

# Advanced Heat Pump Coalition

2021 Update #1

Feb 3, 2020 – 10:00 AM Pacific

# Agenda

36 slides

## **General Information**

**15 minutes**

- Advanced HP Coalition Intro (2 slides)
- Rough Timeline
- Website

## **Workgroup Report Out**

**70 minutes**

- WG #1 – Improved Test Procedure and QPL
- WG #2 – Roadmap Specification and Manufacturer Engagement
- WG #3 – Design & Install Best Practices

## **Collaboration & Wrap-up**

**15 minutes**

**Intention:** Update people on what has been accomplished since June 2020

**Objective:** Increase collaboration

# A “Coalition of the Willing”

## Goal

To increase research collaboration among energy efficiency organizations that are working to accelerate market adoption of advanced heat pumps

## Membership

- ACTIVE = Fund and Guide collaborative activities
- PASSIVE = attend webinars, provide feedback

## Workgroups

- Steering Committee  
(NEEA, NEEP, MEEA, CEC, NRCAN, EPA, NYSEERDA)
- WG #1 – Improved Test Procedure and QPL
- WG #2 – Roadmap Specification and Mfr Engagement
- WG #3 – Best Practices  
(Design, Adaptation, Installation and Operation)

Brightest heat pump minds  
from organizations such as these:



# Challenges We Face

Shifting needs and product technologies

Perfect products do not exist

We don't know how to identify which are best for what application

Utility, HVAC industry and decarbonization needs don't always align

Limited research resources and market leverage

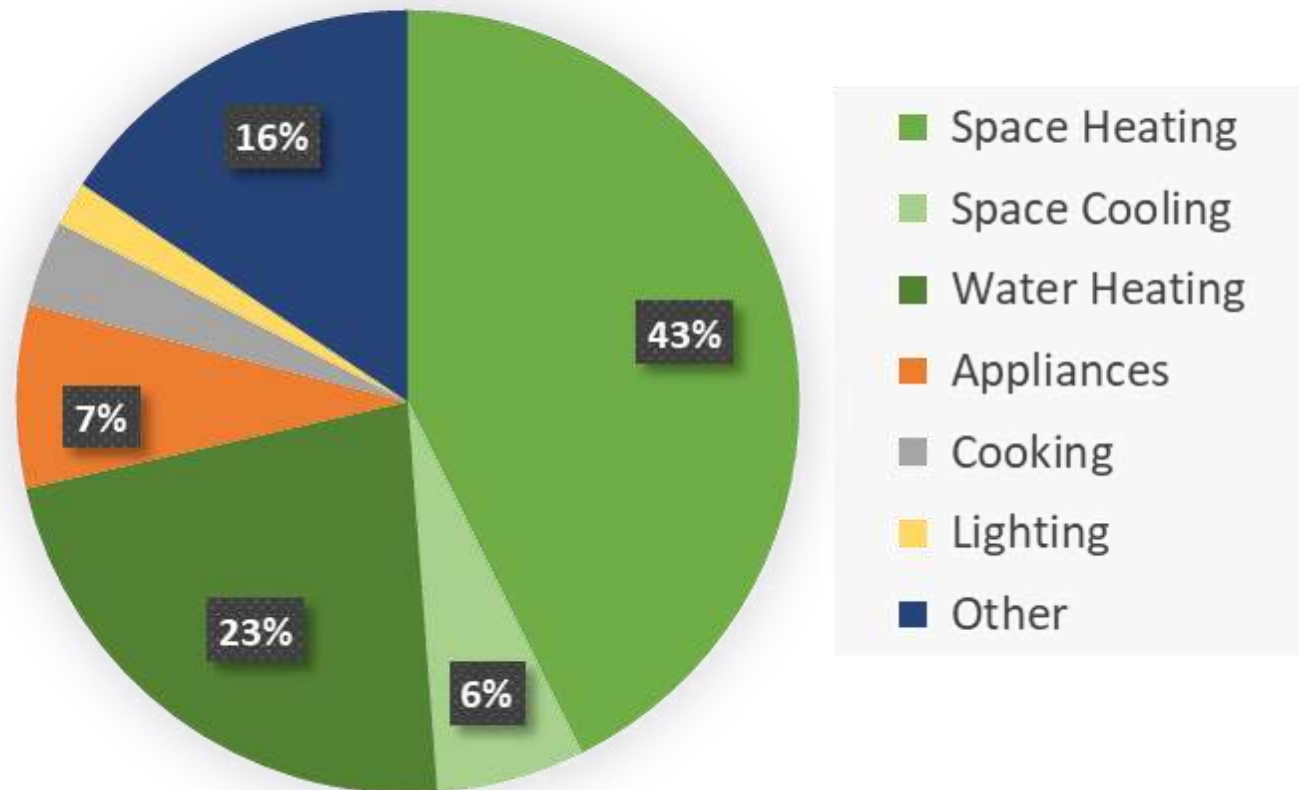
## What is possible?

*(if these problems were addressed collaboratively)*

# Residential Energy by End Use

## US Average Household Energy Use

US EIA 2015

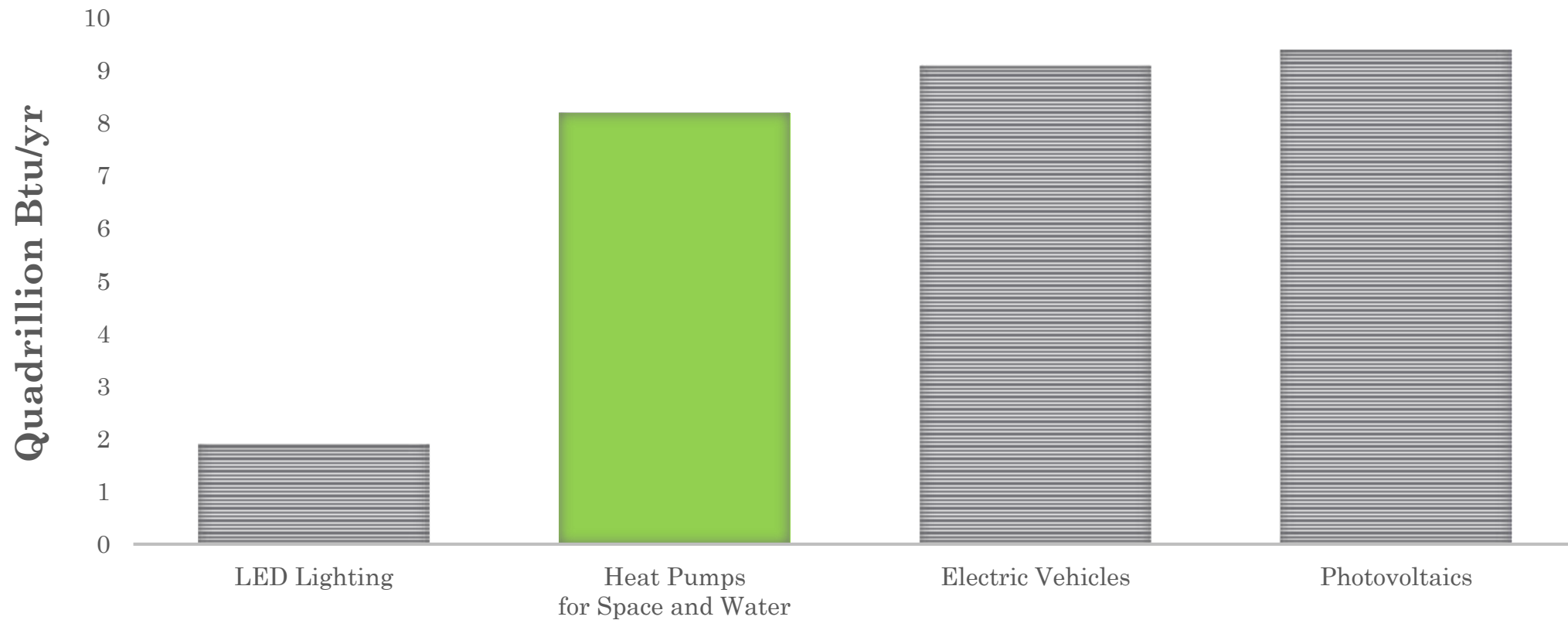


green areas  
can be served  
by a  
heat pump

# The 3<sup>rd</sup> Largest Potential

Customer side contribution to meeting our future energy needs

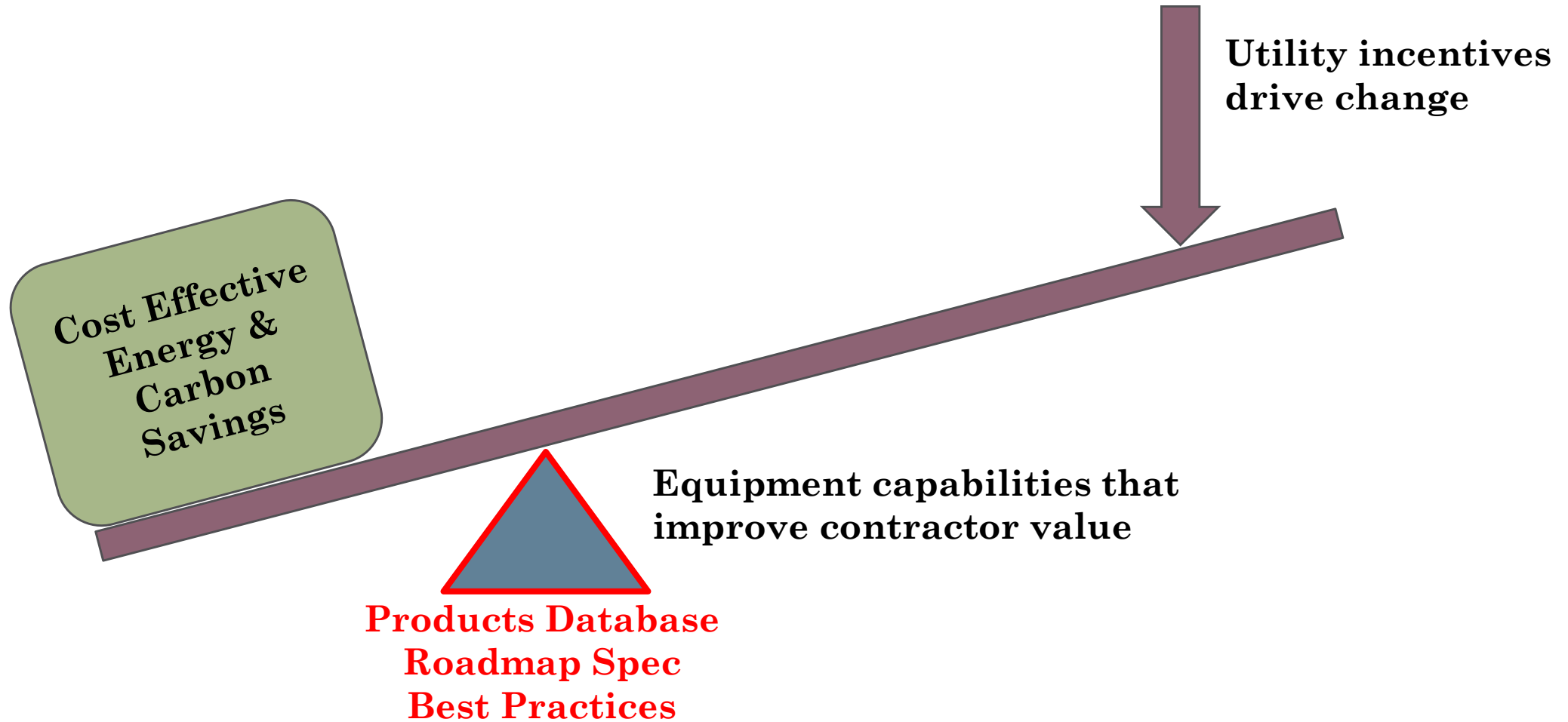
## TECHNICAL POTENTIAL



### Market Transformation Potential of the ASHP - 2018 ACEEE Paper Excerpt

ASHP systems are based on a seasonal COP of 2.2 for water heating and 3.3 for space heating sourced by a 50% efficient electrical grid (generation, transmission and distribution losses). 50% efficient is high, but chosen as a proxy for a gas turbine + renewable energy dominated utility grid likely by 2050. The iASHP systems could also be powered on-site by gas. Such systems would need COP values not much higher than 1.1 for water heating and 1.65 for space heating to provide the equivalent source energy reduction. The lighting baseline estimate is adjusted to pre LED conditions NEEA's building stock assessment (NEEA) values, with end state efficacy estimates of 100 lm/W for residential lighting and 150lm/W for commercial. The photovoltaic "savings" are based on a projected 1000 GWp of installed capacity under a solar resource of 1400 kWh/Wp.

# Creating an “MT Fulcrum”



# Collaborative Projects

## What

- Recommended by workgroups
- Scopes of work defined; co-funders identified
- Advisory groups will be assembled
- Lead organization takes on contracting and facilitation

## Why

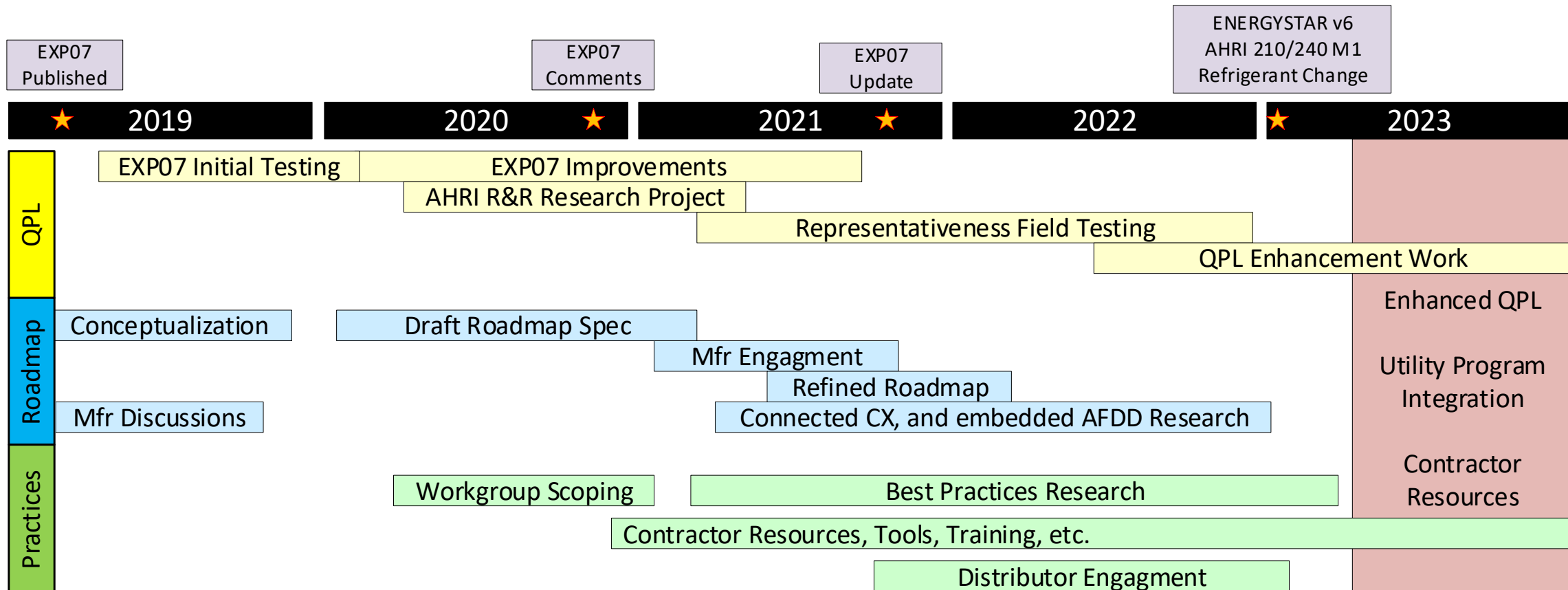
- Better alignment
- More brains, more better
- Greater likelihood results will be used/useful

**Workgroup #1 – Project 1A**  
Representativeness Testing  
of M1 and EXP07

**Workgroup # 2 – Project 2A**  
Connected Commissioning

**Workgroup #3 – Project 3A**  
Best Practices Meta Study

# Draft Timeline



# Website is Live!

Chris Burgess, MEEA

<https://www.mwalliance.org/advanced-heat-pump-coalition>

## The Advanced Heat Pump Coalition

The Advanced Heat Pump Coalition is a group of utility and energy efficiency interested parties that has agreed to share knowledge and align efforts to have biggest impact on HVAC industry efforts that help utilities accelerate market adoption of residential heat pumps. A steering committee consisting of representatives from NEEA, NEEP, MEEA, NRCan, the U.S. EPA, California Energy Commission, and NYSEERDA provides periodic coordination of activities, webinars and meetings. Current general membership includes ~190 folks from utilities, non-profits, cities, and research organizations from across the US and Canada (heat pump nerds).

The coalition is not a formalized organization. This is a "coalition of the willing" and as such, there are no dues or obligations. The hope is this will focus collective resources to identify gaps and fund the actions identified. Please see links to shared documents, webinar recordings, and other materials below. [Contact Theo](#) to join.

### Contents

- [Shared Documents](#)
- [Workgroups](#)
- [Calendar](#)
- [Membership](#)
- [FAQs](#)

[Shared Documents](#)

# WG 1 – Improved Test Procedure & QPL

Dave Lis, NEEP

## **Vision**

- The marketplace (Efficiency Programs/manufacturers/contractors) can identify ASHP products that will deliver actual performance

## **Desired Outcomes**

- An improved test procedure is developed and validated to show enhanced representativeness of ASHPs
- An Advanced ASHP Qualified Product List (QPL), based on the results of an improved test procedure, is built
- Efficiency Programs use QPL to incentivize adoption of advanced ASHPs that deliver real world performance, increasing savings
- Long term- Federal Standards program ultimately more representative test procedure and rating

## **Mechanism employed**

- Improved Test Procedure
- Qualified Products List

# WG 1 – 2020 Update

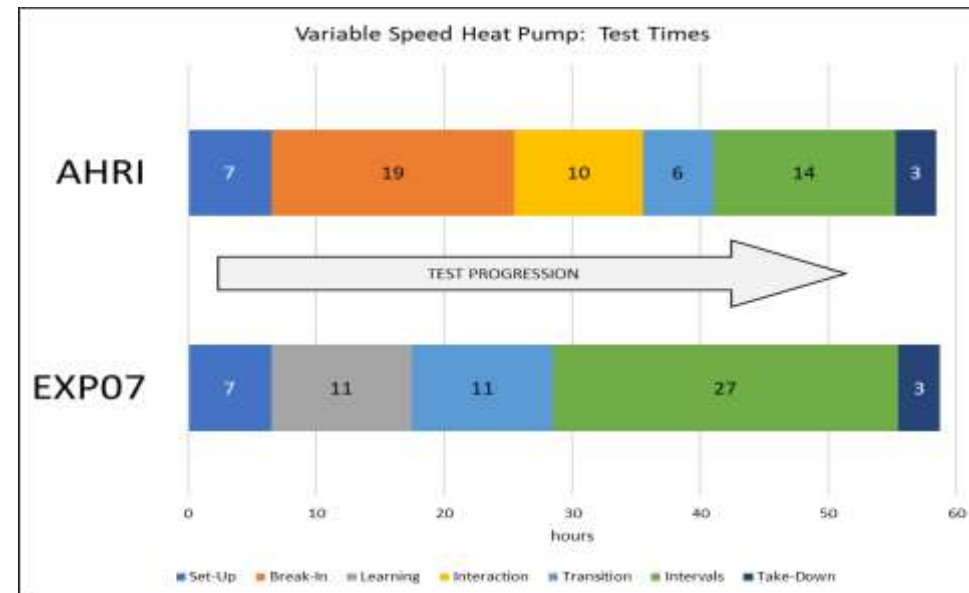
Dave Lis, NEEP

## EXP07 Lab Testing

- Lab testing to date of 19 units (15 ductless and 4 ducted units)
- July 7<sup>th</sup> Initial Findings Report and Plain Language Guide Published – EXP07
- Baseline of Uncertainty and Burden

## NEEP QPL Development

- More representative seasonal rating
- Verifiable performance mapping



NOTE: Test burden time depends a lot on what you consider is part of the test and where it is tested (3<sup>rd</sup> party lab vs Mfr lab)

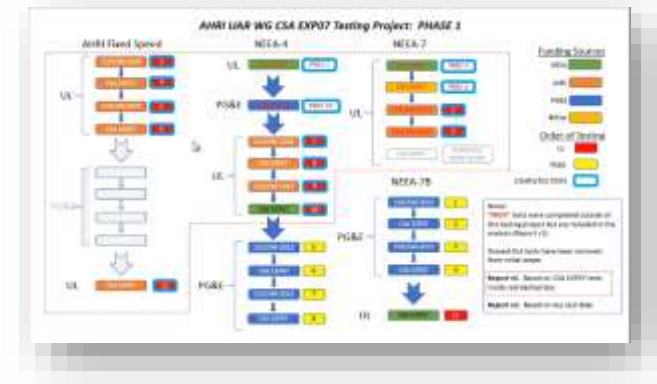
Viewed differently EXP07 can take 3+ times longer than M1

# Test Procedure Work

# AHRI Repeatability & Reproducibility Research Project

- 1 single speed, 1 variable speed unitary, 1 ductless mini split
- Testing at UL, followed by testing at PG&E Lab, then back to UL
- Purdue University Analysis with focus on EXP07 and DOE M1

Mark Baines, UL



# CSA Development Committee

- Technical review version published March 2019
- Review comments due December 15, 2020
- Revised version to be published in Q4 2021
- Canada's Policy Objectives

Gary Hamer, BC Hydro

# EXP07 Development – Draft Timeline

Review & Disposition  
of Comments from  
EXP07 Technical Review

Editing

Publication  
EXP07 v1



Non-Accredited Test Procedure

Jan '21

Jun '21

Sept/ Oct  
2021

## **Funding Support**

NEEA  
NRCAN  
PG&E  
BC Hydro  
Hydro QB  
MB Hydro  
ENS/ NS DOE  
IESO  
FortisBC

## **Technical Support**

NEEP  
Bruce Harley Consulting  
Charlie Stephens  
Purdue University  
UL Labs

Seed Document

Public Review

Publication  
EXP07 v2

Accredited Test Standard

Aug '21

Feb '22

Oct '22

# NRCan and CanMET Field & Lab Testing

Mvuala Suami, NRCan

## **Yukon Territory**

- 5 ducted units, backup electric heat
- Long winter - 8 months of winter

## **Ontario – Toronto area and Thunder Bay**

- 8 ducted units
- Very cheap gas vs electricity costs
- Use hybrid model with natural gas backup

## **Ontario - Ottawa**

- 3 ducted units, 1 ductless unit
- Backup electric heat

## **Research simulation house - Ottawa**

- 2 units in lab houses

# Field Testing Projects

## **Best of the Best Testing**

Robert Weber, BPA

- 30-40 cold climate central forced air heat pumps in 2 climate zones
- Equipment selection based on NEEP QPL key performance metrics
- 2-years of data collection (2021-2023)
- Primary objective: Eliminate/reduce ER heat and determine demand reduction value for BPA measure

## **Air Source Heat Pump Technology Demonstration Initiative**

Dave Podorson, Xcel

- Currently scoping the initiative – current thinking:
  - residential central dual-fuel systems
  - multifamily systems
  - Evaluate excess supply component for commercial facilities (i.e., how can they utilize excess renewable energy)

# Representativeness Project – 1A



## Research Questions:

- How well does CSA EXP07 represent field performance?
- How well does Appendix M1 represent field performance?
- What lab data could be collected to better predict field performance under a voluntary specification? (in addition to Appendix M1 but less than EXP07)

Rick Huddle, Cadeo Group



## Philosophy:

- Keep independent variables constant
- Measure capacity, power – calculate COP vs OAT
- Compare HSPF, HSPF2, and SCOPh to field-tested seasonal COP

# Representativeness Project – 1A



	Proposed Tests
Construction	Construction Trailers- HLL adjusted using insulation
Location(s)	Mobile Home or RV Park in Region IV
Occupancy	Unoccupied
Length	6 months for each units (heating season)
Number of units	6 total 3- ducted 3- ductless
Types of units	Ducted & ductless
Occupancy Load	Simulated
Sizing notes	Units all sized to building load
Comparison type	Field Seasonal COP compared to HSPF, HSPF2, and SCOPh from EXP07
Thermostat	Per OEM recommendation- but not "smart." All located in same location. No setback.

# Representativeness Project – 1A

Christopher & Dave

## Business Case

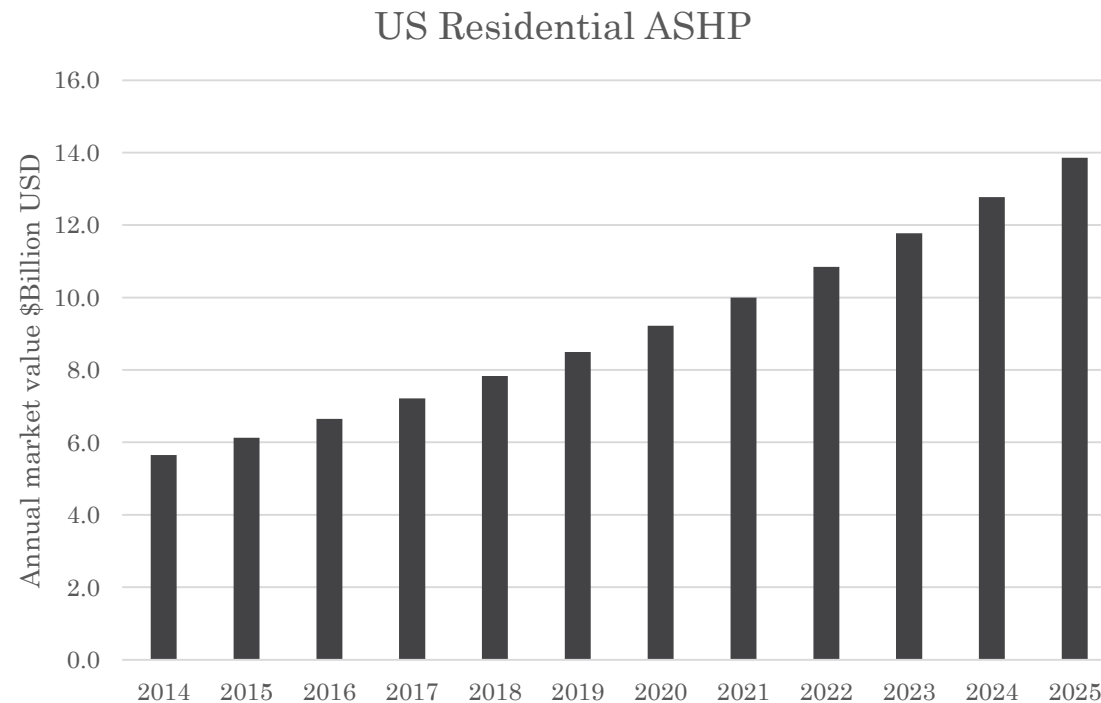
- The proposed \$450,000 project is intended to help differentiate products with a North American annual market value of over \$9.3 billion

## Advisory Group

- Funders
- SMEs
- AHRI
- Participating Manufacturers

## Funding

- ~ 64% committed to date



# Workgroup #1 - Next Steps

## Workgroup Meetings

- |                             |             |
|-----------------------------|-------------|
| • February 24 <sup>th</sup> | 3:00 PM EST |
| • April ?                   | TBD         |

## Representativeness Research Project 1A

- |   |                    |
|---|--------------------|
| • Secure verbal commitments from co-funders | Jan-March          |
| • Assemble Advisory group                   | March              |
| • Issue RFP                                 | April              |
| • Finalize SOW and Contract                 | May                |
| • Data Collection                           | September 2021 - ? |
| • Data Analysis                             | Q3 2022            |

# WG 2 – Roadmap Specification

## Vision

- Heat pump capabilities that enhance in-field performance are well supported by utility programs and provide additional value to the HVAC industry

## What is a “Roadmap Specification”

- It is not program specification
- It includes MT fulcrum items
- It leverages industry direction

## Desired Outcomes

- Manufacturers have clear understanding of what Utilities need
- Widespread utility program support exists for the features specified



# WG 2 – Final Draft Roadmap Completed

Abi Daken, EPA

## **Developing list of features**

- Equipment features; dropped market practices, e.g, proper sizing.
- Some features noted as useful only if/when utilities organize to provide specific market structures or information, e.g., national clearinghouse for rate structures.

## **Document organization**

- Table summarizing requirements
- More detailed description of features, with separate discussion of intentions and tradeoffs
- Two axes: time scale and types of features.

## **Time scale for features to be available**

- Now: Current products offer these features, and those that do can be identified.
- Soon: There is a clear path for features to be included in equipment, and for identifying which equipment has them.
- Future: Features are in the early stages of development and differentiation.

# WG 2 – Final Draft Roadmap

Abi Daken, EPA

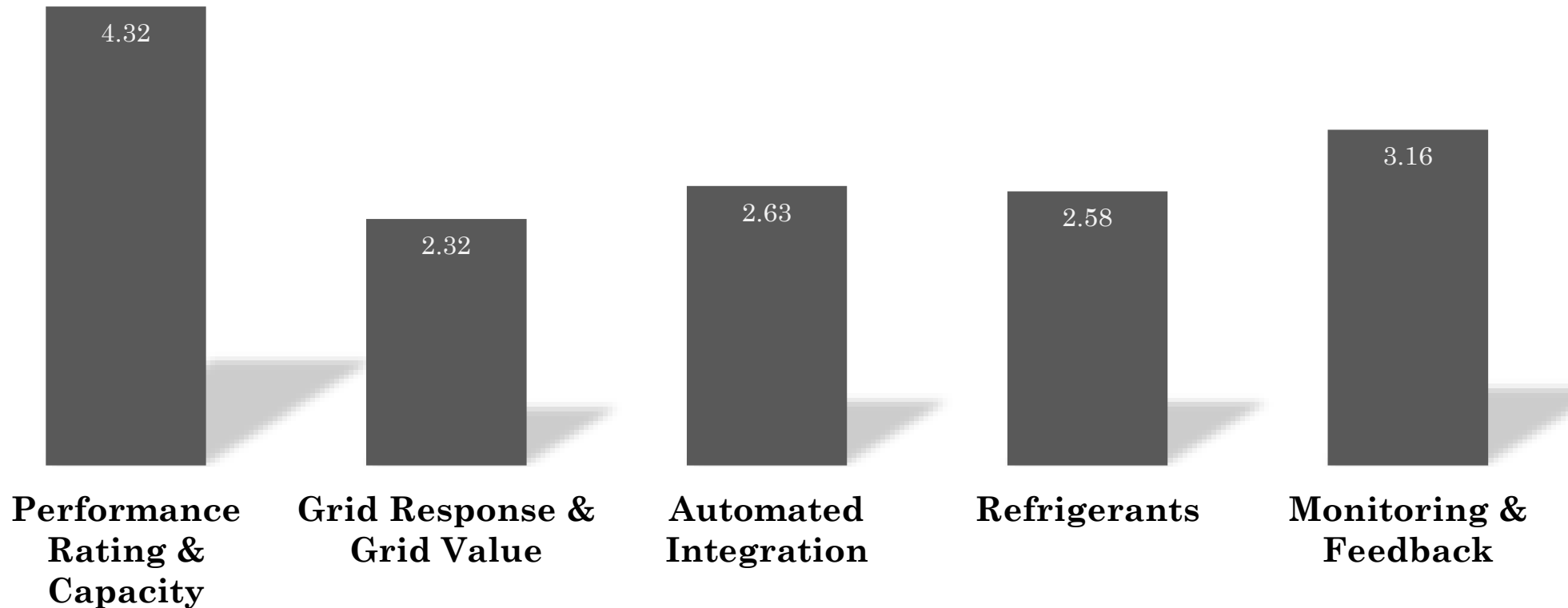
## Types of Features

- **Performance Rating and Capacity:** What metrics and what level or performance on the metrics.
- **Grid response and Grid Value:** Features that support controlling the time and location of energy use.
- **Automated Integration:** Systems work without complex setup, including legacy equipment.
- **Refrigerants:** Which refrigerants are used.
- **Monitoring and Feedback:** Equipment capability supporting automatic commissioning, utility feedback, and system performance monitoring.
- **User Amenities:** Improved user convenience and safety.

# Survey Question 1

N=19

Rank in order of greatest to least need for near term market research



# Survey Question 2

N=19

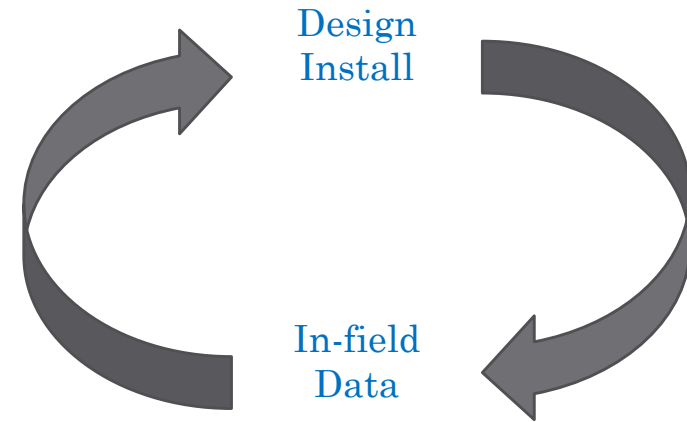
**For each item below, indicate how valuable each feature would be as part of a program specification, incentive, or training requirement:**

Automatically confirm installation (simplify verification process)	123
Automatically commission to suit site and design needs	132
Provide automatic fault detection and diagnostics	131
Provide periodic performance reporting	142
Can adjust to grid signals to provide demand shift/reduction	106
Equipment performance data for designers that is consistent and readily available	159
HP Controls automatic integration with other heating and cooling systems	128
Free design online tool(s) that help contractors size and design a system	137

# Connected Commissioning & AFDD

## Hypothesis:

In-field performance data  
can improve design/install/operation



## Research Questions:

- Will contractors welcome this?
- What do utilities need in order to provide performance based incentives?
- What data structures/agreements need to be in place for this to work?
- What data is already available? What else is needed?
- How much savings will result from performance based incentives?
- What is the path of least resistance?

# NREL, ORNL, & PNNL – Mapping AFDD Barriers

Jon Winkler, NREL

**Scope:** Characterize market and technical barriers impeding broader adoption of AFDD approaches for residential HVAC energy efficiency applications.

## Included AFDD Types or Approaches:

- Single Point, Add-On
- Multi-Point, Add-On
- Technician Smart Tools
- OEM Embedded, Parameter Threshold
- OEM Embedded, Performance Threshold



**Planned Outcome:** Identify gaps and provide the path of research and/or development necessary to more broadly apply AFDD types to energy efficiency measures.

If interested in being a project reviewer, please contact [Jon.Winkler@nrel.gov](mailto:Jon.Winkler@nrel.gov)

# PNNL - Smart Diagnostic Tool Campaign

Chrissi Antonopoulos, PNNL

**Problem:** Improperly installed/maintained ASHP/CAC cause degradation of COP, resulting in energy waste. A technology solution is desirable; broad-scale embedded AFDD is still a ways out.

**Solution:** Ensure HVAC installation & maintenance is performed well to prevent energy waste and equipment failure using smart diagnostic tools.

## Campaign Details:

- Stakeholder engagement & formation of advisory committee
- Characterization & testing of available tools
- Target audience: HVAC contractors, trainers, efficiency programs
- Installer feedback & lessons learned
- Develop & execute recognition program for participants
- Use Campaign as a bridge to promote embedded AFDD & HP installations

**Contact:** [techchallenge@pnnl.gov](mailto:techchallenge@pnnl.gov)



# Project 2A – Connected CX

Christopher Dymond, NEEA

## Desired Outcomes

- Define the feature set and capabilities that generate savings (kW and kWh)
- Understanding of HVAC contractor value proposition – what makes this something they would want enough to sell to their customers?
- Proof of concept --- we can monetize the utility value of connected CX heat pumps

## Description

- 3 different technology solutions tested (3<sup>rd</sup>-party add-on, Existing VSHP control solutions)
- Field test during one heating season
- Collaborate with manufacturers under NDA agreements

## Timeline

- |                    |                   |  |
|--------------------|-------------------|--|
| • Advisory Groups  | Q2 2021           |  |
| • Secure funding   | Q2-Q3 2021        |  |
| • Project          | Q4 2021 – Q3 2022 | Initial findings shared with funders in 2021 |
| • Publish findings | Q4 2022           |  |

# Workgroup #2 - Next Steps

## Roadmap Feedback

• Workgroup and Member Input	Q1	2021
• Outreach to Manufacturers	Q2-Q3	2021
• 2022 Version Published	Jan	2022

## Connected CX Project

• Advisory Groups	Q2	2021
• Secure funding	Q2-Q3	2021
• Project	Q4/21 - Q3/22	
• Publish findings	Q4	2022

## Other projects?

*“If you do not know where you are going, every road will get you nowhere”*

Henry A. Kissinger

# Workgroup 3 – Best Practices

## **Vision**

- HVAC designers/installers have the knowledge and tools that improve the business case for recommending advanced heat pumps to their customers.

## **Desired Outcomes**

- We understand how to optimize performance
- It is easy and profitable for contractors
- Best practices are accessible, known, and applied in the field

## **Mechanisms Employed**

- Manufacturer training for contractors
- Resources, tools, and trainings from utilities, efficiency organizations, and similar
- Online tools and connected system data

# WG 3 – Update

Matt Christie, TRC

## A lot is out there:

- Utility program resources, regional energy efficiency organization resources, manufacturer's guidance, Etc.

## Targeted Best-Practices Topics:



System  
Sizing/Design



Installation &  
Commissioning



Operations &  
Maintenance

**Project 3A: Solicit a best-practices resources catalogue, needs assessment, and resources development plan.**

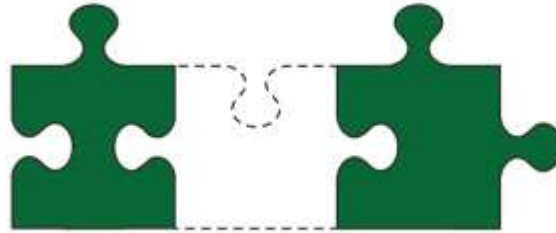
# WG 3 – Project 3A

Matt Christie, TRC

**Scope of work. Create the following:**



Resources  
Catalogue



Needs  
Assessment



Resource  
Development Plan

## **Intended Use Cases:**

- Regional Efficiency Organizations update their support offerings
- Programs extend resources to participating contractors, leverage for program design/implementation
- Installation contractors apply in the field
- Manufacturers develop and/or adapt trainings
- Code authors incorporate into requirements and enforcement mechanisms

# WG 3 – Project 3A

## **WG3 Activities for Project 3A**

- Reviewed, discussed, and collected initial resources and sources
- Narrowed target technologies and topics
- Wrote draft RFP's Scope of Work

## **Next Steps, Call to Action:**

- Identify the project host organization
- Solicit co-funding from heat pump coalition members

# General Discussion

## Questions

- What are you working that you did not see reflected in this presentation?
- What would you like to work on that was not covered?
- What else is missing?

## Group Poll

- What workgroup would you like to be invited to? (1, 2, 3, none)
- How much money do you have for research (in-kind or cash)

# Next Step - Workgroup Calls

## **WG #1 – Improved Test Procedure and QPL**

- February 24 @ 3:00 PM EST

## **WG #2 – Roadmap Specification and Manufacturer Engagement**

- March 2 @ 12:00 PM EST

## **WG #3 – Design & Install Best Practices**

- Not yet scheduled

**To join a workgroup – email Theo**



# Thank You

Special thanks Midwest Energy Efficiency Alliance for hosting a website