Memorandum

To: Joan Wang, Bonneville Power Administration

From: Andrew W. Wood & Tyler Mahone, DNV

Date: 8/3/2022

Subject: 2021-2022 Residential HVAC Expert Panel Summary Memo

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This memorandum documents process, participants, and activities completed as part of the expert panel review of BPA's 2016-2021 Residential HVAC market model and related market research. The activities summarized below were completed between April 2021 and June 2022.

Residential HVAC Market Research Overview

DNV assembled and facilitated a panel of independent experts and regional stakeholders to provide comments, advice, and review of BPA's Residential HVAC market model starting in 2021. BPA has done significant work to characterize the residential HVAC market and quantify Momentum Savings from this market. In 2019 the team completed a full-market model that determines how HVAC electricity consumption in the Pacific Northwest is changing over time and quantifies Momentum Savings using data such as the HVAC distributor sales data, among many other sources. BPA received input on this interim model from the Regional Technical Forum's (RTF) Market Analysis Subcommittee. In 2021, BPA began to update the model and inputs to produce and finalize the estimates of energy consumption and Momentum Savings for 2016-2021. Updated model inputs include 2016-2020 HVAC sales data collected and analyzed in partnership with the Northwest Energy Efficiency Alliance (NEEA), updated program data from the Regional Conservation Progress report, and market data on insulation. DNV provided a panel of experts to provide subject matter expertise in specific applications during this model update process. DNV's first panel facilitation occurred in April 2021.

Further details on BPA's HVAC market research and final 2016-2021 Residential HVAC market model can be found on their website at: HVAC Market Research - Bonneville Power Administration (bpa.gov)

Expert Panel Process

The goal of the expert panel process is to provide BPA with independent expert review and advice on their market research, methodologies, market model, and results. Additionally, the expert panel process ensures continuous engagement in BPA's market research from its stakeholders representing the Northwest Power and Conservation Council (Council), NEEA, the Regional Technical Forum (RTF), and internal BPA staff. DNV accomplished this goal by assembling and facilitating a panel of independent experts and regional stakeholders. DNV recruited the independent expert panelists while BPA recruited regional stakeholders as appropriate for this market.

Expert panel feedback was gathered through technical working sessions and targeted desk review and/or discussions. For each panel engagement, BPA would request facilitation of expert review by DNV. DNV would then meet with BPA and its modeling contractor to understand the objectives of each review and identify the appropriate panelists. DNV would then schedule any required meetings, distribute materials

for review, facilitate the discussion during meetings, provide detailed meeting minutes, and gather any requested feedback from each panelist.

BPA and its modeling contractor document all panelist feedback in a detailed comment tracker and provide a response to each piece of feedback that clearly summarizes any actions taken to address the feedback. After each round of review, the completed comment tracker and any meeting minutes are provided to the panel for final check prior to closing out the review. This process ensures BPA and its modeling contractor can efficiently incorporate panelist feedback into their work, and provides transparency to all parties involved. Each expert engagement occurred over a 2 – 8 week period depending on the scope of the review requested. The comment tracker and all meeting minutes are available to the public via embedded links below.

Expert Panelists

The panel included both experts who participated in differing capacities throughout the review process. In addition to the participating regional stakeholders, independent experts recruited by DNV were classified into four categories to ensure that expertise on all elements of the modeling process were available to BPA.

- **Market/Industry Expert:** A market/industry subject-matter expert (SME) has a strong understanding of residential HVAC market dynamics in the Northwest including who the market players are, what the market trends are, and how the supply chain typically works for residential HVAC equipment. In addition, the market/industry SMEs is up to date on current and any potential future federal or state codes and standards impacting the residential HVAC market, and ideally has past "boots on the ground" experience working within the residential HVAC market (e.g., have worked with/for a manufacturer, distributor, installer, etc.). BPA requested the expert panel to include market/industry SMEs with expertise on the smart thermostat and insulation markets. A market/industry expert helps BPA ground its research and analysis in reality and makes sure BPA is not missing any important aspects of the regional market when trying to model annual full-market stock and sales.

- **Technology Expert:** The technology SME has engineering expertise and a strong understanding of how residential HVAC technologies – including air-source and variable speed heat pumps, ductless heat pumps, central air conditioners, gas furnaces, electric furnaces, electric resistance heating, boilers, smart thermostats, and insulation – work, and preferably know how to model energy consumption for these technologies using SEEM models and other residential building engineering models. Technology experts are up to date on technology trends and issues, emerging technologies, and current and any potential future federal or state codes and standards impacting the residential HVAC market. A technology expert understands how different technical specifications and installation conditions (such as presence of advanced smart thermostats and insulation levels) affect the equipment's performance and energy consumption, which technologies are appropriate for which applications and can explain tradeoffs in efficiency, cost, and performance across numerous technology categories. BPA prefers technology experts that also understand the supply chain and current market trends.

- **Market Analysis Expert:** A market analysis expert is someone with experience using a mix of datasets such as sales data, regional building stock assessment data, utility program data and census data, and analyzing them for the broader regional market/population. A market analysis expert is well versed in assessing the representativeness and uncertainties of a sample dataset to

determine whether and how to use it to make inferences on the population. A market analysis expert has knowledge of inputs, methods and outputs of stock turnover models and is preferably familiar with the Council's power plans and baseline methodologies.

- **Sampling/Statistical Expert:** A sampling/statistical SME has a strong understanding of sampling methods and techniques. They can review and provide feedback to BPA on sampling plans for primary data collection in a way that ensures the data are robust and representative of the population. They help inform BPA on the appropriate use of primary and secondary data sources, including appropriate uses of weights.

- **Regional Stakeholder:** Regional stakeholders are those from the Council, NEEA, RTF, or BPA that participated on behalf of their organization.

Table 1 shows the independent experts and regional stakeholders in the residential HVAC expert panel. Each of the independent experts that participated in this panel are listed based on their primary expertise, but each has expertise in multiple classifications.

Table 1. Expert Panelists

Panelist Name	Expert Classification	Affiliation during panel
Michael Flatt	Market/Industry Expert	Lennox
Mark Jerome	Market/Industry Expert	CLEAResult
Chris McKinney	Market/Industry Expert	FE Company
Abram Conant	Technical Expert	Proctor Engineering
Bob Davis	Technical Expert	ECOTOPE
Kevin Madison	Technical Expert	Willdan
David Baylon	Market Analysis Expert	Independent
Mitt Jones	Market Analysis Expert	Cadmus
Miriam Goldberg	Sampling/Statistics Expert	DNV Energy
Ryan Brown	Regional Stakeholder	NEEA
Christian Douglas	Regional Stakeholder	Council - RTF
Christopher Dymond	Regional Stakeholder	NEEA
Havala Hanson	Regional Stakeholder	NEEA
Tina Jayaweera	Regional Stakeholder	Council
Jennifer Light	Regional Stakeholder	Council - RTF
Robert Weber	Regional Stakeholder	BPA

Review Activities

The panel kicked off in April 2021, and had 10 total panel engagements, ending with the review of draft Residential HVAC market model results in April 2022. Table 2 on the next page shows the full list of panel engagements, topics covered, and panelists involved.

Appendix A follows the activities table. The appendix contains a comment matrix that documents all comments received during this period and the responses/changes made as a result by BPA and its modeling contractor. Comments resulting from both working sessions and desk reviews are documented in the comment matrix.

Table 2 – Expert Panel Completed Activities

#	Review Type	Panel Engagement Period	Topics Reviewed	Independent Experts	Regional Stakeholders	Associated Meeting Minutes
1	Working Session	April 2, 2021	2019 HVAC Sales Data Analysis	Dave Baylon, Mark Jerome, Chris McKinney, and Bruce Severance (Mitsubishi)*	Ryan Brown, Adam Hadley (RTF)*, Havala Hanson, Tina Jayaweera, and Jennifer Light	[PDF] Notes BPA Residential HVAC Se...
2	Working Session	July 15, 2021	Model Overview	Dave Baylon, Abram Conant, Bob Davis, Mark Jerome, Mitt Jones, and Chris McKinney	Ryan Brown, Christian Douglas, Christopher Dymond, Havala Hanson, Tina Jayaweera, and Jennifer Light	[PDF] Notes BPA Res HVAC Expert Meetin...
3	Desk Review	July 23, 2021	SEEM Updates	N/A	Christian Douglass	N/A
4	Working Session	July 28, 2021	Unit Energy Consumption (UEC) Update	Dave Baylon, Abram Conant, Bob Davis, Mark Jerome, Kevin Madison, and Chris McKinney	Ryan Brown, Havala Hanson, Tina Jayaweera, and Jennifer Light	[PDF] Notes BPA Res HVAC Expert Panel S...
5	Targeted Discussion	August 20, 2021	Air Source Heat Pump UECs	N/A	Christian Douglass	N/A
6	Targeted Discussion	September 23, 2021	New Construction UECs	David Baylon and Bob Davis	N/A	N/A
7	Working Session	October 27, 2021	Market Data Updates	Dave Baylon, Mark Jerome, Mitt Jones, and Chris McKinney	Ryan Brown, Havala Hanson, Christian Douglas, Tina Jayaweera, and Jennifer Light	[PDF] Notes BPA Res HVAC Model Update...
8	Desk Review	October – November, 2021	Weatherization (Wx) Workbook Review	David Baylon, Mark Jerome, and Mitt Jones	Christian Douglas, Tina Jayaweera, Jennifer Light, and Robert Weber	N/A
9	Working Session	December 3, 2021	UEC Results and Follow-up Items	Dave Baylon, Bob Davis, Abram Conant, Mark Jerome, and Kevin Madison	Ryan Brown, Christian Douglas, Havala Hanson, Jennifer Light, and Robert Weber	[PDF] Notes BPA Res HVAC Expert Panel S...
10	Desk Review & Working Session	April – June, 2022	Draft Model Results	David Baylon, Abram Conant, Bob Davis, Mark Jerome, Mitt Jones, Kevin Madison, and Chris McKinney	Ryan Brown, Christian Douglas, Christopher Dymond, Havala Hanson, Jennifer Light, Tina Jayaweera, Robert Weber	[PDF] BPA Res HVAC Expert Panel Draft R...

These participants only participated in the first panel session.

Appendix A – Comment Tracker

The comment response matrix documents all comments received during this process, the responses by BPA and its modeling contractor, and any actions or adjustments taken as a result of the comment.

> **Tracker is attached to memo as an xlsx file.**
> **Click here to view attachments**