
Date: June 26, 2020
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Subject: Efficiency Maine HPWH Free-ridership and Baseline Assessment Results Memo

1. Background and Summary

Efficiency Maine offers two ways to take advantage of the heat pump water heater (HPWH) program rebate. The first is the instant rebate channel, in which participating retailers and distributors can discount them by \$750 with an instant rebate. The second is the mail-in channel, where units purchased without an instant rebate qualify for a \$750 mail-in rebate. A survey study of recent program participants was undertaken to answer three key questions about the HPWH program performance:

1. What is the free-ridership rate for HPWHs incented through the program?
2. What is the appropriate baseline to use to determine the savings from the HPWH program?
3. What percentage of program participants are low- income?

The survey was conducted from October 24, 2019 to December 5, 2019. The survey was directed at customers (end-users) who had participated in the program between March 1, 2019 and September 30, 2019. A total of 216 mail-in delivery channel respondents and 59 instant rebate respondents completed surveys.

The summary results for the free-ridership assessment are presented in Table 1. Overall, respondents report that the program is influencing their decision to purchase HPWHs. It is particularly notable that the mail-in rebate channel has a free-ridership rate below 10%.

Table 1 |
Free-ridership Summary

Delivery Channel	Free-ridership
Instant Rebate	23%
Mail-in Rebate	8%

The summary results for the baseline assessment are shown below. Both the instant rebate and mail-in rebate channels are replacing and displacing a variety of different water heaters with different baseline fuels and for different customer decision types.

Table 2 |
Pre-existing Equipment Characteristics

Instant Rebate Channel Installation Pre-existing Equipment Condition and Fuel Type				
Pre-existing Equipment	Total Count	Electric	Gas	Oil/Other
None/New Construction	13	None	None	None
Non-working Unit	16	9	0	7
Working Unit	29	13	0	16
Unknown Condition	1	0	0	1
Total	59	22	0	24
Mail-in Rebate Channel Installation Pre-existing Equipment Condition and Fuel Type				
Pre-existing Equipment Category	Total Count	Electric	Gas	Oil/Other
None/New Construction	40	None	None	None
Non-working Unit	38	26	3	9
Working Unit	129	71	1	55
Unknown Condition	9	0	0	0
Total	216	98	4	64

The summary results for the low-income assessment are shown below. Both the instant rebate and mail-in rebate channels are reaching a similar portion of low-income participants.

Table 3 |
Low-income Participation Summary

Delivery Channel	Total respondents	Decline/ Don't Know Income Status	Not low-income	Low-income	Low-income % of respondents providing income data
Mail-in	216	40	151	25	14.2%
Instant	59	2	49	8	14.0%

2. Free-ridership Methodology

Free-ridership was assessed using the self-report method based on the *Pennsylvania Act 129 Evaluation Framework, Appendix C. Common Approaches for Free Riders for Downstream Programs*. Because only seven participants were not aware of the Efficiency Maine incentive, the free-ridership methodology for downstream programs is appropriate, as the vast majority of participants surveyed were aware of the incentive.

Program attribution considers:

- Intention to carry out the project without program incentive.

- Influence of program in participant's decision to purchase program qualifying equipment.

$$\text{Free-Ridership} = \text{Intention Score} + \text{Influence Score},$$

where each component is measured from 0 to 0.5

A full free-rider will score 1.00, or 100%, with each component measured as 0.5, or 50%. A full non-free-rider will measure 0.00, or 0%.

2.1 Intention

Intention is assessed based on pertinent counterfactual alternatives. Table 4 reflects the alternatives pertinent for a HPWH purchase. If the participant would have selected the same or an equally efficient option without the rebate, the intention score is 0.5. If the participant would have done anything else, the intention score is zero. Those that responded "don't know" to the intention question were dropped from the analysis.

Intention Survey Question: If Efficiency Maine had not provided a \$750 rebate toward the purchase of your new heat pump water heater, what would you have likely done?

Table 4 |
Intention Score Scale

Counterfactual Response	Intention Score
Cancel/Postpone	0
Repair Old Appliance	0
Purchase Less Expensive Appliance	0
Purchase Less Efficient Appliance	0
Purchase Same Appliance without the Rebate	0.5
Don't Know	Drop

2.2 Influence

Influence is measured by assessing how important key program design factors were in the participant's decision. The highest rating for any factor determines the influence score, regardless of what factor it is. Influence factors receiving a "don't know" were dropped from the analysis.

Influence Survey Question: On a scale of 1 to 5 with 1 being "Not at all influential" and 5 being "Extremely influential", how influential was the [INFLUENCE FACTOR] in your decision to install a heat pump water heater?

**Table 5 |
Influence Rating Scale**

Calculation of Influence Score: Rate Influence of program elements							
Influence Factor	Not at all Influential				Extremely Influential		
\$750 Rebate	1	2	3	4	5	DK	NA
Plumber Recommendation	1	2	3	4	5	DK	NA
Retailer Recommendation	1	2	3	4	5	DK	NA

**Table 6 |
Influence Score Scale**

Program Influence Rating	Influence Score
1-Not at all influential	0.5
2	0.375
3	0.25
4	0.125
5-Extremely influential	0
Don't Know	Drop

3. Baseline Assessment Methodology

A self-report survey approach was used to provide information and data for informing the appropriate baseline when determining savings from the HPWH program. The current HPWH program assumes that the HPWHs are lost-opportunity measures. Specifically, it assumes that the baseline technology is a standard efficiency electric resistance water heater, and that water use and heating patterns are constant between the baseline electric resistance heater and the new HPWH.

The survey included information on the fuel source, operating condition, and age of equipment that was replaced with a HPWH. Some qualifying HPWH units are equipped with 'smart' load-shifting features, which may provide additional savings and demand response opportunities. To quantify these components, the following specific data points were included on the survey:

Table 7 |
Baseline Equipment and Operational Data Collection

Baseline Equipment and Operational Data to Collect	
Data Point	Rationale
Baseline fuel type	If data show that fuel switching is occurring, then the relative numbers of each baseline fuel type should be quantified.
Functionality of the old equipment	If retrofit scenarios are encountered, the relative ratio of lost-opportunity to retrofit measures should be estimated.
Estimated cost to repair old unit	Provide information about end user decision-making
Total installation cost	Retrofit cost-benefit testing requires an estimated average total installation cost of the new HPWH.
Use of "smart" or "grid connected" features	HPWHs incented through the program may have 'smart' load shifting features. The ratio of installed units equipped and using load-shifting should be researched if load-shifting/residential demand response benefits are eligible to be claimed.

It can be difficult to assess whether a HPWH installation represents a lost opportunity or a retrofit installation. The installation categorization depends on the interplay between two factors:

1. If the existing equipment was functional when the new equipment was installed
2. The estimated useful life (EUL) and age of the existing unit. EUL assumptions used in this analysis are consistent with the Maine TRM. The EUL for tank water heaters is assumed to be 13 years, and the EUL for tankless water heaters is assumed to be 25 years¹.

Lost Opportunity Installation: This decision type category follows the Maine TRM conventions for customer purchases for "Replace on Burnout" and "New Construction²." The baseline for both decision types are federal standards or standard market practice for new equipment.

- **Replace on Burnout:** The customer is in the market to purchase new equipment because the existing equipment is worn out or otherwise needs to be replaced
- **New Construction:** The customer is in the market to purchase new equipment for a new construction or new capacity project or as part of a planned renovation, or to add controls to improve the performance of new equipment.

Retrofit Installation: This decision type category occurs when a customer's existing equipment is in working order and has remaining useful life. The existing equipment operation becomes the baseline in this scenario.

The decision to use a specific age cut-off to distinguish between a retrofit and "replace on burnout" installation is ambiguous in the TRM, and it impacts what assumptions are used to calculate the savings associated with installation of the new HPWH. There are a range of

¹ https://www.energymaine.com/docs/EMT-TRM_Retail_Residential_v2020_4.pdf

² https://www.energymaine.com/docs/EMT-TRM_Retail_Residential_v2020_4.pdf page 7.

conditions that could result in either a lost opportunity or retrofit categorization. For the purposes of this analysis, the baseline equipment will be determined under two sets of assumptions.

Both sets of assumptions require that the baseline equipment is functional, but the “more restrictive approach” restricts the retrofit categorization to units replacing existing equipment newer than 50% of the EUL. The “less restrictive approach” sets the cutoff at 100% of the existing equipment EUL. Both of these approaches exclude newer equipment that might be in need of repair from the retrofit categorization.

The results of the survey will be used to present the baseline fuel mix and installation type for both criteria definitions. A summary of the screening parameters is provided below in table 8.

Table 8 |
Baseline Equipment and Operational Data Collection

Retrofit Criteria		
Factor	More Restrictive Approach	Less Restrictive Approach
Existing Unit Condition	Functional	Functional
Age of the Existing Unit	Less than 50% of EUL	Less than 100% of EUL

Baseline Fuel Types: The baseline for retrofit installations will be that of the fuel type in use prior to the installation of the new HPWH. For lost opportunity installations, the fuel type of the assumed baseline water heater will be determined based on the answer to question “If you had NOT purchased a heat pump water heater, what type of water heater would you have most likely purchased?” Table 9 outlines the breakdown of fuels that were explicitly reported, as well as an inferred non-electric column. Inferred non-electric totals were tallied from written responses that suggested the HPWH replaced a delivered fuel but did not indicate a specific fuel.

Table 9 |
Pre-existing equipment by Fuel

Pre-existing Equipment by Fuel							
Delivery Channel	Total Count	Electric	Natural Gas	Oil	Propane	Kerosene	Inferred Non-electric
Mail-in	165	97	4	44	11	2	7
Instant	46	22	0	16	3	0	5

Oil, propane, kerosene, and inferred non-electric counts will be reported together for the remainder of this analysis. If no prior fuel type is known or can be inferred, then the installation is excluded from the baseline fuel counts. The following algorithm was used to bin (categorize) each respondent. The percentage of the total respondents in each bin determined the baseline equipment and installation type for HPWH.

Table 10 |
Baseline Variables and Categorization

Measure Category	Fuel Type			Free-Rider
	Electric	Gas	Oil/Other	
Lost Opportunity	$[a+b]/R$	$[a+b]/R$	$[a+b]/R$	Determined using Free-ridership analysis
Retrofit	c/R	c/R	c/R	
Variable				
a	Count of prior fuel type (electric, gas, oil/propane) for HPWHs replacing non-functional/non-existent units if the alternative fuel is not known			
b	Count of alternative fuel type (electric, gas, oil/propane) for HPWHs replacing non-functional/non-existent units (From question 33)			
c	Count of existing fuel type for retrofit installations			
R	Total number of completed surveys with known fuel type (total of a, b and c) and decision type			

3.1 Low-Income

Three questions were used to determine the income status of the respondents.

1. Counting yourself, how many people normally live in your home?
2. We know many people consider income information very private, we are just looking for an above or below response. Over the last year, was your total household gross income before taxes, counting everyone living in your home above or below \$XX,XXX? - *the income threshold was determined based on the answer to question 1.*
3. Does anyone in your household participate in any of these programs?
 - a. The MaineCare program through DHHS (Department of Health and human Services)
 - b. Temporary Assistance for Needy Families (TANF) cash assistance program through DHHS
 - c. Child Care assistance program through DHHS
 - d. Food assistance from the Women, Infants and Children program or WIC through DHHS
 - e. Food Supplements or SNAP
 - f. Medicare Part D subsidy
 - g. Weatherization assistance from a Community Action Agency (CAA)
 - h. LIHEAP fuel assistance from a CAA
 - i. Help with energy costs through a Low Income Assistance Plan from your electric company
 - j. Free or reduced-cost meals in a school breakfast or lunch program
 - k. None
 - l. Other (please specify)

The first two questions asked about the size and income characteristics of the household. If the respondent answered “below” to the second question, then the respondent was classified as

low-income. Households whose income exceeded the low-income threshold were not considered low-income. Respondents that declined to answer or did not know the household characteristics were asked the third question. Respondents that answered “yes” to any of the listed options were also included in the low-income category.

4. Results

The survey was conducted from October 24, 2019 to December 5, 2019. The survey was directed at customers (end-users) who had participated in the program between March 1, 2019 and September 30, 2019. A total of 216 mail-in delivery channel customers and 59 instant rebate customers completed surveys.

4.1 Free-ridership Findings

Overall, the program experienced a relatively low free-ridership rate.

The completed surveys included 216 responses from the mail-in delivery channel, and 59 responses from the instant rebate delivery channel³. Of these, 187 mail-in delivery channel responses and 47 instant rebate responses completed the full free-ridership question set. Only respondents that completed the free-ridership questions were used to calculate the free-ridership scores.

The results show that overall, the instant rebate channel has a free-ridership rate of 23%, and the mail-in rebate has a free-ridership rate of 8% as seen below in table 11. There was little distinction in free-ridership rates based on the operational status of the existing equipment. Looking at the total respondent population, the operational and non-operational units had a free-ridership rate of 10% and 12%, respectively, while new construction and units with unknown operational status had a free-ridership rate of 8% as seen in table 12 below. The free-ridership results are summarized below, along with the individual intention and influence averages.

Table 9 | Free-ridership by Program Channel

Free-ridership by Program Channel				
Program Channel	Sample Size	Intention	Influence	Free-rider %
Instant Rebate	47	16%	7%	23%
Mail-in Rebate	187	5%	3%	8%

³ Only seven total respondents were not aware that the equipment was eligible for a rebate, so it was not necessary to develop a specific battery of questions to calculate free-ridership rates for respondents not aware of the rebate at the time of purchase.

Table 12 |
Free-ridership by Equipment Operational Status

Free-ridership by Equipment Operational Status				
Status	Sample Size	Intention	Influence	Free-rider %
Working	139	6%	4%	10%
Not Working	45	9%	3%	12%
Unknown/New Construction/ N/A	50	6%	3%	8%

4.2 Baseline Findings

The survey responses provided a detailed look at the operating condition and fuel types for the domestic hot water systems that were replaced with HPWH. Overall, the data calculated from table 13 below, show that more than half of the respondents reported that they replaced functional units. This included just under 50% of the instant rebate and 62% of the mail-in rebate installations. Approximately 20% of the installations for both channels were new installations that did not replace existing equipment. When existing equipment was replaced, approximately half (48%) of the removed units in the instant rebate channel and 59% of the removed units in the mail-in channel used electric fuel for their domestic hot water. Most of the rest of the removed equipment used oil or other delivered fuels as the primary fuel source. None of the instant rebate installations, and only four of the mail-in rebate installations replaced existing natural gas equipment.

Table 13 |
Pre-existing Equipment Characteristics

Instant Rebate Channel Installation Preexisting Equipment Condition and Fuel Type				
Pre-existing Equipment	Total Count	Electric	Gas	Oil/Other
None/New Construction	13	None	None	None
Non-working Unit	16	9	0	7
Working Unit	29	13	0	16
Unknown Condition	1	0	0	1
Total	59	22	0	24
Mail-in Rebate Channel Installation Preexisting Equipment Condition and Fuel Type				
Pre-existing Equipment Category	Total Count	Electric	Gas	Oil/Other
None/New Construction	40	None	None	None
Non-working Unit	38	26	3	9
Working Unit	129	71	1	55
Unknown Condition	9	0	0	0
Total	216	97	4	64

The information collected was used to assess the percentage of the total program units that could be classified as either a “Lost Opportunity” or “Retrofit” installation. As described in the methodology section, the retrofit criteria were calculated using either a more restrictive criteria

that required the functional existing unit be newer than half the EUL, and a less restrictive criteria that required that the functional existing unit be newer than the EUL of the existing equipment.

The baseline fuel type for retrofit installations is the fuel type in use prior to the installation of the new HPWH. For lost opportunity installations, the fuel type of the existing water heater was determined based on the answer to the question “If you had NOT purchased a heat pump water heater, what type of water heater would you have most likely purchased?” If no fuel type was recorded for this question, then the prior fuel type was assumed. The following variable inputs listed in

Table 4 were found for mail-in and instant rebate respondents.

Table 14 |
Cleaned⁴ Existing and Alternative Fuel Survey Data

Instant Rebate Channel Installation Preexisting Equipment Condition and Fuel Type								
Equipment Status and Counts		Existing Fuel			Alternative Fuel (Q 33)			Unclassified
		Electric	Gas	Oil/Other	Electric	Gas	Oil/Other	
None/New Construction	13	N/A	N/A	N/A	0	0	0	13
Non-working Unit	16	9	0	7	5	0	1	0
Working Unit	29	13	0	16	6	0	0	9
Unknown Condition	1	0	0	1	0	0	0	1
Mail-in Rebate Channel Installation Preexisting Equipment Condition and Fuel Type								
Equipment Status and Counts		Existing Fuel			Alternative Fuel (Q 33)			Unclassified
		Electric	Gas	Oil/Other	Electric	Gas	Oil/Other	
None/New Construction	40	N/A	N/A	N/A	9	1	3	27
Non-working Unit	38	26	3	9	19	2	8	0
Working Unit	129	71	1	55	40	0	6	26
Unknown Condition	9	0	0	0	0	0	0	9

The installation information was used to determine the appropriate baseline fuel and decision type for each installation. In some cases, the same installation is classified differently depending on the retrofit criteria that was used. This results in slightly different equipment totals in the baseline analysis. The raw age data for the functional equipment and the associated EUL is provided below in Table 15.

⁴ The data cleaning involved classifying “other” and “don’t know” responses using information collected from subsequent responses, as well as analysis of open-ended responses. For example, if a respondent selected “other” for the existing fuel type, and then noted later in the survey that they had an oil boiler with a tankless coil, then this respondent was classified as using oil as the existing fuel.

**Table 15 |
Age of Functional Units**

Instant Rebate: Age of Functional Units							
Decision Type	< 2 Years	2-5 years	5-8 years	8-12 years	> 12 years	Unknown Age	Total
Tank (13 year EUL)	1	1	2	4	8	2	18
Tankless (25 year EUL)	1	0	0	1	6	3	11
Unknown Type	0	0	0	0	0	0	0
Total	2	1	2	5	14	5	29
Mail-in Rebate: Age of Functional Units							
Decision Type	< 2 Years	2-5 years	5-8 years	8-12 years	> 12 years	Unknown Age	Total
Tank (13 year EUL)	1	10	9	22	33	3	78
Tankless (25 year EUL)	2	6	4	6	20	11	49
Unknown Type	0	0	0	0	0	2	2
Total	3	16	13	28	53	14	129

In some cases, it was not possible to classify the retrofit class for a specific unit under different retrofit criteria. For example, a tankless unit with an EUL of 13 years that is reported to be between 5-8 years old would be considered a retrofit under the less restrictive criteria. Under the more restrictive criteria, this unit would be excluded from the analysis, because the reported age range covers units that are between 5-6 years old (retrofit) and 7-8 years (lost opportunity). Tankless units older than 12 years were also excluded from the analysis under the less restrictive retrofit criteria as it is not certain that they are less than 25 years old.

4.2.1 Instant Rebate Channel

The baseline data for the instant rebate channel is shown in Table 16 below. If retrofit criteria are applied that require an age less than the existing equipment EUL, then approximately 32% of the installations would be considered a retrofit, while the rest would be considered a lost opportunity installation. That percentage drops to 8% when the age of the existing equipment is required to be less than 50% of the EUL. Under this more-restrictive criteria existing tank units would have to be less than six years old, and the tankless water heaters would have to be less than 12 years old to be considered retrofits. As noted above, the specific retrofit criteria change the number of units that can be definitively classified as retrofits, resulting in slightly different totals between the Age of Functional Unit total counts and the counts in each retrofit criteria case.

Table 16 |
Instant Rebate Retrofit Breakout by Criteria

Instant Rebate Channel Equipment Baselines Less Restrictive Retrofit Criteria					
Decision Type	Variable	Total	Electric	Gas	Oil/Other
Lost Opportunity	a	23	7	0	7
	b		8	0	1
Retrofit	c	11	6	0	5
Total	R	34	21	0	13
Instant Rebate Channel Equipment Baselines More Restrictive Retrofit Criteria					
Decision Type	Variable	Total	Electric	Gas	Oil/Other
Lost Opportunity	a	33	11	0	13
	b		8	0	1
Retrofit	c	4	2	0	2
Total	R	37	21	0	16

Under either scenario for retrofit classification, a slight majority of the baseline equipment has an electric baseline, while slightly less than half of the baseline equipment would be oil or propane for the instant rebate channel. No units that used gas as the existing or alternative fuel were retrofit through the instant rebate channel based on the survey data. These data are broken out on a percentage basis below in Table 17.

Table 17 |
Instant Rebate Retrofit Breakout Percentages

Instant Rebate Channel Equipment Baselines Less Restrictive Retrofit Criteria				
Decision Type	Electric	Gas	Oil/Other	Total
Lost Opportunity	44%	0%	24%	68%
Retrofit	18%	0%	15%	32%
Total	62%	0%	38%	100%
Instant Rebate Channel Equipment Baselines More Restrictive Retrofit Criteria				
Decision Type	Electric	Gas	Oil/Other	Total
Lost Opportunity	53%	0%	39%	92%
Retrofit	3%	0%	6%	8%
Total	56%	0%	44%	100%

The free-ridership rate of the retrofit participants did not change significantly depending on the retrofit criteria. The results are shown below in table 18. The overall sample size is small for this subset of respondents, but the free-ridership rates of 19.3% and 15.6% for the less and more restrictive criteria, respectively, are both below the 23% free-ridership rate reported for the instant rebate channel overall.

Table 18 |
Instant Rebate Free-ridership by Retrofit Criteria

Instant Rebate Retrofit Free-ridership for More and Less Restrictive Requirements				
Program Channel	Sample Size	Intention	Influence	Free-rider %
Less Restrictive	11	13.6%	5.7%	19.3%
More Restrictive	4	12.5%	3.1%	15.6%

4.2.2 Mail-in Rebate Channel

The baseline data for the mail-in rebate channel is shown in Table 19. If retrofit criteria are applied that require an age less than the existing equipment EUL, then approximately 31% of the installations would be considered a retrofit, while the rest would be considered a lost opportunity installation. That percentage drops to 19% when the age of the existing equipment is required to be less than 50% of the EUL. As noted above, the specific retrofit criteria change the number of units that can be definitively classified as retrofits, resulting in slightly different totals between the Age of Functional Unit total counts and the counts in each retrofit criteria case.

Table 19 |
Mail-in Rebate Retrofit Breakout by Criteria

Mail-in Rebate Channel Equipment Baselines Less Restrictive Retrofit Criteria					
Decision Type	Variable	Total	Electric	Gas	Oil/Other
Lost Opportunity	a	116	39	3	12
	b		50	3	9
Retrofit	c	53	33	1	19
Total	R	169	122	7	40
Mail-in Rebate Channel Equipment Baselines More Restrictive Retrofit Criteria					
Decision Type	Variable	Total	Electric	Gas	Oil/Other
Lost Opportunity	a	125	29	2	21
	b		57	3	13
Retrofit	c	29	11	0	18
Total	R	154	97	5	52

Under either scenario for retrofit classification, most of the baseline equipment is electric: approximately 73% of the baseline equipment would be electric under the less restrictive criteria, and approximately 63% for the more restrictive criteria. Less than 5% of the baseline equipment would be gas under either criteria, and the oil/other fuels account for approximately a quarter to a third of the baseline equipment for the mail-in rebate channel. This data is broken out on a percentage basis below in Table 20.

Table 20 |
Mail-in Rebate Retrofit Breakout Percentages

Mail-in Rebate Channel Equipment Baselines Less Restrictive Retrofit Criteria				
Decision Type	Electric	Gas	Oil/Other	Total
Lost Opportunity	53%	4%	12%	69%
Retrofit	20%	1%	11%	31%
Total	73%	4%	23%	100%
Mail-in Rebate Channel Equipment Baselines More Restrictive Retrofit Criteria				
Decision Type	Electric	Gas	Oil/Other	Total
Lost Opportunity	56%	3%	22%	81%
Retrofit	7%	0%	12%	19%
Total	63%	3%	34%	100%

Taken as a whole, a significant portion of the mail-in HPWH installations are retrofit installations. Roughly a quarter to a third of the HPWH installations represent a shift away from delivered fuels toward electricity for domestic hot water.

The free-ridership rate of the retrofit participants did not change significantly depending on the retrofit criteria. The results are shown below in table 21. Of the 53 less restrictive retrofit installations, 6 did not complete the free-ridership portion of the survey, leaving 47 free-ridership scores for this category. Of the 29 more restrictive retrofit installations, 3 did not complete the free-ridership portion of the survey, leaving 26 free-ridership scores for this category. The free-ridership rates of 7.7% and 3.8% for the less and more restrictive criteria are both below the 8% free-ridership rate reported for the instant rebate channel overall.

Table 21 |
Mail-in Free-ridership by Retrofit Criteria

Mail-in Rebate Retrofit Free-ridership for More and Less Restrictive Requirements				
Program Channel	Sample Size	Intention	Influence	Free-rider %
Less Restrictive	47	5.3%	2.4%	7.7%
More Restrictive	26	1.0%	2.9%	3.8%

4.3 Low-Income Participation Findings

The survey results showed similar outcomes for both the mail-in and instant rebate delivery channels. Of the 216 mail-in delivery respondents, 31 did not know the household characteristics such as family income or household size, nine declined to answer, and one declined to answer but indicated that they participated in other low-income programs. Of the 176 respondents classified by income, 25 were low-income, and 151 were non-low-income. On a percentage basis, 14% of the income classified respondents were low-income.

For the instant rebate channel, of the 59 instant rebate respondents, none reported that they did not know their household income or size, two declined to answer the household income questions and did not report participating in other low-income programs. Two others declined to answer the household income question, but indicated that they participated in other low-

income programs. Of the 57 respondents classified by income status, eight were low-income, and 49 were not low-income. On a percentage basis, 14% of the respondents that provided income information were low-income for the instant rebate channel. These results are summarized in table 22.

Table 22|
Low-Income Participants by Delivery Channel

Delivery Channel	Total respondents	Decline/ Don't Know Income Status	Not low-income	Low-income	Low-income % of respondents providing income data
Mail-in	216	40	151	25	14.2%
Instant	59	2	49	8	14.0%

5. Efficiency Maine and Peer Program Comparison

In addition to the HPWH survey, Efficiency Maine staff compiled information about the performance of peer heat pump water heater program performance, which is used as a touchstone for baseline and free-ridership rates in Maine. Overall, the survey effort showed relatively low free-ridership rates for program respondents. The rate of HPWH installations in Maine is substantially higher than in neighboring regions, and shows a substantial increase over time as program activity in Maine has continued to ramp.

5.1 Peer program performance

Table illustrates a state-by-state comparison of heat pump water heater (HPWH) program performance, cross-referenced with program specifics, state characteristics, and sales per residential electric customer. The data was drawn from direct outreach to program administrators, program evaluation reports sent by other program managers, the U.S. Energy Information Administration (EIA), and the Consortium for Energy Efficiency (CEE). Adoption rates per program are anonymous in CEE's reports, but some data was accessible through direct outreach to program managers.

Of the 121 CEE member programs administering residential water heating programs, 55 of them incentivize HPWHs. According to CEE's *2018 Overview of Residential Water Heating Programs in the U.S. and Canada*, most incentive recipients across water heating technologies are downstream consumers, with 13 out of 44 member programs offering midstream/downstream incentives. The most common water heating product covered by these programs are HPWHs (33%), followed by gas tankless (24%) and gas storage (22%). Almost all the volume of HPWH units sold outside of Maine were driven by Efficiency Vermont, Energize Connecticut, NH Electric Co-op, and Mass Save. It should be noted that this data is not nationally inclusive, as CEE's data is limited to the 44 member programs who supplied unit rebate information.

Incentive levels for HPWHs range from \$150 to \$1,000 across the country, but \$600 to \$750 are the most common rebate amounts among the top performing New England states.

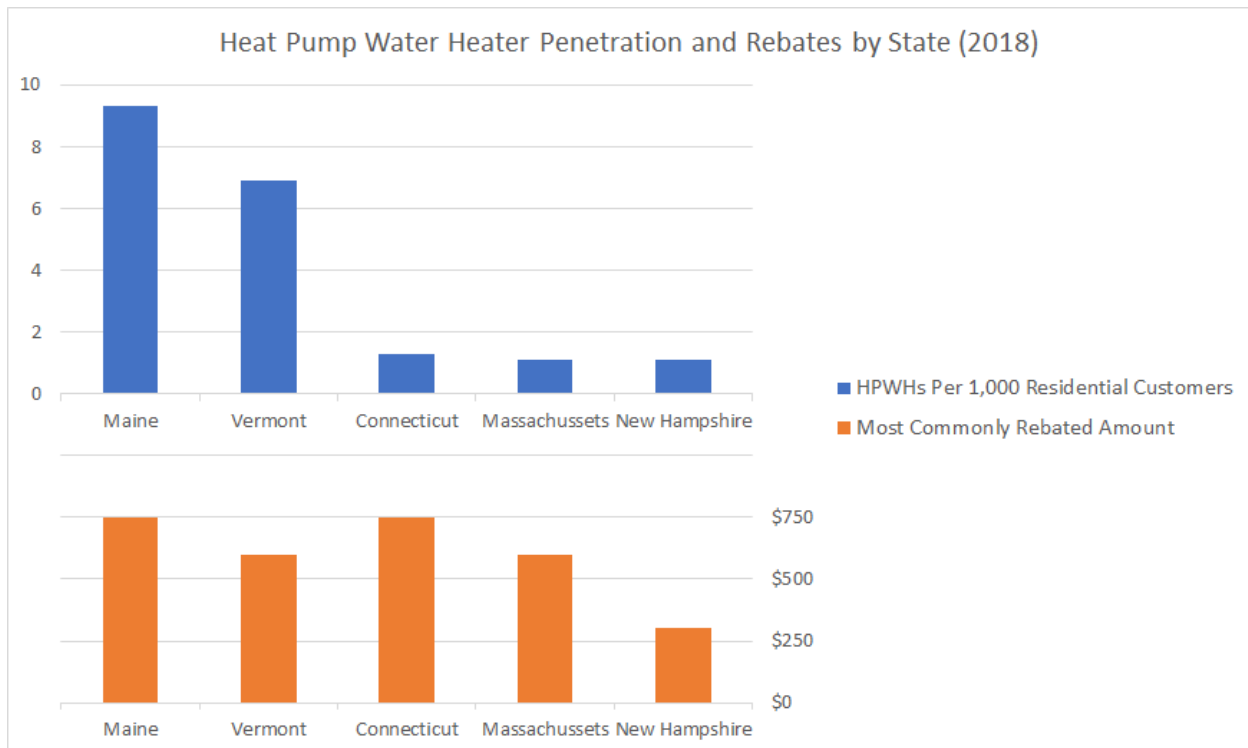
Table 103 |
Peer Program Characteristics

Program Administrator	State	Incentive Structure	Incentivized Units Per Year (not including low-income programs)	Number of Residential Electric Customers Served by Program Administrator (2018) ⁵	Annual sales per 1,000 Residential Customers Served (2018)
Efficiency Maine	ME	\$750 Mail-in (downstream); \$750 Instant (midstream)	2013 – 281 2014 – 2,035 2015 – 2,325 2016 – 2,656 2017 – 4,238 2018 – 5,536 2019 – 5,530	593,568	9.3
Efficiency Vermont	VT	\$300-\$600 Mail-in (downstream); \$300-\$600 Instant (midstream)	2013 – 16 2014 – 1,016 2015 – 2,221 2016 – 2,268 2017 – 1,901 2018 – 1,998	287,952	6.9
Energize Connecticut	CT	\$750 Mail-in (downstream); \$750 Instant (midstream and retail with address verification)	2017 – 1,657 2018 – 1,401	1,056,979	1.3
Mass Save	MA	\$600 Mail-in (downstream); \$750 if unit is larger than 55 gallons	2017 – 1,502 2018 – 1,412	1,307,430	1.1
NH Electricity Co-op	NH	\$300 Mail-in (downstream) in 2018; Rebate raised to \$750 in 2019	2018 – 81	70,261	1.1

Heat pump water heater penetration by state along with the corresponding rebate amounts are illustrated graphically in Figure 1. While Efficiency Maine both offered the largest rebates and yielded the highest penetration rate among New England states, rebate amount and penetration rate do not seem to be directly correlated in all cases. Connecticut offered the same rebate as Maine but had significantly lower penetration, while Vermont found notable success with a lower rebate. This demonstrates that the structure of the rebate and program delivery likely have influence on the overall customer participation.

⁵ EIA, "2018 Utility Bundled Retail Sales- Residential," [Online]. Available: https://www.eia.gov/electricity/sales_revenue_price/.

Figure 1 |
HPWH Penetration and Rebates by State



In 2019, Efficiency Maine incentivized 5,530 residential HPWHs at \$750 each using both a mail-in and instant rebate program. Maine also administered a small direct install program to install HPWHs in low-income residences for the full price of the installation. Maine completed 451 of these low-income installs in 2019, at an average cost of \$1,562 per household. The results of these programs position Maine as a national leader in HPWH installations, despite serving less than 600,000 residential electric customers. Maine's HPWH penetration can be further appreciated through a national comparison. ENERGY STAR tracks market penetration of HPWHs among all electric water heaters shipped each year, currently estimating that HPWHs have just a 2% market share nationally⁶. We estimate that there are over 550,000 water heaters in the state of Maine, around 138,000 of which are electric resistance. Assuming a 10-year useful life for water heaters, the current rate of HPWH rebates suggests that Maine is replacing nearly 10% of all burnt out water heaters with HPWHs, or roughly 40% of all electric water heaters sold in the state. This is an estimated 20 times greater than the national HPWH market share and does not account for the low-income installations that Efficiency Maine does on top of its retail and distributor programs.

It is important to consider free-riders when examining program participation. West Hill Energy and Computing had previously estimated the free-ridership rate among Efficiency Maine's HPWH

⁶ ENERGY STAR, "ENERGY STAR Unit Shipment and Market Penetration Report Calendar Year 2018 Summary," [Online]. Available: https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2018/2018%20Unit%20Shipment%20Data%20Summary%20Report%20.pdf?ff4f-7d06.

program participants from a similar self-reported survey to the one used in this study. West Hill found a significantly higher free-ridership rate, at a combined 31% of all participants⁷. This number was believed to be high and prompted the second look in this evaluation. The first evaluation likely overestimated free-ridership because respondents were surveyed several months to several years beyond their initial purchase, and captured respondents who had received different rebate levels ranging from \$600-\$750. This new evaluation only examines customers who participated within the last six months of being surveyed and who all received the same \$750 rebate. Removing the variability of the rebated amount and surveying participants when the purchase is still fresh in their mind should result in a more accurate net-to-gross analysis. We wanted to compare these free-ridership findings to similar evaluations that were conducted for both Connecticut and Massachusetts in July of 2018. West Hill Energy and Computing evaluated five measures independently in Connecticut's residential program, including its HPWH program.

Connecticut's evaluation relied on survey responses to estimate the intent⁸ of and program influence⁹ on customers, contractors, and distributors to account for the free-ridership of all market actors. A similar methodology was followed by NMR Group, Inc. in Massachusetts. The results of these evaluations in addition to the HPWH sales in 2018 for both states are compared to the state of Maine in table 24. The free-ridership rates found in Connecticut and Massachusetts was notably higher than this evaluation has determined for Maine. These results are logical when put in context of per capita participation because of the definition of the intent portion of free-ridership; there are a certain number of participants in these programs who would have always participated, regardless of an incentive to do so. Therefore, higher per capita participation in Maine should result in an overall lower free-ridership rate when compared to states with less participation.

⁷ West Hill Energy and Computing, "Efficiency Maine Trust Heat Pump Water Heater Initiatives Impact Evaluation," 11 December 2019. [Online]. Available: https://www.energymaine.com/docs/WHEC_EMT_HPWH_Impact_Evaluation_Full_Report_with_Appendices_12_11_2019.pdf.

⁸ Intent estimates the portion of participants who would have always participated, regardless of an incentive

⁹ Program influence estimates the portion of participants who would have never participated without an incentive

Table 114 |
Peer Program per Capita characteristics

2018 Program Comparison			
State	Maine	Connecticut	Massachusetts
Residential Electric Customers ¹⁰	593,568	1,056,979	1,307,430
Yearly HPWH Sales	5,536*	1,401*	1,412*
Annual Sales per 1,000 Residential Electric Customers	9.3	1.3	1.1
Free-ridership Rate	8% (Downstream) 23% (Midstream) 18% (2018 Program Average)	42% ¹¹	32% ¹²

* does not include low-income program installations

5.2 Efficiency Maine program attributes relative to peer programs

The compiled data show that the Efficiency Maine programs are more aggressive than peer programs, and have achieved a much higher per-capita installation rate than other states in the northeast. In 2018, the Efficiency Maine program incented approximately eight times the amount of HPWHs per capita as Massachusetts or Connecticut, indicating that the Efficiency Maine programs as delivered and designed are significantly driving up the installation of HPWH units in Maine.

¹⁰ EIA, "2018 Utility Bundled Retail Sales- Residential," [Online]. Available: https://www.eia.gov/electricity/sales_revenue_price/.

¹¹ West Hill Energy and Computing, "CT HVAC and Water Heater Process and Impact Evaluation and CT Heat Pump Water Heater Impact Evaluation," Prepared for the CT EEB Evaluation Administration Team, July 19, 2018.

¹² NMR Group, Inc, Tetra Tech, Inc., "Massachusetts Residential HVAC Net-to-Gross and Market Effects Study (TxC34)," Massachusetts Electric & Gas Program Administrators, July 27, 2018.