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2019 Alliance Cost Effectiveness Model Review for Ductless Heat Pumps

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To: Amy Webb, Northwest Energy Efficiency Alliance

From: Adria Banks, Ecotope and Ben Larson, Larson Energy Research

RE: Ductless Heat Pump ACE Model Review

Ecotope has been contracted by the Northwest Energy Efficiency Alliance (NEEA) to review the current Ductless Heat Pump (DHP) Alliance Cost Effectiveness (ACE) Model. Specific tasks were to address the following topics:

Task 1: Does the model effectively incorporate the recent Regional Technical Forum (RTF) measure updates in a way that aligns with NEEA's market transformation approach? This includes the use of screened versus unscreened measures and the treatment of Heating Seasonal Performance Factor (HSPF) tiers.

Task 2: Is the model's approach to climate zone weighting for local programs appropriate? Does the approach increase the accuracy of the savings rate by tailoring the climate zone weighting to the locations of the utility program installs?

Task 3: What is the most sensible method for extrapolation? The current approach uses local programs to estimate the total. An alternative approach being considered is to use distributor data and weight up to total market.

This memorandum is organized according to these tasks.

Task 1: Incorporation of recent RTF measure updates.

In October 2019, recent studies of DHP savings[4,1,2], were incorporated into RTF Uniform Energy Savings (UES) measures, specifically for zonal applications, which represents one of NEEA's three target markets[4]. The studies informing these adjustments calculated DHP savings through billing analyses of DHP program participants. Results enumerated lower savings rates for unscreened installations, while screened installations demonstrated savings rates similar to those quantified in previous studies[5]. Screening criteria include knowledge of a home's energy usage prior to DHP installation or the absence of supplementary fuels. NEEA provided a summary of the new unscreened savings rates and requested feedback on incorporation of the new rates into

the ACE Model; specific to the new RTF information, and also in light of NEEA's original market transfer effort. [1,2,3,4,5]

The ACE Model Review team examined the recent RTF UES workbook[6] and the supporting studies and determined that the correct savings rates were supplied in NEEA supplementary materials for the review task. NEEA does not have explicit access to screening criteria, so the use of unscreened rates is appropriate. Additionally, updates to the UES workbook have removed the HSPF efficiency tiers, which had previously been part of the measure definition.

In addition to confirming that the appropriate rates were summarized from RTF sources, NEEA Planning staff requested input into potential methods for capturing additional market sectors (to better align with updated RTF savings rates), phasing of the new rates into the ACE Model, and/or the use of screened savings rates.

Additional Market Sectors

NEEA uses information from utility funders to annually quantify the incented DHP installations in their target markets. Parallel to this effort, NEEA collects annual distributor data to understand the entire market and conducts installer interviews to define non-incented installations in the target markets. To date these efforts have focused on understanding displacement of specific heating fuel/equipment through DHP installations in primary living spaces in existing homes.

The recent Energy Trust of Oregon study[2] provided information on single-family baseline heating systems used to heat the spaces where DHPs were eventually installed. These installations also included non-primary living spaces. NEEA described a method for aggregating

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[1] Dorato, S., P. Goodman, M. Yaggie, A. Esposito, S. Rodriguez-Anderson, and M. Baker. 2018. Impact Evaluation of Residential Ductless Heat Pump and Prescriptive Duct Sealing Measures, Bonneville Power Administration. https://www.bpa.gov/EE/Utility/Evaluation/Evaluation/Impact_Evaluation_of_Res_DHP_and_Prescriptive_Duct_Sealing_Measures_draft_report.pdf

[2] Jackson, Ari, and J. Walczyk. 2019. Residential Ductless Heat Pump Study, Energy Trust of Oregon. Portland OR. https://www.energytrust.org/wp-content/uploads/2019/10/Residential_Ductless_Heat_Pump_Study_Report.pdf

[3] Evergreen Economics. 2019. DHP Replacing Zonal Draft Results, Bonneville Power Administration. Portland OR.

[4] NEEA's DHP target markets include single-family zonal, single-family electric forced air furnace, and manufactured home electric forced air furnace DHP applications.

[5] Baylon, D., P. Storm, and D. Robison. 2013. Ductless Heat Pump Impact & Process Evaluation: Billing Analysis Report, Northwest Energy Efficiency Alliance. Portland OR. http://ecotope.com/wp-content/uploads/2013_006_DHPImpactBilling.pdf

[6] Regional Technical Forum UES Measure Workbook. Ductless Heat Pumps for Zonal Heat SF - Residential DHP for Existing Zonal v5.1. Published Jan 27, 2020. https://rtf.nwcouncil.org/measure/ductless-heat-pumps-zonal-heat-sf. Accessed Jan 28, 2020.

the baseline heating information in the Energy Trust report to characterize a previously unused portion of the non-incented distributor data: installations in New/Add-on (non-primary living) spaces – specifically the displaced electric zonal portion.

The challenges with using the Energy Trust summary data are three-fold.

1) The Energy Trust study predominantly sampled homes in heating zone 1. And there may be regional differences in the heating fuel composition that would not be captured with that dataset.
2) The summary data are a combination of baseline heating characteristics of primary living and new/add-on spaces and no further break-down of the new/add-on subset is provided. The implied assumption would be there is no difference, in the baseline heating aggregates between those space types.
3) The Energy Trust summary describes program participants (i.e., an incented population), and it is unclear what differences there may be in the heating fuels/equipment distribution in the non-incented installations. It could be that there is little difference – in this scenario those installations could have qualified for participation in an incentive program but opted not to.

In spite of the challenges, this remains the best available data source the ACE Model Review team is aware of and recommends NEEA continue with the approach. An opportunity to improve upon the data could come in the form of future installer interviews. If NEEA conducts future surveys, adding questions to understand displacement in single family new, add-on spaces would be valuable. This new information could either be used in place of the Energy Trust aggregation method, or, to support its use (if the percentage of displaced electric zonal equipment in new, add-on spaces via installer surveys is similar). Installer survey data collected to date (as summarized in the most recent Market Progress Evaluation Report[7]) indicate that the proportion of displaced electric zonal data in primary living spaces has changed over the past six years. Adding new, add-on spaces to future surveys would also help understand any trends in electric zonal displacement in this market sector over time.

Phasing of Updated Savings Rates

The ACE Model Review team explored the timing of incorporating the updated RTF savings rates into the ACE Model. As the DHP initiative began in the region, engaged programs and installers were recruiting participants that more likely closely fit the measure definition of an ideal single-family installation in the main living area of the electric zonal house. It would be reasonable then to assume savings could be higher during initial years than shown in recent studies. The 2013 Baylon study[5], in fact, shows higher savings than either the recent 2018

[7] Cadmus. Northwest Ductless Heat Pump Initiative: Market Progress Evaluation #8. Prepared for NEEA. Nov 19, 2019. https://neea.org/resources/northwest-ductless-heat-pump-initiative-market-progress-evaluation-8

Bonneville Power Administration (BPA) study[1] (with 2014-2015 program year participants) and the Energy Trust study[2] (with 2011-2018 program year participants). Given the fact that the Energy Trust study appears to have included more sites with new, add-on spaces than either of the other two, and that the Baylon study represents an earlier cohort, the ACE Model Review team recommends leaving the savings rates through 2013 unchanged. However, for 2014 and later years, the team suggests revising the savings rates to match the recent revisions supported by the RTF.

Screened Savings Rates

Knowledge regarding pre-installation energy usage or the absence of supplemental fuels are screening criteria that lead to higher realized savings. NEEA does not have this information on an installation-by-installation or market sector basis. RTF guidance is that either screened or unscreened rates, may be used for utility programs but not both. This is due, in part, to the definition of unscreened savings. While screened savings are applicable in the ideal installation scenario, unscreened savings rates include both ideal (displacement in the primary living area) and less-ideal applications (e.g., displacement offset by supplementary heat). If some fraction of the market, could be assigned screened savings rates, then the savings rates appropriate to the remaining portion would necessarily be lower than unscreened savings rates (because the screened cases had already been parsed out).

A feasible way for NEEA to use both screened and unscreened estimates in the ACE model exists if utilities report to NEEA which they are using. In that case, NEEA could divide the total population at the utility level: those with screens and those without. That clear geographic split would make it possible to use both estimates across the entire population. Barring that approach, the ACE Review Team found insufficient information available across DHP market sectors to successfully divide the market into distinct sub-sectors where screened and unscreened savings rates could be assessed independently.

Task 2: Climate zone weighting for local programs.

To date, NEEA's DHP ACE Model has weighted RTF energy savings rates for each target market by heating/cooling zone using RBSA I data. Beginning in 2017, NEEA has data for total housing units by utility funder and climate zone. Survey data for incented units can then be used to create an annual aggregate weight by climate zone for each measure. This is then combined with RBSA I weights, which continue to be applied to non-incented units, providing a comprehensive set of climate zone weights for each DHP target market.

For the two years of utility data that NEEA provided for review, the annual year-over-year change for the distribution by climate zone within each market is relatively low. Compared to RBSA I weights, however, there are some larger magnitude differences. Because the incented fraction is estimated to represent the majority of the DHP target markets, this revised weighting approach offers improved accuracy for calculating regionalized savings rates.

The results for the updated weighting method (2017-2018) were compared to regionalized net savings figures for 2016[8], which represent savings rates with RBSA I weights only. Note, that the single-family (SF) zonal base savings rates are from the most recent RTF unscreened site savings estimates[6].

Overall, Table 1 indicates that there is little change in weighted savings rates relative to RBSA I-weighted rates. This is likely due in part to broad geographic coverage of current utility programs.

Table 1. Regionalized savings rate by target market and weighting approach annually (2016-2018)

Target Market	Year	Weighting	Regionalized Net Savings Rate	% Change from RBSA-weighted rates
SF Zonal	2016	RBSA I	1508	
SF Zonal	2017	Hybrid*	1586	5
SF Zonal	2018	Hybrid	1567	4
SF eFAF	2016	RBSA I	2456	
SF eFAF	2017	Hybrid	2439	-1
SF eFAF	2018	Hybrid	2395	-2
MH eFaF	2016	RBSA I	2861	
MH eFaF	2017	Hybrid	2777	-3
MH eFaF	2018	Hybrid	2765	-3

* "Hybrid" weighting combines utility specific climate zone weights with RBSA I weights

However, recent changes in the RTF savings rates (i.e. decreases) may lead to reduced utility program offerings for the single-family zonal DHP market. If fewer utilities offer programs in the future, exactly where those utilities are may shift the savings rates for the single-family zonal DHP market more substantially. The new method of calculating savings will contribute to increased accuracy as geographic coverage of utility programs shift over time. This may be counter-balanced, however, by a smaller fraction of the market being represented by the incented portion (in the event of utility program closures), and a higher non-incented portion (with RBSA I weighting). This may lead to a regionalized savings rate for the SF Zonal market that is more similar to 2016 calculated weighted savings rates (using only RBSA I weights). NEEA should assess over time if the effort required to maintain the new weighting scheme is greater than the incremental accuracy improvements.

Task 3: Extrapolating total market from distributor data.

From 2011 through 2016, NEEA collected DHP sales data directly from Northwest distributors. More recently, in 2017, in partnership with Bonneville Power Administration, NEEA initiated a new process to collect distributor data which expanded the scope to include full-category HVAC

[8] Model_DHP_Revised ACE Model workbook, provided by NEEA 2020-01-17.

data. Partially due to the timing of the data request, and the increased reporting burden, NEEA has experienced attrition in the number of reporting distributors. For 2017-2018, NEEA relied on the incented proportion of DHP sales and the historical non-incented proportion to estimate the total market installations but does not feel that this approach is sustainable long-term. For this review task NEEA proposed a possible method for extrapolating the total DHP installations from current and historical distributor data and requested specific feedback on several topics:

- Is the proposed extrapolation method defensible, reasonable, and conservative?
- Is it reasonable to assume continued market growth?
- As more reporting distributors are added in future years, can this method adapt?
- Should NEEA use extrapolated values only for 2017 and 2018, since 2016 data is available under the prior reporting method?

Proposed extrapolation method

Because fewer distributors are reporting than have previously, the proposed extrapolation method estimates the coverage for current reporters of the total reported in 2016 (under the previous data collection method). Current reporters are estimated to represent 41%, 39%, or 29% of the total historical (2016) market, depending on whether historical distribution data represented 100%, 95%, or 70%, respectively, of the total market. NEEA considers this historical distributor data to cover approximately 90+% of the regional DHP market. To extrapolate to a total market estimate for recent years (2017 and 2018), the annual total for those distributors who have historically reported is then multiplied by the reciprocal of potential 2016 coverage.

NEEA provided calculations showing year to year variability in historical market coverage of currently reporting distributors, and a slight decrease in market coverage from 2011 to 2016 (Figure 1).

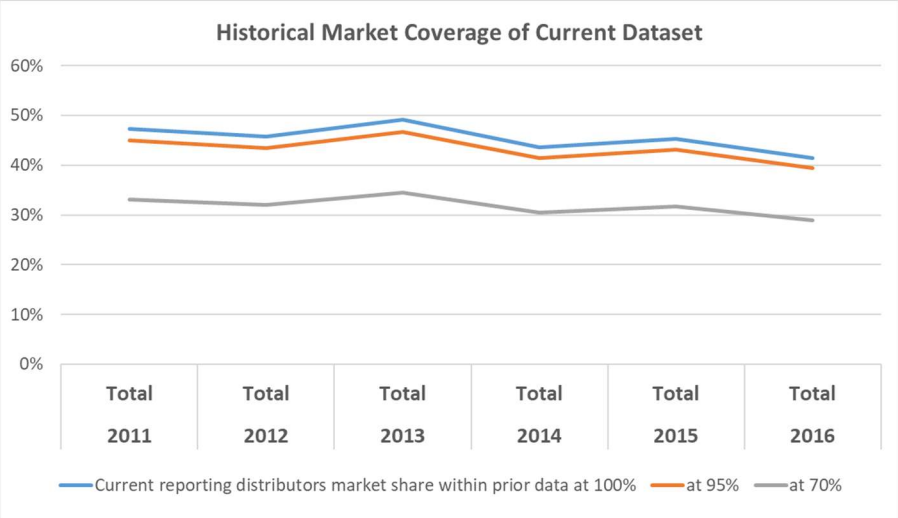

Figure 1. Historical market coverage of currently reporting distributors

Rather than using the market coverage from 2016, the lowest annual coverage since 2011, the ACE Model Review team explored using an average market coverage over the historical reporting period. This changed the market coverage estimates from 41%, 39%, and 29% to 45%, 43%, and 32%. Using an average over the most recent three years, provided intermediate coverage estimates of 43%, 41%, 30%. A comparison of the resulting 2017-2018 market estimates using 1) just the 2016 fraction of market coverage, 2) an average fraction over the most recent three years (2014-2016), and an average fraction over the full historical reporting period (2011-2016), is provided in Table 2.

Table 2. Comparison of total market estimates

	2017 Total Market Estimate			***2018 Total Market Estimate***		
	100% market	**95% market**	**70% market**	**100% market**	**95% market**	**70% market**
2016-fraction	46,031	48,454	65,759	51,331	54,033	73,331
Avg fraction 2014-2016	43,904	46,214	62,719	48,959	51,535	69,941
Avg fraction 2011-2016	41,992	44,202	59,988	46,827	49,291	66,895

Because the extrapolation is based on the reciprocal of the market coverage estimate, there is some sensitivity to starting with estimates based only on 2016 data. A more conservative approach might be to use an average market period over a longer period. The ACE Model Review team recommends using an average over the most recent three years (2014-2016) to smooth the estimation.

Continued Market Growth

The regional DHP market has shown more or less steady growth since the initiative launch in 2010. The most recent Market Evaluation Progress Report indicates a strong market that is demonstrating self-sufficiency[9]. Consumers appreciate increased comfort, cooling and heating functions, as well as energy savings, suggesting that DHPs will continue to be an attractive product in NEEA's target markets. In addition, market supply chain actors are positioned to continue to support consumer demand. Although there is a strong indication that market growth will continue, DHP costs continue to be a barrier to purchase. Market growth may be somewhat

[9] Cadmus. Northwest Ductless Heat Pump Initiative: Market Progress Evaluation #8. Prepared for NEEA. Nov 19, 2019. https://neea.org/resources/northwest-ductless-heat-pump-initiative-market-progress-evaluation-8

tempered if utility incentive programs are reduced due to decreased cost effectiveness. NEEA should continue to track DHP installations to monitor market trends.

Maintaining the extrapolation method

As NEEA maintains this extrapolation method, "new" reporting distributors will fall into two categories: 1) new, not historically reporting, distributors, and 2) recouped historically reporting distributors.

Currently, distributors that have never reported before, are not included in calculations of total market estimates, and, therefore, have no impact on market extrapolation. Because the method relies on the historical proportion, including reports from distributors that had not provided data prior to 2016 would overestimate the current total market. If this fraction were to grow substantially, NEEA may re-assess the extrapolation method to incorporate, or shift to, new sources of information.

In the second case, where NEEA regains a more robust proportion of originally reporting distributors, the fraction that current reporters contributed to historical market estimates will need to be re-assessed annually. The ACE Model Review team reviewed the contribution of each distributor that has reported for at least five out of the last six years. Only in rare instances (and usually with larger volume distributors) did a single distributor's contribution change more than 5 percentage points. This agrees with the stability of the aggregate percent contribution over time as calculated by NEEA in developing the extrapolation method (Figure 1). This stability provides some confidence that additional previous reporters can be integrated into the extrapolation method. Even several years from now, their proportional contribution is expected to resemble historical levels. If NEEA recruits enough previous reporters, the extrapolation can be discontinued.

Extrapolation of 2016 data

Lastly, during conversations with NEEA staff it was noted that the 2016 annual totals collected under the current data collection method differed from the same year's data via the previous data collection method. The ACE Model Review team suggests not using the 2016 extrapolated values because 1) data is available under the prior reporting method, and 2) it is unclear why the individual distributor 2016 totals differ between the two collection methods. If the discrepancy can be resolved, this recommendation may be reconsidered.

Conclusion

The ACE Model Review Team focused on three main areas for NEEA's 2019 DHP ACE Model review:

- **Incorporation of updated RTF savings rates**: NEEA is using the correct values from the recently updated RTF workbooks to bring the ACE Model in alignment with new savings rates.

  - The use of unscreened rates is appropriate because NEEA does not have independent knowledge of specific market sectors within the single-family electric zonal target market that could be used to accurately identify a distinct sub-population where screened rates could be applied. However, if a utility specifically identifies as using screens or not, there is an approach, outlined in the review, to using both screened an unscreened estimates across the entire population.
  - Because the recent RTF savings rate revisions come from a more recent cohort of houses, the historic savings rates in the ACE Model should be updated only back to 2014. Prior to 2014, the savings rates should remain unchanged.
  - Further, because the new savings rates include DHP installations from previously excluded market sectors (such as installations in new, add-on spaces), NEEA may consider including single-family displaced electric zonal from these new market sectors either through use of Energy Trust summaries and/or future installer interviews.

- **Integrating utility climate zone weighting into savings rate weights for incented installations**: NEEA's integration of utility-specific climate zone weighting appears to offer some accuracy improvement in savings rates in NEEA's target markets. If the geographic distribution of utility programs shift in the future, this method is expected to reflect those changes more closely. Recent reductions to RTF savings rates and cost effectiveness generate some uncertainty into future utility incentive programs offerings. If, over time, the incented proportion of NEEA's target markets is reduced, the weighting may more closely resemble RBSA I weights (which has been the historical weighting schema). If this occurs, NEEA should assess the effort required to maintain the new weighting method.

- **An extrapolation method for estimating the total DHP market**: The ACE Model Review team supports NEEA's proposed extrapolation method with the suggested refinement of using an average of recent years (2014-2016) market coverage to be the basis for extrapolation. Additionally, we suggest applying the extrapolation from 2017 onward. Maintaining the method over time will require annually assessing the historical contribution of distributors in a given reporting year. This proportion (for currently reporting distributors) has remained fairly stable over the period of distributor data collection (since 2012). Although larger volume distributors contribute variability, using an average over the 2014-2016 reporting period will help smooth the extrapolation and the inclusion of previous reporters into future market estimates.