust

From: Teri Lutz, Brian Uchtmann, Paige Markegard, and Joel Pertzsch

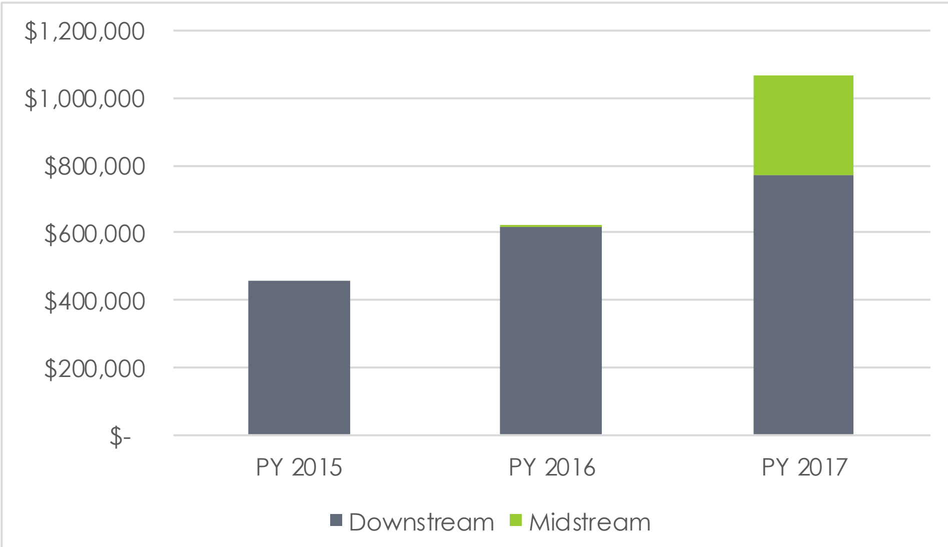
Subject: Residential and Commercial Midstream HVAC Market Study Results: DRAFT (Master Services Agreement No.: 20180017)

1. Introduction

The Efficiency Maine Trust contracted with Michaels Energy (Michaels) to identify cost effective residential and commercial HVAC measures that could be efficiently delivered through a midstream program model and are not already being offered by Efficiency Maine. The midstream HVAC program model works directly with distributors and contractors rather than end-users. Michaels has estimated the annual budgets for new measures and likely program activity for the identified midstream measures for the next three year planning period.

Program administrators across the country are achieving increased unit sales of cost-effective measures and streamlined administrative functions by partnering with distributors to carry energy efficient HVAC equipment and accessories. This program design allows for more efficient delivery by reducing the costs of individual rebate form processing, expanding the market to more customers with lower overhead, and reducing the lost opportunity sales by ensuring program eligible equipment is stocked and sold. Efficiency Maine has had great success using midstream delivery for certain commercial HVAC measures. From PY 2016 to PY 2018, The value of C&I HVAC rebates for measures that have moved from exclusive downstream delivery to a mix of downstream and midstream delivery channels have increased substantially, as shown in Figure 1, and account for much of the increased program activity in this technology segment.

Figure 1 |
Selected Efficiency Maine C&I HVAC Program Incentives



Midstream channel delivery details can vary. Some offer distributors incentives to stock and promote program qualifying equipment, with incentives passed down to contractors and then to customers. Others offer distributors incentives that they can use in any way they choose: to provide incentives to contractors and end-use customers, to cover administrative costs, to purchase marketing, or to improve their margins. Efficiency Maine currently utilizes both midstream and downstream delivery for prescriptive HVAC equipment, as shown in Table 1.

Table 1 |
Current Efficiency Maine Residential and Commercial HVAC Measures

Sector	Measure	Channel
Residential	Ductless Heat Pumps	Downstream
	Boilers	
	Furnaces	
	Biomass Boilers	
	Biomass Furnaces	
	Geothermal Heat Pumps	
	Pellet Stoves	Retail Mail-in Rebate
	Wood Stoves	
	Smart Thermostats	
Commercial	Ductless Heat Pumps	Downstream
	Packaged Heat Pumps	
	Variable Refrigerant Flow Systems	
	VFDs for HVAC	
	Boilers > 500 MBtu/h	
	Modulating Burner Controls	
	Boiler Economizers (Standard or Condensing)	
	Boiler Reset/Lockout Controls	
	Boiler Oxygen Trim Controls	

	Boiler Turbulators	
	Programmable Thermostats	
	Boilers <= 500 MBtu/h	Midstream
	Furnaces <= 300 MBtu/h	
	Low-Intensity Infrared Heaters	
	Warm Air Heaters	
	Tankless Water Heaters	

This program design is not without trade-offs. A key element of moving programs upstream is the removal of participation barriers for upstream partners. This means streamlining data collection processes and data requirements comes as a trade-off. Generally, less data is collected, and the implementer does not have as much direct control and oversight of installation Quality Assurance and Quality Control (QA/QC). Additionally, when delivery moves upstream, the program may lose the customer contact opportunity and many customers will not realize that they are receiving a program incentive. Efficiency Maine does maintain oversight over key elements for the program, and collects fuel type, installation location, and contractor information on measures that have been moved to midstream delivery.

1.1 Key Recommendations

The Michaels team has found that the current Efficiency Maine midstream program efforts have been successful in driving the installation of cost-effective high efficiency equipment in Maine. To build on this success, Efficiency Maine should continue to offer existing midstream measures, and adopt these three key recommendations.

1. Introduce electric commutated hot water smart pump incentives for residential customers through a midstream delivery channel that covers the full marginal cost of the high-efficiency pump relative to a standard pump.
2. Increase existing commercial electric commutated hot water smart pump incentives to cover the full marginal cost of upgrading from a standard pump, and promote delivery through a midstream channel
3. Add a midstream delivery channel for current residential oil-boiler measure incentives.

2. Analysis

The Michaels team has assessed the current Efficiency Maine Prescriptive HVAC program offerings and delivery channels, and has conducted benchmarking, cost effectiveness screening, in-depth interviews, and market assessment to provide Efficiency Maine with recommendations to refine delivery and rebate strategies for their prescriptive HVAC programs.

The benchmarking activities and program reviews were used to develop a list of target measures to help focus contractor and supplier in-depth interviews. Detailed information on the current penetration and existing characteristics of these measures was collected from market participants active in the Maine HVAC market. After this information had been collected, the measures were screened to see if they represented cost-effective opportunities measures for Efficiency Maine to move to a midstream delivery channel.

Finally, the interview and specific measure information was compiled and reviewed in a market assessment to help Efficiency Maine set rebate levels and anticipate likely program activity and budget requirement for their midstream offerings.

2.1 Benchmarking

Details of the benchmarking exercise are included below. This information was used to screen different equipment for midstream delivery, as well as review different incentive levels from peer organizations. Peer review was used to identify residential and commercial HVAC measures that could be considered for Efficiency Maine offerings, and to gather data and information to be used in cost-effectiveness testing. The team conducted internet research to complete this task, and compared midstream offerings from comparable energy efficiency programs.

2.1.1 Peer Organizations

2.1.1.1 Efficiency Vermont

Efficiency Vermont launched its first upstream program in 2009[1]. Today, they offer rebates for four different types of HVAC equipment. Table 2 shows their current offerings.

Table 2 |
Efficiency Vermont Midstream HVAC Measures[2]

Custom Sector	Measure Name	Current Efficiency Maine Program Offering?	Rebate/Incentive
Residential, Commercial & Industrial	Heat Pump Systems	Yes	cold climate heat pump $600 or $800 rebate
Residential, Commercial & Industrial	High Performance Circulator Pumps	C&I only	$50-$600
Residential, Commercial & Industrial	Heat Pump Water Heater	Yes	$600
Commercial & Industrial	Efficient Evaporator Fan Motors (New in 2017)	No	$60 - case motors $100 - walk-in motors

2.1.1.2 Energize Connecticut

Energize Connecticut currently only offers upstream HVAC rebates for the residential sector. Energize Connecticut offers Instant Discounts of up to $500 to residential customers for ductless heat pumps. Table 3 shows their current offerings.

[1] http://mwalliance.org/conference/sites/default/files/pdf/MES_2014_presentations_Brown.pdf
[2] https://contractors.efficiencyvermont.com/news-resources/2017-efficiency-vermont-program-updates

Table 3 |
Energize Connecticut Upstream HVAC Measures[3]

Customer Sector	Measure Name	Current Efficiency Maine Program Offering?	Rebate/Incentive
Residential	Ductless Heating and Cooling System of Matched Assembly Single Indoor Unit	Yes	$300/Home
Residential	Ductless Heating and Cooling System of Matched Assembly Multi-Indoor Unit	Yes	$500/Home

2.1.1.3 Mass Saves

Mass Saves serves the utilities in the state of Massachusetts. They began using the upstream approach for lighting in 2011 and added upstream HVAC in 2013[4]. Their current program offerings can be found in Table 4.

Table 4 |
Mass Saves Upstream HVAC Measures[5]

Customer Sector	Measure Name	Current Efficiency Maine Program Offering?	Rebate/Incentive
Commercial & Industrial	Unitary Air Conditioners	Yes	unitary and split system - Tier 1 - $50-125/ton Tier 2 - $175/ton
Commercial & Industrial	Heat Pump Systems	Yes	air source, water source, & ground source - Tier 1 - $50-$125/ton Tier 2 - $175/ton
Commercial & Industrial	Ductless Heat Pump – Commercial/Industrial	Yes	mini-split heat pumps - $300, $500, $625
Commercial & Industrial	Dual Enthalpy Economizer Controls	Yes	$250
Commercial & Industrial	ECM for HVAC Fans	Yes	$150
Commercial & Industrial	Large Commercial Air-Cooled RTU and Split Systems	Yes	N/A

[3] https://www.energizect.com/your-home/solutions-list/ductless-split-heat-pump-rebates
[4] http://aceee.org/files/proceedings/2014/data/papers/4-618.pdf
[5] https://www.masssave.com/en/saving/business-rebates/upstream-electric-hvac-program/

Commercial & Industrial	Water- and Evaporative-Cooled Air Conditioning Systems	Yes	N/A

Generally, Efficiency Maine is comparable to regional peer organizations in terms of their overall prescriptive HVAC offerings, as well as midstream offerings in the C&I sector. Some regional peers have had great success with expanded prescriptive HVAC midstream offerings that include residential high performance hot water circulator pumps and heat pumps.

2.1.2 HVAC Midstream Channel Program Design Benchmarking

The objective of this task was to identify key success factors for residential and commercial HVAC midstream channel program designs. The team conducted internet research to complete this task.

2.1.2.1 ENERGY STAR

At the annual ENERGY STAR Products Partner Meeting in Chicago in October 2017, presenters discussed how residential HVAC and water heater midstream programs are delivering far greater results than the downstream model. Figure 2 is an excerpt from their presentation[6].

Figure 2 |
Residential Midstream HVAC and Water Heating Participation Increases

Table 1: Participation Improvement for Distributor-Focused Residential Midstream Programs Compared to Downstream Programs

Efficiency Program	Measure	Incentive Amount	Increase in Program Participation
efficiency MAINE	ENERGY STAR Certified Heat Pump Water Heater (HPWH)[3]	$750	423%[4] (PY1)[5]
Efficiency Vermont	ENERGY STAR Certified HPWH[6]	$400	750%[7] (PY1)
energize CONNECTICUT CT	ENERGY STAR Certified HPWH[8] and Natural Gas Water Heaters[9]	$300 for gas; $600 for HPWH	1000%[10] (PY2)
	ENERGY STAR Certified Natural Gas Boiler and Furnaces[11]	$450 to $800	234% (PY2)
Energy Trust of Oregon	ENERGY STAR Certified HPWH[12] and Natural Gas Water Heaters[13]	$100 for gas; $300 for HPWH[14]	Just began program in 2017

Order of magnitude increase in program participation!

The success factors for implementing the midstream HVAC channel presented at this meeting are:

- Leveraging the distributor relationship with contractors to sell to end-use customers
- Communication and training with delivery channel (distributors and contractors)
    - Periodic updates, trainings, and communications via email

[6] *Gain Steam, Go Midstream! Distributor Focused Residential HVAC and Water Heater Incentives*, ENERGY STAR Products Partner Meeting, October 24, 2017, Chicago, IL, https://www.energystar.gov/sites/default/files/asset/document/2017_ESPPM_Gain%20Steam%2C%20Go%20Midstream%21%20FINAL.pdf (accessed May 2018)

- Weekly email newsletters
- Communicating the value proposition with distributors
    - Return on Net Assets
    - Inventory reduction
    - Marketing support
- Sales, Marketing, Inventory and Training Plans (VEIC tactic): work with distributors to establish plans to sell program eligible equipment

The EPA offers technical support through ENERGY STAR and a Technical Advisory Group with members from: AO Smith, CLEAResult, Energize CT, Energy Solutions, Energy Trust of Oregon, NEEA, SDG&E, and VEIC[7].

2.1.2.2 ACEEE Resources

At the ©2016 ACEEE Summer Study on Energy Efficiency in Buildings, D+R International and others presented a paper on residential midstream HVAC program design[8]. Two factors for success different from those above that they advocate are:

- Contractor education combined with consumer marketing to increase downstream demand for the high-efficiency products stocked by distributors
- A thorough understanding of the market and effective identification of the most important *local factors* hindering the penetration of energy-efficient technologies

Generally, Efficiency Maine midstream offerings and procedures are in line with industry practice. Notably, Efficiency Maine's heat pump water heater midstream measure delivery is best-in-class. Efficiency Maine has appropriately focused on lost-opportunity measures through their midstream program offerings. Efficiency Maine has additional opportunities to streamline reporting and payment procedures with participating distributors and expanding measure offerings in the residential market segment.

2.2 Interviews

Michaels conducted in-depth interviews with Efficiency Maine program staff, HVAC distributors and contractors active in the state, and manufacturers actively developing and selling high efficiency products in the state (Maine market actors). An interview was also conducted with an out-of-state utility program manager for commercial HVAC midstream and downstream programs.

The objectives of these interviews were to understand the structure of the current Maine market, identify potential new measures, and identify measures that may be good candidates for midstream delivery. The interviews also focused on identifying key considerations for and potential barriers to midstream program delivery.

[7] Contact: midstreamdistributor@energystar.gov to set up a call

[8] See: *Swimming to Midstream: New Residential HVAC Program Models and Tools,* Stephen Bickel, Rivett, B., Vida, D., Nelson, M., Parsons, J., Merson, H., Nelson, M., http://aceee.org/files/proceedings/2016/data/papers/7_888.pdf (accessed May 2018)

Table 5 |
Maine Market Actor In-depth Interview Summary

Segment	Number of Interviews	Key Take-Away
Contractors	10	• High efficiency residential heating and cooling equipment is widely available. Purchase and installation decisions are not driven by "what is on the shelf" – a full range of equipment efficiencies are available for most residential equipment. One contactor noted that if he was called to a job on a Friday afternoon, he could get a residential boiler in any size and efficiency within a few hours, even during non-business hours. • Majority of the residential heating installations appear to be roughly split between oil and gas installations, as existing oil customers (~65% of households) slowly switch to gas and propane units. A small fraction (<10%) of installations are heat-pump or bio fuel only. • Contractors who have completed a large number of commercial rebates found the process to be easy. • Contractors who were less active in the commercial program reported frustration in handling the commercial rebate applications, making it less appealing to provide rebates to the customer. • Contractors report that new universal residential HVAC forms have simplified the rebate process. • Downstream program delivery for residential heat pump measures are working. Contractors report that the current downstream delivery model for residential heat pump incentives is generally efficient, and that quality assurance documentation and processes are not overly burdensome.
Distributors	3	• Distributors noted that it was not always clear what products qualified for midstream rebates, and that having a list of qualified equipment would make rebates easier to process on their end, including for current hot water circulation pumps. • Distributors active in multiple states noted that approximately 10% of small hot water pumps currently sold have modulating ECM motors in Maine, while a large majority sold by participating distributors are sold in states like Vermont with robust midstream incentives. • Distributors don't like participating in midstream programs without a distributor incentive (SPIFF), but are unlikely to stop participating in midstream programs if the SPIFF is discontinued. • A list of qualifying models, instead of a list of qualifying parameters, would streamline the paperwork on their end. • Maine offers fewer distributor (SPIFF) incentives than neighboring states.
Manufacturers	2	• The market for 90+% efficient oil boilers will continue to develop as more efficient equipment types become available.

2.2.1 Contractor Findings

Ten contractor interviews were completed over the course of the study. One of these contractors was active in only the commercial market, three were active in both the residential and commercial markets, and six were active primarily in the residential market. The contractor population represented companies that ranged in size from a few employees to large contractors with regional and multi-state footprints. All of the interviews were conducted with staff who were focused on the Maine market, even if the organization had a regional focus.

Most contractors found residential forms to be relatively easy to process. Many noted that the new "universal" form was a big improvement over the prior residential forms which varied by equipment type. Most contractors had noted that mini-split heat pumps are expanding in both the commercial and residential market, and are used primarily as supplemental heating systems. Very few homes or businesses are retrofit to heat-pump only systems, even in the new construction market.

Of the four contractors working in the commercial heating and cooling programs, two felt that the incentive paperwork and system was hard to navigate. These contractors felt that midstream delivery might simplify the process for them.

Many contractors active in the oil market felt that Efficiency Maine had fewer oil-equipment offerings relative to the equipment available for other fuels.

2.2.2 Distributor Findings

Three distributor interviews were conducted. One of the interviews was with a corporate representative that dealt with rebate programs in several different states. Generally, distributors are not excited to participate in midstream programs without an administrative payment. However, they are likely to participate in the program without the payment as they understand the positive impact on the sale of energy efficient equipment which often has a higher gross profit than cheaper standard-efficiency equipment.

All of the distributors indicated that the midstream model placed them at increased financial risk due to their reliance on the contractor for information for the instant rebate reimbursement from Efficiency Maine. When a contractor provides bad information, the distributor takes the financial hit.

Some of the distributors stated that they did not receive enough information from Efficiency Maine with their rebate checks. This is an issue when the check amount received is less than expected. The lack of granularity makes it difficult to reconcile which specific rebate had not been processed.

All of the suppliers stressed that it is easier for them to process the rebates if they are tied to a specific SKU, rather than to go through a flow chart to determine if a piece of equipment qualifies for a rebate.

2.2.3 Manufacturer Findings

The interviews with the manufacturers were used to assess the current state of the market, and the potential for new products that may become available in the near future. Two heating equipment manufacturer representatives were interviewed, and they provided a significant amount of information about the availability and price premiums of high efficiency heating equipment. The results for individual equipment types has been included in the market assessment section, but the general take away was that for a wide range of residential HVAC equipment, they can get any model of equipment to anywhere in the state within 24 hours.

Broadly, the manufacturers thought that nameplate efficiencies and actual system performance would continue to slowly improve going forward, and that 95% + AFUE gas and 90% + AFUE oil equipment would become much more common in the medium term.

2.2.4 Out-of-state Utility Program Manager Findings

An in-depth interview was conducted with the program manager for the Xcel Colorado Commercial HVAC Program in November 2017. This interview was conducted outside of this project.

The Xcel Colorado Commercial HVAC program was moved from a downstream rebate channel to the midstream channel in 2015. Program incentives cover 60 to 70 percent of the incremental cost through a tiered incentive structure. Since moving to the midstream model, Xcel Colorado has seen significant growth in program eligible equipment installations.

Distributors provide a list to the program implementer containing: serial number, model number, customer, installation location, and building type. The building type is used to develop the full load operating hours. The incentive deemed savings calculations are based on the IEER values, the tonnage, and the full load operating hours. At the time of the interview, only cooling efficiency was taken into account, and no controls or advanced technology was considered.

Key findings from this interview:

- Program success is tied to:
    - Distributors provide input into program design to ensure a program that works for them.
    - Distributors are able to use the incentive payments in any way they determine best for their business: administration, marketing, buy-down, etc.
    - Distributors are given a monthly report that indicates their rank in program eligible sales compared to other participating distributors. Distributors see their ranking with other distributor names not listed.
- The most valuable part of the program is the compounding effect driving market transformation. Distributors are stocking more high efficiency units, lowering the standard efficiency unit stocking rates. This in turn drives more efficient purchases and drives down lead times, decreasing shipping costs and making more efficient units less costly. The program administrator must be comfortable with the fact that end-use customers will not likely know about the program incentive. The name of this game is market transformation, not customer satisfaction with the utility or program administrator.
- Plan for a budget that reflects the anticipated program uptake under a midstream model. Underfunding a successful program can lead to disillusionment with distributors.

- How this distributor incentive is handled impacts the TRC. Until 2017, 100% of the incentive was treated as administrative costs. Now, the program manager received data from the program implementer that supports an allocation of 35-40% to incentives, which improves the TRC.

2.3 Measure Screening

To reach this recommendation, the Michaels team considered the feasibility of offering several of Efficiency Maine's existing downstream HVAC measures through midstream delivery. The team also considered a range of new measures identified through program benchmarking and in-depth interviews conducted with market participants active in the state of Maine. Efficiency Maine program participation data was reviewed, and program logic models and a cost-benefit analysis using contractor supplied inputs were used to vet and recommend a set of measures for Efficiency Maine to offer through midstream channels.

Michaels used the measure screening process consistent with Efficiency Maine's approved process. $TRC = \frac{Benefits_{NPV} \times NTG}{NTG \times (PC + Incentive) + (FR \times Incentives)}$

Where

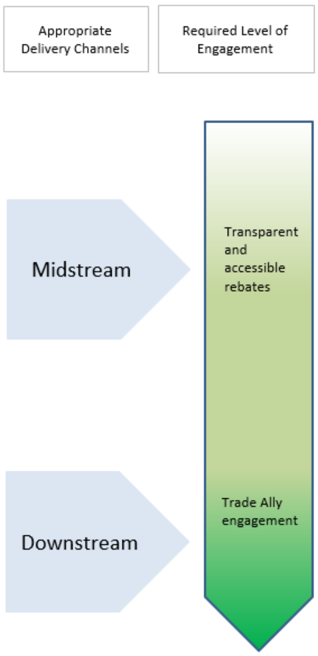
$Benefits_{NPV}$	= net present value of avoided energy and demand costs
NTG	= net to gross ratio
PC	= participant costs
Incentive	= incentives paid to participants
FR	= free ridership rate (%)

The benefits for each measure were determined using a spreadsheet provided by Efficiency Maine that calculates the net present value (NPV) of the benefits based on each fuel, and the relevant seasonal avoided energy costs. These savings are based on an 11% program delivery cost, and a 25% free ridership rate. An initial cost-benefit screen was completed for advanced rooftop controllers, dual enthalpy economizers, ductless heat pumps, residential hot water circulation smart pumps, smart thermostats, unitary air conditioning, and natural gas and propane boilers. These inputs used updated marginal cost and baseline efficiency information from contractor interviews, as appropriate. Additional cost-effectiveness analysis results are included in Appendix A.

To determine if the measure was suitable for midstream delivery in Maine, the Michaels team developed a program logic model to identify characteristics of measures that furthered Efficiency Maine's overall program delivery strategy and objectives.

Our assessment is that midstream delivery is best when designed to streamline workflows for measures for which savings can be reasonably estimated without extensive data requirements. Other delivery channels and program designs will be more effective at capturing retrofit measures. Therefore, an important consideration was to limit midstream delivery for lost-opportunity type measures.

Figure 3 | Midstream Residential and Commercial HVAC Program Logic Model



Goal: Provide cost-effective HVAC product offerings in Maine				
Objective	Activities	Outputs	Short-Term Outcomes	Long-Term outcomes
Induce contractors and end users to select high efficiency lost-opportunity equipment	•EM: Maintain and Develop TRM •EM: Market Energy Efficiency; Cultivate trade ally network, increase customer awareness on the benefits of EE/Resources available •EM: Provide Rebates	•End Users: Know about HE offerings •EM: Provides transparent and easy-to-access rebates •EM: Provides a list of qualifying equipment	•Distributors stock high efficiency equipment •Trade Allies present customers with HE options •Customers select high efficiency equipment •Customers save energy, Program has high realization rate	•Market shifts toward high efficiency equipment •EM: Adapts offerings and refines qualifying products list
Improve the energy performance of HVAC equipment in Maine	•EM: Promote EE •EM: Provide training to Trade Allies •EM: Provide rebates •Trade Allies: Engage with customers •Trade Allies: Quantify cost/benefit	•EM: Provides appropriate incentives for appropriate equipment •QP: Knowledge about rebates and customer cost/benefit	•Customers install high efficiency equipment	•Market shifts toward high efficiency equipment •Efficiency Maine adapts offerings to continue to drive cost-effective energy efficiency in Maine

Filtering the proposed measures through the program logic model indicated that advanced roof-top controllers, dual enthalpy economizers, ductless heat pumps, and smart thermostats are not the best candidates for midstream delivery at this time. The annual savings for advanced roof-top controls varies considerably depending on the type of equipment it is installed on. Additionally, the EUL of the advanced roof-top controller is highly dependent on the condition of the pre-existing equipment. Finally, advanced roof-top controllers do not represent a lost opportunity measure. The savings for dual enthalpy economizers are variable in a Maine climate, and they also do not represent a lost-opportunity measure. Finally, smart thermostats also do not typically represent a lost-opportunity measure. The pre-case thermostat is typically operational, and is replaced prior to failure with a smart thermostat. At this time, smart thermostats may be more appropriate for downstream delivery.

For the remaining measures, it was found that residential unitary air conditioning, and residential propane and natural gas boilers did not pass a TRC test, using approximate costs and efficiency baselines for the existing Maine market. Residential hot water circulation smart pumps and residential oil boiler measures are both cost effective measures, and will fit well into the midstream delivery channel.

Table 6 |
Measure Delivery Recommendations

Custom Sector	Measure Name	Baseline Efficiency[9]	TRC	Recommendation
Residential	Hot Water Circulation Smart Pumps < 1.25 amps	NA	1.40	New measure, offer midstream
Residential	Unitary Air Conditioning	14 SEER	0.58	Not a current measure, do not offer
Residential	Natural Gas Boilers	0.87 AFUE	0.83	Not a current measure, do not offer
Residential	Propane Boilers	0.87 AFUE	0.89	Not a current measure, do not offer
Residential	Oil Boilers	0.82 AFUE	2.50	Existing measure, offer midstream

2.4 Market Size Assessment

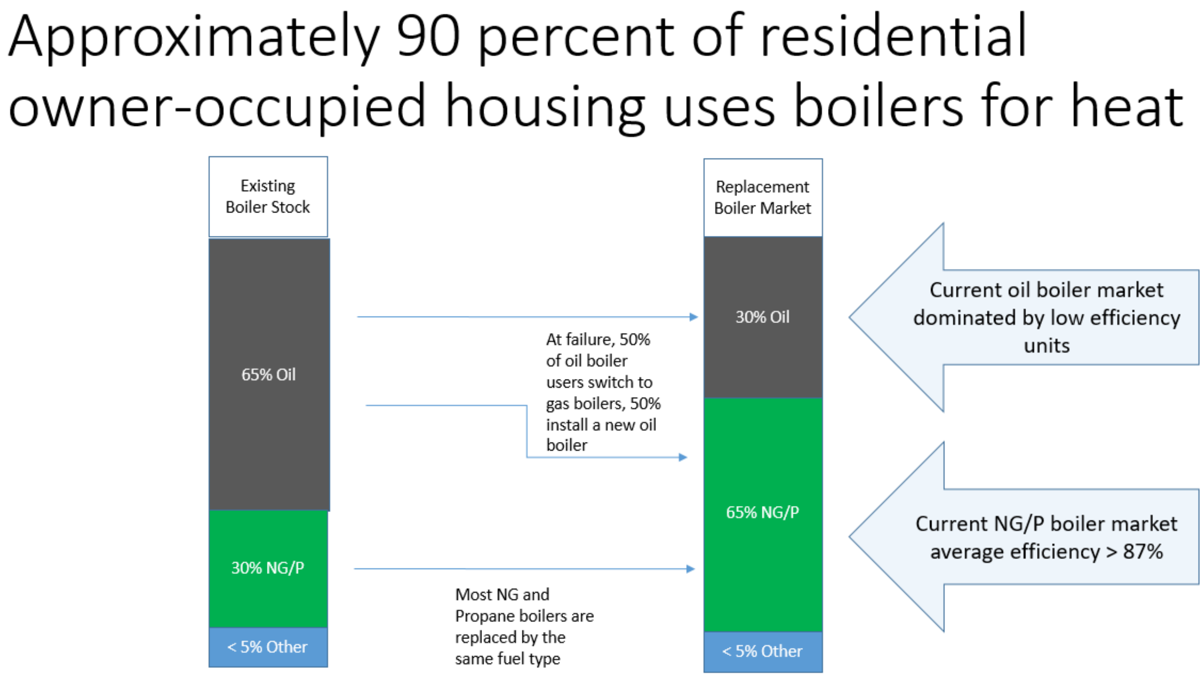
Over the course of the study, the Michaels team conducted interviews, consulted industry literature, and used professional engineering judgement to characterize the Maine HVAC market. A summary of the results are provided here.

Boiler Market: The Michaels team interviewed contractors and suppliers about the Maine heating market. They indicated that 80-90% of homes use boilers for heat, with a combination of electric resistance, forced air, and wood stoves providing the balance of home heat. Very few homes in Maine use heat pumps as the sole source of heat.

At failure, few home owners or business elect to change between with either a forced air or hydronic heating system. Interviewees indicated that approximately half of residential oil users in Maine switch to natural gas or propane when they replace their heating units. Most of the natural gas units installed are combi units. For homeowners who do not select combi units, but who have propane or natural gas available at the home, direct fire, indirect tank, and HPWH are all commonly installed for domestic hot water (DHW). The figure below outlines the current and replacement boiler market. The Michaels team believes that the annual turnover for residential boilers in the state is approximately 20,000 units per year based on a 20 year EUL. Contractors, manufacturers and suppliers reported that the replacement residential boiler market is split relatively evenly between natural gas, propane, and oil boilers.

[9] Based on contractor and supplier interviews in Maine and TRM references, and may not reflect past or prospective evaluated TRC values.

Figure 4 |
Maine Residential Boiler Market



Hot Water Circulator Smart Pumps: Currently, about 10% of hot water circulator pumps have ECM motors and integral feedback controls, per supplier interviews. The Michaels team estimates that the annual market turnover of small residential hot water circulator pumps <1.25 amps is approximately 15,000 – 20,000 units per year in Maine. It should be noted that some of the pump units may be purchased online, or through non-participating retailers. Suppliers with regional footprints indicated that in states with substantial midstream rebates most small hot water circulator pumps they sell are smart pumps.

2.4.1 Detailed Maine HVAC Market Assessment Findings

The contractors, manufacturers, and distributors were asked about their perception and experience with the Maine HVAC market. When applicable, contractors were asked about baseline efficiencies, marginal costs, controls, the ratios of highly efficient and less efficient equipment that is currently in the market, and what they perceive as trends in their niche marketplace. A high level summary of the market assessment information is provided below:

***Chimney Liners*:** Gas, propane, and oil boiler units typically require a new chimney liner regardless of efficiency level (if a chimney is present), but a liner is not needed if the units are directly vented. Three contractors who worked in this market gave specific breakouts, and estimated that new chimney liners cost about $700 for a poly liner, and $1,200 – $1,500 for a stainless steel liner. One contractor felt that stainless steel liners were only necessary for condensing oil boilers, and two indicated that they install stainless steel liners for all condensing boilers regardless of fuel type. Some units are directly vented through an exterior wall, and do not require new liners. Contractors were not able to give precise estimates of the relative number of chimney installations compared to direct vent units. Both are common. The construction and layout of the house and exterior environment factor into how the unit will be vented.

Oil Boilers*:* Contractors who were active in Efficiency Maine programs indicated that they sold mostly high efficiency oil (>87% AFUE) and gas (>90% AFUE) equipment. The contractors and distributors thought that the majority of the market was installing approximately <85% AFUE equipment. The suppliers estimated that about 80% percent of the Maine oil boiler market is less than 87% AFUE.

- Marginal Cost: Boilers that have an AFUE less than 85% % currently dominate the market. The marginal cost of upgrading to 87% AFUE efficiency will raise the equipment cost by about 10%. Upgrading to a very efficient 90% AFUE oil boiler will increase the equipment cost by about 40% relative to an >85% AFUE oil boiler. Very broadly, manufacturer reps, contractors, and distributors interviewed by the Michaels team reported that retail residential oil boiler costs were about; $4,500 for an 85% AFUE boiler; $5,000 for an 87% AFUE boiler; and $6,500 for a 90% AFUE boiler.

Gas and Propane Boilers: Contractor and distributor interviews show that many of the current gas and propane boilers being installed in the state are combi units. The baseline efficiency is likely > 87% with an estimated 50% high efficiency units.

Furnaces: Overall, forced air furnaces are not a large portion of the heating market. Contractors and distributors reported that less than 25% of the total heating replacement market in Maine. It is dominated by gas, and about half of the units sold could be considered high efficiency.

Domestic Hot Water: Generally, the perception among contractors and suppliers is that the majority of replacement DHW systems are split between tankless coil units, heat pump water heaters, and indirect water heaters, while conventional and other DHW systems were not commonly installed. Interviewees noted that heat pump water heaters have gained a significant share of the residential DHW market in Maine in recent years. It is notable that a Maine residential baseline study from 2015 found that indirect, tankless, and conventional water heaters accounted for 31%, 28% and 28% of existing DHW systems, respectively. Heat pump water heaters only accounted for 5% of existing DHW systems[10] in Maine in 2015. Contractors reported that tankless coil units are most often seen on lower efficiency installations where first cost is an important consideration.

Several contractors also noted that in many instances they recommend against using heat pump water heaters if there are significant hot water needs because the system recharge rate for the heat pump water heater was too low to supply adequate quantities of hot water.

- DHW Marginal Cost: Moving up from a tankless coil to an indirect heater is around $700-$1,200, depending on the specific set up.
- HPWH mostly displace direct-fire and electric resistance DHW.

[10] https://www.efficiencymaine.com/docs/2015-Maine-Residential-Baseline-Study-Report-NMR.pdf page 55.

Hot Water Circulation Pumps: Suppliers indicated that efficient hot water circulator pumps with integral modulating controls are a very small portion of the market, and that in states that heavily incent and promote smart pumps, they have gained a large share of the market for professional installations acquired through wholesalers.

3. Recommendations

3.1 Measure Recommendations and Estimated Market Sizes

The Michaels team recommends that Efficiency Maine develop a new residential hot water circulator smart pump measure that covers the full marginal cost between a standard pump and the smart pump.

Additionally, we recommend that the existing rebates for commercial hot water circulator smart pumps be increased to cover the full marginal cost of this upgrade. This measure has been successfully offered in Vermont. In 2017, Efficiency Vermont provided granular data to Efficiency Maine, but this data is not for public consumption. The Vermont data was used at a high level to estimate the potential market activity of this measure in Maine.

Finally, we recommend that Efficiency Maine move the existing residential oil boiler to a midstream delivery model. The potential market activity and Efficiency Maine budget for those measures is included below.

Table 7 |
Recommended Program and Measure Budgets for New and Modified Midstream Measures

Fuel	Delivery Channel	Sector	Equipment	Equip. EUL	Annual Maine Sales	Potential Efficiency Maine Market Share	Total Annual Incented Units	Rebate per Unit	Direct Delivery Costs	Spiff	Total Efficiency Maine Cost/Unit	Total Direct Costs	TRM TRC Ratio
Electric	Midstream	Residential	Hot Water Circulator Smart Pumps <1.25 amps	20	26,005	80%	20,804	$ 100	$ 11.00	$ 15	$ 126	$ 2,621,304	**1.40**
	Midstream	Commercial	Commercial <1.25 amps	20	1,661	80%	1,329	$ 100	$ 11.00	$ 15	$ 126	$ 167,468	**1.11**
	Midstream	Commercial	Commercial 1.25 - 5 amps	20	692	80%	554	$ 758	$ 83.38	$ 50	$ 891	$ 493,644	**1.02**
	Midstream	Commercial	Commercial >5 amps	20	554	80%	443	$ 1,018	$ 111.98	$ 50	$ 1,180	$ 522,776	**2.44**
Oil	Midstream	Residential	Boiler	25	7,433	25%	1,858	$ 500	$ 55.00	$ 50	$ 605	$ 1,124,241	**2.50**

3.2 Program Recommendations

The success of a midstream delivery model is dependent on the cooperation and participation of distributors. The distributors interviewed indicated that there are two program changes that Efficiency Maine could make to their midstream programs to reduce the work associated with program participation without sacrificing program accuracy.

The first is to provide suppliers a list of qualifying equipment stock keeping unit (SKUs) numbers. The second provide more granular information with their midstream supplier payments. As a reference, the qualifying products list from Vermont can be found in Appendix B for hot water circulator smart pumps.

Appendix A | Individual Measures Cost Effectiveness

Cost Effectiveness Modeling

Michaels completed cost effectiveness modeling for HVAC measures that are included in the Maine TRM, and also for HVAC measures that it would make sense to bundle together (i.e. high efficiency furnaces and programmable thermostats). Note – this high level screening reflects marginal costs and savings largely derived from the Efficiency Maine TRM, and does not include revised cost and savings information from contractor and supplier interviews.

Michaels used the net total resource cost (TRC) test for determining cost effectiveness. The net TRC does not count benefits that accrue to free riders or program delivery costs. Additionally, it adds in the incentives paid to free riders as an additional cost item. The equation for net TRC is shown below.

$$TRC = \frac{Benefits_{NPV} \times NTG}{NTG \times (PC + Incentive) + (FR \times Incentives)}$$

Where

$Benefits_{NPV}$	= net present value of avoided energy and demand costs
NTG	= net to gross ratio
PC	= participant costs
Incentive	= incentives paid to participants
FR	= free ridership rate (%)

The benefits for each measure were determined using a spreadsheet provided by Efficiency Maine that calculates the net present value (NPV) of the benefits based on each fuel, and the relevant seasonal avoided energy costs.

We used 25% free-ridership rate for our base case scenario consistent with Efficiency Maine's proxy for unevaluated new measures. The incentive amount for each measure was assumed to be 50% of the incremental cost if the rebate amount was not known. It should be noted that some of the efficiency and capacity combinations of the reviewed equipment may not be common in the state, and may warrant inclusion in custom programs, rather than through a prescriptive program.

Table 8 | Individual Measures Cost Effectiveness

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Unitary Air Conditioners (US1)	Tier I (<5.42 tons)	0.64
Unitary Air Conditioners (US2)	Tier I (>=5.42 to <11.25 tons)	0.84
Unitary Air Conditioners (US3)	Tier I (>=11.25 to <20 tons)	0.50
Unitary Air Conditioners (US4)	Tier I (>=20 to 63.33 tons)	0.72
Unitary Air Conditioners (US5)	Tier I (>63.33 tons)	0.79

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Unitary Air Conditioners (US6)	Tier II (<5.42 tons)	0.91
Unitary Air Conditioners (US7)	Tier II (>=5.42 to <11.25 tons)	1.34
Unitary Air Conditioners (US8)	Tier II (>=11.25 to <20 tons)	0.75
Unitary Air Conditioners (US9)	Tier II (>=20 to 63.33 tons)	1.00
Unitary Air Conditioners (US10)	Tier II (>63.33 tons)	0.88
Unitary Air Conditioners (US11)	Tier III (<5.42 tons)	1.34
Unitary Air Conditioners (US12)	Tier III (>=5.42 to <11.25 tons)	2.63
Unitary Air Conditioners (US13)	Tier III (>=11.25 to <20 tons)	1.67
Unitary Air Conditioners (US14)	Tier III (>=20 to 63.33 tons)	1.35
DCV (US15)	DCV for Tier I (<5.42 tons)	0.02
DCV (US16)	DCV for Tier I (>=5.42 to <11.25 tons)	0.06
DCV (US17)	DCV for Tier I (>=11.25 to <20 tons)	0.12
DCV (US18)	DCV for Tier I (>=20 to 63.33 tons)	0.31
DCV (US19)	DCV for Tier I (>63.33 tons)	0.56
DCV (US20)	DCV for Tier II (<5.42 tons)	0.02
DCV (US21)	DCV for Tier II (>=5.42 to <11.25 tons)	0.06
DCV (US22)	DCV for Tier II (>=11.25 to <20 tons)	0.11
DCV (US23)	DCV for Tier II (>=20 to 63.33 tons)	0.30
DCV (US24)	DCV for Tier II (>63.33 tons)	0.53
DCV (US25)	DCV for Tier III (<5.42 tons)	0.02
DCV (US26)	DCV for Tier III (>=5.42 to <11.25 tons)	0.06
DCV (US27)	DCV for Tier III (>=11.25 to <20 tons)	0.11
DCV (US28)	DCV for Tier III (>=20 to 63.33 tons)	0.29
Dual Enthalpy Economizer (US29)	DEE for Tier I (<5.42 tons)	0.15
Dual Enthalpy Economizer (US30)	DEE for Tier I (>=5.42 to <11.25 tons)	0.39
Dual Enthalpy Economizer (US31)	DEE for Tier I (>=11.25 to <20 tons)	0.76
Dual Enthalpy Economizer (US32)	DEE for Tier I (>=20 to 63.33 tons)	2.20
Dual Enthalpy Economizer (US33)	DEE for Tier I (>63.33 tons)	4.00
Dual Enthalpy Economizer (US34)	DEE for Tier II (<5.42 tons)	0.14
Dual Enthalpy Economizer (US35)	DEE for Tier II (>=5.42 to <11.25 tons)	0.36
Dual Enthalpy Economizer (US36)	DEE for Tier II (>=11.25 to <20 tons)	0.71
Dual Enthalpy Economizer (US37)	DEE for Tier II (>=20 to 63.33 tons)	2.07
Dual Enthalpy Economizer (US38)	DEE for Tier II (>63.33 tons)	3.93
Dual Enthalpy Economizer (US39)	DEE for Tier III (<5.42 tons)	0.13
Dual Enthalpy Economizer (US40)	DEE for Tier III (>=5.42 to <11.25 tons)	0.28
Dual Enthalpy Economizer (US41)	DEE for Tier III (>=11.25 to <20 tons)	0.55
Dual Enthalpy Economizer (US42)	DEE for Tier III (>=20 to 63.33 tons)	1.89
Heat Pump Systems (US43)	Tier I (<5.42 tons)	2.95
Heat Pump Systems (US44)	Tier I (>=5.42 to <11.25 tons)	2.44
Heat Pump Systems (US45)	Tier I (>=11.25 to <20 tons)	2.44
Heat Pump Systems (US46)	Tier I (>=20 tons)	2.44
Heat Pump Systems (US47)	Tier II (<5.42 tons)	1.34

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Heat Pump Systems (US48)	Tier II (>=5.42 to <11.25 tons)	1.36
Circulator Pumps (US49)	Amp <= 1.25	1.11
Circulator Pumps (US50)	1.25 < Amp <= 5	1.02
Circulator Pumps (US51)	Amp > 5	2.44
Ductless Heat Pumps (US52)	Single Head	9.05
Ductless Heat Pumps (US53)	Multi-Head	17.16
High Efficiency Furnaces (US54)	CEE Tier I (90%)	1.08
High Efficiency Furnaces (US55)	CEE Tier II (95%)	1.33
High Efficiency Furnaces (US56)	CEE Tier III (97%)	1.43
ECM Supply Fan Motor (US57)	Heating Only	2.39
ECM Supply Fan Motor (US58)	Cooling Only	0.84
ECM Supply Fan Motor (US59)	Heating & Cooling	3.22
Kitchen Vent Hood Controls (US60)		0.36
Advanced Rooftop Controls (US61)	5HP	1.69
Advanced Rooftop Controls (US62)	7.5HP	2.33
Advanced Rooftop Controls (US129)	10HP	2.86
Advanced Rooftop Controls (US130)	15HP	3.71
Advanced Rooftop Controls (US131)	20HP	4.36
Advanced Rooftop Controls (US132)	25HP	4.88
Advanced Rooftop Controls (US133)	30HP	5.29
Packaged Terminal Air Conditioner (PTAC) (US63)	Standard Size < 7,000 Btu/h	0.42
Packaged Terminal Air Conditioner (PTAC) (US64)	Standard Size 7,000 - 15,000 Btu/h	0.42
Packaged Terminal Air Conditioner (PTAC) (US65)	Standard Size > 15,000 Btu/h	0.42
Packaged Terminal Air Conditioner (PTAC) (US66)	Non-Standard Size < 7,000 Btu/h	0.42
Packaged Terminal Air Conditioner (PTAC) (US67)	Non-Standard Size 7,000 - 15,000 Btu/h	0.42
Packaged Terminal Air Conditioner (PTAC) (US68)	Non-Standard Size > 15,000 Btu/h	0.42
Packaged Terminal Heat Pump (PTHP) (US69)	Standard Size < 7,000 Btu/h	1.35
Packaged Terminal Heat Pump (PTHP) (US70)	Standard Size 7,000 - 15,000 Btu/h	1.26
Packaged Terminal Heat Pump (PTHP) (US71)	Standard Size > 15,000 Btu/h	1.19
Packaged Terminal Heat Pump (PTHP) (US72)	Non-Standard Size < 7,000 Btu/h	1.26
Packaged Terminal Heat Pump (PTHP) (US73)	Non-Standard Size 7,000 - 15,000 Btu/h	1.35
Packaged Terminal Heat Pump (PTHP) (US74)	Non-Standard Size > 15,000 Btu/h	1.26
Variable Refrigerant Flow (US75)		7.50
Modulating Burner Controls (US76)	Boiler for space heating	1.29
Boiler Stack Heat Exchanger (US77)	Standard Economizer	3.53
Boiler Stack Heat Exchanger (US78)	Condensing Economizer	4.99
Boiler Reset/Lockout Controls (US79)		3.46
Oxygen Trim for Boilers and Heaters (US80)		0.30

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boiler Turbulator (US81)		0.25
Programmable Thermostat (US82)		6.35
High Efficiency Boilers (US83)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.12
High Efficiency Boilers (US84)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.08
High Efficiency Boilers (US85)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.72
High Efficiency Boilers (US86)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.48
High Efficiency Boilers (US87)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.74
High Efficiency Boilers (US88)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.57
High Efficiency Boilers (US89)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.75
High Efficiency Boilers (US90)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.64
High Efficiency Boilers (US91)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.74
High Efficiency Boilers (US92)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.66
High Efficiency Boilers (US93)	Hot Water Oil-Fired < 200 Mbtu/h	1.88
High Efficiency Boilers (US95)	Hot Water Oil-Fired 200 - 300 Mbtu/h	2.38
High Efficiency Boilers (US97)	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.66
High Efficiency Boilers (US99)	Hot Water Oil-Fired 500 - 1000 Mbtu/h	3.97
High Efficiency Boilers (US101)	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.63
High Efficiency Boilers (US103)	Hot Water Oil-Fired > 2500 Mbtu/h	3.79
High Efficiency Boilers (US105)	Steam Gas-Fired < 300 Mbtu/h	1.86
High Efficiency Boilers (US107)	Steam Gas-Fired 300 - 2500 Mbtu/h	7.73
High Efficiency Boilers (US109)	Steam Gas-Fired > 2500 Mbtuh	12.55
High Efficiency Boilers (US111)	Steam Oil-Fired < 200 Mbtu/h	0.61
High Efficiency Boilers (US113)	Steam Oil-Fired 200 - 300 Mbtu/h	1.12
High Efficiency Boilers (US115)	Steam Oil-Fired 300 - 500 Mbtu/h	1.76
High Efficiency Boilers (US117)	Steam Oil-Fired 500 - 1000 Mbtu/h	2.89
High Efficiency Boilers (US119)	Steam Oil-Fired 1000 - 2500 Mbtu/h	5.02
High Efficiency Boilers (US121)	Steam Oil-Fired > 2500 Mbtu/h	7.67
Infrared Unit Heater (US123)	Gas-Fired	7.06
Warm Air Unit Heater (US124)	Gas-Fired	5.71
Tier 3, US125	Geothermal Heat Pump, Tier 3	0.45
Pellet/Wood Stove (US126)	Pellet/Wood Stove	1.70
Pellet/Cord Wood Boiler (US127)	Pellet/Cord Wood Boiler	1.09
Wi-Fi Enabled Thermostat (US128)	Wi-Fi Enabled Thermostat	2.06
Residential ECM Hot Water Circulator Pump (US134)		1.86

Table 9 |
Measure Bundles Cost Effectiveness

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
A/C (US1) + Economizer (US29)	Tier I (<5.42 tons)	0.29
A/C (US2) + Economizer (US30)	Tier I (>=5.42 to <11.25 tons)	0.61
A/C (US3) + Economizer (US31)	Tier I (>=11.25 to <20 tons)	0.59
A/C (US4) + Economizer (US32)	Tier I (>=20 to 63.33 tons)	0.95
A/C (US5) + Economizer (US33)	Tier I (>63.33 tons)	1.10
A/C (US6) + Economizer (US34)	Tier II (<5.42 tons)	0.36
A/C (US7) + Economizer (US35)	Tier II (>=5.42 to <11.25 tons)	0.83
A/C (US8) + Economizer (US36)	Tier II (>=11.25 to <20 tons)	0.74
A/C (US9) + Economizer (US37)	Tier II (>=20 to 63.33 tons)	1.17
A/C (US10) + Economizer (US38)	Tier II (>63.33 tons)	1.17
A/C (US11) + Economizer (US39)	Tier III (<5.42 tons)	0.47
A/C (US12) + Economizer (US40)	Tier III (>=5.42 to <11.25 tons)	1.42
A/C (US13) + Economizer (US41)	Tier III (>=11.25 to <20 tons)	1.29
A/C (US14) + Economizer (US42)	Tier III (>=20 to 63.33 tons)	1.44
A/C (US1) + DCV (US15)	Tier I (<5.42 tons)	0.10
A/C (US2) + DCV (US16)	Tier I (>=5.42 to <11.25 tons)	0.27
A/C (US3) + DCV (US17)	Tier I (>=11.25 to <20 tons)	0.28
A/C (US4) + DCV (US18)	Tier I (>=20 to 63.33 tons)	0.58
A/C (US5) + DCV (US19)	Tier I (>63.33 tons)	0.74
A/C (US6) + DCV (US20)	Tier II (<5.42 tons)	0.14
A/C (US7) + DCV (US21)	Tier II (>=5.42 to <11.25 tons)	0.40
A/C (US8) + DCV (US22)	Tier II (>=11.25 to <20 tons)	0.38
A/C (US9) + DCV (US23)	Tier II (>=20 to 63.33 tons)	0.76
A/C (US10) + DCV (US24)	Tier II (>63.33 tons)	0.80
A/C (US11) + DCV (US25)	Tier III (<5.42 tons)	0.19
A/C (US12) + DCV (US26)	Tier III (>=5.42 to <11.25 tons)	0.73
A/C (US13) + DCV (US27)	Tier III (>=11.25 to <20 tons)	0.77
A/C (US14) + DCV (US28)	Tier III (>=20 to 63.33 tons)	1.00
A/C (US1) + Economizer (US29) + DCV (US15)	Tier I (<5.42 tons)	0.11
A/C (US2) + Economizer (US30) + DCV (US16)	Tier I (>=5.42 to <11.25 tons)	0.29
A/C (US3) + Economizer (US31) + DCV (US17)	Tier I (>=11.25 to <20 tons)	0.37
A/C (US4) + Economizer (US32) + DCV (US18)	Tier I (>=20 to 63.33 tons)	0.76
A/C (US5) + Economizer (US33) + DCV (US19)	Tier I (>63.33 tons)	0.99
A/C (US6) + Economizer (US34) + DCV (US20)	Tier II (<5.42 tons)	0.14

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
A/C (US7) + Economizer (US35) + DCV (US21)	Tier II (>=5.42 to <11.25 tons)	0.39
A/C (US8) + Economizer (US36) + DCV (US22)	Tier II (>=11.25 to <20 tons)	0.44
A/C (US9) + Economizer (US37) + DCV (US23)	Tier II (>=20 to 63.33 tons)	0.91
A/C (US10) + Economizer (US38) + DCV (US24)	Tier II (>63.33 tons)	1.05
A/C (US11) + Economizer (US39) + DCV (US25)	Tier III (<5.42 tons)	0.18
A/C (US12) + Economizer (US40) + DCV (US26)	Tier III (>=5.42 to <11.25 tons)	0.63
A/C (US13) + Economizer (US41) + DCV (US27)	Tier III (>=11.25 to <20 tons)	0.73
A/C (US14) + Economizer (US42) + DCV (US28)	Tier III (>=20 to 63.33 tons)	1.10
Furnaces (US54) + ECM Supply Fan Motor (US57), Heating Only		1.18
Furnaces (US54) + ECM Supply Fan Motor (US59), Heating & Cooling		1.25
Furnaces (US55) + ECM Supply Fan Motor (US57), Heating Only		1.42
Furnaces (US55) + ECM Supply Fan Motor (US59), Heating & Cooling		1.48
Furnaces (US56) + ECM Supply Fan Motor (US57), Heating Only		1.51
Furnaces (US56) + ECM Supply Fan Motor (US59), Heating & Cooling		1.58
Furnaces (US54) + Programmable Thermostat (US82)		1.46
Furnaces (US55) + Programmable Thermostat (US82)		1.70
Furnaces (US56) + Programmable Thermostat (US82)		1.79
Heat Pump Systems (US43) + Programmable Thermostat (US82)		4.22
Heat Pump Systems (US44) + Programmable Thermostat (US82)		3.14
Heat Pump Systems (US45) + Programmable Thermostat (US82)		2.85
Heat Pump Systems (US46) + Programmable Thermostat (US82)		2.66
Heat Pump Systems (US47) + Programmable Thermostat (US82)		1.40
Heat Pump Systems (US48) + Programmable Thermostat (US82)		1.40
Boilers (US83) + Programmable Thermostat (US82)		1.57
Boilers (US84) + Programmable Thermostat (US82)		1.32
Boilers (US85) + Programmable Thermostat (US82)		1.98

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US86) + Programmable Thermostat (US82)		1.63
Boilers (US87) + Programmable Thermostat (US82)		1.89
Boilers (US88) + Programmable Thermostat (US82)		1.66
Boilers (US89) + Programmable Thermostat (US82)		1.82
Boilers (US90) + Programmable Thermostat (US82)		1.68
Boilers (US91) + Programmable Thermostat (US82)		1.77
Boilers (US92) + Programmable Thermostat (US82)		1.67
Boilers (US93) + Programmable Thermostat (US82)		2.73
Boilers (US95) + Programmable Thermostat (US82)		2.98
Boilers (US97) + Programmable Thermostat (US82)		1.99
Boilers (US99) + Programmable Thermostat (US82)		4.17
Boilers (US101) + Programmable Thermostat (US82)		3.69
Boilers (US103) + Programmable Thermostat (US82)		3.83
Boilers (US105) + Programmable Thermostat (US82)		2.47
Boilers (US107) + Programmable Thermostat (US82)		7.67
Boilers (US109) + Programmable Thermostat (US82)		12.42
Boilers (US111) + Programmable Thermostat (US82)		1.00
Boilers (US113) + Programmable Thermostat (US82)		1.68
Boilers (US115) + Programmable Thermostat (US82)		2.08
Boilers (US117) + Programmable Thermostat (US82)		3.11
Boilers (US119) + Programmable Thermostat (US82)		5.08
Boilers (US121) + Programmable Thermostat (US82)		7.64
Infrared Unit Heater (US123) + Programmable Thermostat (US82)		6.85
Warm Air Unit Heater (US124) + Programmable Thermostat (US82)		5.88
Modulating Burner Controls (US76) + Oxygen Trim for Boilers and Heaters (US80)		0.34
Boilers (US83) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.14

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US84) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	0.95
Boilers (US85) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.44
Boilers (US86) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.34
Boilers (US87) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.56
Boilers (US88) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.48
Boilers (US89) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.66
Boilers (US90) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.60
Boilers (US91) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.69
Boilers (US92) + Circulator Pumps, Amp <= 1.25	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.64
Boilers (US93) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired < 200 Mbtu/h	1.11
Boilers (US95) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired 200 - 300 Mbtu/h	1.50
Boilers (US97) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.34
Boilers (US99) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired 500 - 1000 Mbtu/h	2.93
Boilers (US101) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.34
Boilers (US103) + Circulator Pumps, Amp <= 1.25	Hot Water Oil-Fired > 2500 Mbtu/h	3.60
Boilers (US83) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	0.99
Boilers (US84) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.01
Boilers (US85) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.47
Boilers (US86) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.37
Boilers (US87) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.57
Boilers (US88) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.49
Boilers (US89) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.67
Boilers (US90) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.60
Boilers (US91) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.70
Boilers (US92) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.64
Boilers (US93) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired < 200 Mbtu/h	1.23

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US95) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired 200 - 300 Mbtu/h	1.56
Boilers (US97) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.39
Boilers (US99) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired 500 - 1000 Mbtu/h	2.85
Boilers (US101) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.30
Boilers (US103) + Circulator Pumps, 1.25 < Amp <= 5	Hot Water Oil-Fired > 2500 Mbtu/h	3.57
Boilers (US83) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.57
Boilers (US84) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.32
Boilers (US85) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.97
Boilers (US86) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.63
Boilers (US87) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.88
Boilers (US88) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.66
Boilers (US89) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.81
Boilers (US90) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.68
Boilers (US91) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.77
Boilers (US92) + Circulator Pumps, Amp > 5	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.67
Boilers (US93) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired < 200 Mbtu/h	2.61
Boilers (US95) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired 200 - 300 Mbtu/h	2.85
Boilers (US97) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.97
Boilers (US99) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired 500 - 1000 Mbtu/h	4.04
Boilers (US101) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.66
Boilers (US103) + Circulator Pumps, Amp > 5	Hot Water Oil-Fired > 2500 Mbtu/h	3.81
Boilers (US83) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.24
Boilers (US84) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.16
Boilers (US85) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.66

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US86) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.48
Boilers (US87) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.70
Boilers (US88) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.56
Boilers (US89) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.73
Boilers (US90) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.64
Boilers (US91) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.73
Boilers (US92) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.65
Boilers (US93) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired < 200 Mbtu/h	1.66
Boilers (US95) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired 200 - 300 Mbtu/h	1.95
Boilers (US97) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.61
Boilers (US99) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired 500 - 1000 Mbtu/h	3.15
Boilers (US101) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.40
Boilers (US103) + Circulator Pumps, Amp <= 1.25 + Programmable Thermostat (US82)	Hot Water Oil-Fired > 2500 Mbtu/h	3.63
Boilers (US83) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.30
Boilers (US84) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.20
Boilers (US85) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	1.68
Boilers (US86) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.50

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US87) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	1.71
Boilers (US88) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	1.57
Boilers (US89) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	1.73
Boilers (US90) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	1.64
Boilers (US91) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.73
Boilers (US92) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.66
Boilers (US93) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired < 200 Mbtu/h	1.70
Boilers (US95) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 200 - 300 Mbtu/h	1.95
Boilers (US97) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.64
Boilers (US99) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 500 - 1000 Mbtu/h	3.05
Boilers (US101) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.36
Boilers (US103) + Circulator Pumps, 1.25 < Amp <= 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired > 2500 Mbtu/h	3.60
Boilers (US83) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.68
Boilers (US84) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.41
Boilers (US85) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	2.42
Boilers (US86) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.91
Boilers (US87) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	2.64
Boilers (US88) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	2.10
Boilers (US89) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	2.83
Boilers (US90) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	2.28

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
Boilers (US91) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	1.73
Boilers (US92) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	1.66
Boilers (US93) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired < 200 Mbtu/h	1.70
Boilers (US95) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 200 - 300 Mbtu/h	1.95
Boilers (US97) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 300 - 500 Mbtu/h	1.64
Boilers (US99) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 500 - 1000 Mbtu/h	3.05
Boilers (US101) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	3.36
Boilers (US103) + Circulator Pumps, Amp > 5 + Programmable Thermostat (US82)	Hot Water Oil-Fired > 2500 Mbtu/h	3.60
Boilers (US83) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 0	1.68
Boilers (US84) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired < 350 Mbtu/h, CEE Tier 1	1.41
Boilers (US85) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 0	2.42
Boilers (US86) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 350 - 500 Mbtu/h, CEE Tier 1	1.91
Boilers (US87) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 0	2.64
Boilers (US88) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 500 - 1,000 Mbtu/h, CEE Tier 1	2.10
Boilers (US89) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 0	2.83
Boilers (US90) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired 1,000 - 2,500 Mbtu/h, CEE Tier 1	2.28
Boilers (US91) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 0	3.35
Boilers (US92) + Boiler Reset/Lockout Controls	Hot Water Gas-Fired > 2,500 Mbtu/h, CEE Tier 1	2.49
Boilers (US93) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired < 200 Mbtu/h	1.97
Boilers (US95) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired 200 - 300 Mbtu/h	2.78
Boilers (US97) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired 300 - 500 Mbtu/h	2.44
Boilers (US99) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired 500 - 1000 Mbtu/h	5.52
Boilers (US101) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired 1000 - 2500 Mbtu/h	5.11
Boilers (US103) + Boiler Reset/Lockout Controls	Hot Water Oil-Fired > 2500 Mbtu/h	6.80
High Efficiency Boilers (US105) + Boiler Reset/Lockout Controls	Steam Gas-Fired < 300 Mbtu/h	2.14

Measure Code	Measure Detail	TRC Ratio at Default Free-ridership Level (25%)
High Efficiency Boilers (US107) + Boiler Reset/Lockout Controls	Steam Gas-Fired 300 - 2500 Mbtu/h	7.96
High Efficiency Boilers (US109) + Boiler Reset/Lockout Controls	Steam Gas-Fired > 2500 Mbtuh	13.44
High Efficiency Boilers (US111) + Boiler Reset/Lockout Controls	Steam Oil-Fired < 200 Mbtu/h	0.60
High Efficiency Boilers (US113) + Boiler Reset/Lockout Controls	Steam Oil-Fired 200 - 300 Mbtu/h	1.03
High Efficiency Boilers (US115) + Boiler Reset/Lockout Controls	Steam Oil-Fired 300 - 500 Mbtu/h	1.72
High Efficiency Boilers (US117) + Boiler Reset/Lockout Controls	Steam Oil-Fired 500 - 1000 Mbtu/h	2.87
High Efficiency Boilers (US119) + Boiler Reset/Lockout Controls	Steam Oil-Fired 1000 - 2500 Mbtu/h	5.12
High Efficiency Boilers (US121) + Boiler Reset/Lockout Controls	Steam Oil-Fired > 2500 Mbtu/h	8.23
Packaged Terminal Air Conditioner (PTAC) (US63) + Programmable Thermostat	Standard Size < 7,000 Btu/h	0.07
Packaged Terminal Air Conditioner (PTAC) (US64) + Programmable Thermostat	Standard Size 7,000 - 15,000 Btu/h	0.10
Packaged Terminal Air Conditioner (PTAC) (US65) + Programmable Thermostat	Standard Size > 15,000 Btu/h	0.14
Packaged Terminal Air Conditioner (PTAC) (US66) + Programmable Thermostat	Non-Standard Size < 7,000 Btu/h	0.10
Packaged Terminal Air Conditioner (PTAC) (US67) + Programmable Thermostat	Non-Standard Size 7,000 - 15,000 Btu/h	0.07
Packaged Terminal Air Conditioner (PTAC) (US68) + Programmable Thermostat	Non-Standard Size > 15,000 Btu/h	0.10
Packaged Terminal Heat Pump (PTHP) (US69) + Programmable Thermostat	Standard Size < 7,000 Btu/h	0.20
Packaged Terminal Heat Pump (PTHP) (US70) + Programmable Thermostat	Standard Size 7,000 - 15,000 Btu/h	0.31
Packaged Terminal Heat Pump (PTHP) (US71) + Programmable Thermostat	Standard Size > 15,000 Btu/h	0.42
Packaged Terminal Heat Pump (PTHP) (US72) + Programmable Thermostat	Non-Standard Size < 7,000 Btu/h	0.31
Packaged Terminal Heat Pump (PTHP) (US73) + Programmable Thermostat	Non-Standard Size 7,000 - 15,000 Btu/h	0.20
Packaged Terminal Heat Pump (PTHP) (US74) + Programmable Thermostat	Non-Standard Size > 15,000 Btu/h	0.31

Appendix C | Efficiency Vermont High Performance Circulator Pumps Qualifying Products List

High Performance Circulator Pumps
Qualifying Products (Sorted by Manufacturer)
Updated: 6/21/18

www.aquamotionhvac.com

www.armstrongfluidtechnology.com

www.bellgossett.com

www.grundfos.com

www.taco-hvac.com

Note: Tier level indicates product's automatic optimization control strategy. Automatic optimization adjusts to system requirements to minimize energy use with minimal to no requirement for installer programmable inputs, calculations, or settings.

Tier Level	Automatic Optimization Control Strategy
2	Circulator uses proportional pressure control or temperature differential (delta T)
1	Circulator does not use proportional pressure control or temperature differential

Manufacturer	Model Number	Description	Max Input (watts)	Tier	Product Incentive
AquaMotion	AM55-FL	Einstein	38	2	$50
	AM55-FVL	Einstein Stainless with Check	38	2	$50
	AM55-SFL	Einstein Stainless	38	2	$50
	AM55-SFVL	Einstein Stainless with Check	38	2	$50
Armstrong	180203-604	Compass 20 20 SS Union	45	2	$50
	180203-606	Compass 20 20 CI Flanged	45	2	$50
	180203-607	Compass 20 20 SS Flanged	45	2	$50
	180203-684	Compass H 20 20 SS union	45	2	$50
	180203-686	Compass H 20 20 CI Flanged	45	2	$50
	180203-687	Compass H 20 20 SS Flanged	45	2	$50
	0306-001.0	4300/4380/4312/4392 Design Envelope Pump	800	2	$600
	0406-001.0	4302/4382 Design Envelope Pump	800	2	$600
	0308-003.0	4300/4380/4312/4392 Design Envelope Pump	2136	2	$600
	0408-003.0	4302/4382 Design Envelope Pump	2136	2	$600
Bell & Gossett	6050B2002	ecocirc 19-16 Cast Iron	60	2	$50
	6050B2003	ecocirc 19-16 Stainless Steel	60	2	$50
	104303	ecocirc XL 15-75 115v	150	2	$200
	104308	ecocirc XL 20-140 208-230v	470	2	$200
	104453LF	ecocirc XL N 15-75 115v	150	2	$200
	104458LF	ecocirc XL N 20-140 208-230v	470	2	$200
	104403LF	ecocirc XL B 15-75 115v	150	2	$200
	104408LF	ecocirc XL B 20-140 208-230v	470	2	$200
Grundfos	59896832	ALPHA 15-55F/LC	45	2	$50
	59896833	ALPHA 15-55FR/LC	45	2	$50
	59896834	ALPHA 15-55SF/LC Stainless	45	2	$50
	59896877	ALPHA 15-55F	45	2	$50
	59896878	ALPHA 15-55FR	45	2	$50
	59896879	ALPHA 15-55SF Stainless	45	2	$50
	98528922	ALPHA 15-55FC - EVT	45	2	$50
	98546569	ALPHA 15-55FRC - EVT	45	2	$50
	99285998	ALPHA1 15-55 F	45	1	$15
	99287244	ALPHA1 15-55 FR	45	1	$15
	99287250	ALPHA1 15-55 SF	45	1	$15
	99287256	ALPHA1 15-55 F/LC	45	1	$15
	99287259	ALPHA1 15-55 FR/LC	45	1	$15
	99287262	ALPHA1 15-55 SF/LC	45	1	$15
	99295829	ALPHA1 15-55F/LC Johnstone	45	1	$15
	99295830	ALPHA1 15-55FR/LC Johnstone	45	1	$15
	99295831	ALPHA1 15-55SF/LC Johnstone	45	1	$15
	99295832	ALPHA1 15-55F Johnstone	45	1	$15
	99295833	ALPHA1 15-55FR Johnstone	45	1	$15
	99295834	ALPHA1 15-55SF Johnstone	45	1	$15

Manufacturer	Model Number	Description	Max Input (watts)	Tier	Product Incentive
Grundfos	99163903	ALPHA2 15-55F	45	2	$50
	99163906	ALPHA2 15-55F/LC	45	2	$50
	99163932	ALPHA2 15-55FR	45	2	$50
	99163934	ALPHA2 15-55FR/LC	45	2	$50
	99163937	ALPHA2 15-55SF	45	2	$50
	99163972	ALPHA2 15-55SF/LC	45	2	$50
	98126820	MAGNA3 32-60F CI 115V,208-230V	108	2	$50
	98126822	MAGNA3 32-60FN SS 115V, 208-230V	108	2	$50
	98126824	MAGNA3 32-100F CI 115V, 208-230V	178	2	$200
	98126826	MAGNA3 32-100FN SS 115V, 208-230V	178	2	$200
	98126800	MAGNA3 40-80F CI 115V	276	2	$200
	98126828	MAGNA3 40-80F CI 208-230V	276	2	$200
	98126802	MAGNA3 40-80FN SS 115V	276	2	$200
	98126830	MAGNA3 40-80FN SS 208-230V	276	2	$200
	98126804	MAGNA3 40-120F CI 115V	422	2	$200
	98126832	MAGNA3 40-120F CI 208-230V	422	2	$200
	98126806	MAGNA3 40-120FN SS 115V	442	2	$200
	98126834	MAGNA3 40-120FN SS 208-230V	442	2	$200
	98126808	MAGNA3 40-180F CI 115V	614	2	$600
	98126836	MAGNA3 40-180F CI 208-230V	614	2	$600
	98126810	MAGNA3 40-180FN SS 115V	614	2	$600
	98126838	MAGNA3 40-180FN SS 208-230V	614	2	$600
	98126812	MAGNA3 50-80F CI 115V	318	2	$200
	98126840	MAGNA3 50-80F CI 208-230V	318	2	$200
	98126814	MAGNA3 50-80FN SS 115V	318	2	$200
	98126842	MAGNA3 50-80FN SS 208-230V	318	2	$200
	98126816	MAGNA3 50-150F CI 115V	630	2	$600
	98126844	MAGNA3 50-150F CI 208-230V	630	2	$600
	98126818	MAGNA3 50-150FN SS 115V	630	2	$600
	98126846	MAGNA3 50-150FN SS 208-230V	630	2	$600
	98124696	MAGNA3 65-120F CI 115V	769	2	$600
	98126848	MAGNA3 65-120F CI 208-230V	769	2	$600
	98124702	MAGNA3 65-120FN SS 115V	772	2	$600
	98126850	MAGNA3 65-120FN SS 208-230V	772	2	$600
	98126852	MAGNA3 65-150F CI 208-230V	1301	2	$600
	98126854	MAGNA3 65-150FN SS 208-230V	1301	2	$600
	98126856	MAGNA3 80-100F CI 208-230V	1301	2	$600
	98126858	MAGNA3 80-100FN SS 208-230V	1301	2	$600
	98126860	MAGNA3 100-120F CI 208-230V	1576	2	$600
	98126862	MAGNA3 100-120FN SS 208-230V	1576	2	$600
	98126863	MAGNA3 D 65-150F CI 208-230V	1301	2	$600
	98126864	MAGNA3 D 80-100F CI 208-230V	1301	2	$600
	98126865	MAGNA3 D 100-120F CI 208-230V	1576	2	$600
	98126819	MAGNA1 32-60F CI 115V,208-230V	103	2	$50
	98126821	MAGNA1 32-60FN SS 115V,208-230V	103	2	$50
	98126823	MAGNA1 32-100F CI 115V,208-230V	170	2	$200
	98126825	MAGNA1 32-100FN SS 115V,208-230V	170	2	$200
	99408274	UPML 25-104 165F VDC 100W US 115V	100	2	$50
	99407026	UPMXL 25-124 165F 115V 50/60Hz	120	2	$50
Taco	VR 1816	00e Series	44	2	$50
	VB1016-HY1	00e Series	44	1	$15
	VB1016-HY2	00e Series	44	2	$50
	006e3	00e Series	44	1	$15
	VM1212	00e Series	44	1	$15
	HLPe	00e Series	44	1	$15
	SPe	00e Series	44	1	$15
	007e-F2	00e Series	44	1	$15
	007e-F4	00e Series	44	1	$15

Manufacturer	Model Number	Description	Max Input (watts)	Tier	Product Incentive
Taco	007e-2F2	00e Series	44	2	$50
	007e-2F4	00e Series	44	2	$50
	0015e3-F2	00e Series	44	1	$15
	0015e3-F4	00e Series	44	1	$15
	0015e3-2F2	00e Series	44	2	$50
	0015e3-2F4	00e Series	44	2	$50
	VM1816-HY1	00e Series	44	1	$15
	VM1816-HY2	00e Series	44	2	$50
	VT2218-HY2	00e Series	58	2	$50
	VR 3452	00e Series	180	2	$200

Participating Distributors:

Appalachian Supply, Inc.
www.appalachiansupplyinc.com

BellSimons Companies
www.bellsimons.com

Blodgett Supply
www.blodgettsupply.com

Central Supply
www.plumberssupplyco.com

F.W. Webb Company
www.fwwebb.com

The Granite Group
www.thegranitegroup.com

www.hulbertsupply.com

Premier Supply Group
www.premiersupplygroup.com

R.E. Michel Company, LLC
www.remichel.com

Sid Harvey's
www.sidharvey.com

For more information, visit: www.efficiencyvermont.com/pumps