Public Reporting Update and Preliminary Data Analysis

October 12, 2023

TECH CLEAN CALIFORNIA

Welcome!

Goal: Review objectives of TECH Clean California data reporting, present preliminary analysis results, and discuss next steps.

Guidelines:

- This is a webinar format, so please direct your questions to the Q&A feature. We will do our best to answer your questions during our reserved Q&A time.
- Today's slides and a recording of the presentation will be accessible on our website.

Get Involved:

Visit the TECH public reporting website at http://techcleanca.com/

Check out our FAQ
or submit questions to
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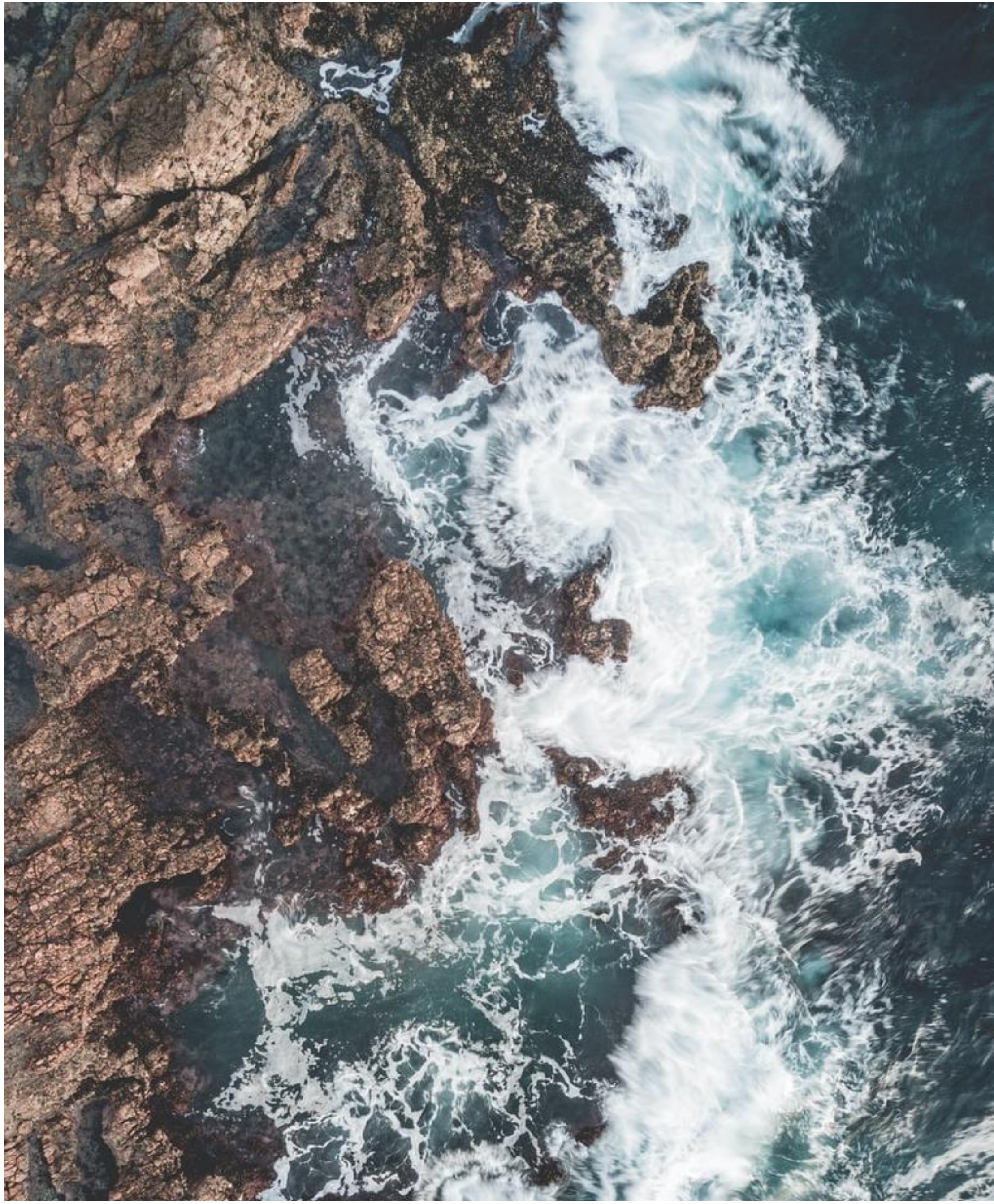
Agenda



1 Introduction

TECH Clean California Overview

What is TECH Clean California?

- California's flagship heat pump market transformation initiative
- Guiding principles: scale, equity, regulatory simplicity, market transformation
- Designed to put the state on the path to carbon free homes by 2045

Activities

- Spur the market with statewide incentives, training, and outreach
- Address market barriers with regional pilots
- Inform decarbonization framework through reporting and analysis

For a more complete overview check out techcleanca.com

	California Heat Pump Goals
Heat Pump Water Heating	**6 million heat pumps installed by 2030**
	Climate ready / friendly homes: • 3 million by 2030 • 7 million by 2035
Heat Pump HVAC	**50% of funding** delivered to low-income households or disadvantaged communities

Source: California Office of Governor website. July 2022.
"Governor Newsom Calls for Bold Actions to Move Faster Towards Climate Goals"

TECH Team: Energy Solutions, Association for Energy Affordability, Building Decarbonization Coalition, Recurve, Ortiz (The Ortiz Group), veic, Ardenna Energy, Frontier Energy, Electrify My Home, NCI National Comfort Institute, Inc., Tre'Laine

The TECH Clean California initiative is funded by California ratepayers and taxpayers under the auspices of the California Public Utilities Commission.

Major Data Flows

Energy Solutions — Application Data *from TECH-funded projects*

Energy Solutions — Layered Application Data *from Partner Programs (e.g. CCCE, SGIP)*

Opinion Dynamics — Survey Data *from Evaluators*

RECURVE — Meter-Based Consumption Data *from CPUC / CEC*

Energy Solutions, Opinion Dynamics — Market Data *from Industry Organizations (HARDI)*

Equipment, Installation, Location, Cost

Customer, Contractor experience

Gas, electricity, utility bill, and GHG impacts for TECH participants

Meter-based customer targeting

Heat pump market, sales, and price tracking.

Comprehensive picture of the CA heat pump market

Deployment Progress to date (HP HVAC and HPWH combined):
> 1000 contractors participating
Single Family: > 15,000 units
Multi-Family: > 10,000 units
38% of incentives deployed in equity communities

[1] Central Coast Community Energy
[2] Self Generation Incentive Program

How Our Data Informs Decarbonization Decisions

Key Questions TECH Clean California Data Can Answer

Program Design

- How does contractor availability and experience affect installation costs and performance?
- How much does increasing efficiency save on utility bills versus adding in first cost?

Public Policy

- How do different electricity rates impact utility bill impacts?
- How did availability of TECH incentives impact the rate of heat pump installation across CA?

Local Gov and Community-Based Organizations

- Are electrical infrastructure upgrades needed more often for some areas?
- Will GHG savings increase with home age at the same rate that costs increase?

Private Investment

- What is the average avoided grid cost for a heat pump installation, and where is it captured?
- Which installations generate positive cash flow that could be lent against?

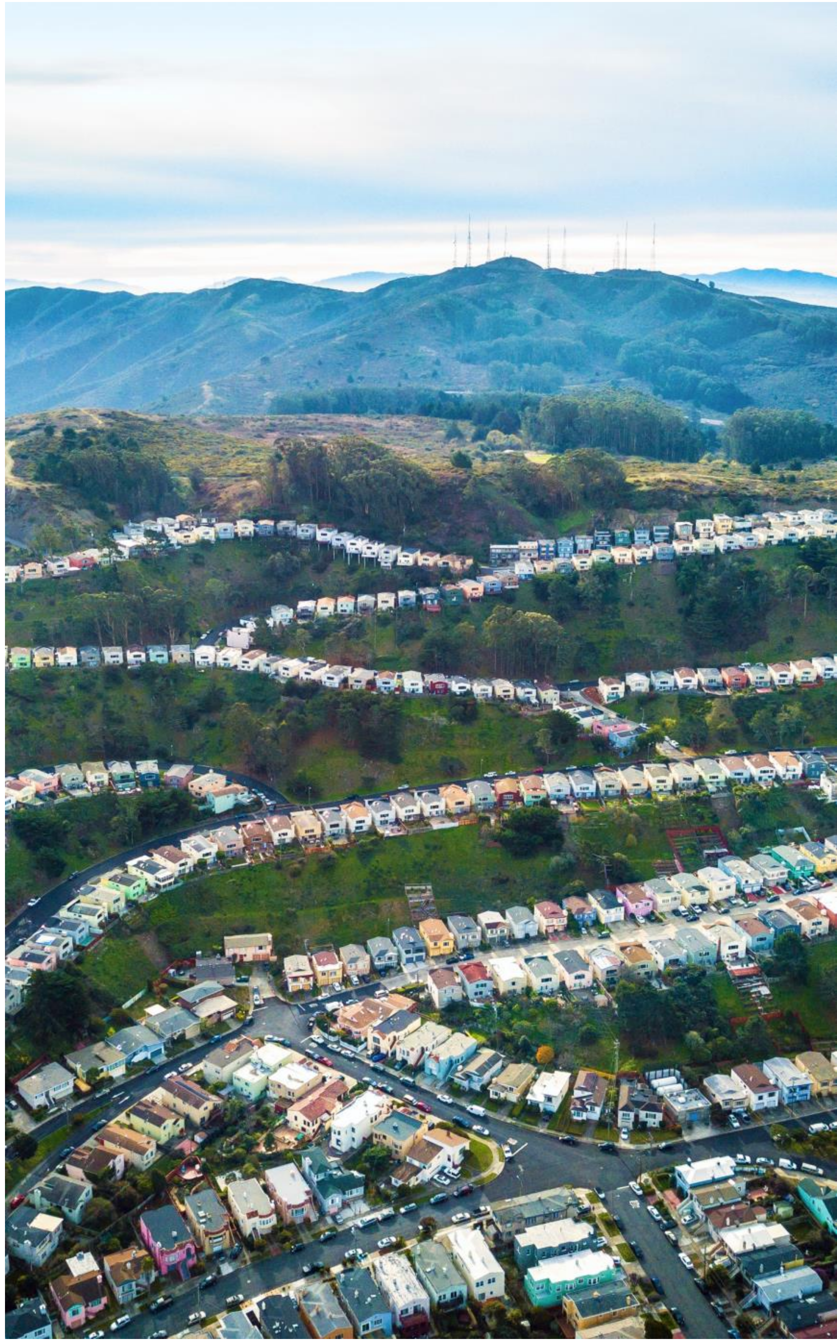
Data Webinar Goals

Our Priorities

- Share preliminary data analysis findings
- Present proposed methods for future analyses
- Answer questions, encourage stakeholders to start analyses

Not Our Priorities

- Tell stakeholders how to use analysis results
- Make claims about the overall California population



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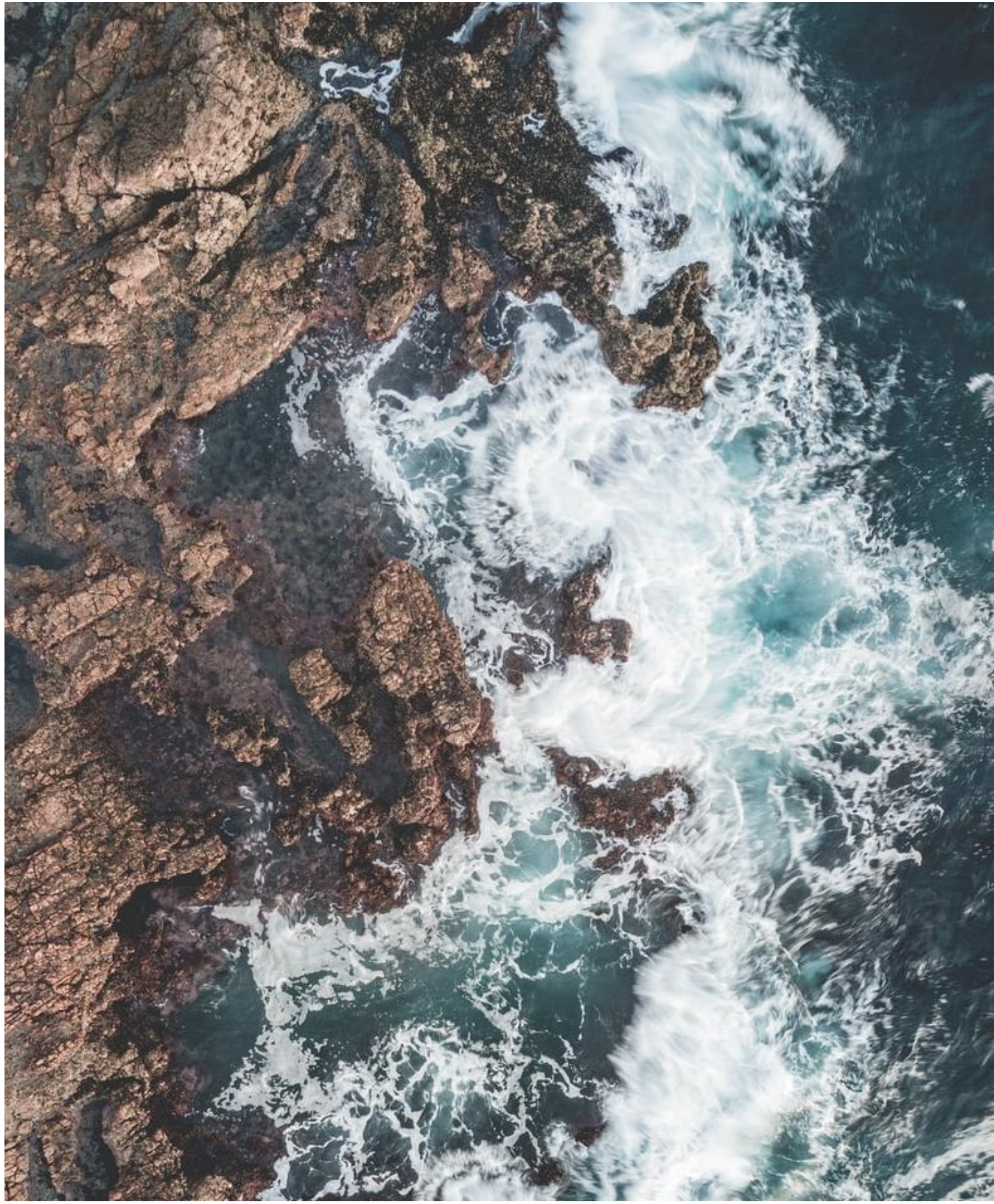

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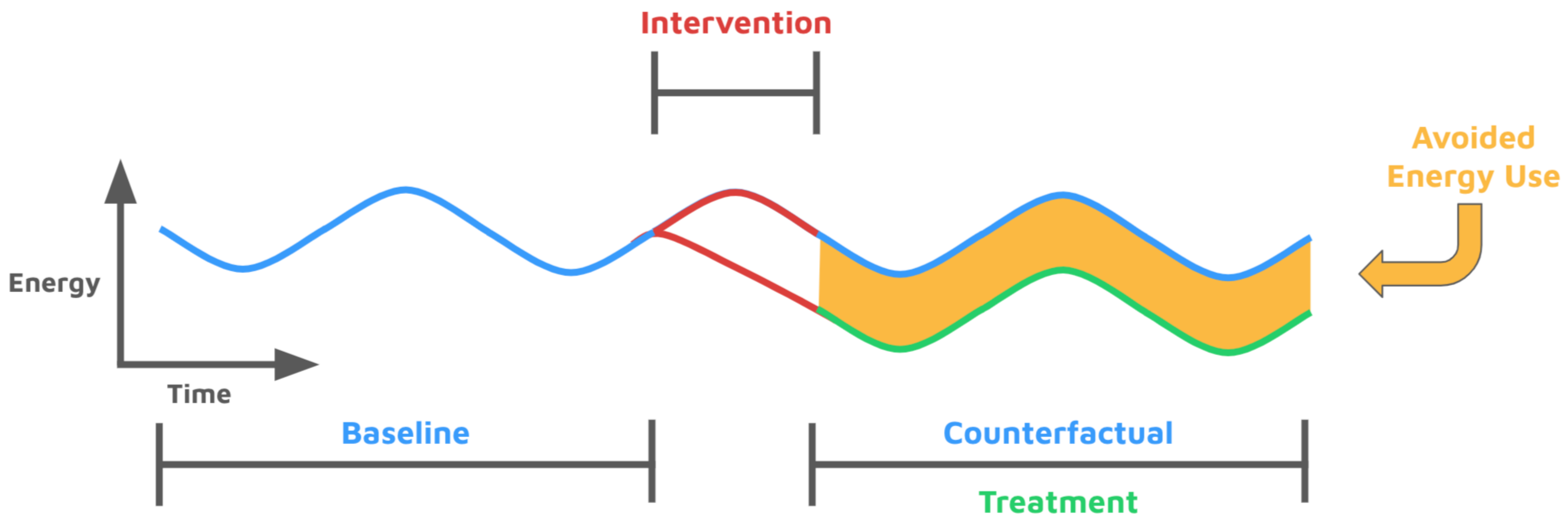
How much energy do residential heat pump retrofits save?

Preliminary Meter Data Analysis Methods

- Data source: Meter data collected by CEC via the Title 20 Section 1353 data request, covering six utilities: PG&E, SCE, SCG, SDG&E, LADWP, SMUD
  - **Note:** These preliminary results include approximately 630 projects across **PG&E territory only**
- Used open-source methods (OpenEEMeter) to analyze hourly electricity data and billing-level gas data
- CEC, CPUC, and our Evaluators Opinion Dynamics have been irreplaceable collaborators
  - Special thanks to Jason Harville's team at CEC



The Promise of Electrification

- Electrification is key to decarbonization. It also brings unique new equity and grid challenges.
- Key goal of metered impact analysis is to go beyond averages to optimize for continuous improvement.

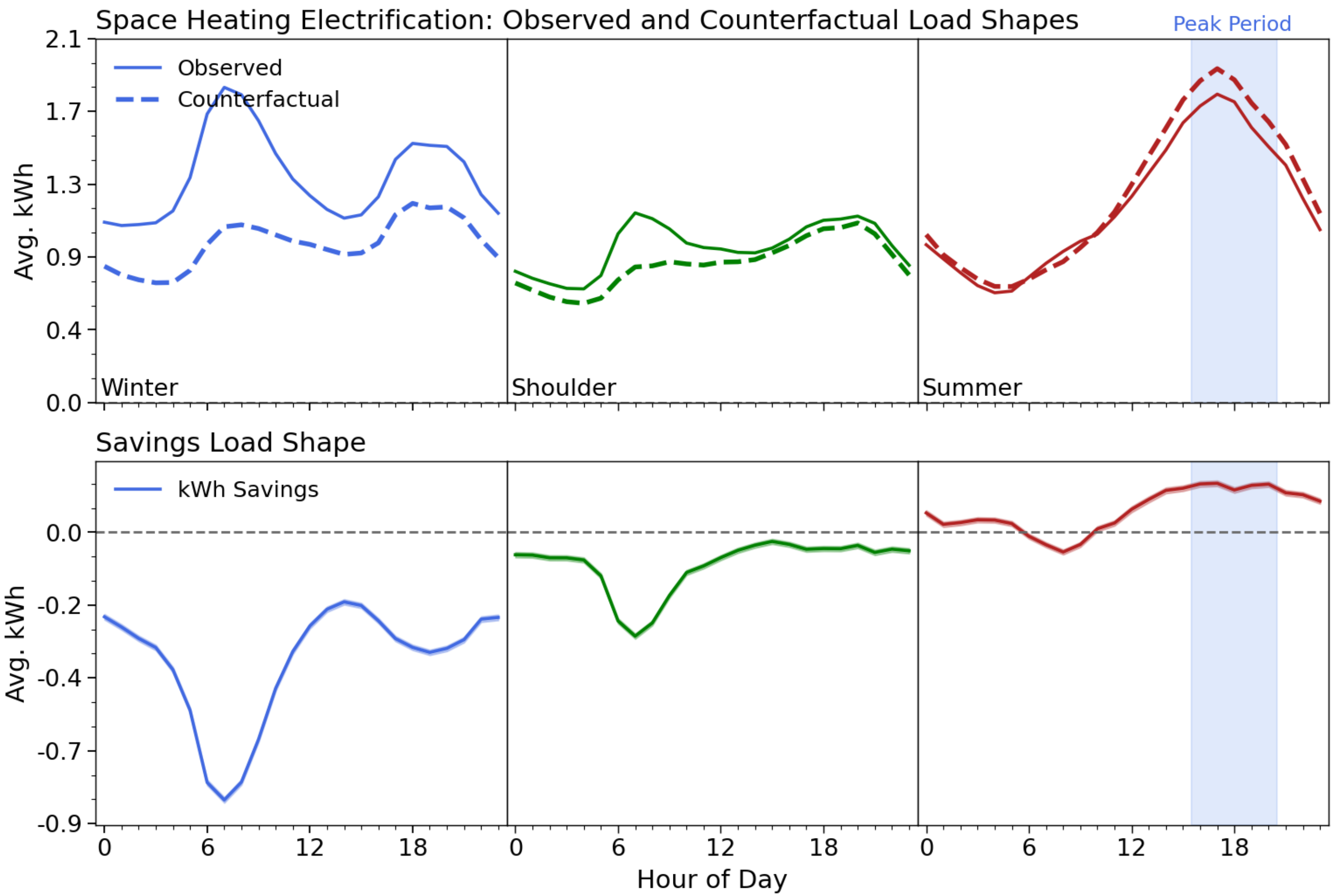
- **Overall preliminary results show significant net grid and climate benefits**
  - Net benefit to the grid $3,750 per HVAC project and $1,695 per heat pump water heater project
  - Net benefit to climate 10.9 and 5.7 tons GHG saved, respectively

Average Project	Electric Impacts				Gas Impacts			Total Lifetime Impacts	
Portfolio	Annual MWh Savings	Peak^ MWh Savings	Lifetime TSB*	Lifetime GHG Savings (Tons)*	Annual Therms Savings	Lifetime TSB*	Lifetime GHG Savings (Tons)*	Total Value*	GHG Savings (Tons)*
Space Heating†	-1.25 ± 0.11	0.088 ± 0.03	-$347	-5.25	235 ± 29	$4,097	16.14	**$3,750**	**10.89**
Water Heating‡	-1.47 ± 0.10	-0.078 ± 0.03	-$778	-4.23	219 ± 21	$2,475	9.92	**$1,696**	**5.69**

*Lifecycle net, 0.85 NTG, 2022 ACC, 7.6% quarterly discounting, varying climate zones. Calculated using open source FlexValue software based on the CPUC Avoided Cost Calculator
† 15-year EUL
‡ 10-year EUL
^June - Sept 4 - 9 pm

Space Heating Electrification Results - Electricity

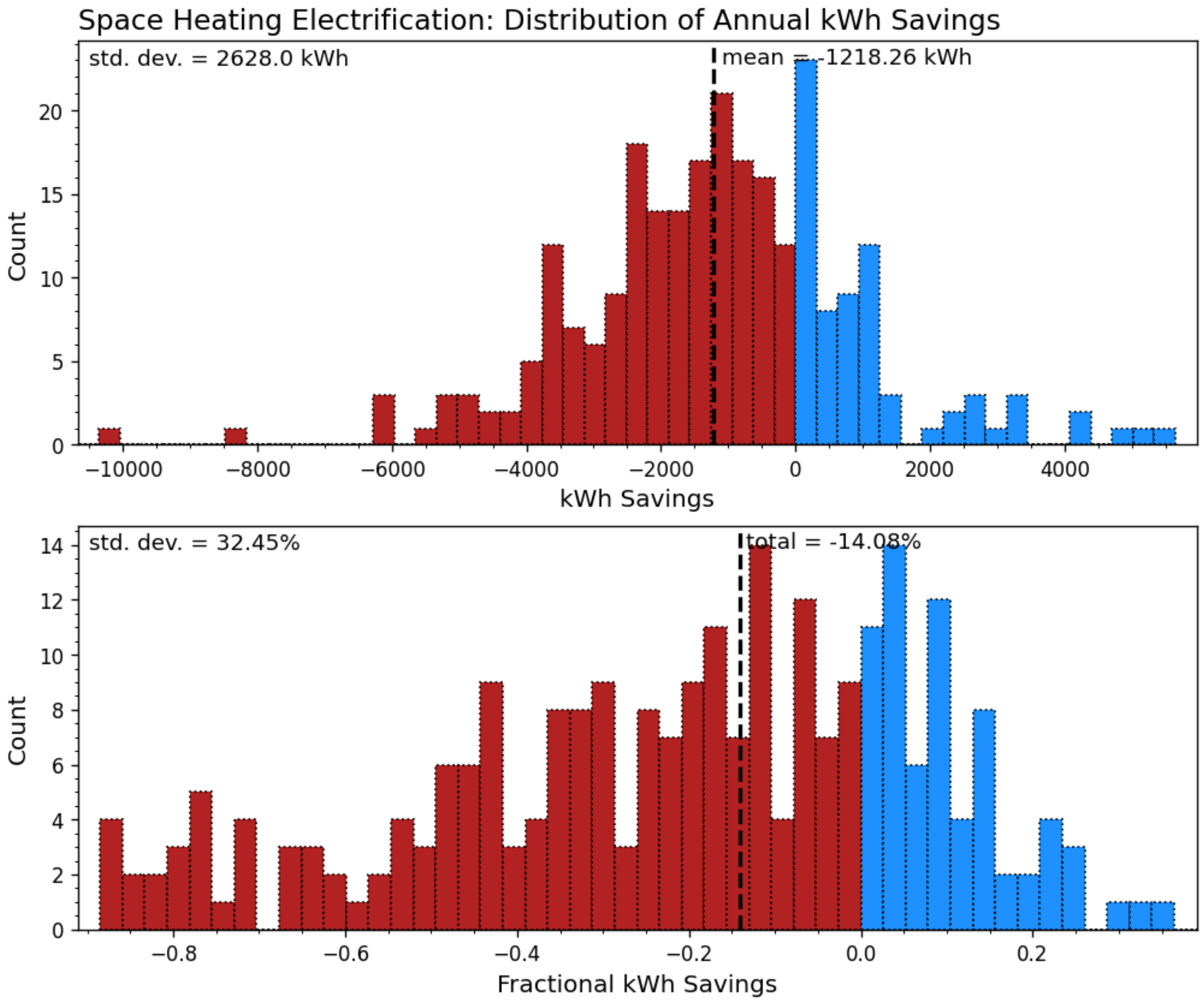
- Overall, 14% increase in electricity usage, but average 7.8% decrease during summer peak hours
- Increased winter consumption, as expected
  - Winter morning hours from space heating
  - Similar effect to lesser degree in shoulder months
  - Customer annual peak shifted to winter morning
- Midday and peak savings in summer due to heat pumps providing more efficient air conditioning



Results shown above are for the average TECH participant without on-site solar who completed a heat pump HVAC project.

Space Heating Electrification – Beyond Averages

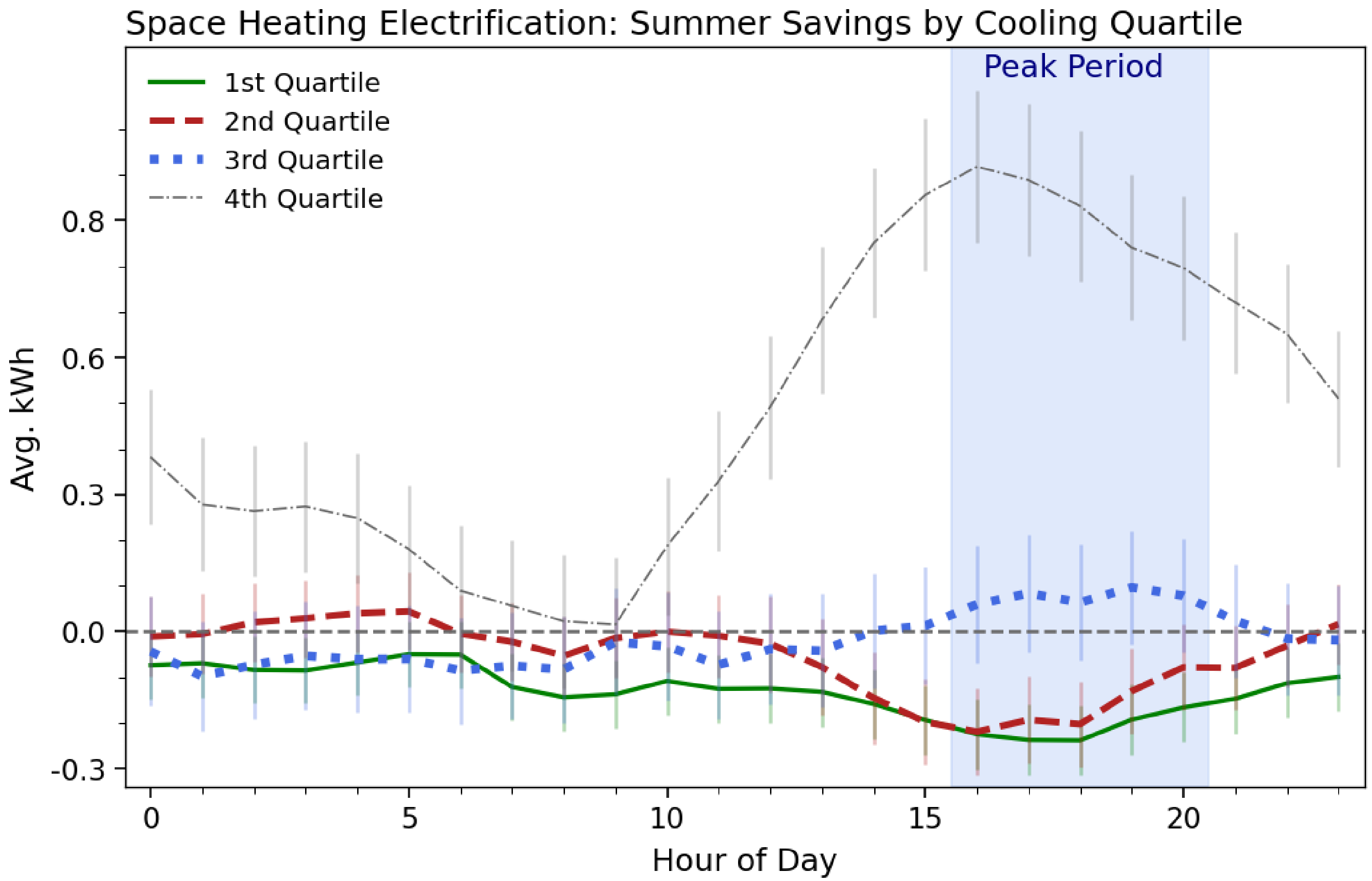
- Although the average project increased electricity usage by 14%, some customers actual reduced annual usage even while electrifying heating
  - Many customers saw significant net electric savings (10-20%+)
  - Question: was this driven by cooling savings?



Results shown above are for the average TECH participant without on-site solar who completed a heat pump HVAC project.

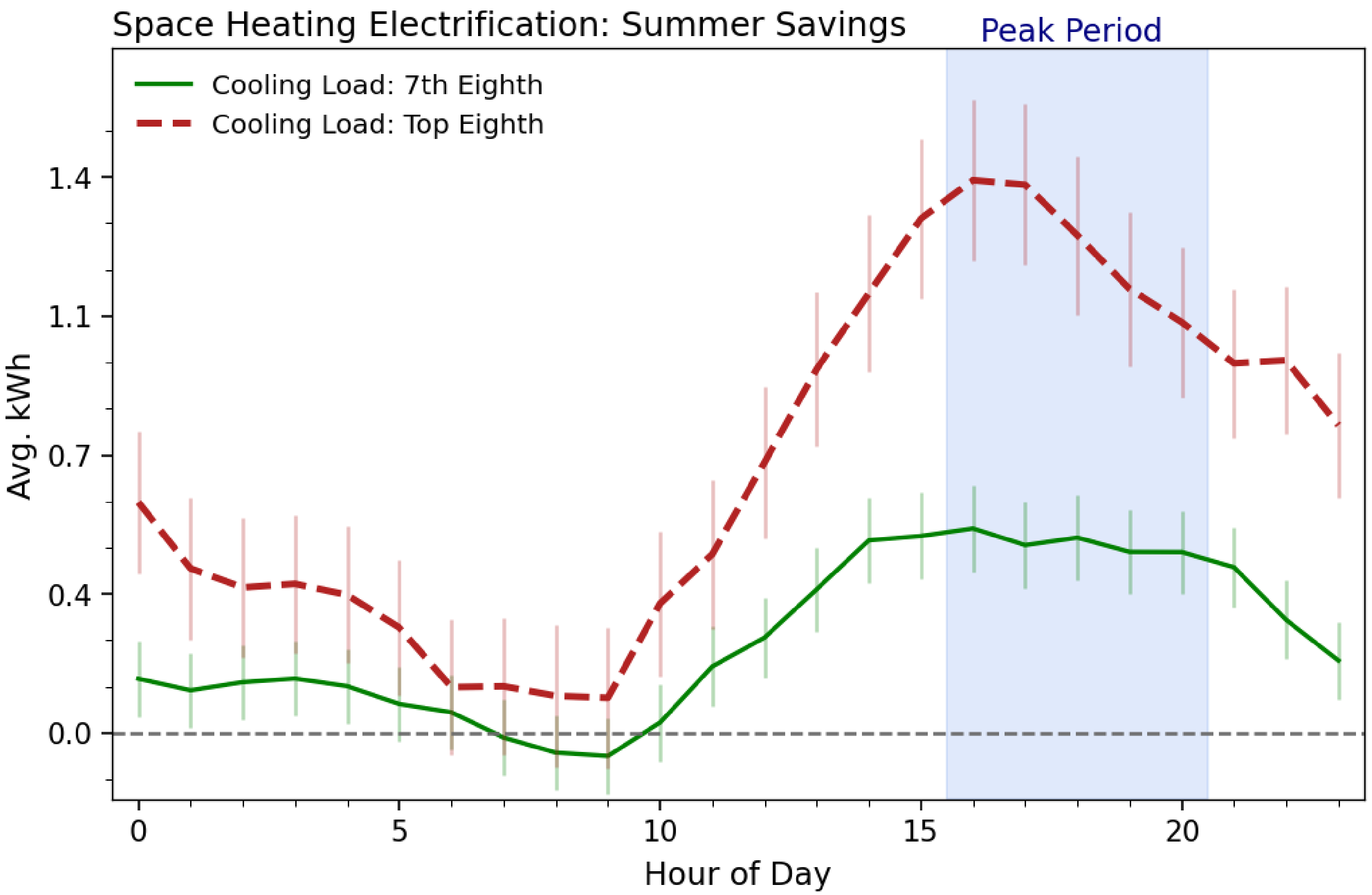
Striking Difference for Higher Baseline Cooling Users

- The highest quartile pre-participation cooling users achieved over 500 kWh per year in summer peak savings
  - Median pre-program annual cooling usage of 5,200 kWh
- New AC users (bottom 50%) added about 100 kWh of summer peak usage
- Moderate cooling users (3rd quartile) stayed about the same



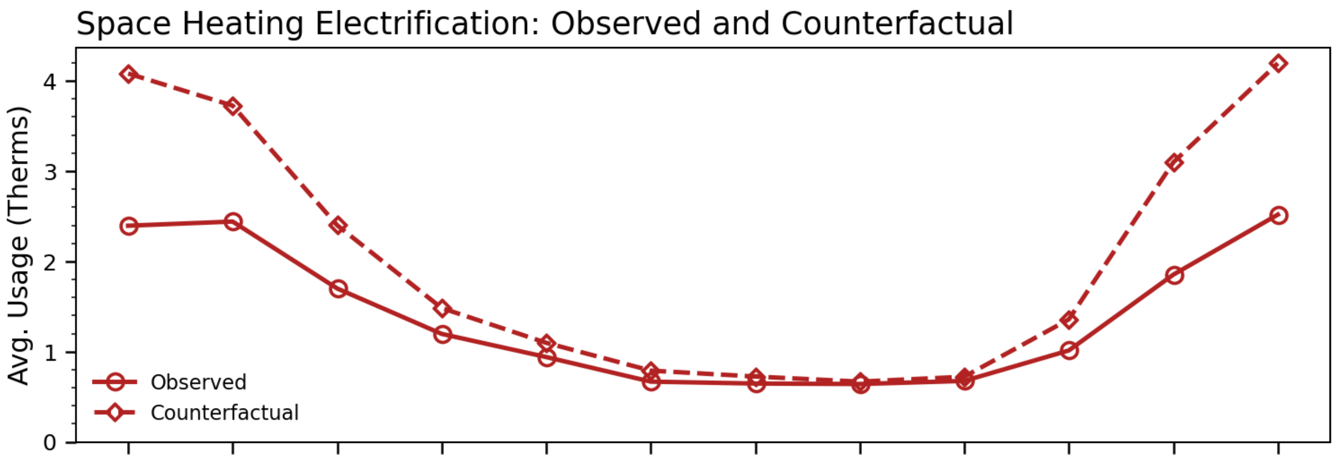
Extreme Cooling-Burdened Customers

- The top 8th of pre-participation cooling users saved over 750 kWh during summer peak
  - — $2,500 in lifecycle grid value for electricity alone
  - — Virtually 0 net GHG electric impact. Large summer peak cooling savings offset winter morning heating increases
  - — + all expected grid and GHG benefits of gas savings
  - — Most likely to experience significant bill impact benefits
- Over 1.5 million residential customers in CA already meet this profile



Space Heating Electrification Results – Natural Gas

- Annual Natural Gas Savings of 32%
  - Average project savings of 235 Therms per year
  - Average lifetime avoided costs / total system benefit of $4,100 from gas alone
  - 16 Tons lifetime GHG savings
- Top Quartile for Pre-Participation Space Heating
  - Over 380 Therms saved per year
  - $6,700 in lifetime gas grid value
  - 26 tons lifetime GHG savings from gas alone
  - The above represents +60% higher savings than average



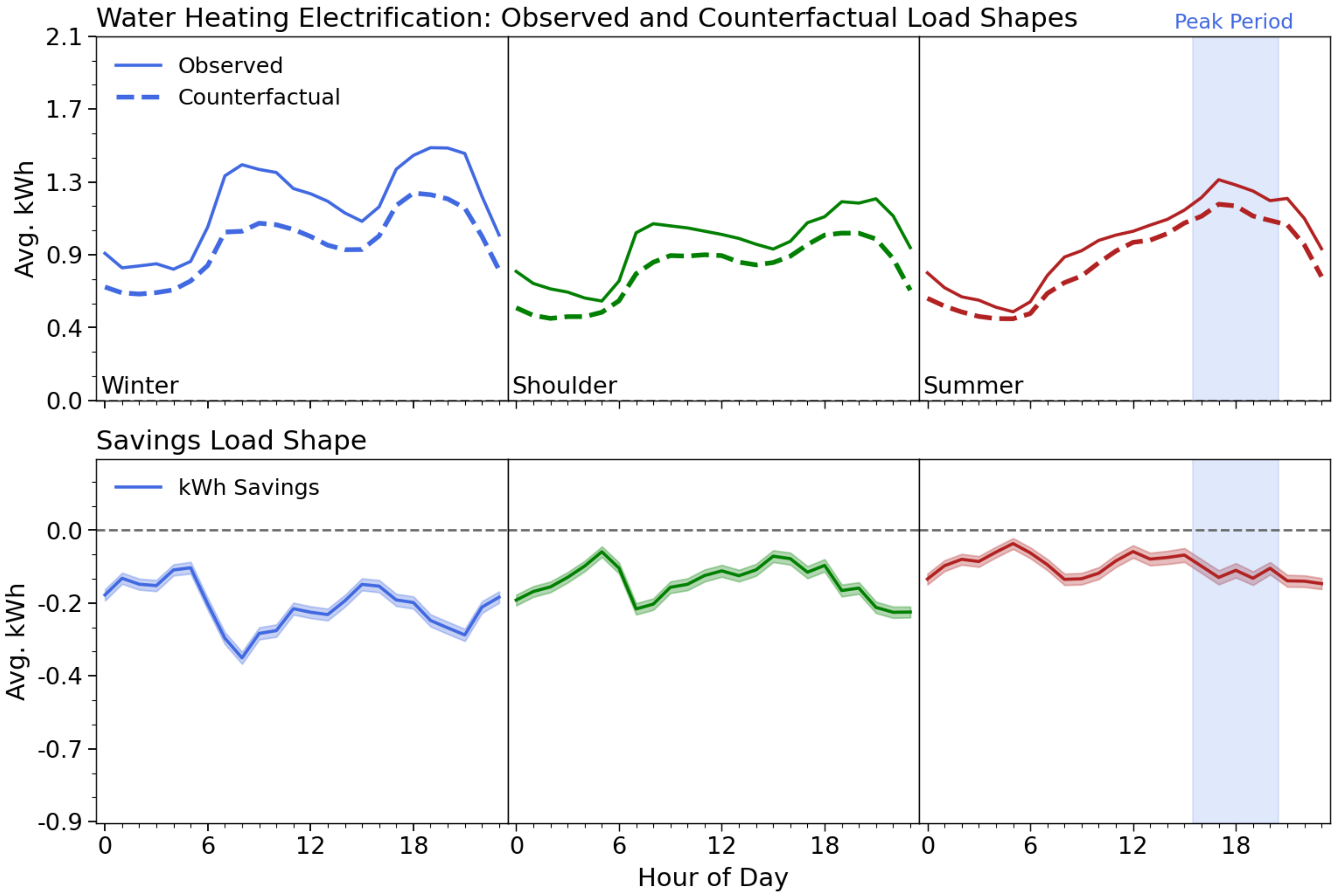
Space Heating Electrification (Avg. Gas Values)

Heating Quartile	Annual Heating Therms	Annual Therms Savings	Gas Grid Value*	Gas GHG Savings (Tons)*
1	99	104.0 ± 12.5	$1,773	7.11
2	212	180.1 ± 17.8	$3,152	12.32
3	315	274.4 ± 22.4	$4,787	18.84
4	1,018	382.6 ± 63.2	$6,696	26.37

* Lifecycle net, 15 year EUL, 0.85 NTG, 2022 ACC, 7.6% quarterly distounting, varying climate zones

Water Heating Electrification Results - Electricity

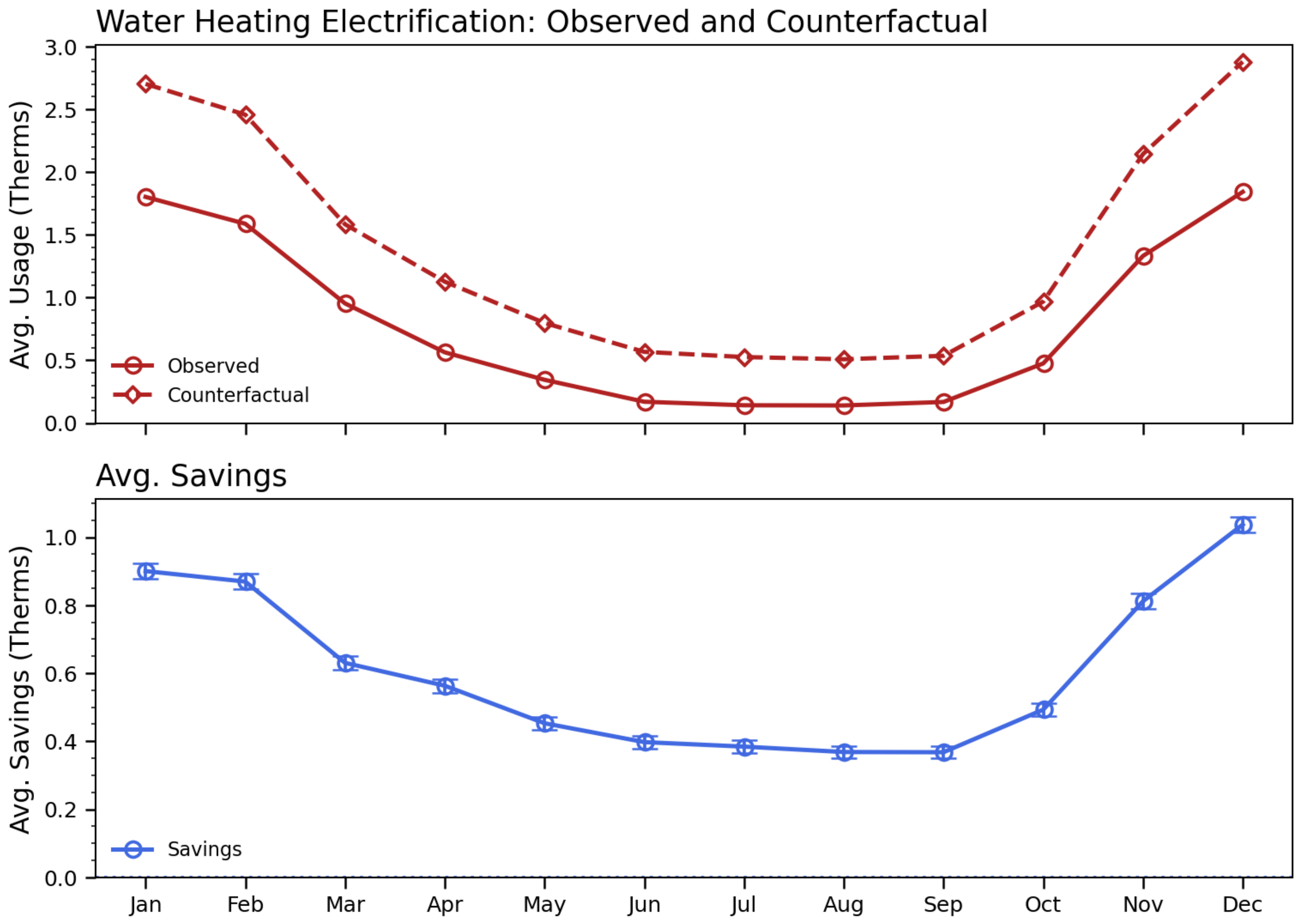
- Electricity increases through-out the year
  - Overall 14% increase in annual electricity usage
  - 11% summer peak period increase (4-9p)
  - New annual winter peak
  - Slightly larger increase in winter electricity consumption (colder input water, etc.)
  - Negative $778 electric-only grid value



Water Heating Electrification Results - Natural Gas

- Gas decreases throughout the year with minimal seasonal effects
  - 216 Therms (43%) total annual gas savings
  - Average lifetime avoided costs / total system benefit for gas only of $2,475
  - 9.9 Tons lifetime GHG savings for gas alone

—Average net heat pump water heater project impacts $1,696 in total system benefit (gas + electric) and 5.7 Tons GHG savings



3 How will we measure bill impacts?

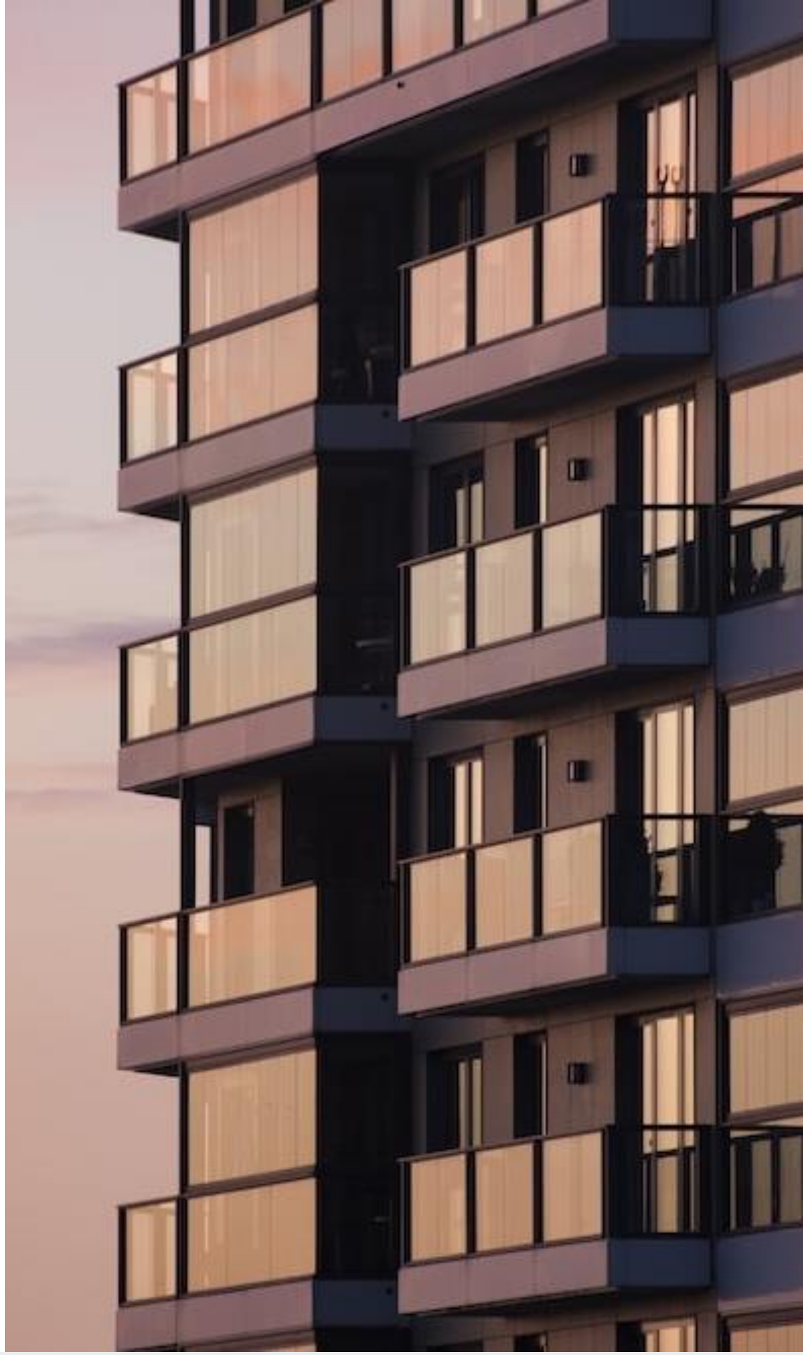
Bill Impacts Estimate

Methods

- Assume all customers are bundled IOU customers
- Assume all customers on Time of Use Rate
- All winter natural gas savings were above utility baseline allowance
- All winter electricity increases were below utility baseline allowance (due to becoming an electric heating household)

Findings

- Average household saved on natural gas bills, but electricity bills went up more than gas bills went down using the above assumptions
  - This could be mitigated in real-world scenarios by customers being on solar rates, or switching to more favorable rate plans
- HVAC heat pump customers who replaced an existing cooling system saved about as much on cooling as they added in heating costs each year
- However, customer survey results indicated that most participants thought their bills had gone down overall. This highlights the need for the more rigorous bill modeling and savings measurement (currently underway)



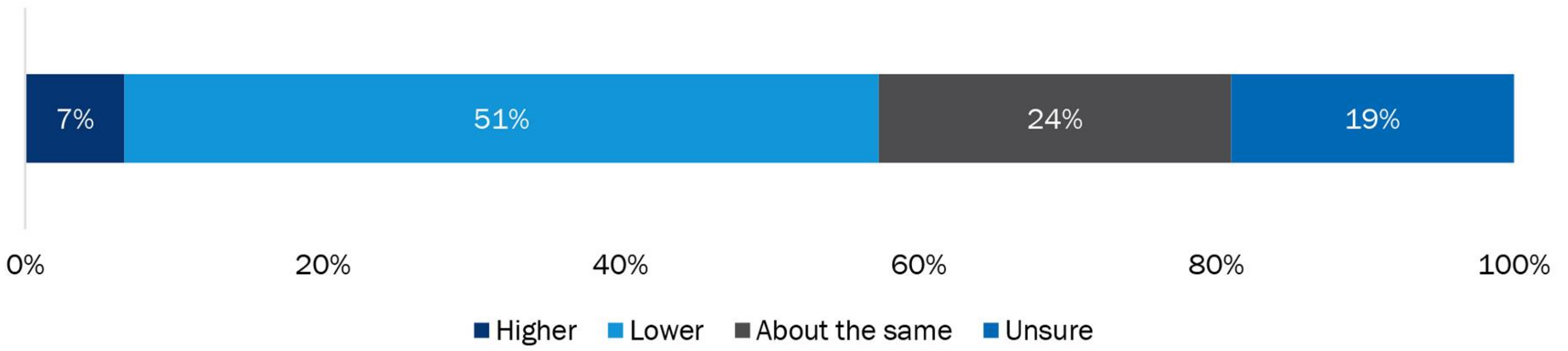
Customer Experience: Heat Pump Water Heater

Opinion Dynamics

- Results from a 6-month post-install customer survey conducted by Opinion Dynamics indicate most TECH participants thought their bills went down.
- Underlines the need for the full meter-based bill impacts analysis.

Since having their new HPWH installed, half (152 or 300; 51%) of respondents' monthly energy bills reportedly decreased. Almost three-quarters (109 of 152; 72%) of HPWH customers whose monthly energy bills went down mentioned they have a solar PV system that generates electricity for their home. Respondents were instructed to consider both gas and electric utility bills combined, if applicable.[7]

Figure 14. Change in Monthly Energy Bills Since Installing HPWH (n=300)



Source: "Insights into Customer Experience and Satisfaction", Opinion Dynamics. September 2023. https://techcleanca.com/public-data/evaluation-studies/

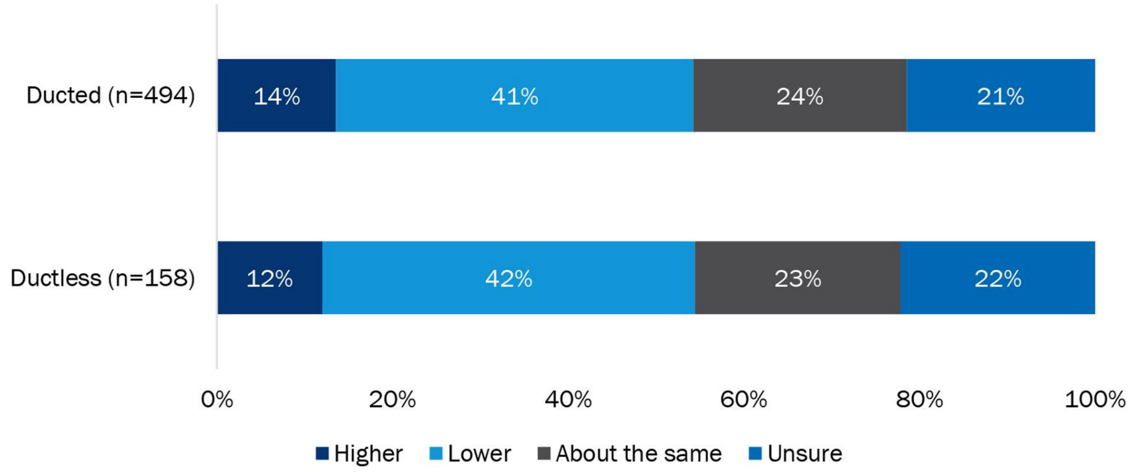
Customer Experience – Heat Pump HVAC

Opinion Dynamics

- Results from a 6-month post-install customer survey conducted by Opinion Dynamics indicate most TECH participants thought their bills went down.
- Underlines the need for the full meter-based bill impacts analysis.

Whether respondents' energy bills went up or down was very similar between those with ducted and ductless systems (Figure 36). About one-quarter said their monthly bills remained the same, while two-fifths (268 of 652; 41%) said they had decreased. Over half (154 of 268; 57%) of customers whose monthly energy bills went down had a solar PV system that generated electricity for their home. Respondents were instructed to consider both gas and electric utility bills combined, if applicable.

Figure 36. Perceived Change in Monthly Energy Bills by HVAC Type



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Who are the optimal heat pump candidates?

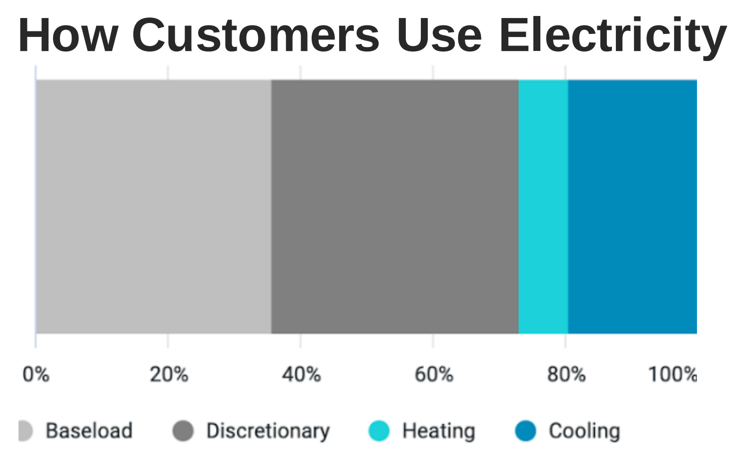
Bundled IOU Customer: Load Disaggregation

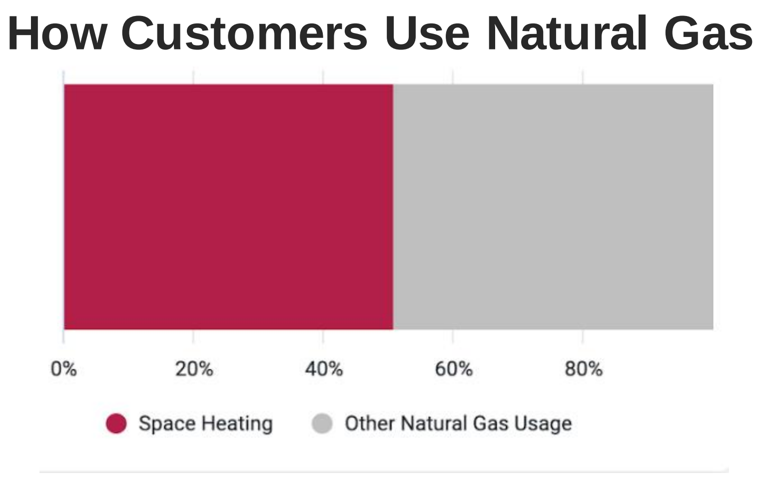
Electricity Usage Percentile	Annual MWh
25th	3.4 MWh
50th	5.4 MWh
75th	8.2 MWh
90th	11.5 MWh

Baseload 36%; Discretionary 37%; Heating 7%; Cooling 20%

Natural Gas Usage Percentile	Annual Therms
25th	210 Therms
50th	340 Therms
75th	490 Therms
90th	680 Therms

Space Heating 51%; Non-space-heating 49%





Likely Bill Savings Candidates by IOU

- Cooling-burdened customers with moderate space heating needs are most likely to save on their bills with HVAC heat pump under current common rate structures
- Customers who are in both the top quartile of cooling users and bottom half of natural gas space heating users represent about 11-14 percent of each IOU territory
- Note that the bill savings candidates are not the same as maximum GHG savings candidates
- Underscores why targeting for specific outcomes is important

Electricity	Baseload	Discretionary	Heating	Cooling	Summer Peak kW
CA Average	36%	37%	7%	20%	1.4
High-Cooling PG&E	28%	34%	3%	35%	2.3
High-Cooling SCE / SCG	27%	23%	2%	46%	2.5
High-Cooling SDG&E	35%	26%	2%	37%	1.3

Natural Gas	Space Heating	Other Natural Gas Usage
CA Average	51%	49%
Low-Heat PG&E	36%	64%
Low-Heat SCE/SCG	26%	74%
Low-Heat SDG&E	24%	76%

Next Steps for TECH Meter-Based Impact Analysis

1. **Bill impacts analysis:** Perform high-resolution bill modeling by utility territory to understand detailed bill impacts by customer segment for the TECH initiative.
   - Break out bill impacts by baseline heating and cooling loads
   - Break out by demographic and geographic segments

2. **Scale statewide**: Calculate meter-based results for TECH claims in all of the six largest utility territories in the state as updated meter data for those regions becomes available via the CEC.
   - Expecting refreshed data quarterly from CEC that will expand the number of projects with mature results for continued analysis and publication

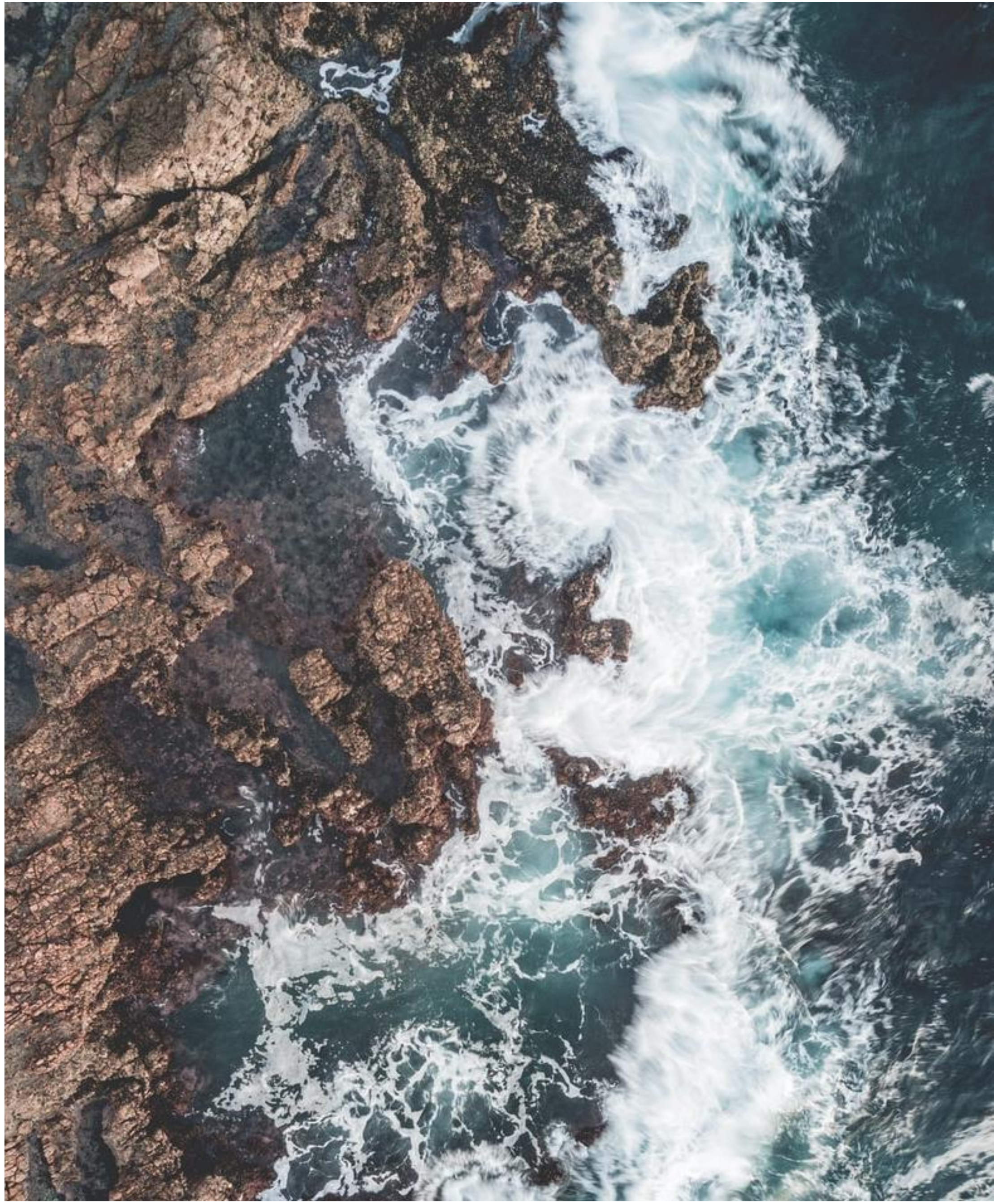
3. **Targeting expansion**:
   - Refresh targeting dashboard.
   - Continue to apply learnings about optimal participants from results and building on the TECH advanced customer targeting pilot success to introduce meter-based targeting to more aspects of TECH outreach.

4. **Program optimization**:
   - Continue to refine ideal participant profiles based on metered results – cycle of continuous improvement
   - Analyze metered project performance by other metrics (equipment type, size, project cost, contractor)

Questions

Agenda

1	Introduction
2	Energy Savings
3	Bill Impacts
4	Statewide Energy Usage
5	Questions Part 1
6	Heat Pump HVAC Cost Drivers
7	Electrical Panel Upgrades
8	Questions Part 2



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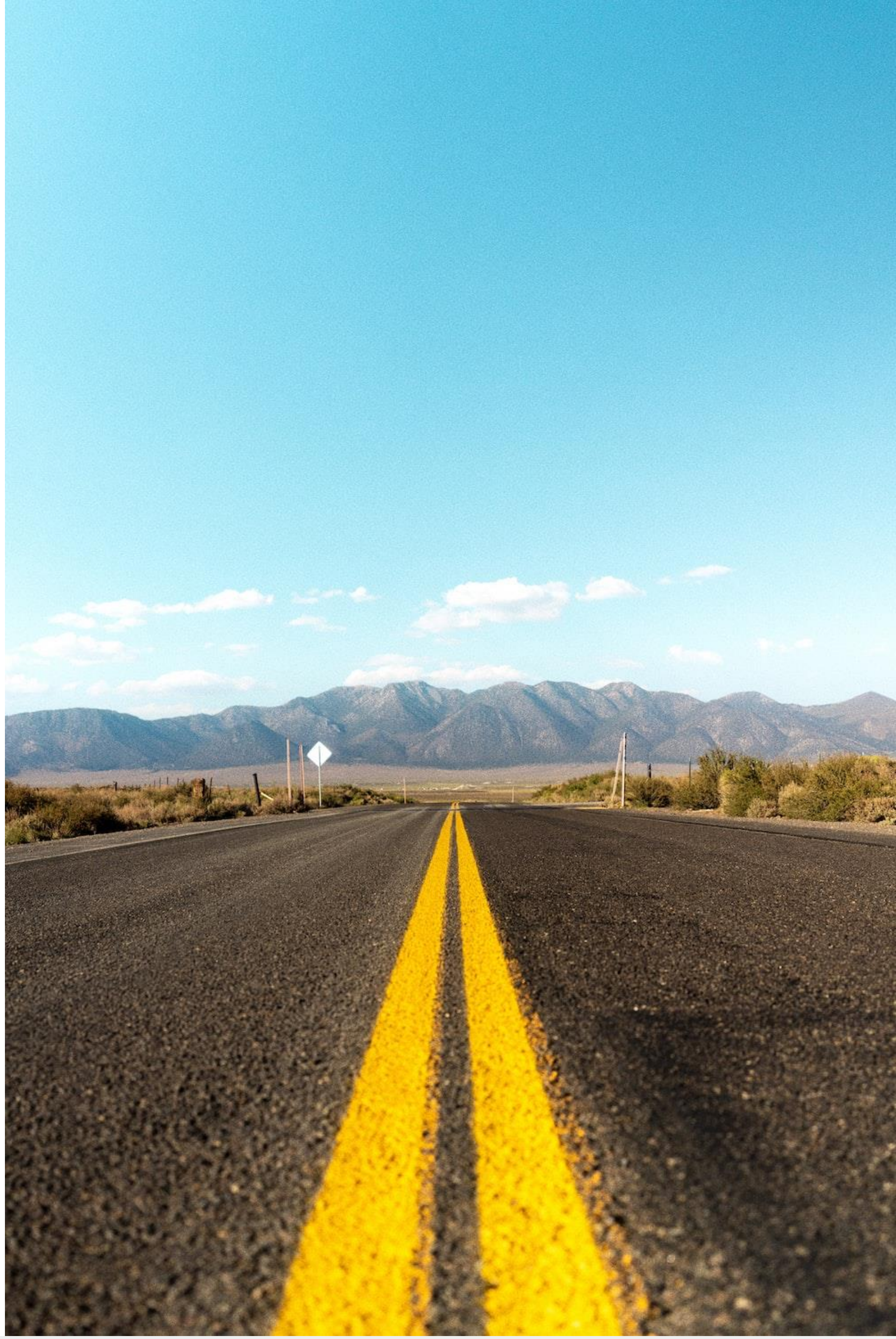
What drives cost differences for heat pump HVAC retrofits?

Purpose

California needs the most cost-effective pathway to electrify space and water heating. Heat pump HVAC retrofits are particularly expensive, with a median cost of almost $18,000.

To develop strategies to maximize heat hump retrofit cost-effectiveness, we must first find and quantify **cost drivers**.

At the same time, many features that add costs to heat pump HVAC projects also improve performance. Here we only look at cost drivers, but by pairing this analysis with savings data we can quantify cost-effectiveness.



Data Source: Incentive Applications

Goals

1. Minimize contractor burden
2. Verify compliance
3. Document key features

Category	Questions	Look-Up
Contractor	Contact info, license #	
Customer	Address, contact info	Eligibility, climate, census tract data
New Equipment	1. Model # 2. Serial # 3. Quantity of units	Specs via QPL[1]
Prior Equipment	1. Furnace fuel type 2. Air Conditioning type	
Installation	1. Panel upgrade? 2. Duct replacement? 3. Duct sealing? 4. Smart thermostat? 5. Manual-D/Manual-J 6. Installation duration	
Cost	Total project cost	Cost per capacity

TECH Working Data Set

https://techcleanca.com/public-data/download-data/

Total Project Cost

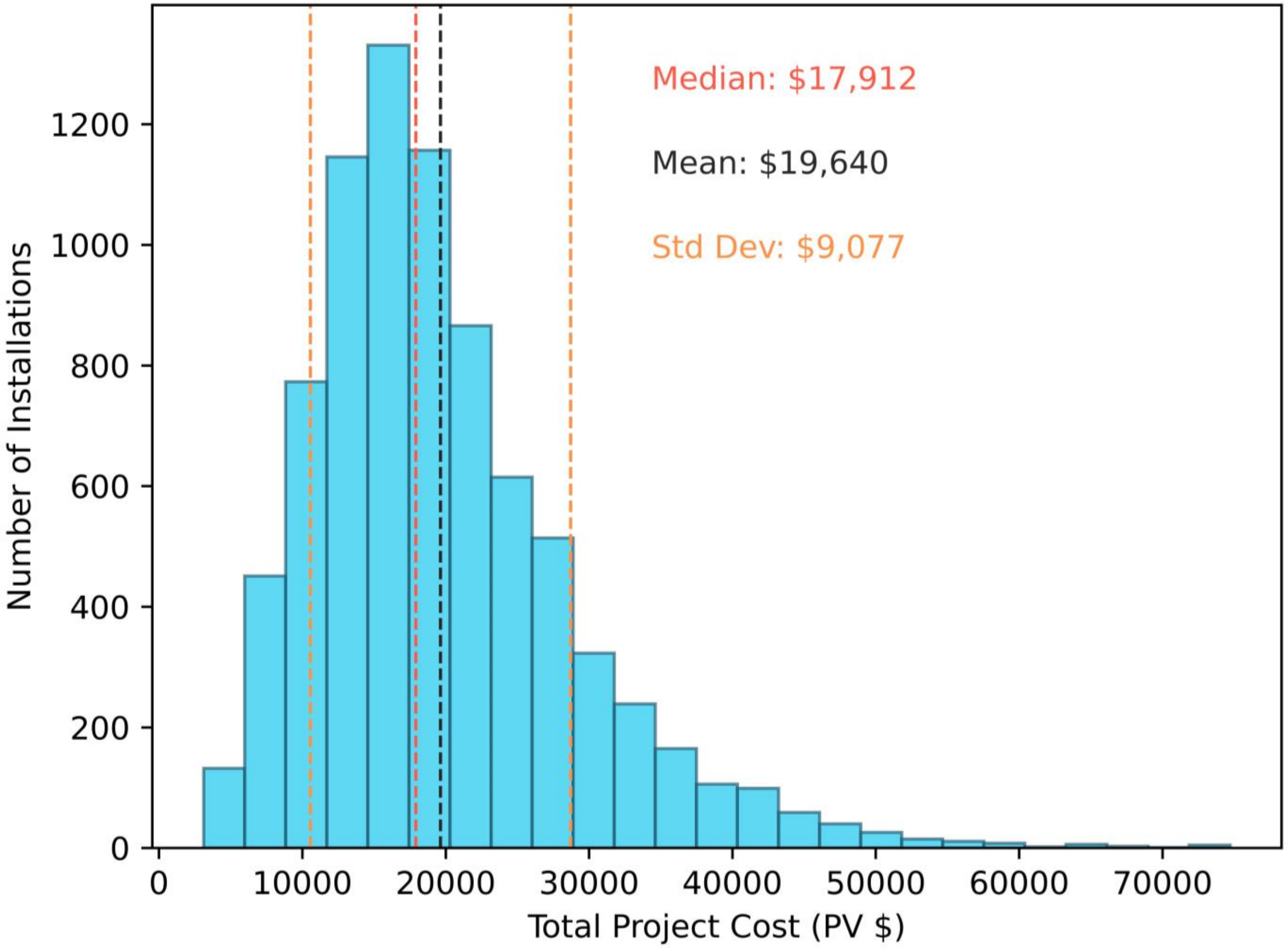
Single Family Heat Pump HVAC

Instructions for TECH contractors:

Report total cost of the heat pump installation and related measures (material, labor, permitting, etc.) PRIOR to TECH incentive being applied

As of July 2023:

- Count projects = 9,744
- Count units = 10,608



Cost Driver Analysis

Goal 1

Build easily interpretable model to predict heat pump HVAC retrofit costs

Method

Used multivariate linear regression model with 14 covariates

Goal 2

Measure how much variation we can explain in total project cost

Outcome

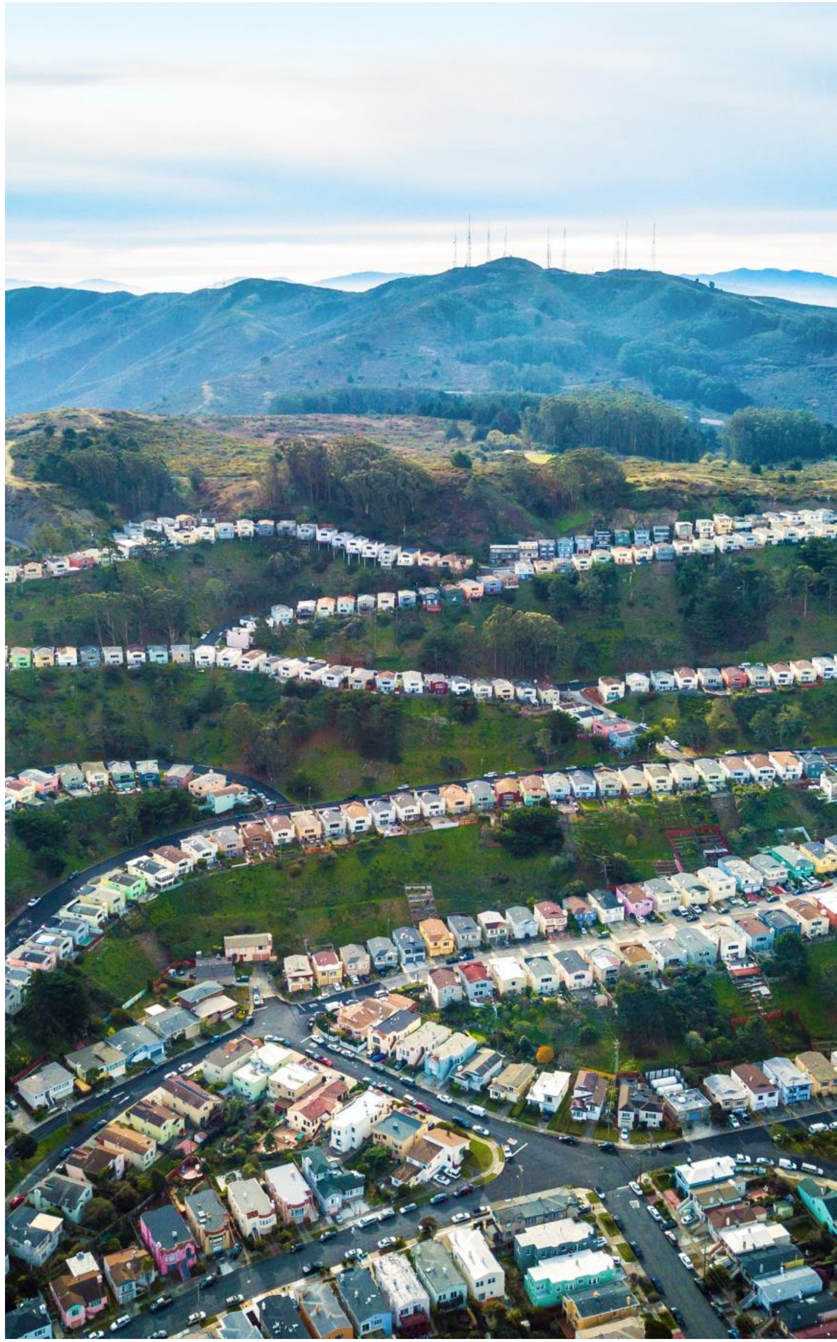
- R^2 = 24% on training set. As expected, the model is not optimized for prediction.
- A decision tree regressor with depth of 4 achieved same R^2.

Goal 3

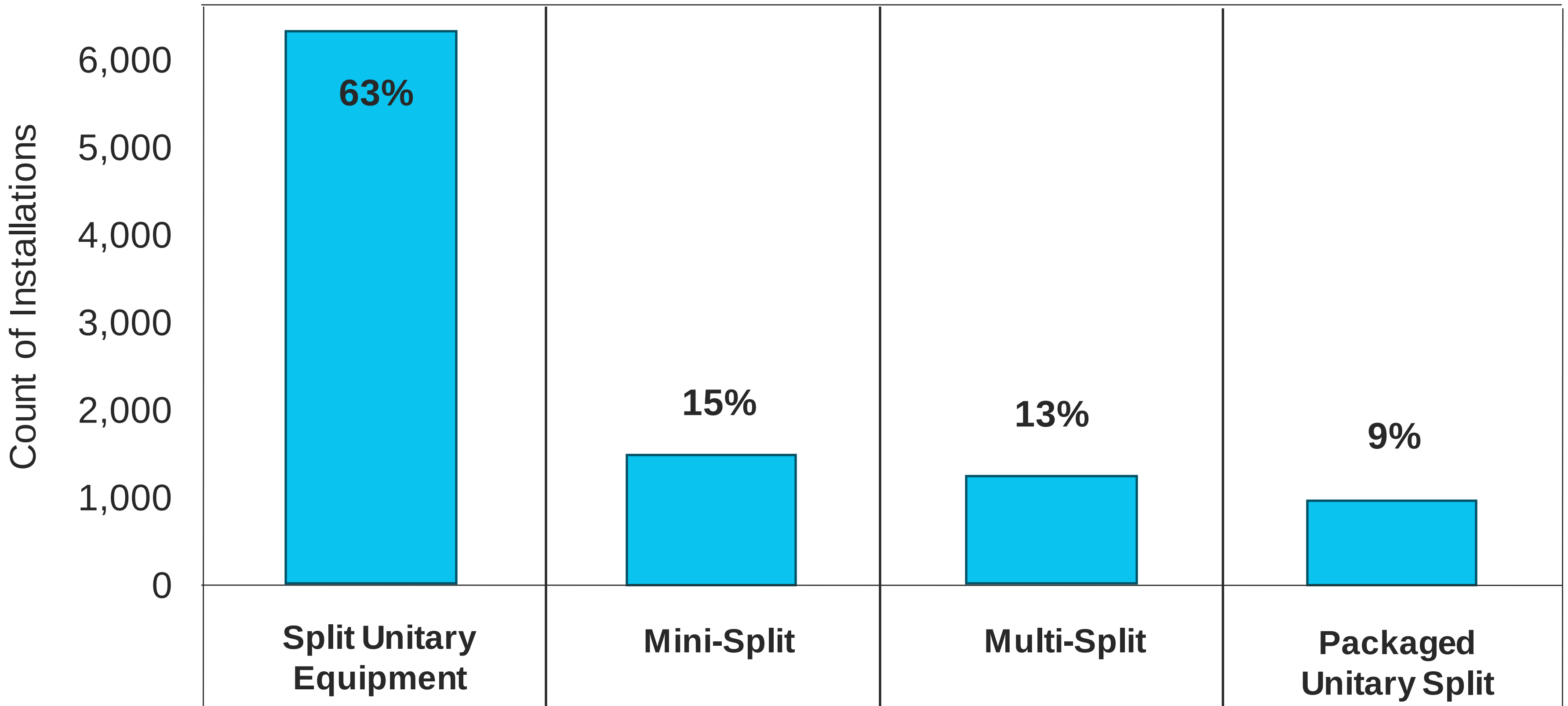
Estimate how common project features drive costs up or down

Outcome

12 of 14 covariates have statistically significant regression coefficient, so the model can quantify major cost drivers



Installed Equipment Types



Examples:

Carrier
25HHA4

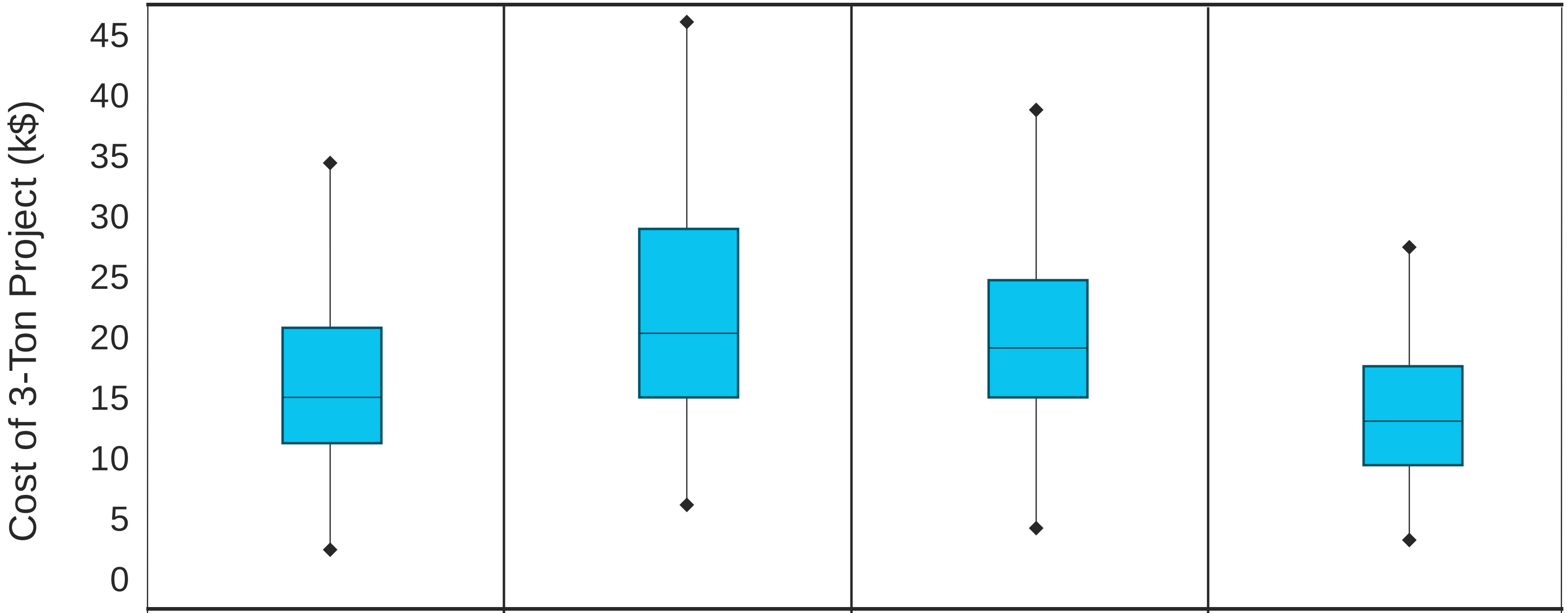
Mitsubishi
P-Series

Fujitsu
AOU18RLXFZ

Daikin
DP14HH

Categories defined by the Air Conditioning, Heating and Refrigeration Institute (AHRI) based on model number.

Costs by Equipment Type



	Split Unitary Equipment	Mini-Split	Multi-Split	Packaged Unitary
Avg Project Cost (3-ton*) [k$]	**16.3**	**21.9**	**20.3**	**13.8**
Avg Cost Without Cost Drivers (3-ton) [k$]	12.7	16.5	14.3	10.1
Avg Amount Attributable to Cost Drivers [k$]	3.6	5.4	5.9	3.7

*Tons of cooling capacity = 12,000 Btuh

Cost Drivers

Starting with a baseline cost of $12,635 for a ducted split unitary system

Field	Mean and Range	Average Impact on cost of a 3-ton installation	Example
Avg Age of Homes in the Census Tract	Range: 11 to 103 yrs Mean: 50 yrs	For every 10 years added to avg home age in a tract, project cost increases by $826 (± $59)	Projects in tracts with avg home age of 70 years cost $4k more than projects in tracts with avg home age of 20 years
Seasonal Energy Efficiency Ratio ("SEER")	Range: 14 to 30 Mean: 17	For each unit of SEER above 14, project cost increases by $637 (± $48)	All else equal, a 20-SEER unit costs ~$3,600 more than a 14-SEER unit
Installation Duration (Days)	Range:1 to 366 Mean: 5	Project cost increases logarithmically with the installation duration	A 10-day installation costs ~$1,200 more than a one-day installation
Duct Replacement (T/F)	True for 15% of projects	Projects involving a duct replacement were $2,926 (± $277) more expensive	
Number of TECH-Certified Contractors Serving County	Range: 11 to 279 Mean: 144.	Project cost decreases logarithmically with number of enrolled contractors serving the county	Projects in counties served by 100 TECH contractors cost $1,031 (± $147) less than projects in counties served by 10

Cost Drivers

Starting with a baseline cost of $12,635 for a ducted split unitary system

Field	Mean and Range	Average Impact on cost of a 3-ton installation	Example
Number of Heat Pump HVAC Projects Performed by Installing Contractor	Ranges from 1 to 406, mean of 89	Project cost increases logarithmically with the number of heat pump HVAC projects performed by the installing contractor	Projects performed by contractors with 50 TECH-funded installations cost $863 (± $122) more than those with just one
Home Floor Area (ft^2)	Range: 500-10,000 Mean: 2,000	Project cost increases by $69 (± $11) per 100 ft^2 of added floor area	*Holding the cooling capacity of the installed system constant*
Pre-existing Air Conditioning	None: 48% Present: 52%	Projects in homes with pre-existing A/C were $972 (± $192) less expensive	
Manual D/J Completed (T/F)	True for 7% of projects	Projects involving Manual-D/Manual-J Load Calcs cost $1,847 (± $369) more	
Electrical Panel Upgrade (T/F)	True for 4% of projects	Projects involving a panel upgrade cost $1,567 (± $525) more	

Example Use Cases

- An incentive program aiming to boost SEER of installed equipment but maintain customer cost can estimate the new incentive amount needed
- Agencies estimating the cost of electrifying homes can seek out home age data and plan costs for each home age group
- Homeowners can evaluate the costs and benefits of quality installation measures in a contractor-agnostic setting
- TECH Clean California compares results with meter-based energy, GHG, and bill savings to measure cost-effectiveness of project features and recommend prioritizing the best ones

Access the full report on https://techcleanca.com/about/reporting/ starting October 20, 2023

6 Where are panel upgrades occurring?

Introduction

This analysis encompasses 15,177 single-family homes where a heat pump water heater and/or heat pump HVAC system was installed, and the installer received a TECH incentive. Installations occurred between December 2021 and July 2023.

On each TECH incentive application, the installer was asked if the installation involved an electrical **panel upgrade**. This constitutes any work needed to increase the home's electrical capacity. Upgrades could include, but are not limited to:

- Replacing main service panel
- Installing subpanel
- Installing smart load center

From December 2021 through May 2022, TECH offered a $2,800 bonus incentive for panel upgrades accompanying HPWH installations in single-family homes in PG&E service territory. This added to a baseline HPWH incentive of at least $3,100 per unit installed. **Some, but not all, of the projects analyzed received a panel upgrade bonus incentive**.

Initial Scope

This analysis covers:

- Panel upgrade frequency
- Panel capacity
- Project cost impacts

In the total project population only 5% of projects included a panel upgrade

TECH Equity Community Definition Elements Applicable to Single Family Buildings Only			
Criteria	Building Type		
	Single-Family	Multi-family	Other
Home in a Census Tract labeled by CalEnviroScreen 4.0 as a Disadvantaged Community ("DAC")	X	X	X
Occupant of home enrolled in a CARE or FERA utility rate program (for gas or electricity)	X		X

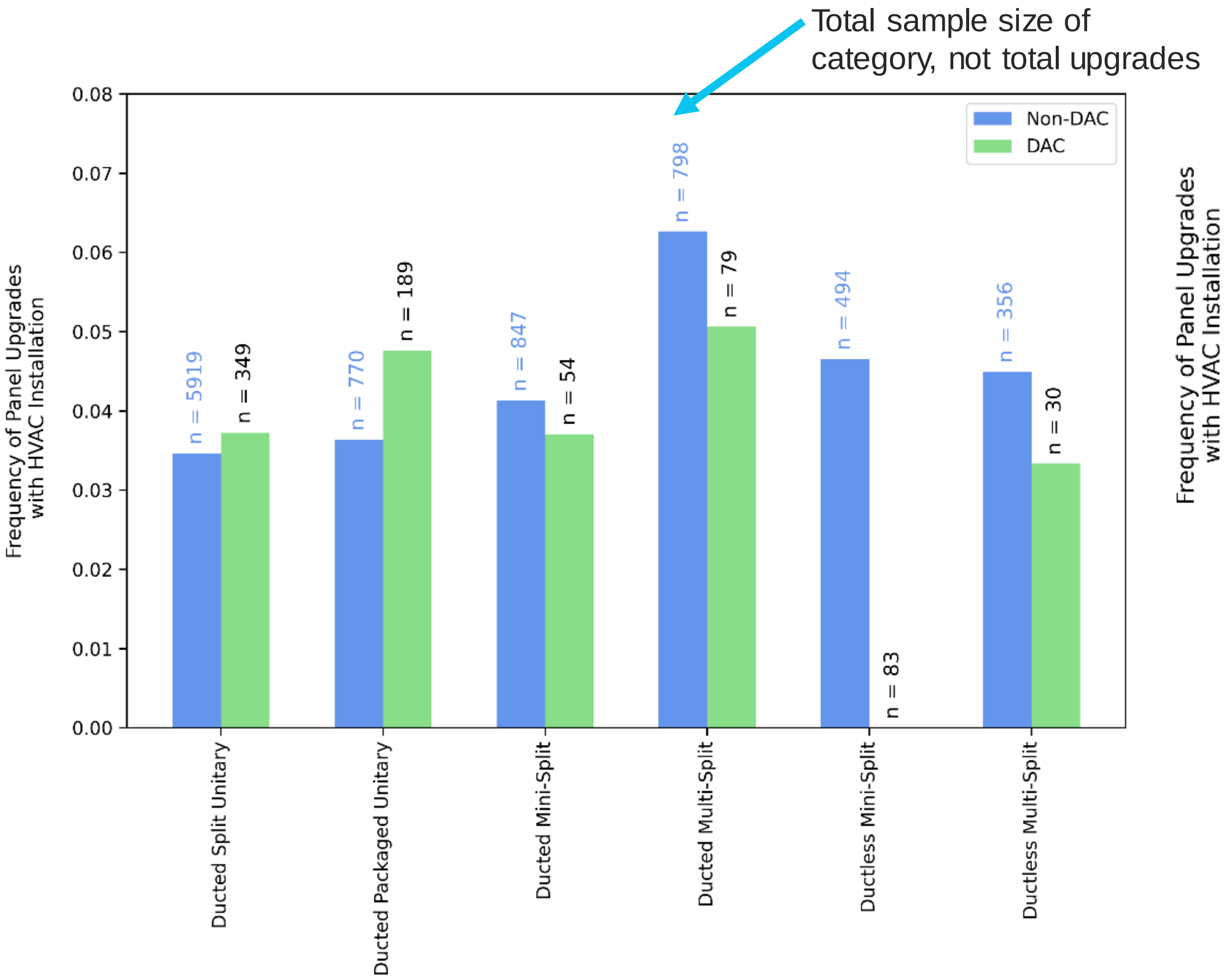
Initial Research Questions: HVAC Projects

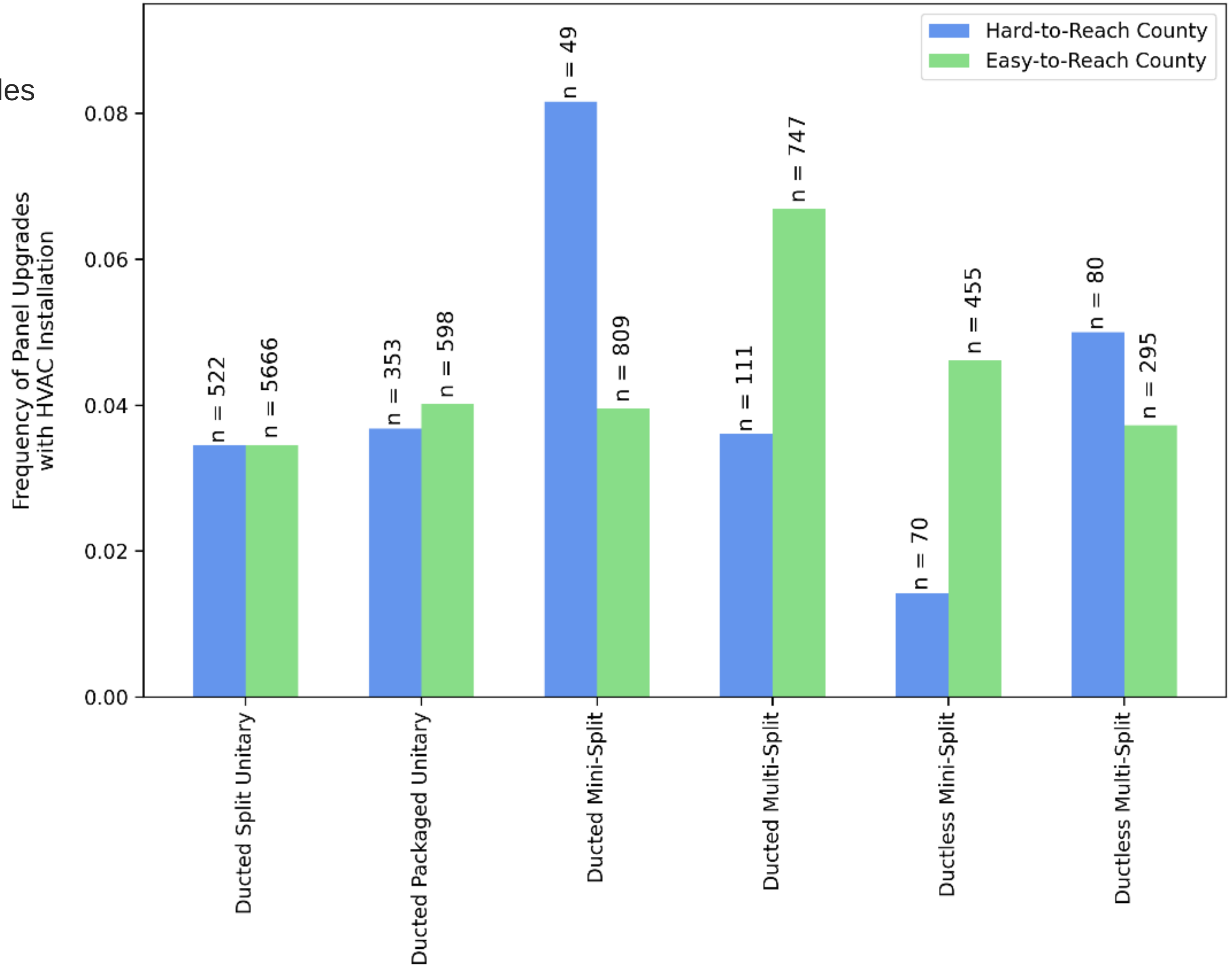
- Are panel upgrades more prevalent in DAC or hard-to-reach (HTR) projects?
- Are panel upgrades associated with:
  - pre-existing fuel types?
  - pre-existing panel sizes?
  - post-install status of furnace?
  - different heat pump equipment types or capacities?
- How does area building vintage influence panel upgrades?

Used a logistic regression model with panel upgrade as dependent variable.

Are panel upgrades more prevalent in disadvantaged communities or hard to reach counties?

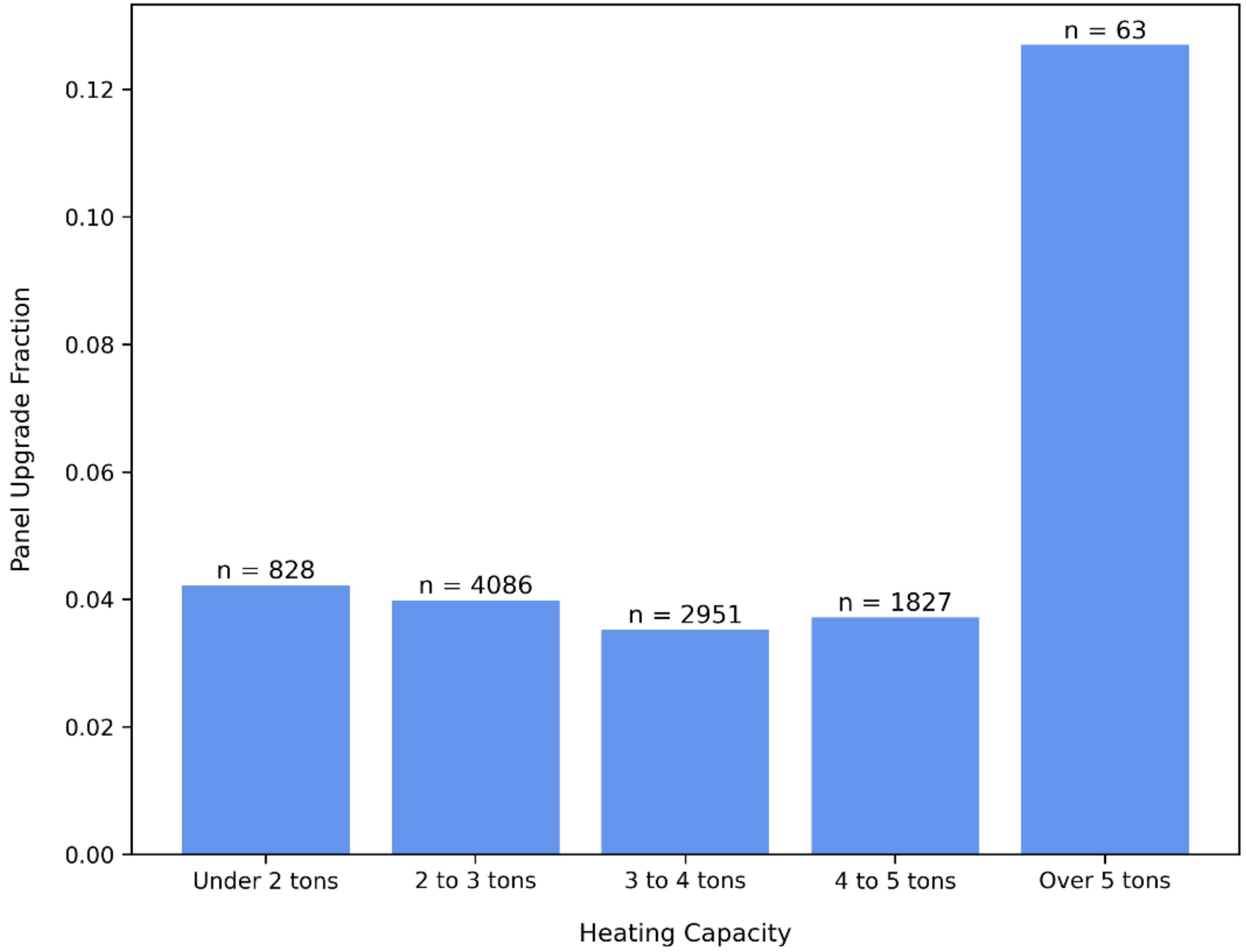
A: No strong evidence that they are





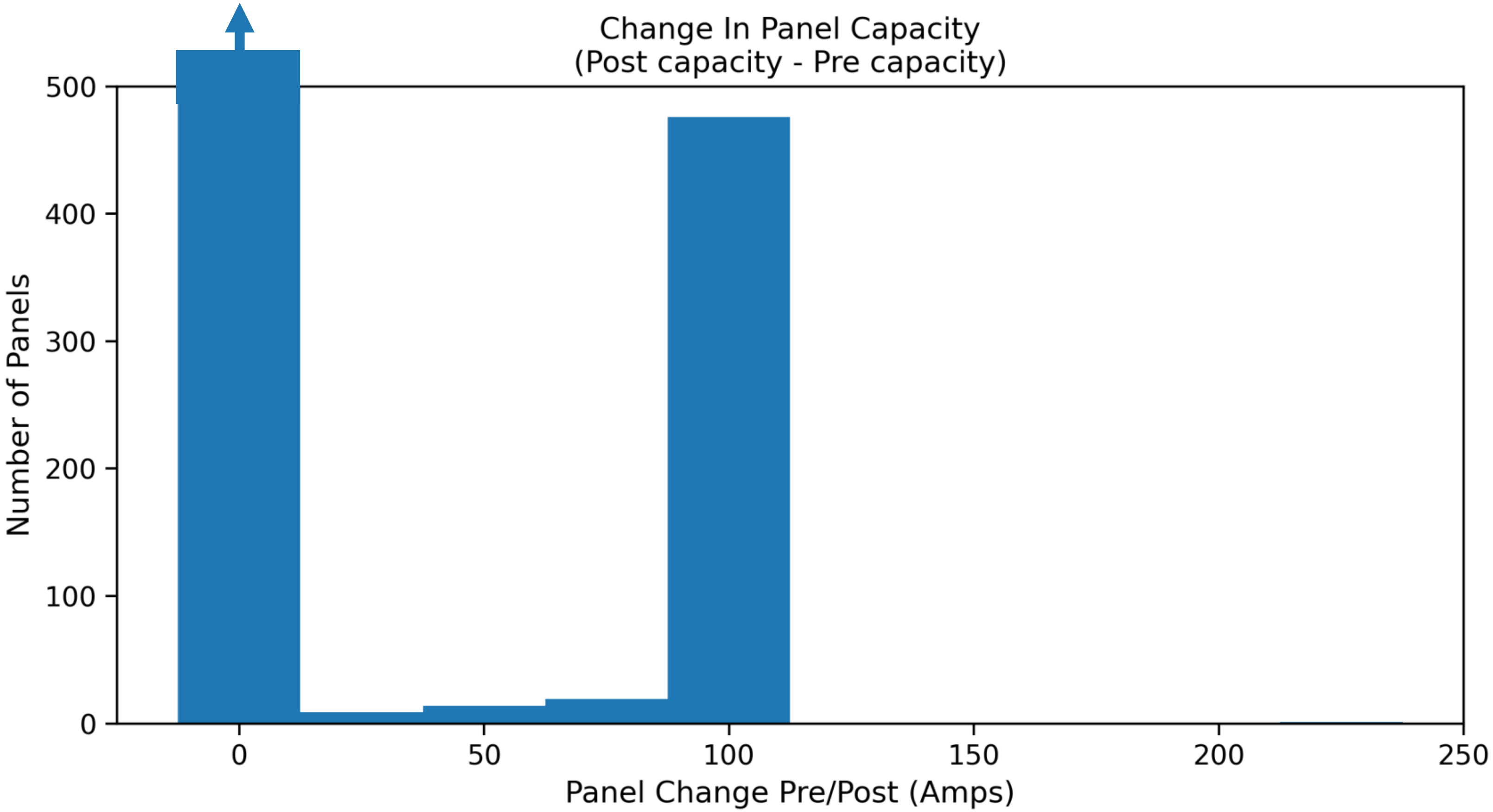
How does the capacity of the HVAC equipment influence the prevalence of panel upgrades?

A: It does not, for almost all HVAC system capacities



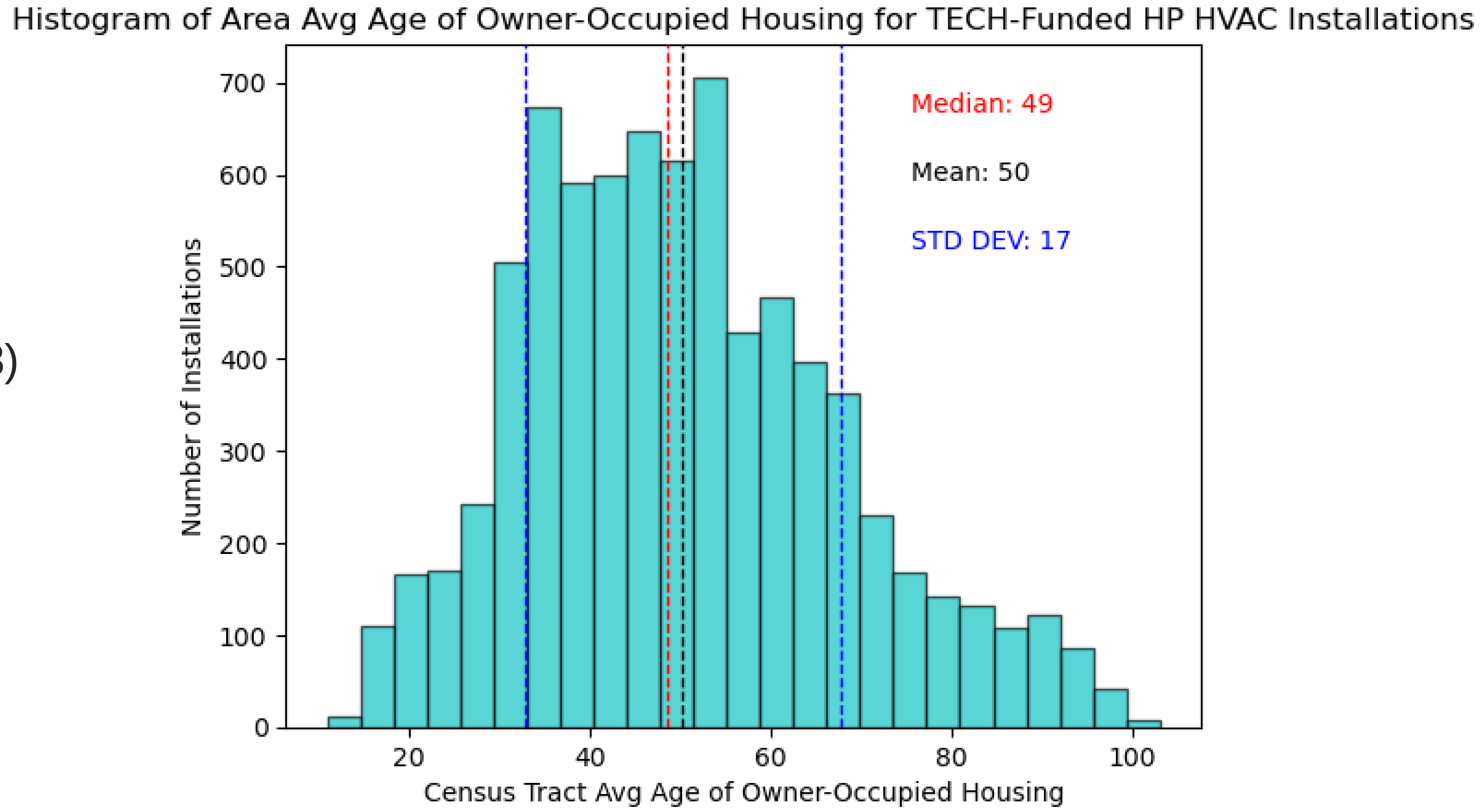
Are different pre-install panel sizes more associated with panel upgrades?

A: Pre-install panel size is not predictive of whether there was a panel upgrade

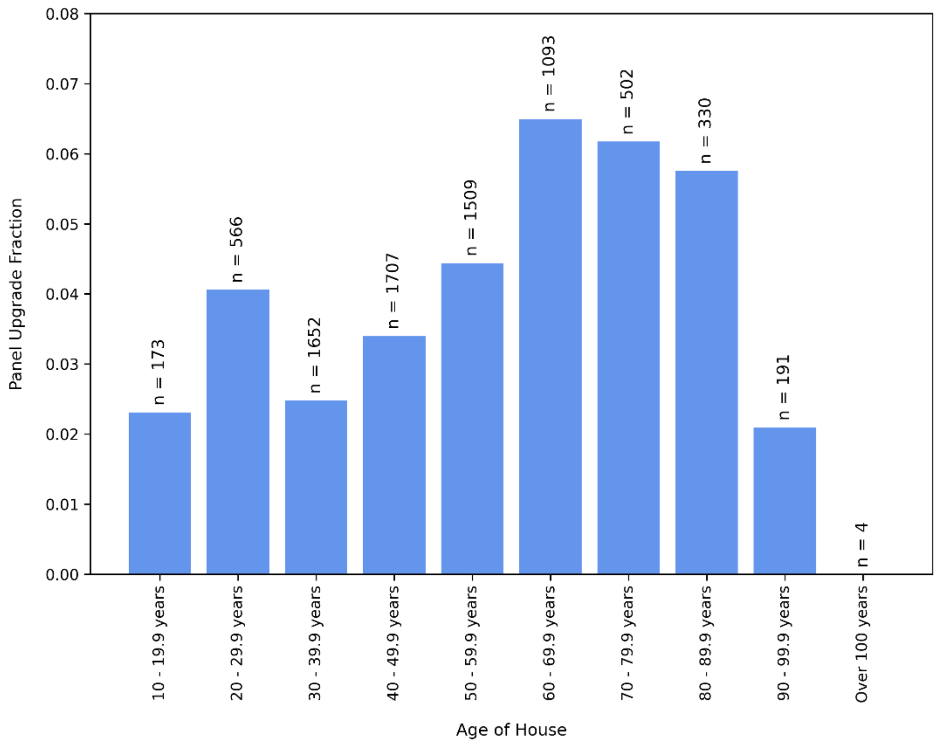


Average age of homes in census tracts for TECH projects

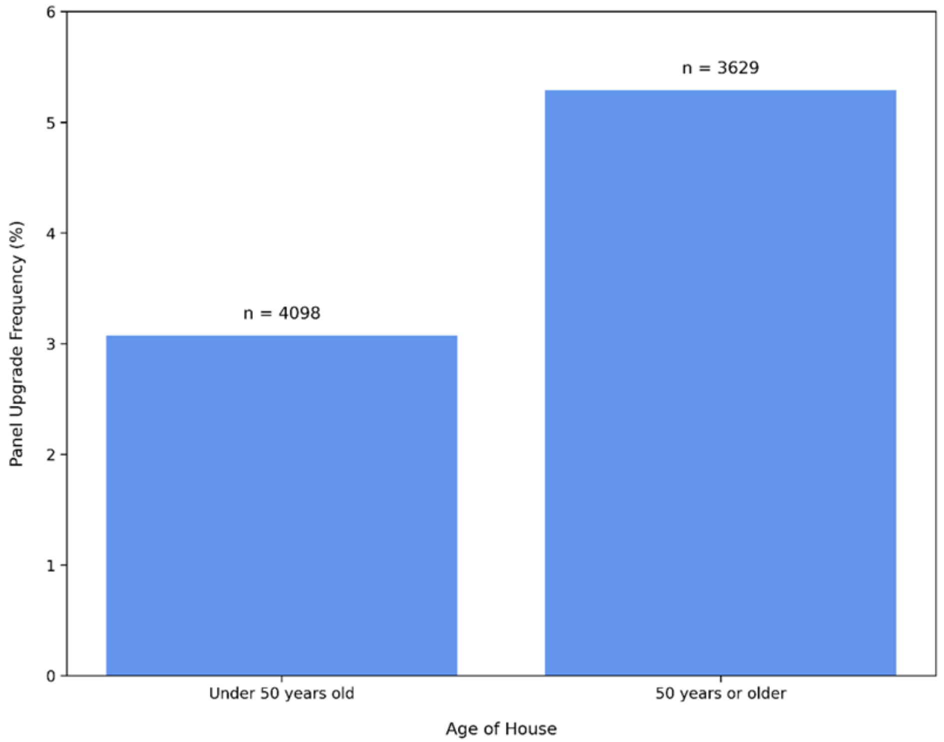
10,742 projects (2/3) belonged to census tracts with available home vintage data



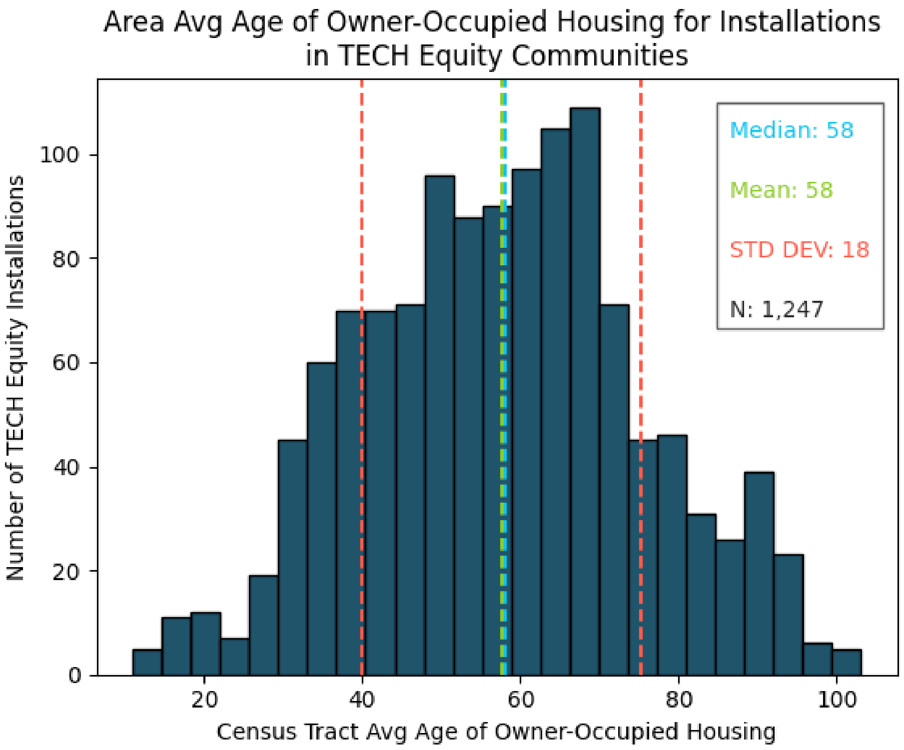
How does building area vintage influence panel upgrades?

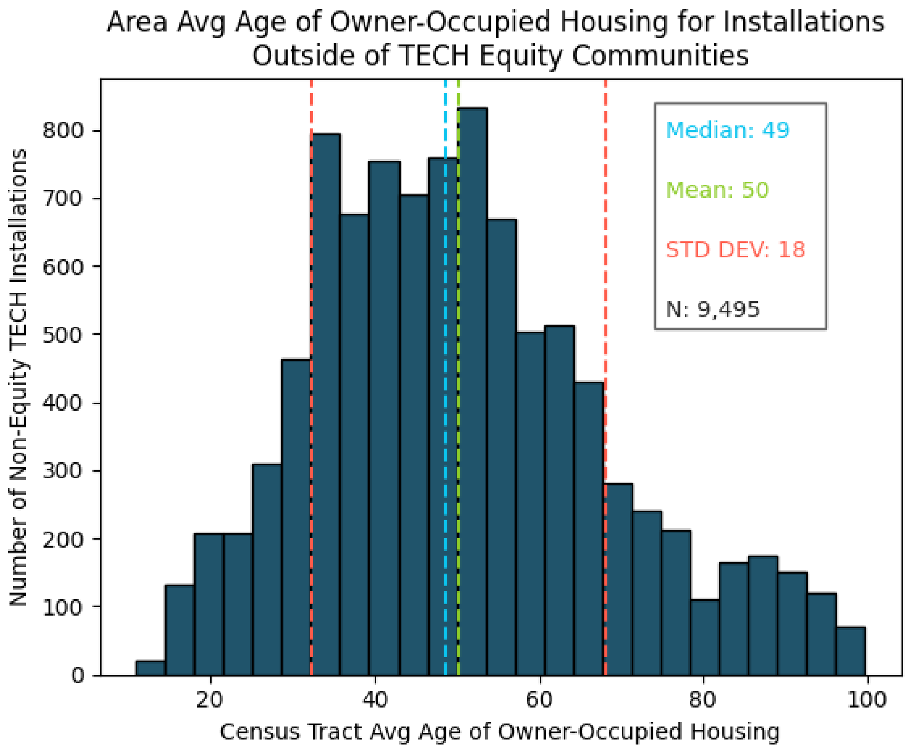


A: Homes >50 years old needed a panel upgrade at a **1.75x higher rate** than homes <50 years old



Average area home age differs for equity communities

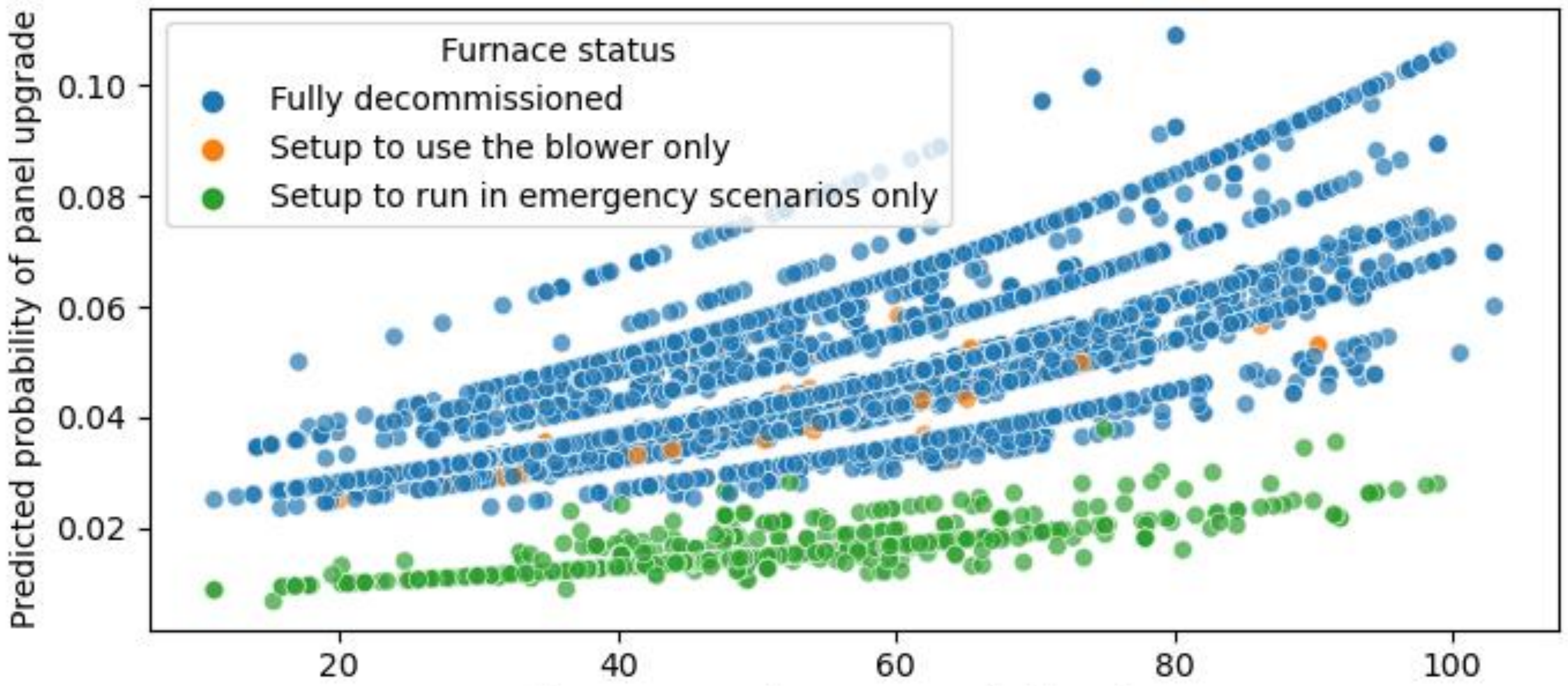




TECH Equity Community homes belonged to census tracts with a median age of 58 years, **nine years older** than the median age for homes in the general population.

How does post-install furnace status associate with panel upgrades?

A: Panel upgrade frequency is clearly associated with post-install status of furnace

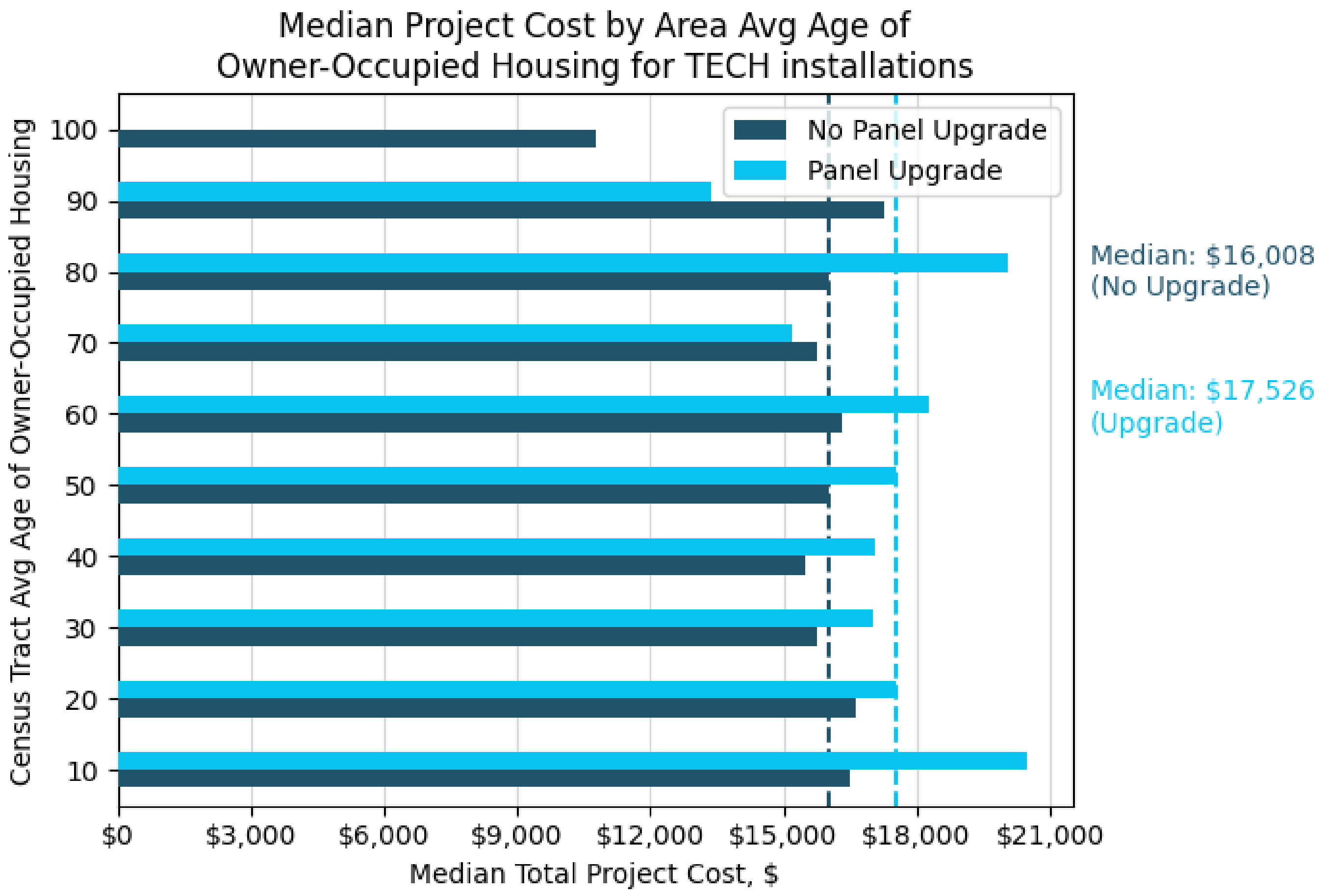


Average age of homes in census tract

How does median project cost vary by average area home age and whether a panel upgrade was performed?

- Projects with panel upgrades were a median **$1,500** more expensive

- The project cost increase resulting from a panel upgrade did not differ significantly for homes of different ages



Panel Analysis Summary

- Panel upgrades were infrequent (5%) among TECH single family HVAC projects
- Based on a regression analysis using a variety of independent variables, panel upgrades were not statistically associated with:
  - Project located in Disadvantaged Community or Hard-to-reach county
  - HVAC system capacity
  - Pre-installation panel capacity
- Panel upgrades were not clearly associated with equipment type however sample sizes were small in some cases
- Panel upgrades are clearly associated with the complete decommissioning of a furnace
- Panel upgrades are associated with projects in census tracts with older homes, especially in tracts with average ages >50, where panel upgrades were 75% more frequent
- Projects with panel upgrades cost about $1500 more than projects without; a relationship that held true across area home age categories

Next Steps

Iteration 1 (complete)

- Building age data source: average age of owner-occupied housing by Census Tract

Iteration 2 (expected Q4 2023)

- Building age data source: **true individual home age**, from county assessor
- Same 2 outputs using individual home age

Iteration 3 (expected Q1 2024)

- Output 1: panel upgrade *frequency* **grouped by Type of Panel Upgrade** vs individual home age, grouped by Equity Community status, for heat pump HVAC projects installed starting April 2023
- Output 2: panel upgrade *cost* **grouped by Type of Panel Upgrade** vs individual home age, grouped by Equity Community status, for heat pump HVAC projects installed starting April 2023

Questions

Thank You

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8 Appendix

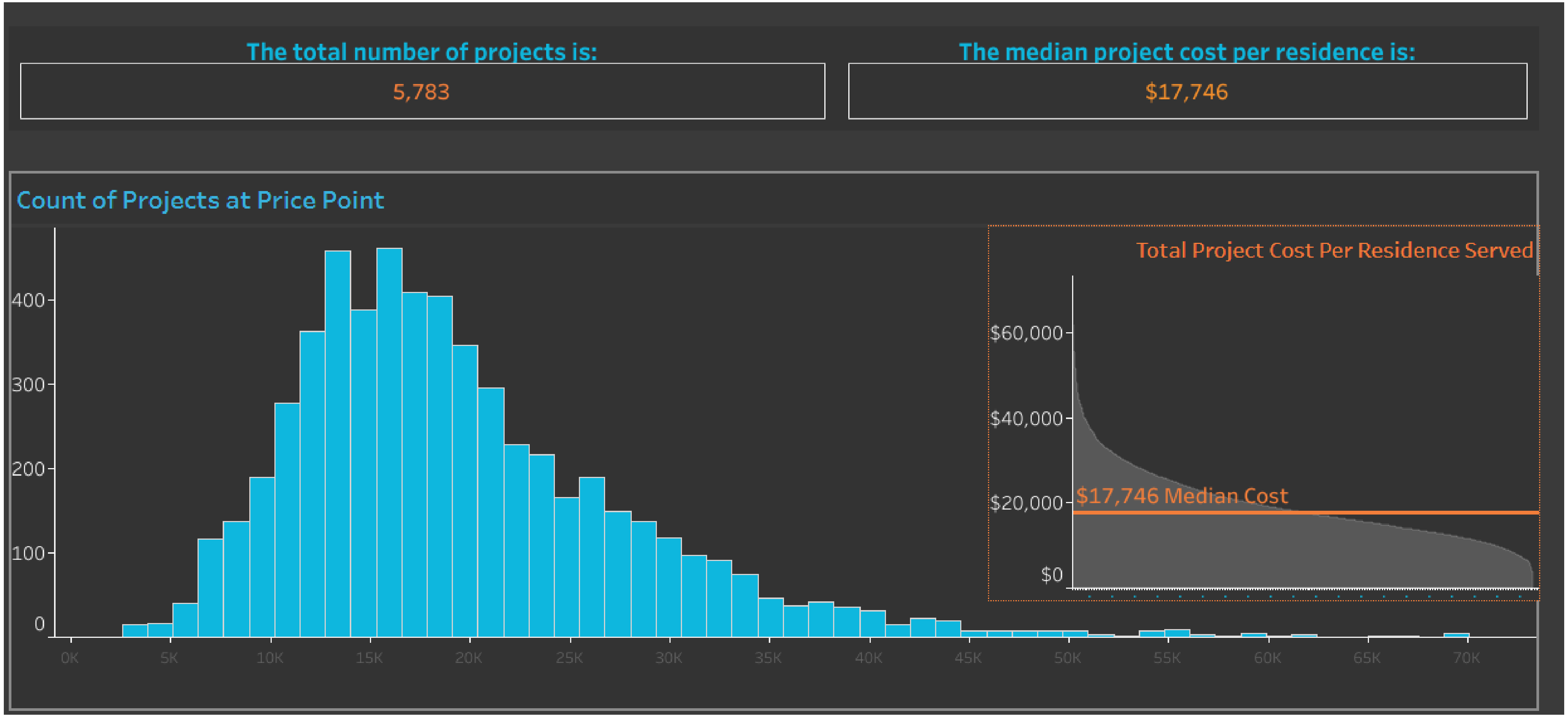
Costs and Preliminary Savings for Residential Heat Pump HVAC Replacing Central AC

Scope

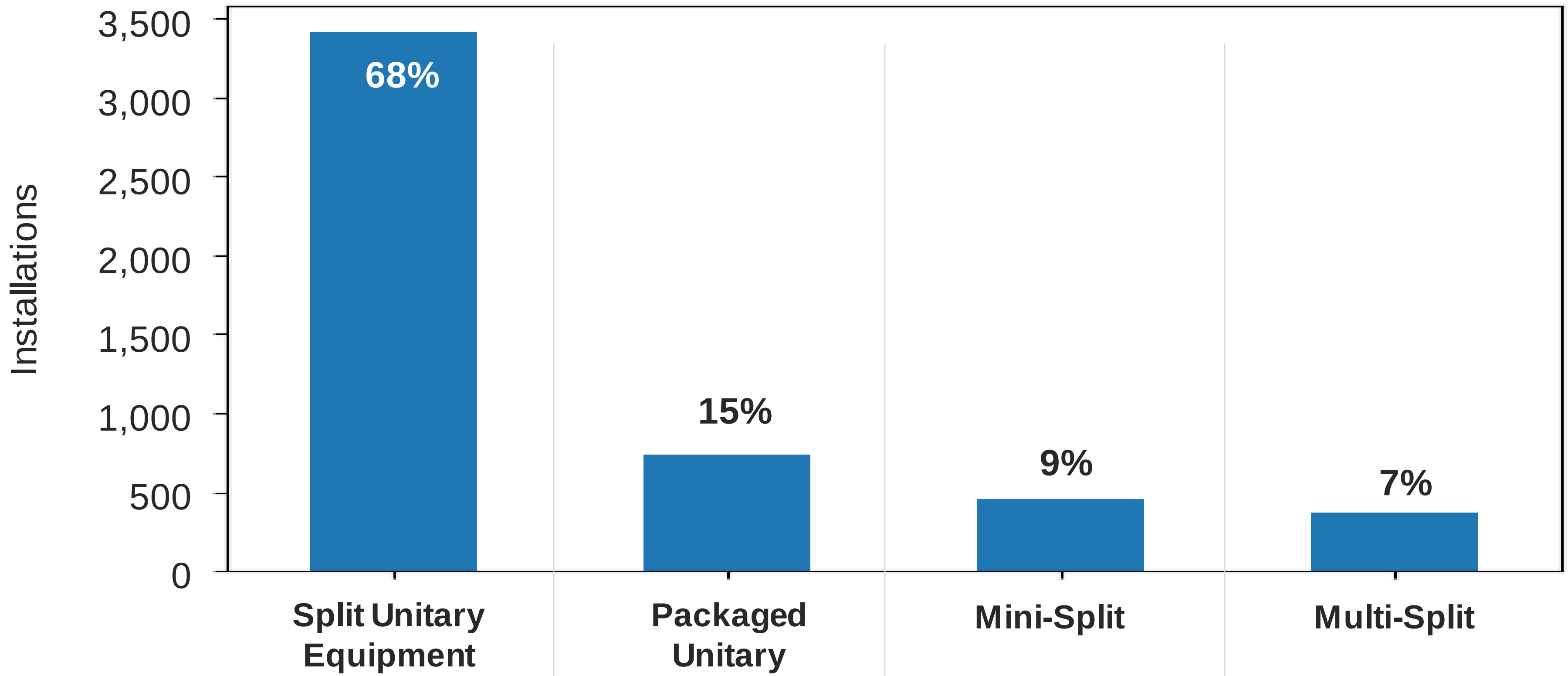
This analysis includes

1. Total Project Cost data from 5,783 heat pump HVAC retrofits in single-family homes in California performed at some point between January 2022 and July 2023.
   - All of these projects received a TECH Clean California incentive.
   - In all of these homes, a central air conditioning system was present before the heat pump HVAC installation, according to the contractor who submitted the incentive application.
2. A Cost Drivers analysis using linear regression to measure the impact that project and site features have on Total Project Cost
3. Weather-normalized, meter-based impacts analysis for 167 of the same projects performed using OpenEEMeter methods.

Costs: Overview



Installed Equipment Types



Examples:

Carrier
25HHA4

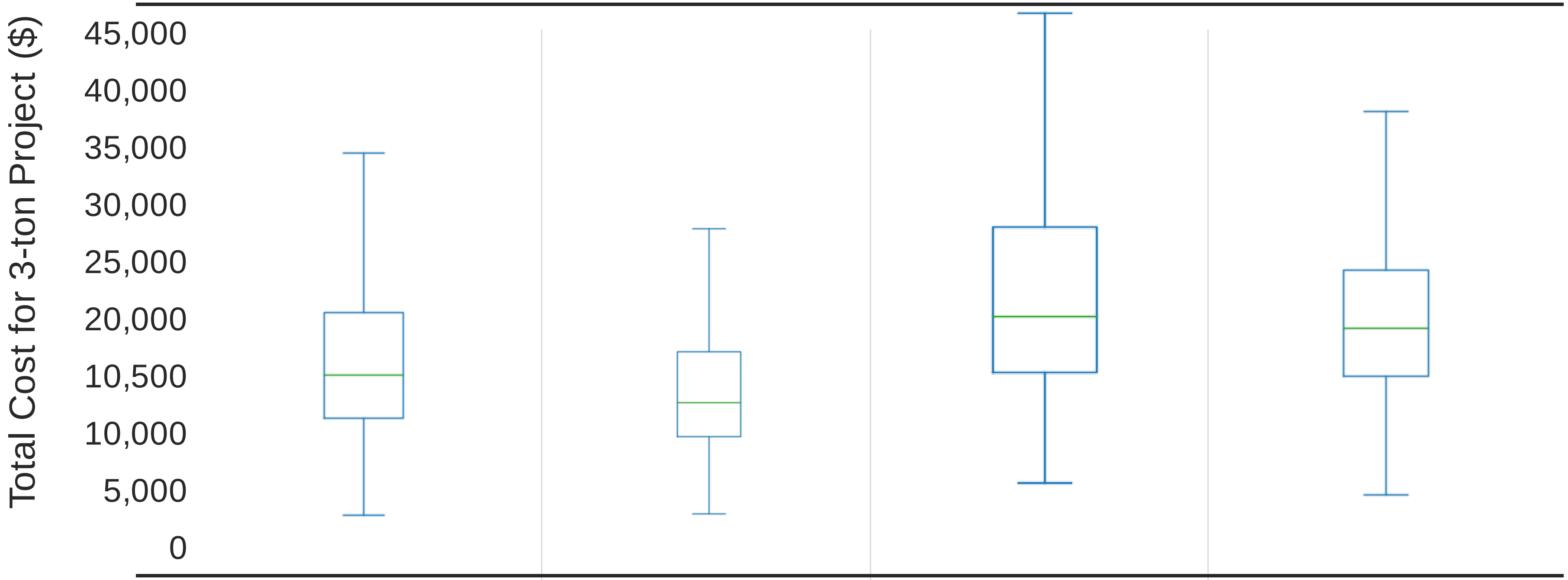
Daikin
DP14HH

Mitsubishi
P-Series

Fujitsu
AOU18RLXFZ

Categories defined by the Air Conditioning, Heating and Refrigeration Institute (AHRI) based on model number.

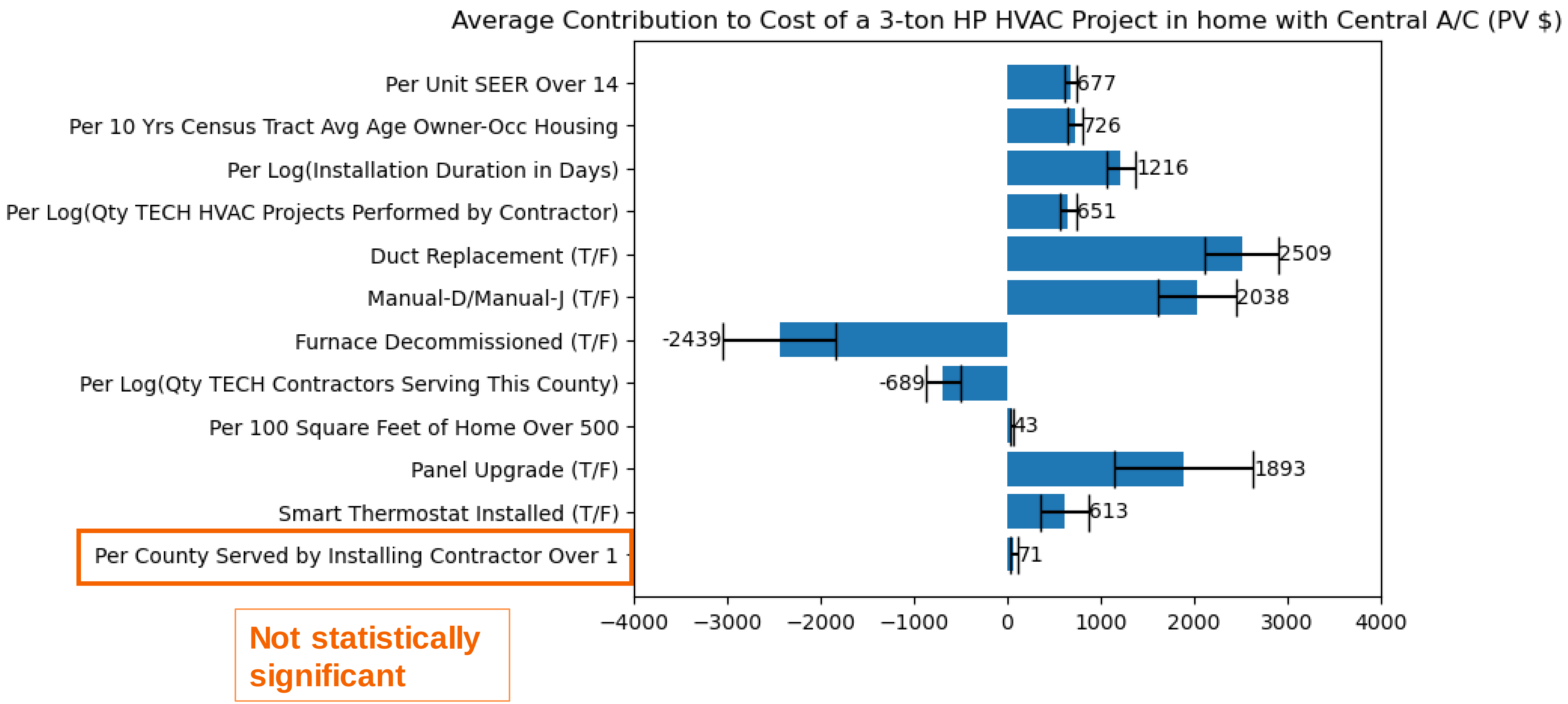
Costs by Equipment Type



	Split Unitary Equipment	Packaged Unitary	Mini-Split	Multi-Split
Avg Project Cost (3-ton)	$15,851	$13,235	$22,144	$20,499
Avg Cost *Without Cost Drivers* (3-ton)	$11,790	$9,219	$16,785	$14,898
Avg Amount Attributable to Cost Drivers	$4,061	$4,016	$5,359	$5,601

Cost Drivers

Starting with **avg cost w/o cost drivers** of $11,790 for split unitary system…



Cost Drivers

Starting with **avg cost w/o cost drivers** of $11,790 for split unitary system…

Project Feature	Mean and Range	Average Impact on Total Project Cost of a 3-ton installation	Example
Seasonal Energy Efficiency Ratio ("SEER")	Range: 14.0 to 29.4 Mean: 17	For each unit of SEER above 14, project cost increases by $677.	All else equal, a 20-SEER unit would cost ~$3,600 more than a 14-SEER unit
Average Age of Homes in the Census Tract	Range: 11 to 103 years, Mean: 50 years.	Adding 10 years to average home age in a tract adds $726 to Total Project Cost.	Projects in tracts with an average owner-occupied home age of 70 years are $3,630 more expensive than projects in tracts with average home age of 20 years
Installation Duration (Days)	Range: 1 to 366 days, Mean: 5 days.	Total Project Cost increases logarithmically with the installation duration.	A 10-day installation costs ~$1,200 more than a one-day installation.
Number of Incentivized HP HVAC Projects Performed by Installing Contractor	Range: 1 to 406 Mean: 89 projects	Project cost increases logarithmically with the number of HP HVAC projects performed by the installing contractor	Projects performed by contractors with 50 TECH-funded installations cost ~$900 more than those with just one
Duct Replacement (T/F)	True for 15% of projects	Performing a duct replacement increased project cost by $2,500.	

Cost Drivers

Starting with **avg cost w/o cost drivers** of $11,790 for split unitary system…

Project Feature	Mean and Range	Average Impact on Total Project Cost of a 3-ton installation	Example
Manual D/J Completed (T/F)	True for 11% of projects	Projects involving Manual-D/Manual-J Load Calcs were $2,038 more expensive	
Furnace Decommissioned (T/F)	True for 93% of projects	Projects in which the furnace was fully decommissioned were $2,439 less expensive	
Number of TECH Contractors Serving County	Ranges from 11 to 279, mean of 144.	Total project cost decreases logarithmically with the number of enrolled contractors serving the county.	Projects in counties served by 100 TECH contractors cost ~$750 less than projects in counties served by 10
Home Floor Area (ft^2)	Range: 500-10,000 Mean: 2,000	Total project cost increases by $43 per 100 ft^2 of added floor area	*Holding cooling capacity of the system constant*, a retrofit in a 3500 ft^2 house would cost $860 more than a 1500 ft^2 house
Electrical Panel Upgrade (T/F)	True for 4% of projects	Projects involving an electrical panel upgrade were $1,893 more expensive	
Smart Thermostat Installed (T/F)	True for 55% of projects	Projects including installation of a smart thermostat were $613 more expensive	

Overview and Qualifiers

This analysis presents **preliminary** findings from a meter-based NMEC energy savings analysis of 167 heat pump HVAC retrofit projects that were completed and received a TECH Clean California incentive in 2022

The findings presented herein do not represent expected outcomes for all California homes.

These projects involved installing air-source heat pump HVAC equipment in a single-family home in Northern California, largely in California Climate Zones 12 and 13.

The homes in which these projects occurred had pre-existing central air conditioning prior to the heat pump HVAC installation, according to the contractors who completed the installation and applied for the TECH Clean California incentive.

Preliminary Energy Savings Analysis: CAC Replacements

Furnace status after installation	Median Impacts		
	Annual gas savings (Therms)	Annual electricity savings (kWh)	Annual GHG savings (Mton CO2e)
Fully decommissioned	224	-752	1.02
Not fully decommissioned (Dual-fuel)	110	784	0.64

Number of projects = 167

Future Iterations

Savings and costs broken out by:

- Variable speed versus non-variable speed compressor type
- Climate Zone
- Building Type
- Home age

Compare Cost Drivers versus Savings Drivers to answer questions like:

- How much does increasing SEER save on utility bills versus adding in cost?
- Will GHG savings increase with home age at the same rate that costs increase?
- Which climate zones are the least and most cost-effective in terms of Total System Benefit?