



Residential HVAC / DHW Performance and Potential Assessment

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Evergreen Economics

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Overall Study Objective

Develop representative, defensible estimates of HVAC and DHW energy and peak demand impacts.

First Kick-off meeting feedback:

- Study should be more focused on increasingly prevalent heat pump-based HVAC and DHW equipment.
- Sample frame can be expanded to include utility program tracking data (not just RASS).

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Updated Work Plan

Targets:

- Original: more representative of CT HVAC
- Updated: emphasis on heat pumps

Sample Frame:

- Original: RASS only
- Updated: incorporate utility program tracking data from residential programs:
 - Ductless heat pumps
 - Ducted heat pumps
 - Heat pump water heaters

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Next Steps

Urgent:

- Need utility program tracking databases by 2/21/20 to ensure full summer data collection / metering.
- Both utilities have indicated they can meet this schedule – essential for summer metering this year.
- (Data request coordinated with NMR, R1965)

Other Next Steps:

- Send customer-facing recruitment materials (letter) to utilities for approval.

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Targeted End Uses

Original Targets:

- Gas / Fuel Boilers: 60 sites
- Gas / Fuel Furnaces: 60 sites
- Ducted Heat Pumps: ~15 sites
- Ductless Heat Pumps: ~10 sites
- Heat Pump Water Heaters: ~5 sites

Revised Targets (focus on HPs):

- Ducted Heat Pumps: 50 sites
- Ductless Heat Pumps: 60 sites
- Heat Pump Water Heaters: 40 sites

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Other End Uses

HP sample naturally obtains other desired end-uses

- DHW (electric or gas) in all homes targeted for HVAC measures
- Many homes with DHPs will have other HVAC
- Homes with HPWHs will have HVAC
 - Approximately 40% will have furnaces
 - Approximately 40% will have boilers

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Project Steps

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Project Steps

Project will achieve:

- Energy metering of HVAC and DHW equipment at 150 homes for approximately 1 year.
- Gas usage estimated by metering electrical components of gas appliances.
- Estimated load shape and annual fuel usage for PSD update.
- Nameplate efficiency data added to RASS (from RASS sites, only).

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Project Setup

Key Steps:

- Data requests
 - RASS site contact info (issued)
 - Program tracking databases (issued w/NMR)
 - Summer 2020 and winter 2021: recruited site gas billing data
- Refined sample plan
- Energy metering equipment configuration

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Metering Equipment Installation

On-site Steps:

- Recruitment and scheduling
- Site assessment and nameplate documentation
- Metering equipment installation with licensed electrician
 - Compliance with new CT metering safety requirements
- Wrap up / Incentive



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Data QC and Analysis

- Data QC
- Estimate load shapes and peaks for HVAC and DHW end-uses
 - Regression analysis to control for known sources of variation (e.g., weather)
 - Identify statistically significant differences
 - Identify demand during grid peak conditions
- Deliver 8760 energy load profiles and data

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Deliverables: Updates to PSD

Deliverable	Details
Load shapes & Effective full load hours	<ul style="list-style-type: none"> • By capacity (HVAC) or volume (DHW) • Standalone vs supplemental (DHPs) • Sample too thin to draw statistically significant conclusions <i>within</i> measures (i.e., by capacity)
Seasonal on / off-peak %	<ul style="list-style-type: none"> • Direct input to PSD
Summer & winter peaks (ISO-NE)	<ul style="list-style-type: none"> • Input for impact evaluations (retrospective) • Useful for load forecasting (prospective)
Information to support baseline estimation	<ul style="list-style-type: none"> • Pre-existing technologies will be metered (furnaces, boilers, storage water heaters), but sample sizes may be too thin. • Data can be combined with other baseline studies (that look at alternative actions homeowners might have taken) to develop baseline estimates for HP measures.

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Deliverables: HP Potential

Deliverable	Details
One of two inputs needed to understand grid impacts of shifting to HPs (in conjunction with R1965)	<ul style="list-style-type: none"> Two inputs needed to understand grid impacts of shifting to HPs: <ol style="list-style-type: none"> This study will provide impacts on shift towards HPs at the widget level "HP / HPWH Baseline & Potential Assessment" (R1965) will provide estimates of achievable market potential for heat pump measures (scale of shift) These outputs will provide CT utilities with the basis for understanding grid impacts of shifting to HPs.
Drivers of variation in load shapes (e.g., occupancy)	<ul style="list-style-type: none"> Within measures, statistically analyze variation in usage and attempt to explain variation using variables such as occupancy, home size, etc. Sample likely too thin to draw statistically significant conclusions.

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Deliverables: HP Potential

Deliverable	Details
Cold climate HP usage	<ul style="list-style-type: none"> Data collection will focus on homes with cold climate HPs (from recent program incentives). We will analyze cold climate HP usage data for particularly cold days and compare to other winter days to inform whether they are used or function differently during very cold conditions.
Assess impact of partial displacement of gas / fuel HVAC by DHPs	<ul style="list-style-type: none"> Pre/post billing analysis for gas / fuel HVAC required to assess impact is not feasible within existing budget. Sample too thin to draw statistically significant conclusions due to variation in DHP system configuration.
Not included: In field cold climate HP efficiency (BTU per kW)	<ul style="list-style-type: none"> Monitoring equipment required is prohibitively expensive. Equipment is significantly more obtrusive (numerous sensors in the home; plumber required for HPWHs)

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Deliverables: Future Analysis

Deliverable	Details
Clean analysis dataset	<ul style="list-style-type: none"> • Database will contain tables of: <ol style="list-style-type: none"> 1. Demographic and building characteristics 2. Monitored equipment specs 3. Interval usage data (1-minute) for monitored equipment 4. Nameplate efficiency / sizing data • Data will be available for further analysis as new research objectives arise.

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Deliverables Summary

*Deliverables listed in RFP

Objectives	PSD (inform HP impacts)	Program/Resource Planning	Support Future Analysis?
Load shapes / Effective full load hours*	✓	✓	
Seasonal on / off-peak %*	✓	✓	
Summer and winter peaks (ISO-NE defined)*	✓	✓	
Drivers of variation in load shapes (e.g., occupancy)	✓	✓	
Cold climate HP usage (load shapes, peak)	✓	✓	
Clean dataset*			✓
Baseline	Will Inform		✓
Grid impacts of shifting to HPs (in conjunction with R1965)		Will Inform	✓
Impact of partial displacement of gas/ fuel HVAC by DHPs		Will Inform	✓
In field cold climate HP efficiency (BTU/kW)	No	No	No

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Schedule of Reports

Report 1: Fall 2020

- Covers summer 2020
- Focus on space cooling and water heating

Report 2: Spring 2021

- Covers winter 2021
- Focus on space heating and water heating

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Q&A

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