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Project Title:	2022 Energy Code Pre-Rulemaking
TN #:	236845
Document Title:	Residential Heat Pump Baselines
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California Energy Commission Docket Unit, MS-4
Docket No. 19-BSTD-03
1516 Ninth Street

Sacramento, CA 95814-5512

Subject: Comments on the Proposed Changes for Low-Rise Residential Heat Pump Baselines for the 2022 Energy Code

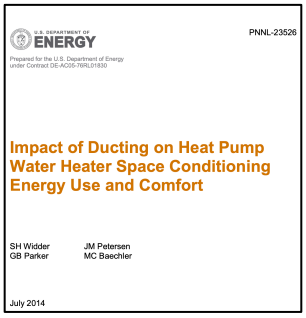
Dear Payam Bozorgchami:

On February 11, 2021, Southern California Gas Company (SoCalGas) provided comments on the proposed updates to the 2022 the Building Energy Efficiency Standards (Energy Code), specifically on heat pump baselines for low-rise residential buildings, presented at the January 26, 2021 California Energy Commission (CEC) workshop, and asked CEC Staff to consider technical comments on three topic areas.

I respectfully offer the following responses to SoCalGas's comments for your consideration:

1. Using the oldest, least well-informed research from 2013, but nothing since then, SoCalGas requests that CEC evaluate the change in HVAC energy resulting from use of HPWHs when they draw from conditioned air within the apartment. That research has been performed 4 times by the Department of Energy, in 2014, 2016, 2016 and 2018, then additionally summarized as recommendations in 2019 at the ACEEE Summer Study by Dr. Sarah Widder and Ben Larson of Ecotope, from which I quote:

"*The collective findings suggest that HPWHs save energy in almost any location*, including interior conditioned space, but the energy savings potential is affected by the HVAC system efficiency in those situations. The optimal installation location is also influenced by climate, where interior installs are favored in warm climates and basement or garage installs are best in cool climates. *Ducting HPWHs is never recommended for energy reasons*, although it could be considered to address comfort concerns." (Italics are mine)


PNNL-23526

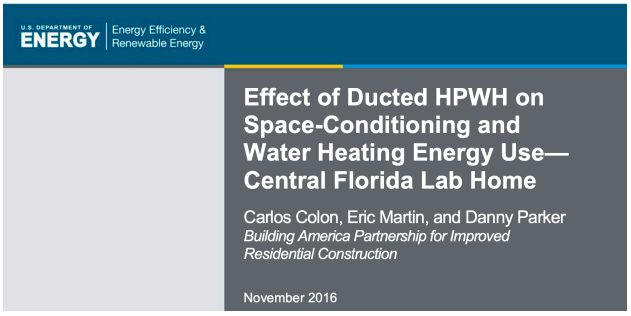
ENERGY

Prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830

Impact of Ducting on Heat Pump Water Heater Space Conditioning Energy Use and Comfort

SH Widder GB Parker JM Petersen MC Baechler

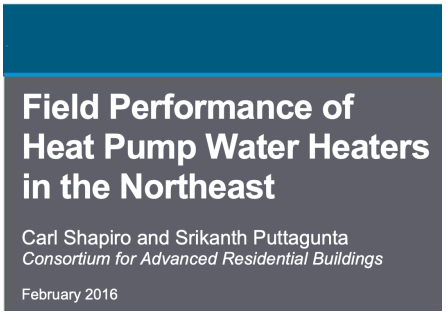
July 2014


U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Effect of Ducted HPWH on Space-Conditioning and Water Heating Energy Use—Central Florida Lab Home

Carlos Colon, Eric Martin, and Danny Parker
Building America Partnership for Improved Residential Construction

November 2016


Field Performance of Heat Pump Water Heaters in the Northeast

Carl Shapiro and Srikanth Puttagunta
Consortium for Advanced Residential Buildings

February 2016

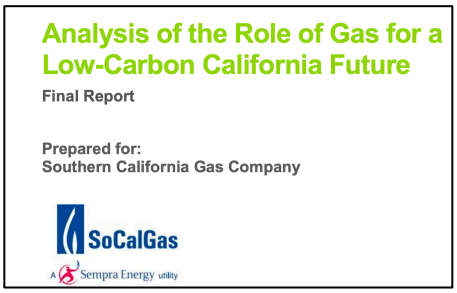
To Duct or Not to Duct: Evaluating the Space Conditioning Impacts of Heat Pump Water Heaters in the PNNL Lab Homes

Sarah Widder and Graham Parker, Pacific Northwest National Laboratory
Brady Peeks, Northwest Energy Works
Greg Sullivan, Efficiency Solutions
Scott Shaffer, GE Appliances

The HPWH Handbook: Optimum Installation Practices and Answers to Lingering Research Questions

Sarah Widder, PhD, Cadeo Group LLC
Ben Larson, Ecotope, Inc.

2. SoCalGas inquires as to what are the installation costs of Heat Pump Water Heaters. SoCalGas has published on this topic in their 2018 "Analysis of the Role of as for a Low-Carbon California Future"with their contractor Navigant. They found that a Condensing Tankless Water Heater cost $4,497 while an Electric Heat Pump Water Heater cost less, at $4,313. See below tables 2-6 and 2-7 from their study.



NAVIGANT

Analysis of the Role of Gas for a Low-Carbon California Future

Table 2-6 summarizes installed costs for high efficiency gas appliances. These appliances were analyze as incremental values to the energy efficiency already included in the Potential and Goals study. The team did not analyze advanced gas technologies such as gas heat pumps for space heating or micro combined heat and power (mCHP) systems.

Table 2-6. Gas Energy Efficiency Measures Selected for Analysis

Building Segment	Gas Technology (Installed Base)	Installed Cost	Source/Notes
Residential (per home)	Gas Furnace (92% AFUE, SEER 14 AC)	$10,213	Based on KPF Group Appliance Data for existing home, fully installed cost in 2016
	Condensing Tankless Water Heater	$4,497	Based on KPF Group Appliance Data for existing home, fully installed cost in 2016[49]
	ENERGY STAR Gas Clothes Dryer	$615	Based on DEER Workpaper, has $50 incremental cost

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Analysis of the Role of Gas for a Low-Carbon California Future

Table 2-7. Residential and Commercial Electric Appliance Cost Estimates

Building Segment	Electric Replacement (Efficiency)	Installed Cost	Source/Notes
Residential (per home)	Electric Heat Pump (SEER 14, HSPF 8.2, COP 3)[51]	$8,152	Based on KPF Group Appliance Data for existing home, fully installed cost in 2016
	Electric Heat Pump Water Heater (EF 2)	$4,313	Based on KPF Group Appliance Data for existing home, fully installed cost in 2016
	Electric Clothes Dryer (Baseline)	$509	Based on KPF Group Appliance Data for existing home, fully installed cost in 2016

Should SoCalGas not believe their own research, the Sacramento Municipal Utility District has provided residential retrofit costs to the CEC in Docket 19-DECARB-01, excerpted below, which are inherently conservative prices compared to new construction. The Electric-to-Electric costs are closest to new construction, as they avoid wiring upgrades, and a 50 gallon high-efficiency HPWH tank costs $3629 to install, on average. A Gas-to-Electric costs more, at $4,155, both lower than the $4,313 found by SoCalGas in 2018. A review of the Standard Deviations from the Average is informative as to the range of retrofit prices.

Docket Number: 19-DECARB-01
Project Title: Decarbonization
TN Number: 234862
Title: Sacramento Municipal Utility District Comments - SMUD Residential Electrification Project Costs

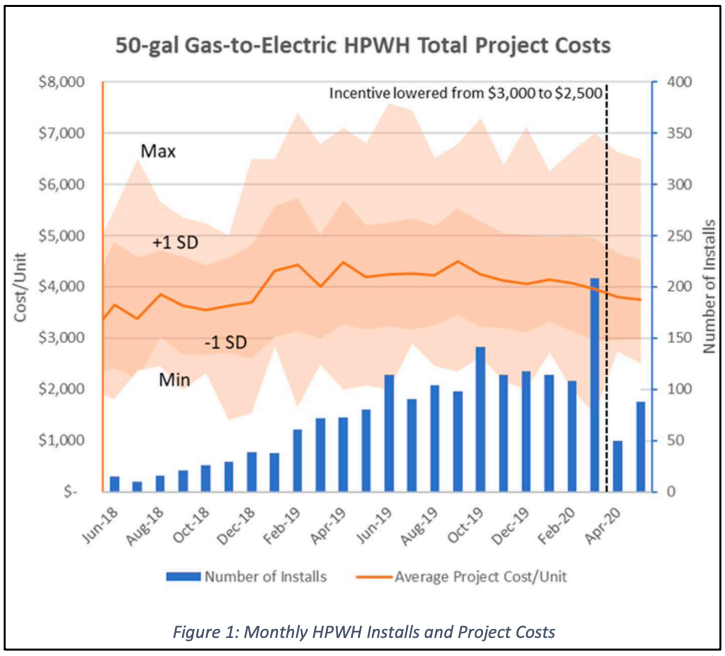

Figure 1: Monthly HPWH Installs and Project Costs

Table 1: HPWH Project Costs

SMUD Residential Heat Pump Water Heater Total Project Costs									
Technology		2018		2019		2020		Total	
		Cost/Unit	Count	Cost/Unit	Count	Cost/Unit	Count	Cost/Unit	Count
50-gal	**Gas to Electric**	**$ 3,763**	**114**	**$ 4,291**	**1,005**	**$ 3,983**	**531**	**$ 4,155**	**1,650**
	Electric to Electric	$ 3,299	51	$ 3,747	99	$ 3,769	37	$ 3,629	187
	All	$ 3,619	165	$ 4,242	1,104	$ 3,969	568	$ 4,101	1,837
65/80-gal	**Gas to Electric**	**$ 3,781**	**9**	**$ 4,578**	**25**	**$ 4,381**	**30**	**$ 4,374**	**64**
	Electric to Electric	$ 3,813	3	$ 3,806	12	$ 4,003	6	$ 3,863	21
	All	$ 3,789	12	$ 4,328	37	$ 4,318	36	$ 4,247	85

[1] Total project costs are assumed to include equipment, labor, permits, and profit, but these items are not collected by SMUD - some total costs may include additional costs or exclude some items.

[2] SMUD gas-to-electric HPWH incentive level of $3,000/unit began in May 2018 and went down to $2,500 in April 2020; the electric-to-electric incentive level is currently $500/unit.

3. SoCalGas inquires about the GHG impacts of the refrigerants used in Heat Pump Water Heaters. This is a worthwhile inquiry when comparing the annual GHG impact of leaked methane associated with a gas water heater to the possible (not guaranteed) GHG impact of leaked refrigerant from the HPWH. When I performed this analysis assuming a 3% methane leakage rate, from wellhead to water heater, I found that a single year of methane leakage associated with just the water heater equaled the GHG impact of leaking 100% of the refrigerant in a HPWH.

   While my analysis was done in consultation with two leading researchers, one in water heating and the other in climate change science, I encourage the CEC to perform a similar analysis to authoritatively show the profound harm done to our environment by Methane leakage compared to refrigerant.

   Thank you for the opportunity to respond,

Sean Armstrong
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