Bay Area Air District

Zero NO_x Building Appliance Rules Implementation Working Group Phase 2: Rule 9-4 (furnaces) General Meeting #2

December 3, 2025

Meeting Instructions

Chat for
tech issues only

IWG encouraged to
turn video on, if able

Turn your **audio on** when it's your turn to speak

Everyone can leave **Questions and Comments** here

Reactions > Raise Hand to ask questions out loud

Meeting Agreements

- Make space, take space.
- Be collaborative and solutions-focused.
- Be respectful and purposeful.
- Attendance.

Agenda

1:00 pm	Welcome and Grounding
1:10 pm	Building Electrification and Electric Grid Reliability
1:30 pm	California Public Utilities Commission (CPUC) Updates
1:50 pm	Top Drivers of Air Source Heat Pump HVAC Retrofit Costs
2:10 pm	Zero NOx Appliance Cost Findings
2:30 pm	Public Q&A (for items on today's agenda)
2:45 pm	IWG Member Q&A (for items not on today's agenda)
2:55 pm	Next steps
3:00 pm	Adjourn

Objectives

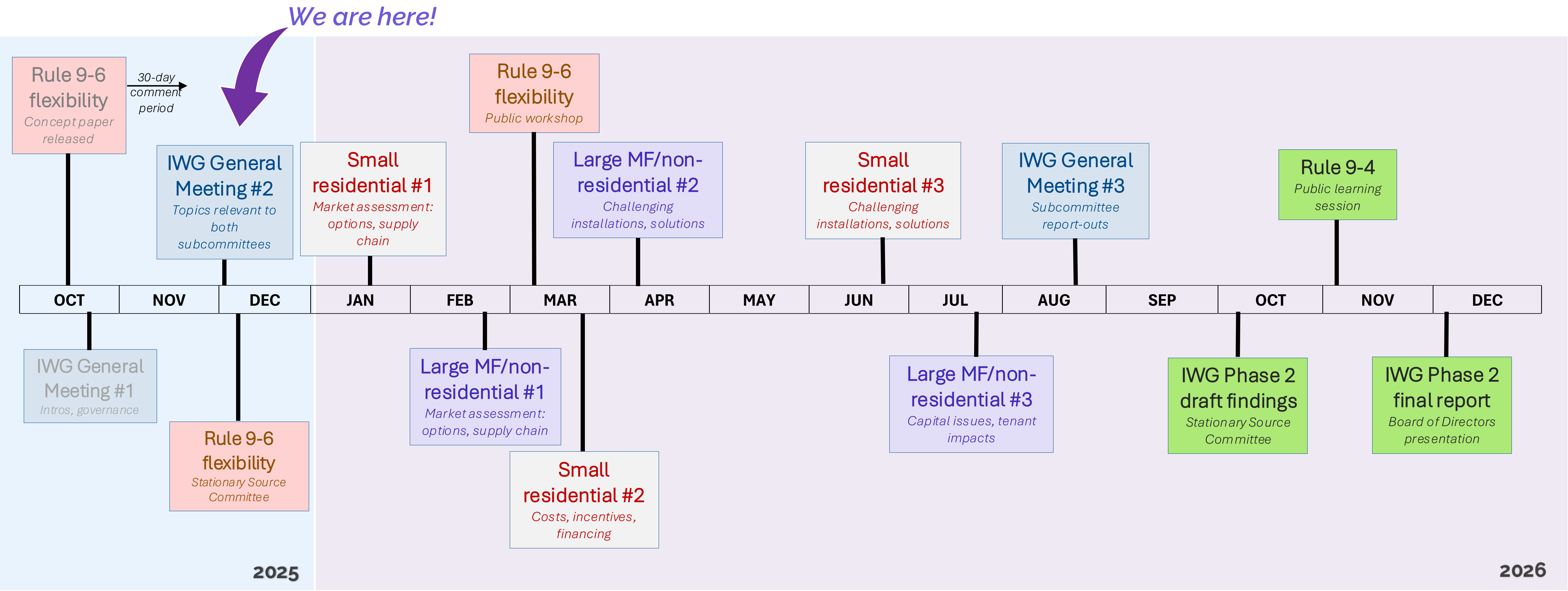
IWG

Collect and share insights on technical and equity issues related to appliance rule implementation.

Today's meeting

Learn about grid impacts and California policy updates related to zero-NOx appliances, as well as cost drivers and incremental costs of zero-NOx HVAC.

IWG Meetings Roadmap



NOTE: Final IWG meeting topics and dates, and other meeting and workshop dates TBD and subject to change.

Building Electrification and Electric Grid Reliability

Bay Area Air District

Rule 9-4 Implementation Working Group

12/3/2025

Energy+Environmental Economics

Ari Gold-Parker, Director

About Energy & Environmental Economics, Inc. (E3)

Technical and Strategic Consulting for the Clean Energy Transition

~130 consultants across 5 offices with expertise in economics, mathematics, policy, modeling


San Francisco


New York


Boston


Denver


Calgary

400+ projects per year across diverse topic areas

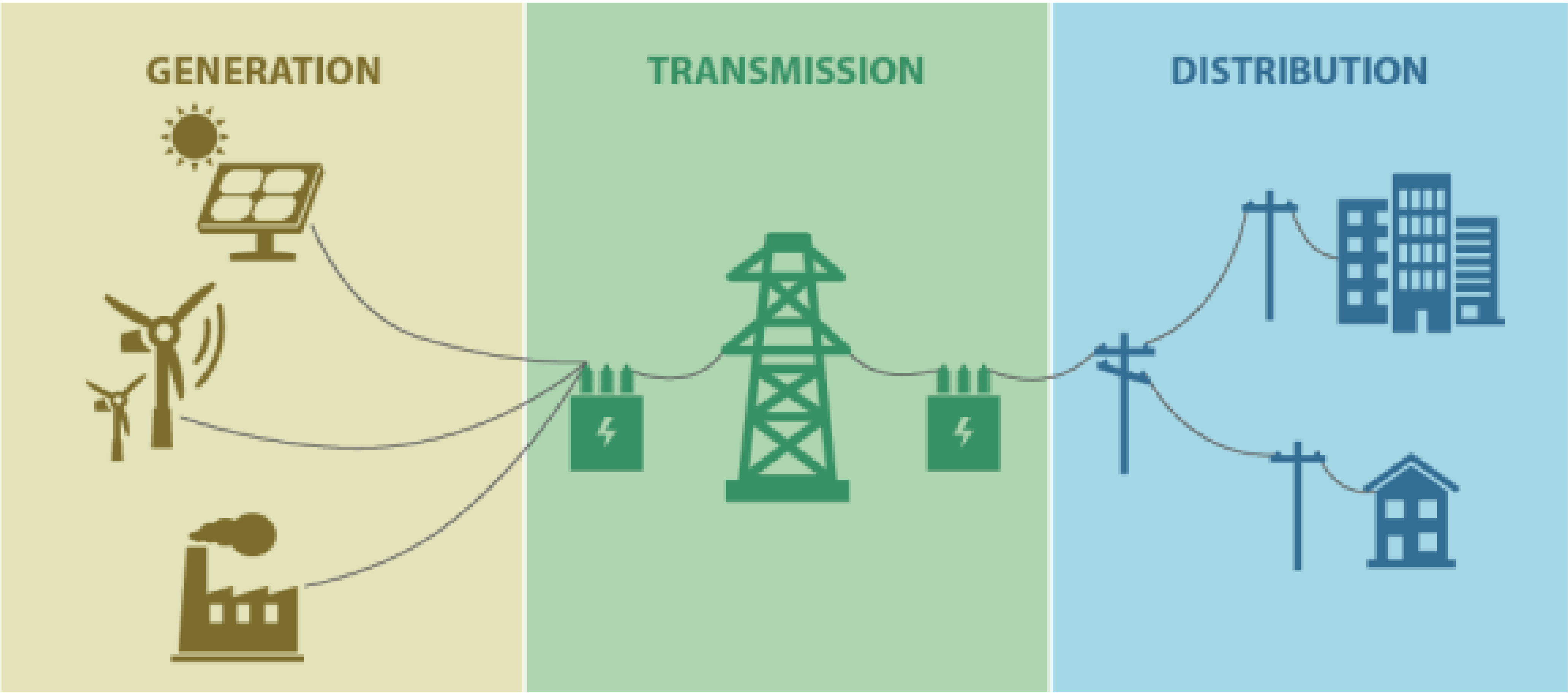
Recent Projects

- Bay Area Air District Zero NOx Electric Infrastructure Impacts – E3 supported the Air District by analyzing the potential electric infrastructure impacts associated with Zero NOx rules
- CARB Scoping Plan – E3 supported the California Air Resources Board in using our PATHWAYS economy-wide decarbonization model to evaluate long-term scenarios aligned with California's climate targets

Energy+Environmental Economics

Electric Grid Reliability

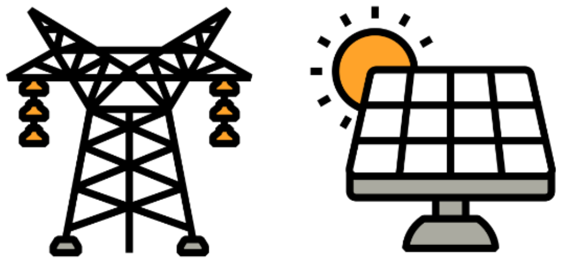
The electric grid: overview



What is “electric grid reliability”

+ Reliability = maintaining electricity service for customers, “keeping the lights on”
+ Broadly speaking: two kinds of reliability that describe different types of power outages

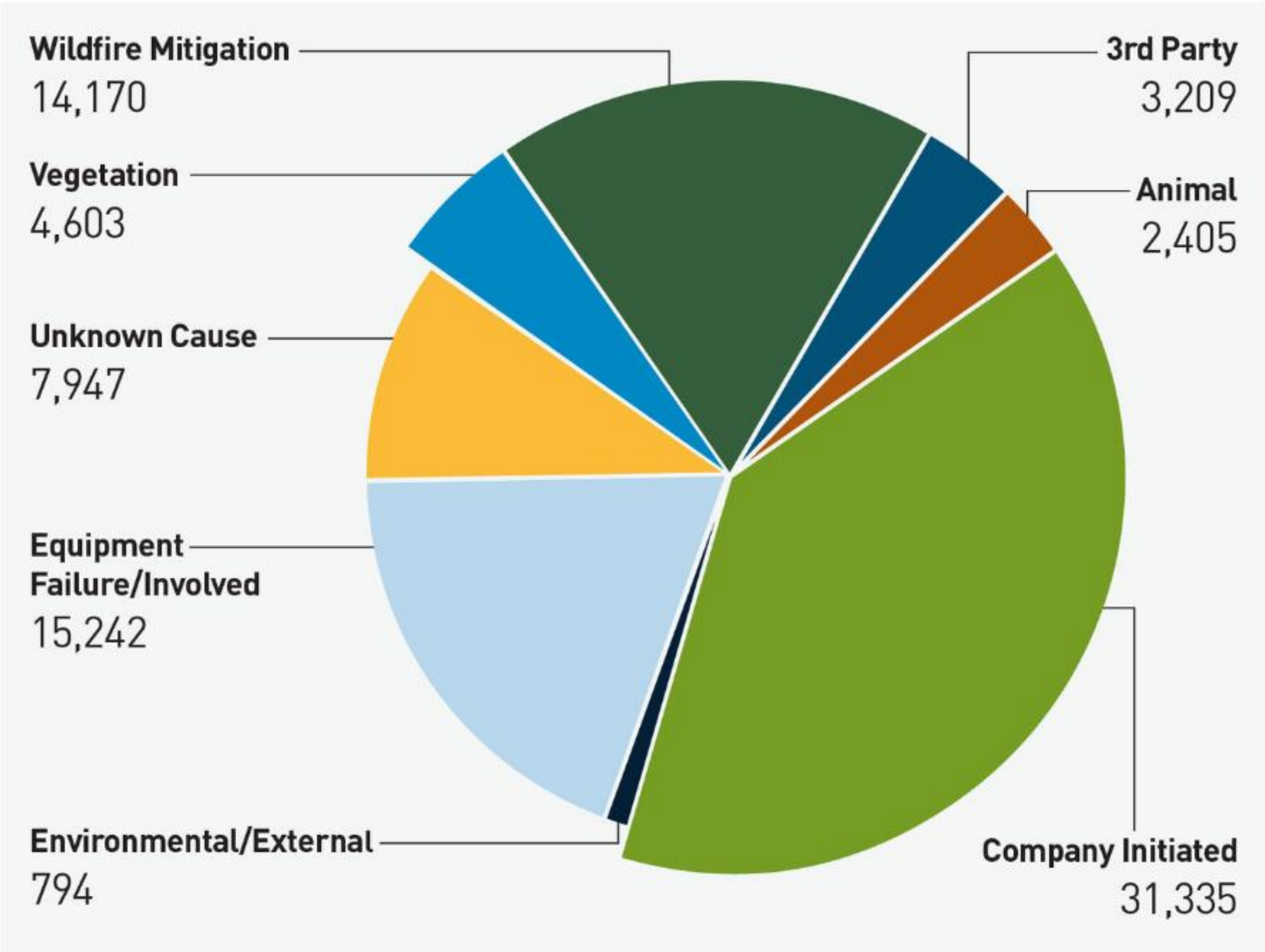
	Distribution system reliability	“Bulk system” reliability, a.k.a. “Resource Adequacy”
Type of outage	• Local outage on part of the distribution system	• System-wide blackout • Rolling blackouts
Overall outage drivers	• Weather • Equipment failures or maintenance	• Not enough generation (and/or transmission) to meet peak load
Direct causes of outages	• Tree falling on power line • Public Safety Power Shutoff (PSPS) due to fire risk • Planned maintenance projects	• Inadequate generation to meet peak load • Generator and/or transmission outages



Distribution system outages

- **Distribution system outages are the most common outages**
  - There has been only **one** bulk system outage in CA since the 2001 Energy Crisis: the August 2020 rolling blackouts
  - There have been **hundreds of thousands** of distribution-system outages over this period
- **Distribution system outages are driven by factors including *weather* and *maintenance***
  - PG&E customer average: 1.8 distribution system outages per year (2024)
- **Distribution system outages are generally not caused by *customer load***
  - New loads may require distribution system upgrades and associated costs
  - Utilities typically size distribution assets to ensure that new customer loads do not cause outages

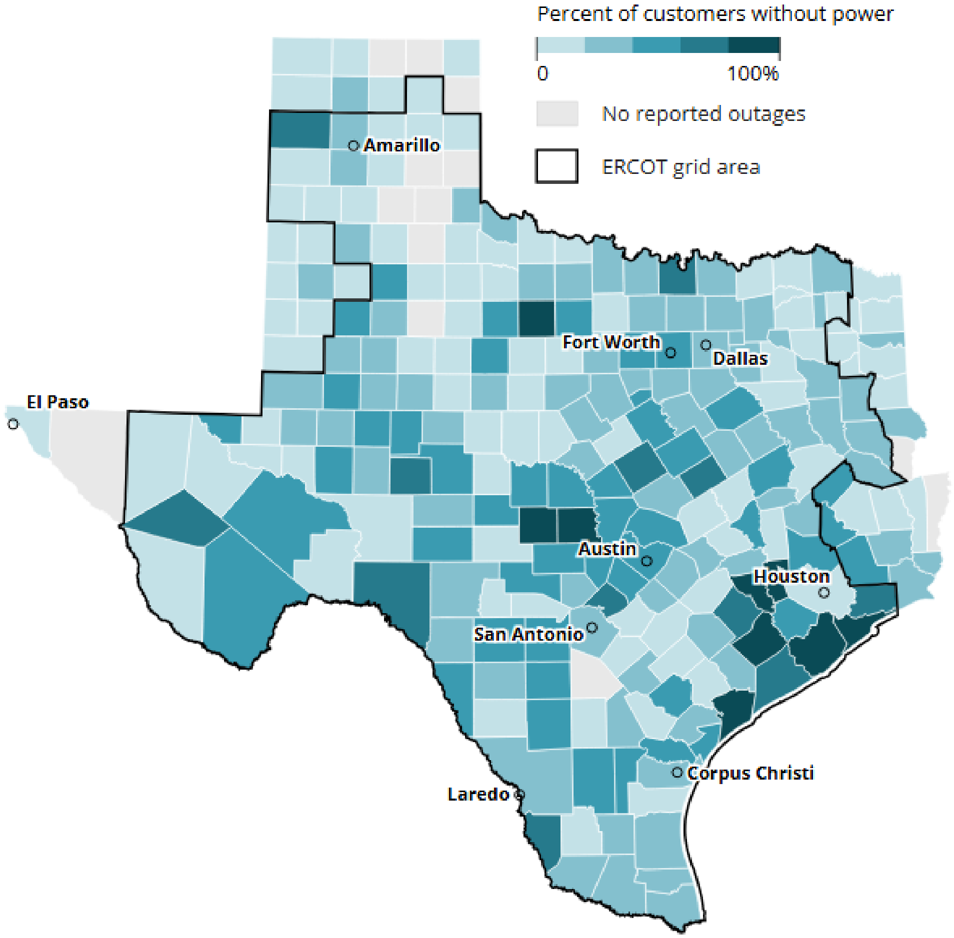
PG&E 2024 Sustained Outages by Cause



Bulk system outages

- **Bulk system outages are uncommon, but can be very disruptive when they occur, e.g.:**
  - California rolling blackouts during the 2000-2001 energy crisis
  - Texas blackouts during the 2021 Winter Storm Uri
- **Proximate causes may include high loads, generator outages, or transmission outages, if these occur during system peak hours**
- **The root cause is generally related to issues in system planning, such as:**
  - Forecasting of load growth
  - Modeling of severe weather
  - Capturing correlations in generator and/or transmission outages
  - Reflecting capacity value of different resources
- **Bulk power systems are generally designed to a "1-in-10-year" standard**
  - Empirically, California's bulk system has met this standard since the energy crisis

Texas - percent of customers without power
Feb 16, 2021



What does this all mean for electrification?

- **New loads may require new investment**
  - Distribution system capacity investments are driven by connected load or local peaks
  - Transmission and generation capacity investments are driven by system peak demand
  - Any new loads may require new electric generation resources to serve them
- **New loads should not directly affect reliability as long as utilities (PG&E) and load serving entities (PG&E and CCAs) plan accordingly**
  - CPUC and CAISO have structured planning processes for this purpose

What does this all mean for electrification?

- **New loads may require new investment**
  - Distribution system capacity investments are driven by connected load or local peaks
  - Transmission and generation capacity investments are driven by system peak demand
  - Any new loads may require new electric generation resources to serve them
- **New loads should not directly affect reliability as long as utilities (PG&E) and load serving entities (PG&E and CCAs) plan accordingly**
  - CPUC and CAISO have structured planning processes for this purpose
- **Note: winter reliability may pose a long-term planning challenge in the 2040s**
  - California's electric system currently peaks in the *summer*, driven by air conditioning loads
  - Very high levels of building electrification may eventually shift reliability needs to the *winter* (e.g., in 2040-2045)
  - It is difficult to serve peak winter loads using wind, solar, and batteries; gas generation currently fills this role
  - Serving winter peak loads would require either novel "clean firm resources" or continued reliance on gas capacity

IWG Member Q&A

Building Decarbonization Regulatory Updates

Building Decarbonization Section, Energy Division

Presenter: Abhilasha (Abhi) Wadhwa /*she*/

Presented to Bay Area Air Quality Management District Implementation Working Group on 12/03/2025

California Public Utilities Commission

Introduction: Relevant Proceedings

- Building Decarbonization Proceeding: R.19-01-011
- Income Graduated Fixed Charge Proceeding: R.22-07-005
- Long-term Gas Planning Proceeding: R.24-09-012
- Energization Proceeding: R.24-01-018

Building Decarbonization Proceeding Roadmap

Phase 1: Established Building Decarbonization Pilots – BUILD and TECH (March 26, 2020)

Phase 2: i) Incentive layering; ii) "Wildfire and Natural Disaster Resiliency Rebuild" (WNDRR) program; iii) Rate adjustments and, iv) Data requirements (November 9, 2021)

Phase 3a: Eliminate Gas Extension Subsidies for dual fuel (September, 2022)
Phase 3b: Eliminate Electric Extension Subsidies for dual fuel (2023)

Phase 4a: Common facility Cost Treatment, Alternatives to line upsizing, TECH expansion (June 2025)
Phase 4b: Baseline Allowances and Electrification Rates (TBD)
Phase 4c: Zonal Decarbonization and Long-term Action Plan (TBD)

Building Decarb Phase 4A Decision

Section 4: Common Facility Cost Treatment for certain under-resourced customers

Section 5: Adopts measures to prevent unnecessary electric service line upsizing

- Meter Socket Adapters
- Customer/contractor education on upsizing alternatives

Section 6: Extend line extension elimination deadline of Phase 3B Decision

Section 7: Building Decarb Reporting Requirements

Section 8: Authorizes $40 million for the TECH Initiative pursuant to Assembly Bill (AB) 157

- Statewide incentives for power-efficient technologies

Common Facility Cost Treatment

Authorizes PG&E to recover **up to $2.3 million annually** for 4 years from electric ratepayers to cover utility-side service line upsizing costs not already covered by existing allowances for:

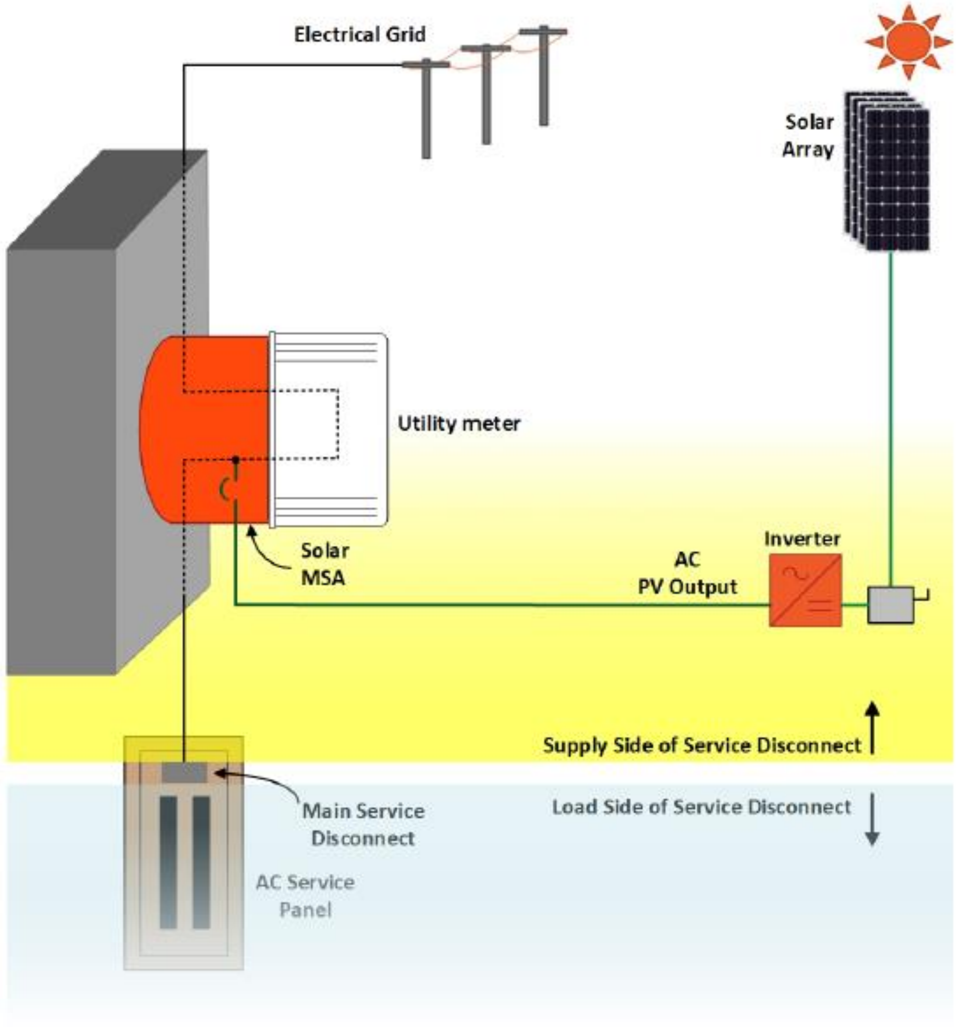
- Under-resourced residential and small business customers:
    - ➢ whose existing premise's electric service line capacity is below 100 amps.
    - ➢ are participants of a building decarbonization program that results in electrification of at least two appliances, one of which must be a heat pump for either space or water heating.
    - ➢ Establishes a benefit cap of $10,000 per single family and small business project
    - ➢ No benefit cap for multifamily units
    - ➢ Who is under-resourced is determined by the program/s that incentivized premise electrification
- Caps the upsized line at 200 amp for all customers getting the benefit
- Last test year will be July 1, 2028, to June 30, 2029; CPUC to review participation data from prior 3 years

Alternatives to Panel Upsizing

- Decision emphasizes use of power-efficient technologies to avoid service and panel upsizing
- Examples: low voltage appliances, circuit sharing devices, meter socket adapters
- Modifies a prior Microgrids decision to extend evaluation and testing funds for “non-isolating” devices for building electrification
- Extends TECH incentives to power-efficient technologies

Isolating and Non-isolating devices; Meter Socket Adapters

- Behind-the-meter but front of electric panel adapters that allow additional load to be added without a service line upsize
  - ➢ Isolating adapters are meant for situations where disconnecting the premise from the grid is needed (e.g. solar with battery/ microgrid)
  - ➢ Non-isolating adapters (none yet approved) are meant for situations where new load needs to be added without disconnecting from the grid (e.g. EV charger, heat pump)
  - ➢ Cheaper and faster than service upsizing
  - ➢ Still requires a utility truck roll to connect to meter



Isolating MSA schematic
Source: ConnectDER

Encouraging Service Upsizing Alternatives

- TECH implementer to develop resources about alternatives to electric service and panel upsizing (ongoing)
- Utilities must revise their service request application portal to reference TECH implementers' website/ resources for customer education
- Approves TECH incentives to extend to power-efficient technologies and devices such as circuit-sharing devices, meter socket adapters (anticipated launch April 2026)

Income Graduated Fixed Charge (D.24-05-028)

	Large Electric IOUs		
Tier	Fixed Charge /Month	Assignment	% Federal Poverty
1	$6.00	CARE Status	200%
2	$12.08	FERA or Affordable Housing Status	< 250 % (or 80% AMI)
3	$24.15	Non-CARE/FERA	> 250%

Estimated Rate Reductions at Time of Decision

- Volumetric rate reductions across all TOU periods

- Summer peak reduction of 8-10% (estimates based on 2023 revenue requirements)
  - PG&E – $0.437/kWh ($0.047/kWh reduction)
  - SCE – $0.522/kWh ($0.046/kWh reduction)
  - SDG&E – $0.783/kWh ($0.068/kWh reduction)

- Optional rates required to have same fixed charges

BSC ME&O Timeline

Commission adopted SDG&E, SCE, and PG&E BSC Implementation Plans

December 2024/ January 2025

30-90 days before Go-Live (advance notice)

SDG&E Go-Live

October 1, 2025

SCE Go-Live

November 15, 2025

30-90 days before Go-Live (advance notice)

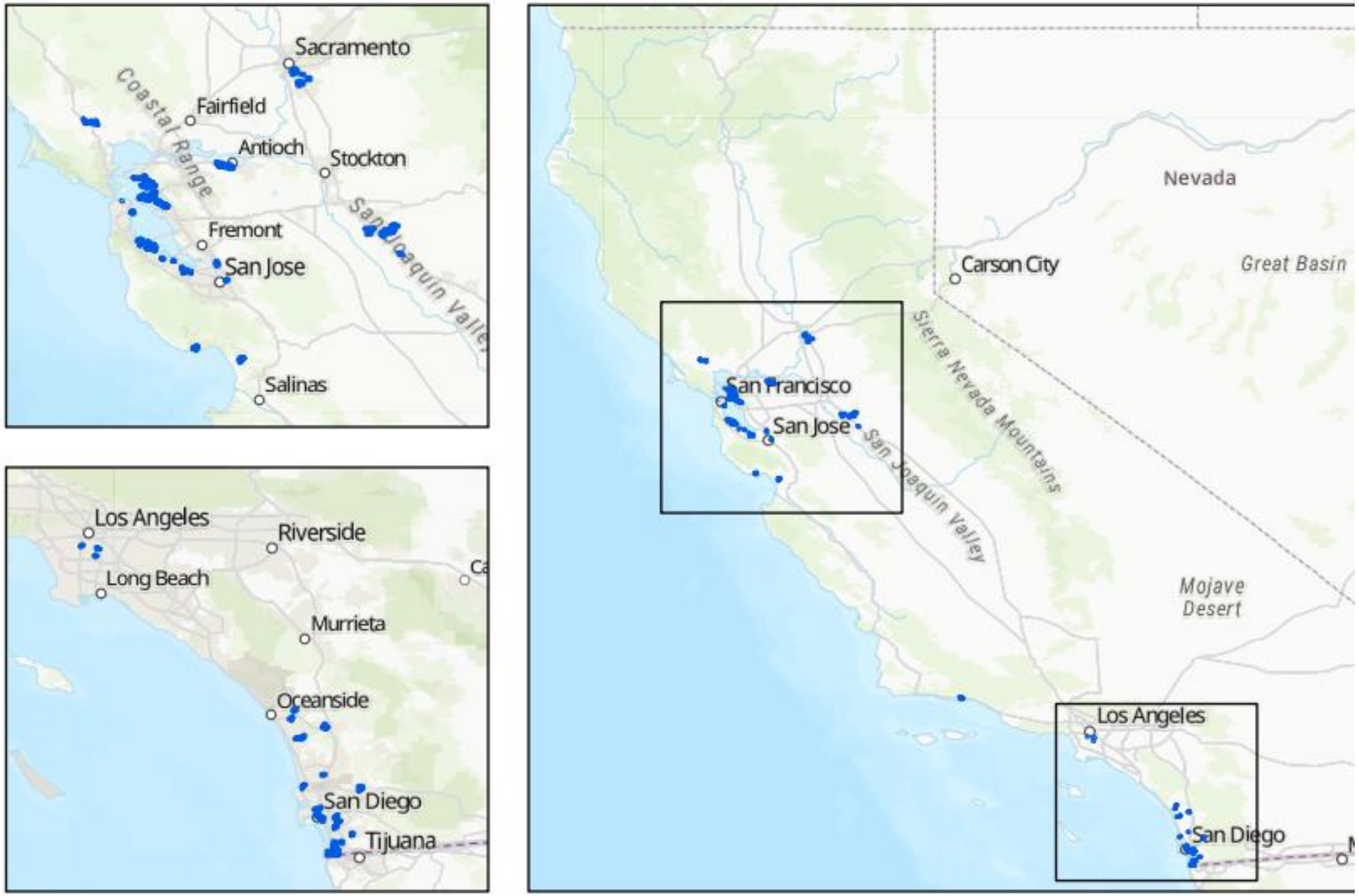
PG&E Go-Live

March 1, 2026

Long-term Gas Planning Proceeding/ SB 1221 Neighborhood Decarbonization

- SB 1221 (Min, 2024) envisions up to 30 neighborhood decarbonization projects across the state
- Proposed Decision released November 13th 2025: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M587/K210/587210797.PDF
- Designates 142 California census tracts as initial neighborhood decarbonization zones in compliance with SB 1221 where:
  - ➢ a local government or organization requested to participate; and
  - ➢ planned gas distribution replacement projects constitute 10 percent or more of the gas main mileage
  - ➢ while capping the resulting tracts by county, for any county that otherwise would have more than 25 tracts, by:
    - ➢ keeping the 25 tracts with the highest gas replacement percentages, and
    - ➢ keeping all tracts with CalEnviroScreen scores above the 75th percentile, which is the main factor used to define disadvantaged communities.

Initial SB 1221 Neighborhood Decarbonization Zones



California State Parks, Esri, TomTom, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS, USFWS, California State Parks, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS

Energization Proceeding Progress: Flexible Service Connections

- Proposed Decision expected Early 2026
  - ➢ will focus on near-term program implementation in Flexible Service Connections for firm capacity
    - Firm capacity refers to a fixed LLP based on a predetermined schedule agreed upon by customer and utility
  - ➢ Increase transparency for interested customers that may want to consider Flexible Service offerings for their operations
  - ➢ Remove barriers preventing PG&E and SCE from scaling their FSC offerings

IWG Member Q&A

Top Drivers of Air Source Heat Pump HVAC Retrofit Costs

Presented to:
Bay Area Air District
Building Appliance Rules Meeting

Dylan Sarkisian

Senior Data Scientist

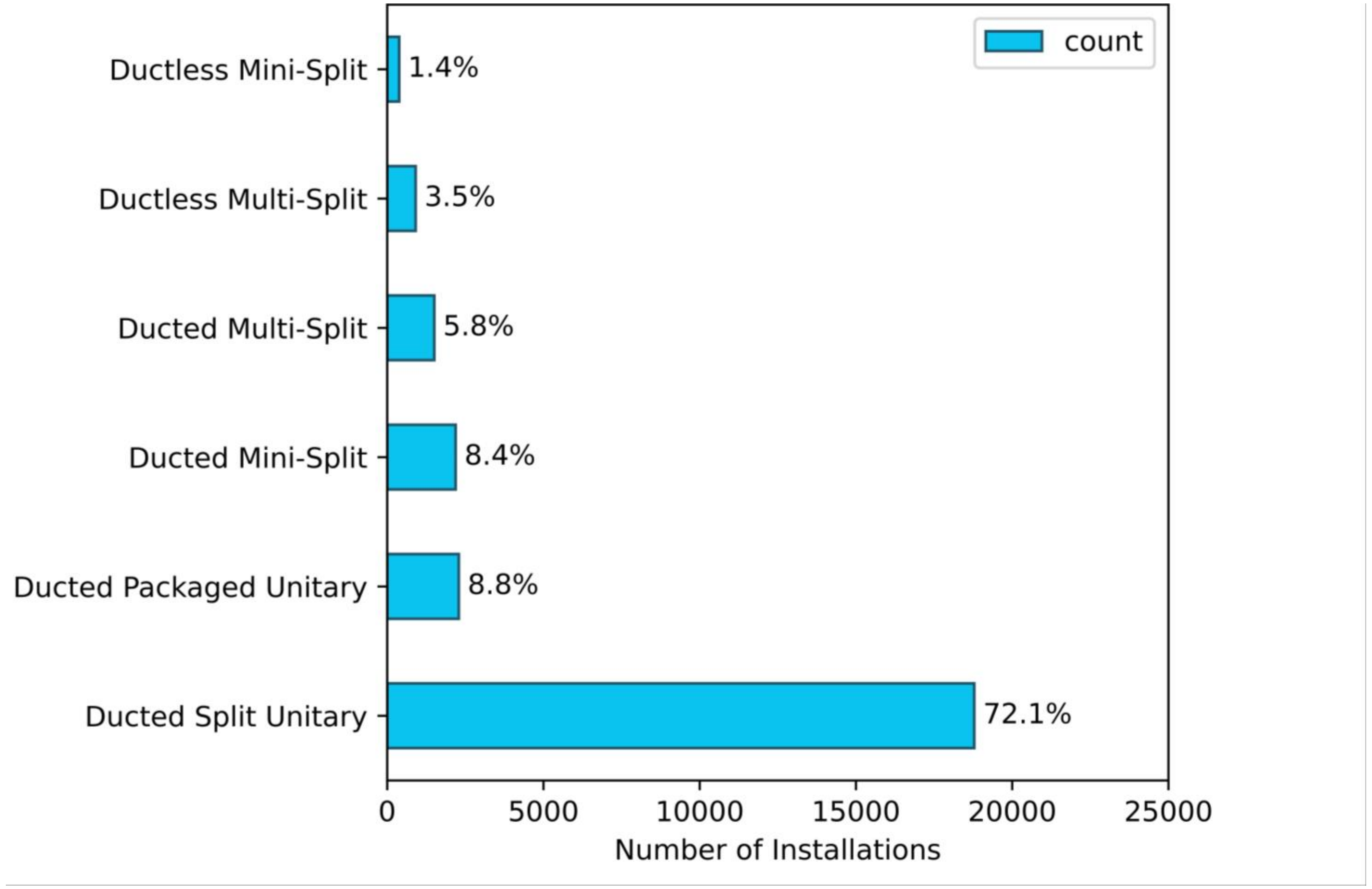
Energy Solutions

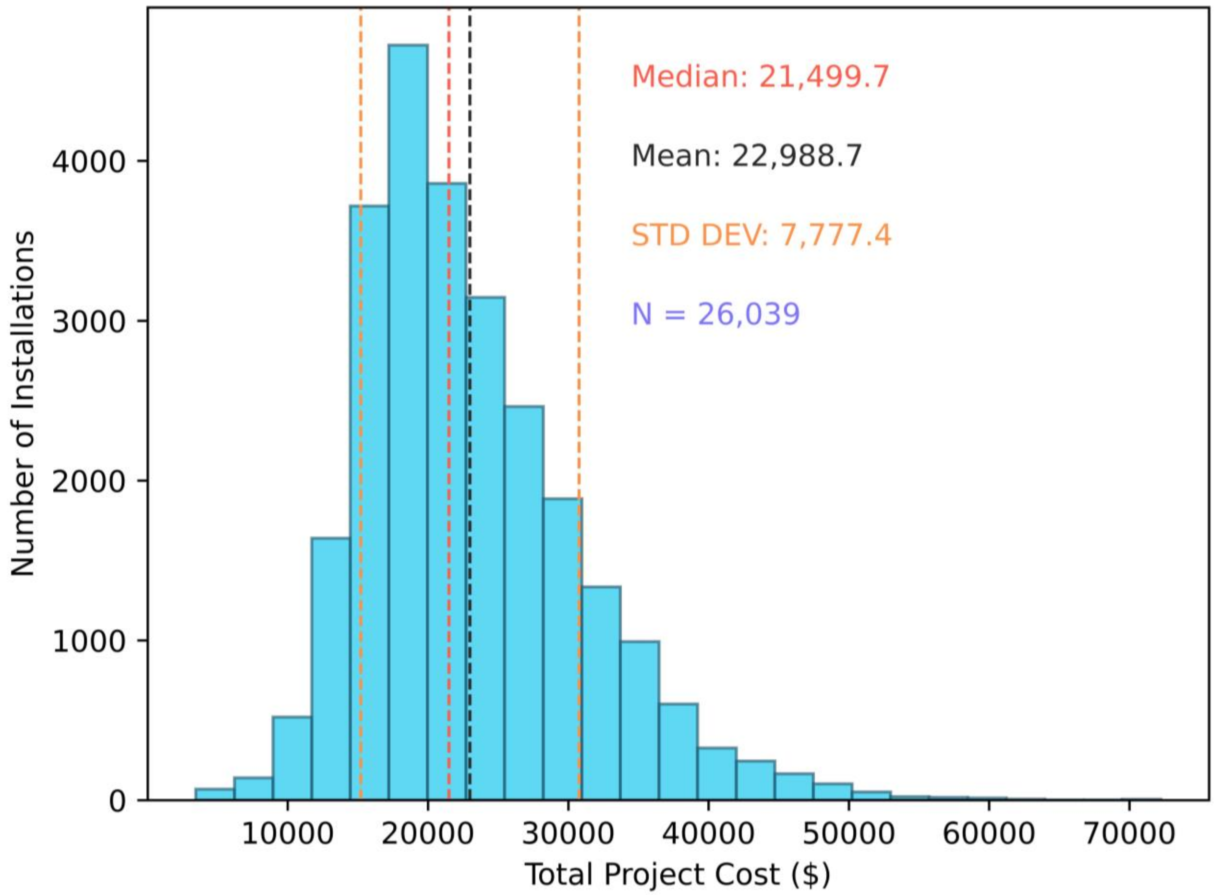
December 3, 2025

TECH CLEAN CALIFORNIA

Visualizing Heat Pump Costs

Statewide single-family air-source heat pump retrofits. Over 99% of installations replaced a gas furnace.





Total Project Cost data shown is not affected by any incentives received and is adjusted to July 2025 dollars using the Consumer Price Index.

Research Questions

For single family air-source heat pump retrofits:

1. How well can we explain variation in Total Project Cost among TECH projects with available data on equipment, customers, homes, and contractors?

2. What are the strongest predictors, or ***top drivers***, of Total Project Cost?

3. What is the relationship between Total Project Cost and each of the top drivers?

Data Characteristics

Data: 26,039 air-source heat pump HVAC retrofits in single-family homes across CA, including 32 variables.

Home, Equipment, Installation, Location, and **Cost** variables were sourced from TECH project data, joined with census, property assessor, and climate data.

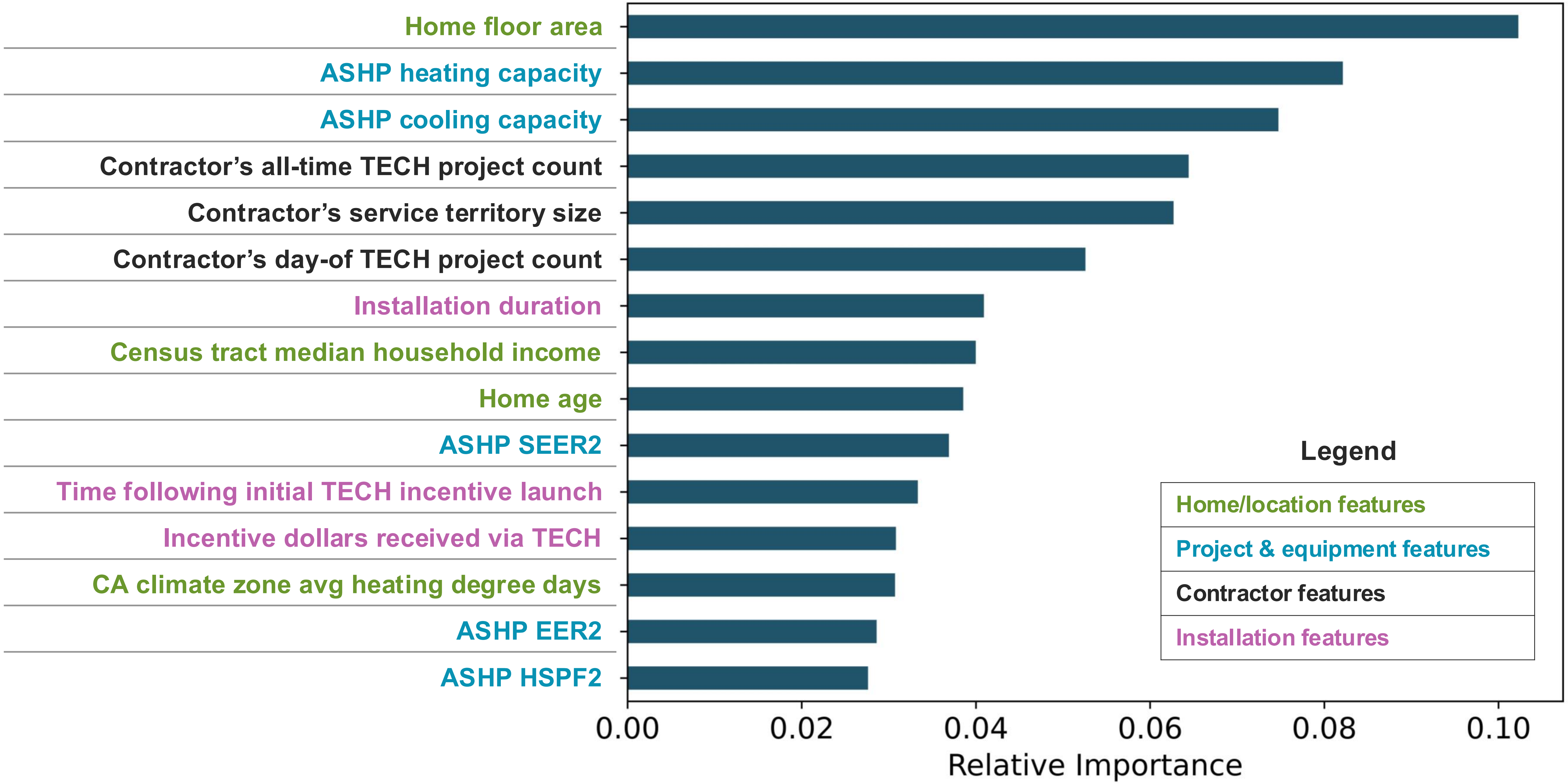
Contractor variables were sourced from TECH project data and data collected from contractors upon enrollment.

Category	Number of Variables
Contractor Features	4
Home Features	2
Equipment Specifications	8
Installation Features	10
Location	5
Cost and Incentives	3
Total	**32**

Download TECH Clean California Project Data

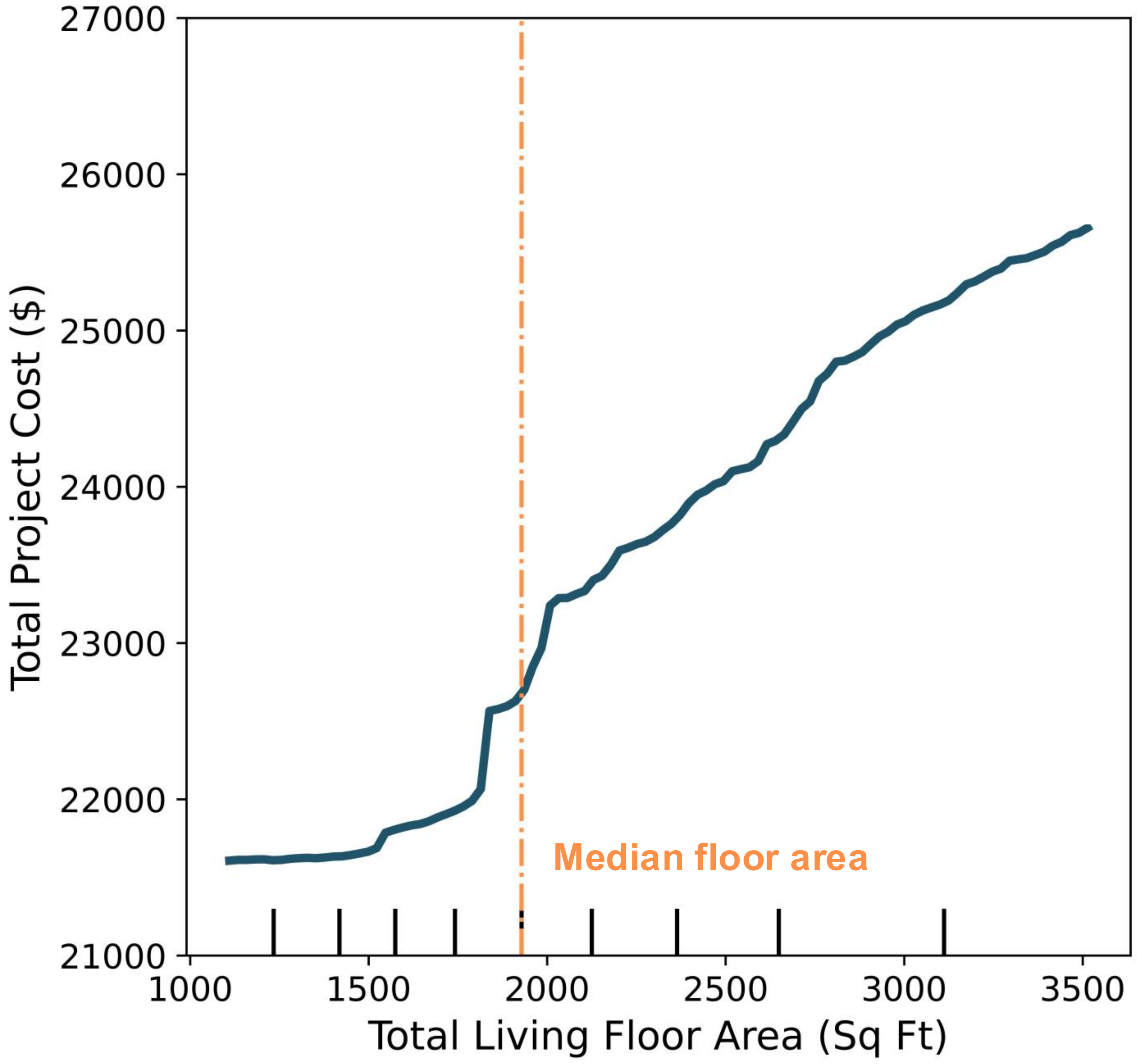
Top ASHP Cost Drivers Identified by Random Forest Regression

Variable importance ranking, n = 24,400



Home Floor Area versus Total Project Cost

Holding all else constant, how does Y vary with X?



Summary statistics

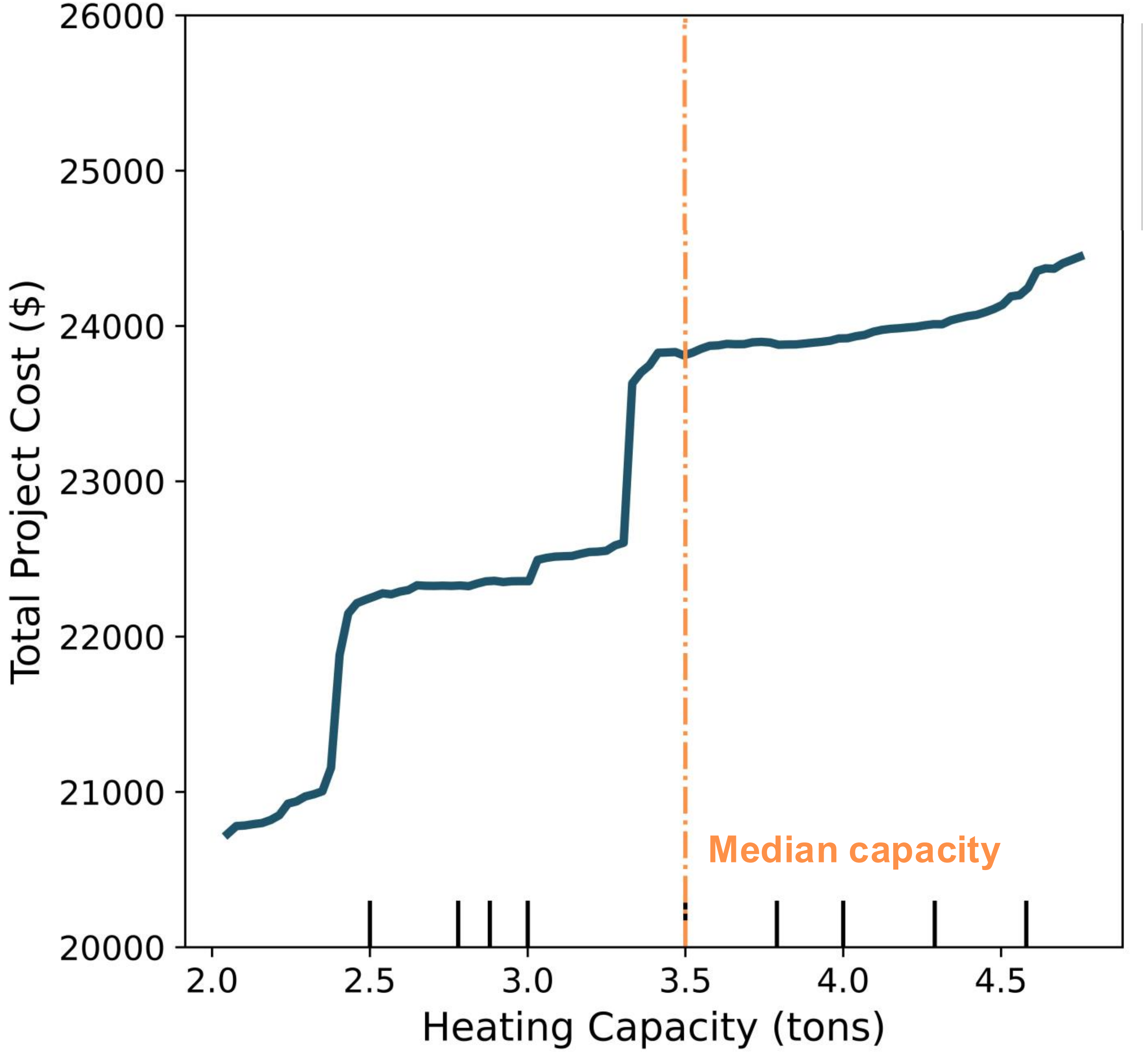
- Median living floor area: 1,922 ft^2
- Range of living floor area: 2,350 ft^2
- Range of total project cost: $4,050

Holding all else constant, cost increases minimally for homes ranging from 1,000 to 1,900 ft^2, then rapidly for homes ranging from 1900 to 2200 ft^2.

For homes >2,200 ft^2, cost increases at ~$1.6 per ft^2.

Heating Capacity versus Total Project Cost

Holding all else constant, how does Y vary with X?



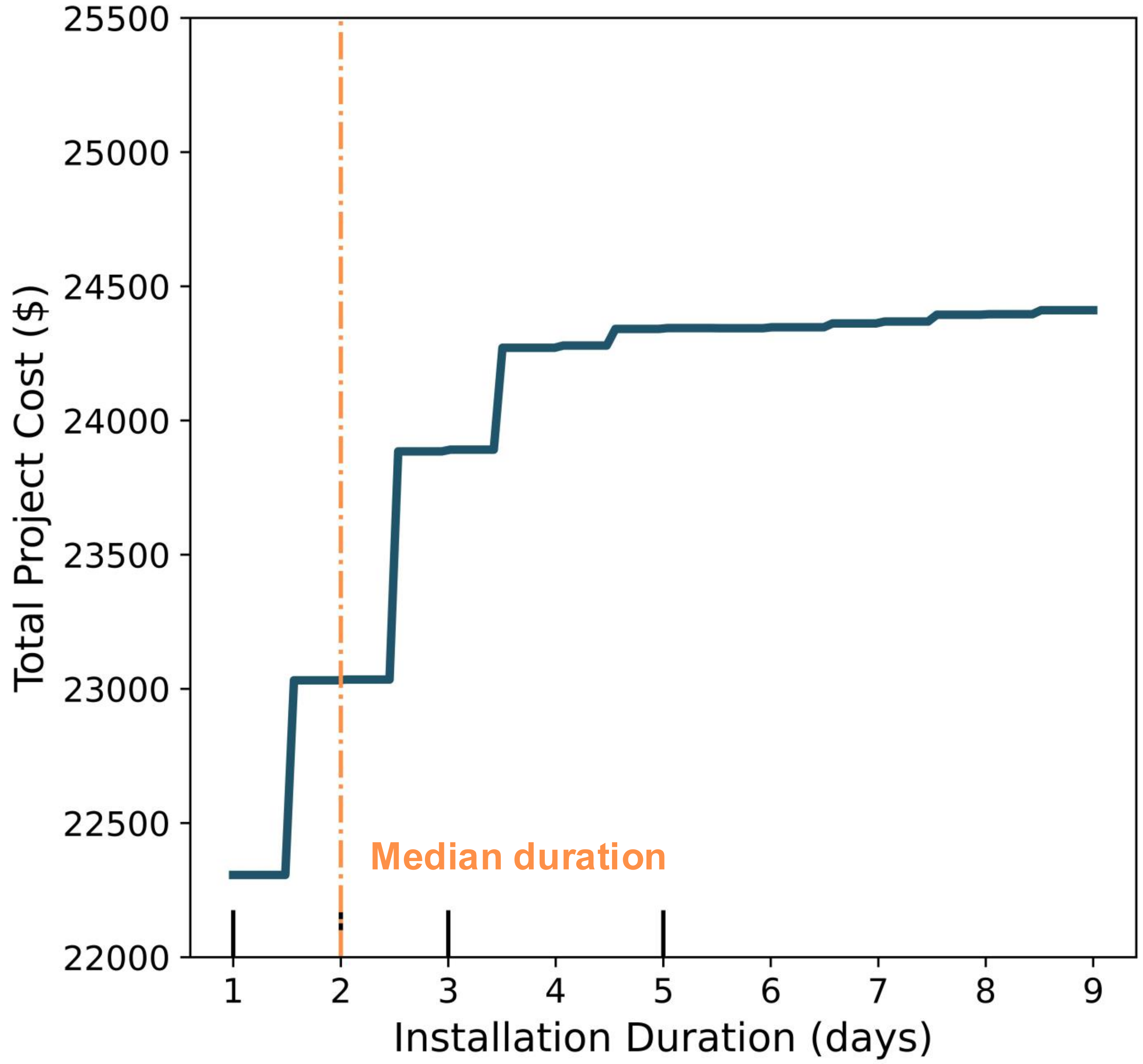
Summary statistics
- Median heating capacity: 3.5 tons
- Range of heating capacity: 2.6 tons
- Range of total project cost: $3,716

Holding all else constant, cost increases are concentrated at two points: 2.4 and 3.4 tons.

An opportunity may exist to reduce costs by right-sizing equipment below 2.4 and 3.4-ton thresholds.

Installation Duration versus Total Project Cost

Holding all else constant, how does Y vary with X?



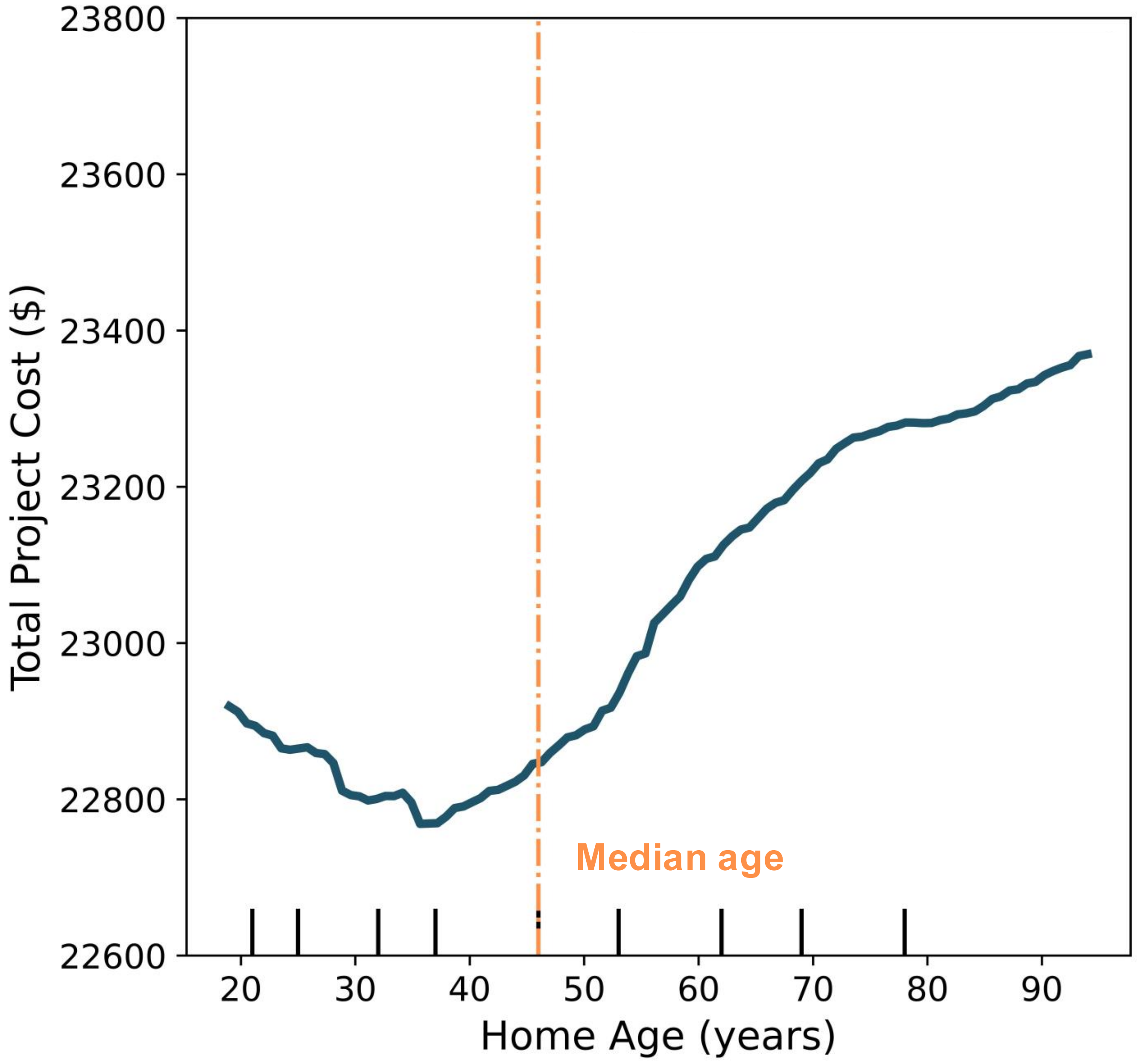
Summary statistics
- Median duration: 2 days
- Range of duration: 8 days
- Range of total project cost: $2,104

Holding all else constant, cost increases the most when going from a 2 to 3-day install (+$900) and a 1 to 2-day install (+$750).

Conversely, the greatest cost savings opportunity exists in the first 3 days of the installation.

Home Age versus Total Project Cost

Holding all else constant, how does Y vary with X?



Summary statistics
- Median home age: 46 years
- Range of home age: 75 years
- Range of total project cost: $601

Holding all else constant, cost decreases slightly for homes 20-40 years old, then increases for homes >40 years old.

An opportunity to reduce costs may exist in better understanding what makes costs minimal for 30- to 40-year-old homes.

Conclusions

Nonlinear machine learning models like random forests generally explain ASHP retrofit Total Project Cost better than linear models, as well as find top cost drivers *and* visualize complex relationships between project cost and each driver.

For ASHPs in the TECH Clean California dataset, the top cost drivers come from a variety of categories including home, equipment, contractor, and installation features.

Case studies of the following top cost drivers reveal potential opportunities to reduce costs by taking advantage of cost inflection points:

- Home Floor Area
- ASHP Heating Capacity
- Installation Duration
- Home Age

Thank You

For more information, contact:

Dylan Sarkisian

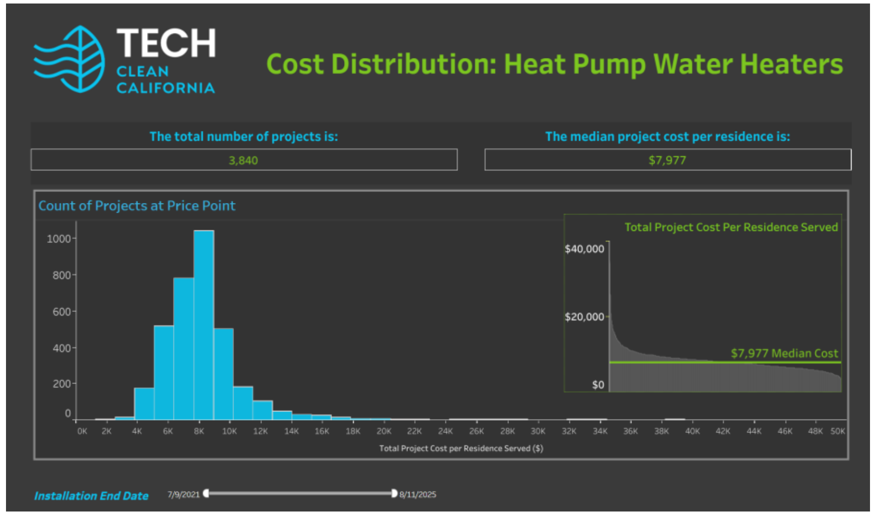
Senior Data Scientist

Energy Solutions

TECH.Data@energy-solution.com

TECH Program Dataset

https://techcleanca.com/heat-pump-data/



TECH Evaluator Research Index

https://opiniondynamics.com/tech-clean-california-research-index/

CATEGORY QUICK LINKS:

Awareness, contractors	Awareness, customers	Barriers to Purchasing a Heat Pump
Costs	Demand Response	Disadvantaged Community
Disadvantaged Workers	Equipment Issues, TECH customers	Financing
Finding a Contractor	Heat Pump Benefits	Heat Pump Drawbacks/Concerns
Heat Pump Experience	Hiring Preferences	Homeowner Environmental Values
HPWH Sizing	Incentives	Installation Standards
Interest in Electric Devices	Labor Market	Market Penetration
Multifamily	Natural Gas – Equipment	Panel Upgrades (Electrical)
Promotion of Heat Pumps	Purchasing Factors	Satisfaction, contractor
Satisfaction, TECH customer	Single-family	Sourcing, pricing, & profitability
TECH	TECH Participation, contractors	TECH Participation, customers
Thermostat	Thermostatic Mixing Valves	Time-of-Use Rates
Training	Water Heater Replacements	

IWG Member Q&A

Zero NOx Appliance Cost Findings

Rincon Consultants on behalf of the Air District

Implementation Working Group Meeting

December 3, 2025

Part 1:
Costs for Zero NOx Heat Pump HVAC Installation

Analysis Overview

- Reviewed appliance and installation costs provided by several CCA's and rebate providers.
- 17k+ individual projects in total across 7 datasets
- Data limitations
  - Sometimes difficult to determine what "projects" included in cost
    - Some projects double counted costs/included insulation
    - Some costs likely have more than one system (i.e. one per floor)
  - Most costs included panel upgrade costs if they occurred
    - Likely higher average due to this
  - Limited multifamily data points
    - Lack of larger system installs (mainly on HVAC side)

rincon

Cost Data Timeframes

Project Type	Data Source (Project Counts)	Year(s)
HP HVAC	Peninsula Clean Energy (3,025)	2022-2025
	San Jose Clean Energy (556)	2024-2025
	Sonoma Clean Power (581)	
	TECH Clean California (10,395)	2021-2025
	City of Palo Alto Utilities (57)	2025
	Silicon Valley Clean Energy (1,088)	2022-2024
	CLEAResult (1,244)	2020-2023
Gas Furnace	CLEAResult (2,945)	2019-2023

HVAC Cost Results

NOx-emitting Cost Baseline: Gas Furnace Only

CLEAResult (2,945 Projects)
$6,846 Avg./$6,347 Median

Gas-Fired Furnace

- **Average** includes skewing of major outlier
- **Median** is closer to what most people paid

NOx-emitting Cost Baseline: Gas Furnace and AC

CLEAResult (2,945 Projects)

$6,846 Avg./$6,347 Median

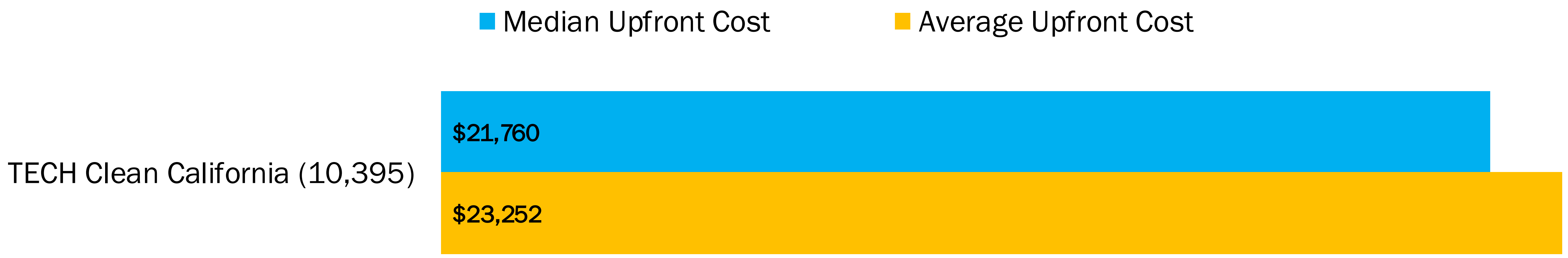
Gas-Fired Furnace

California Energy Commission Codes & Standards Data

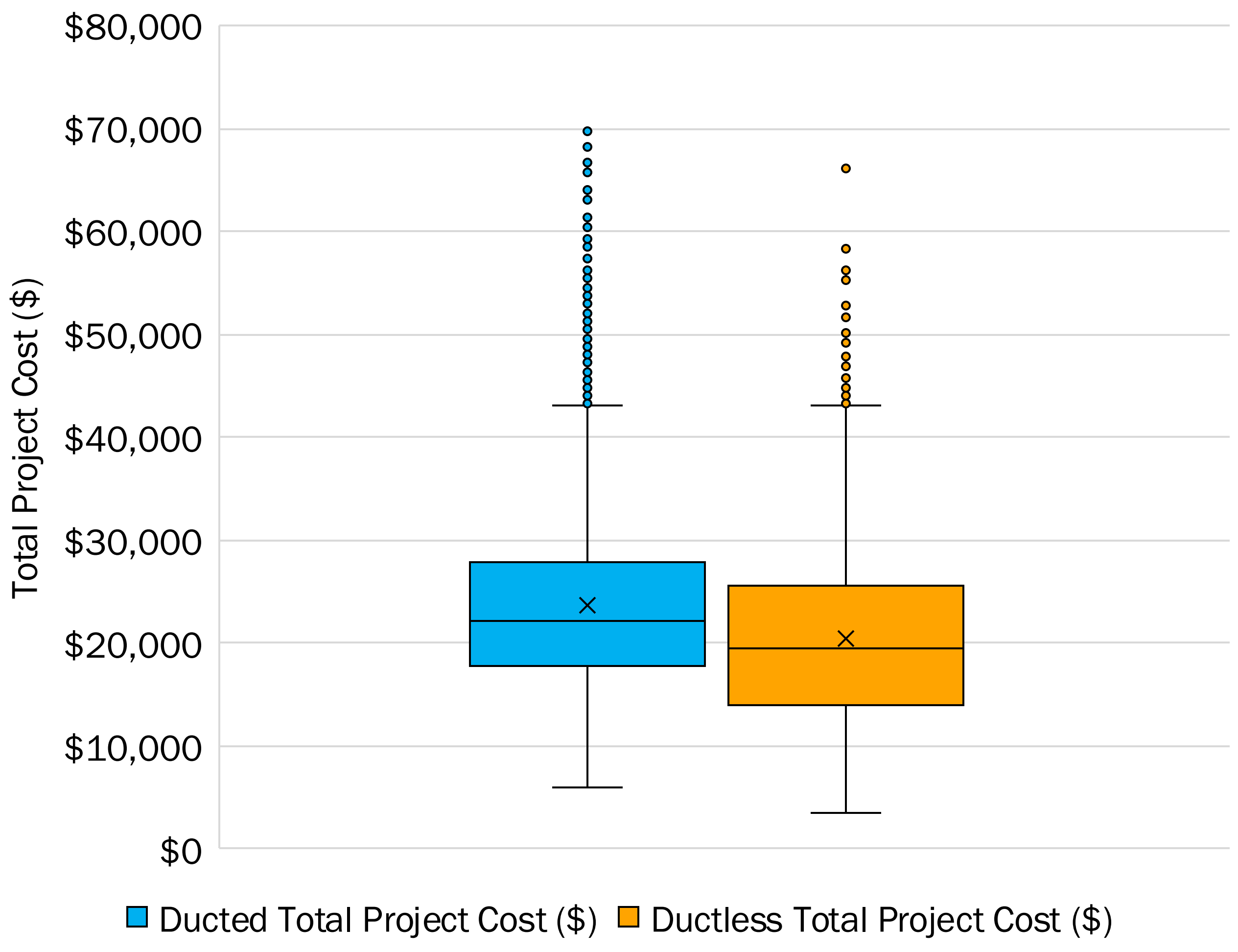
$10,431 Avg.

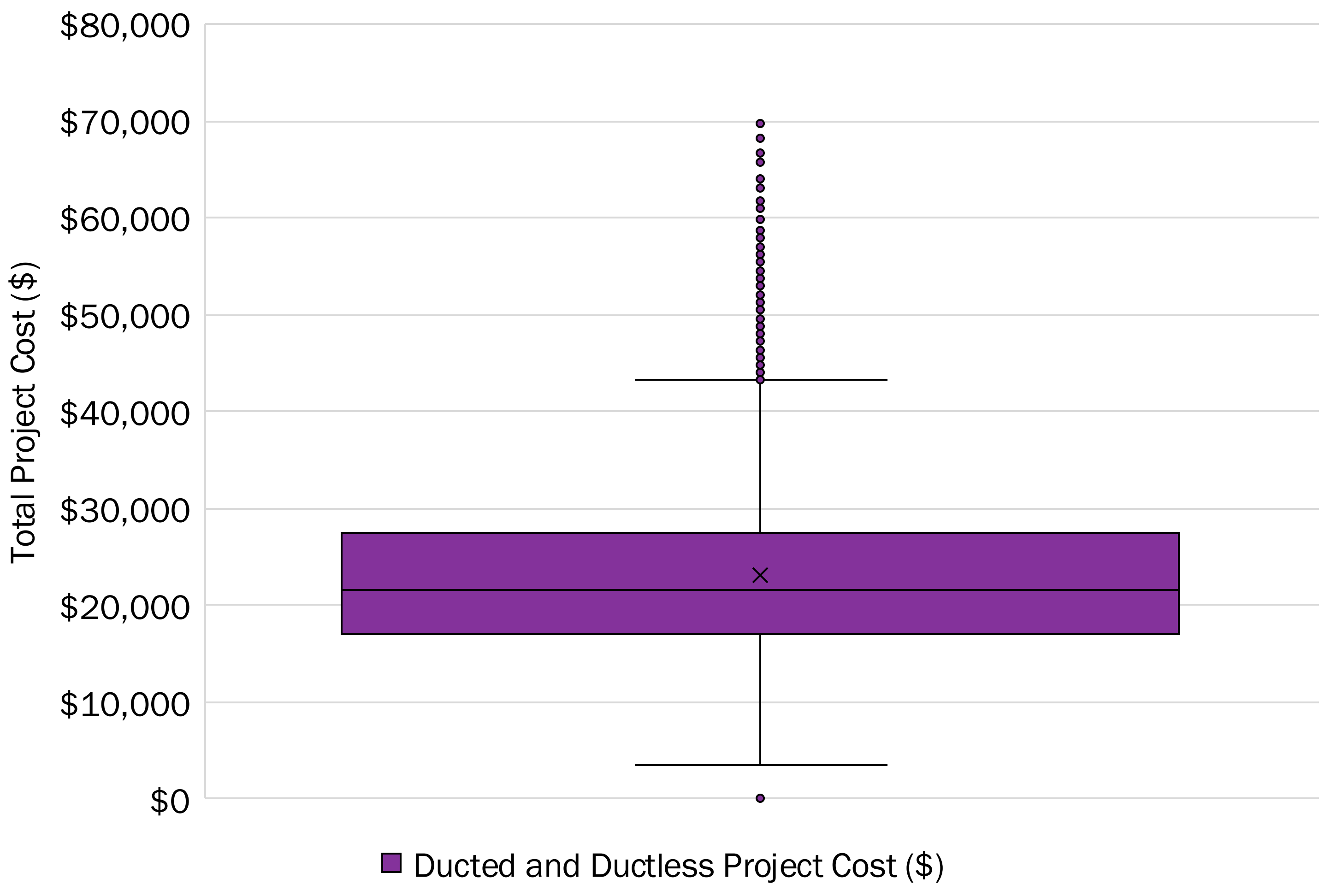
Central AC Unit

TECH Clean California Zero NOx HP HVAC Costs (Single-family)

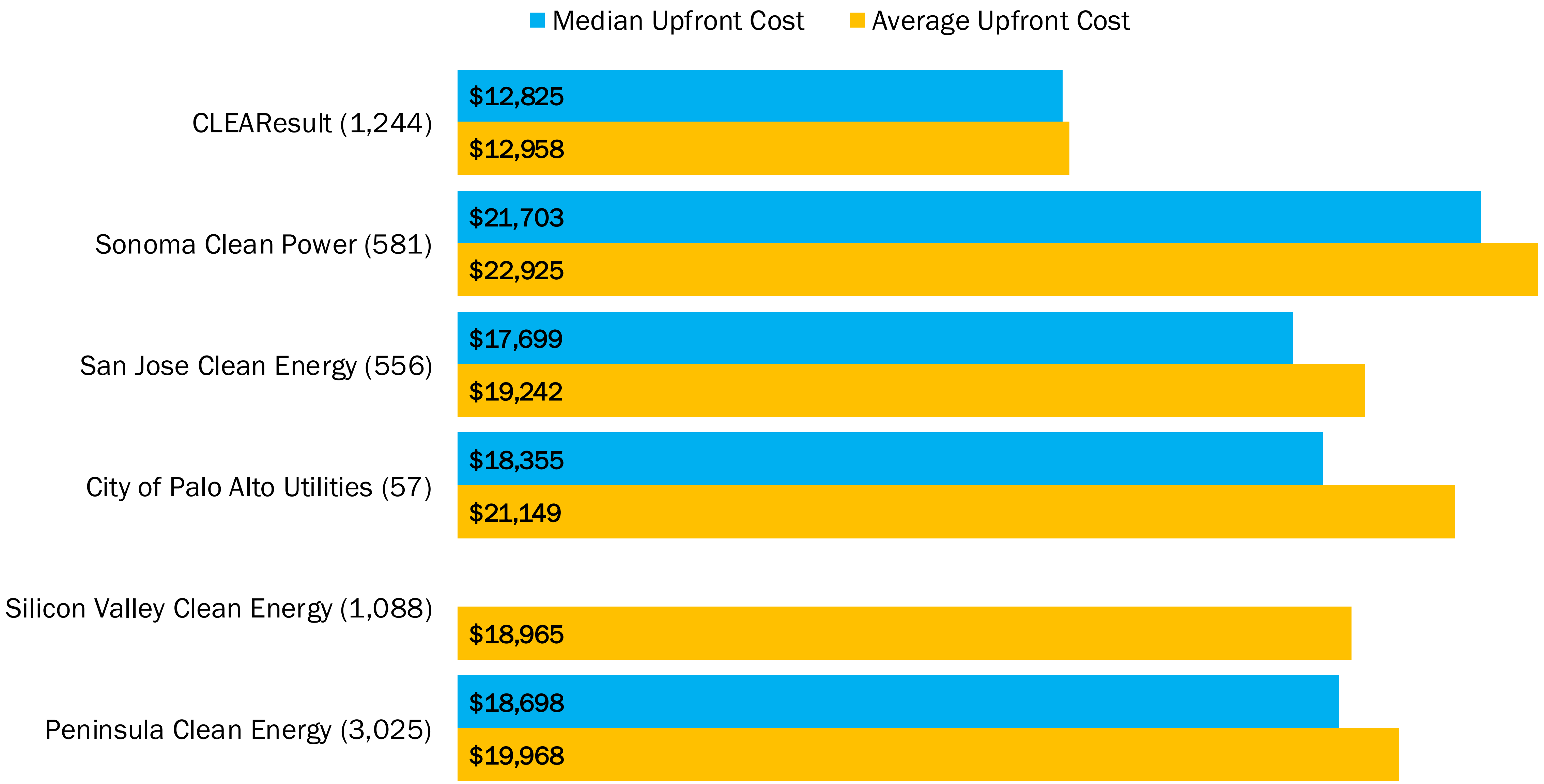


TECH Clean California Zero NOx HP HVAC Costs Distribution (Single-family)

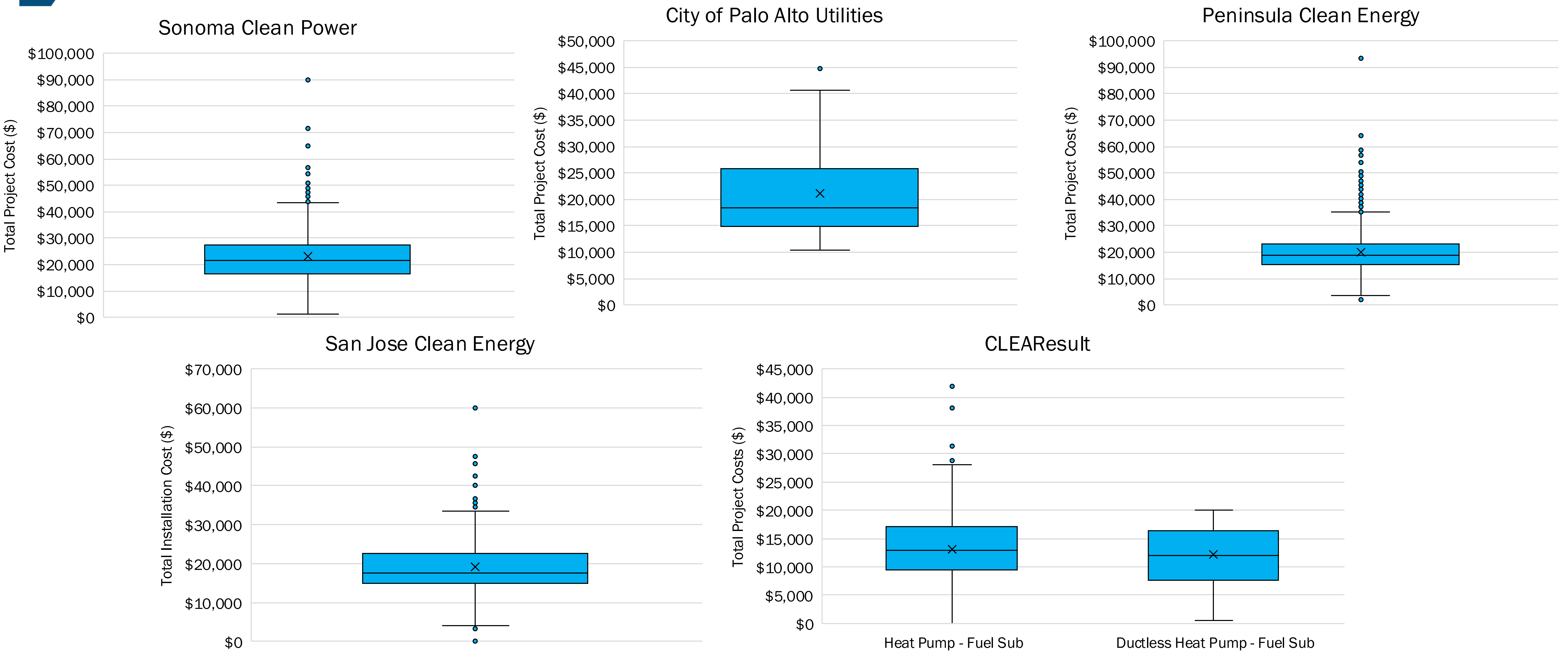




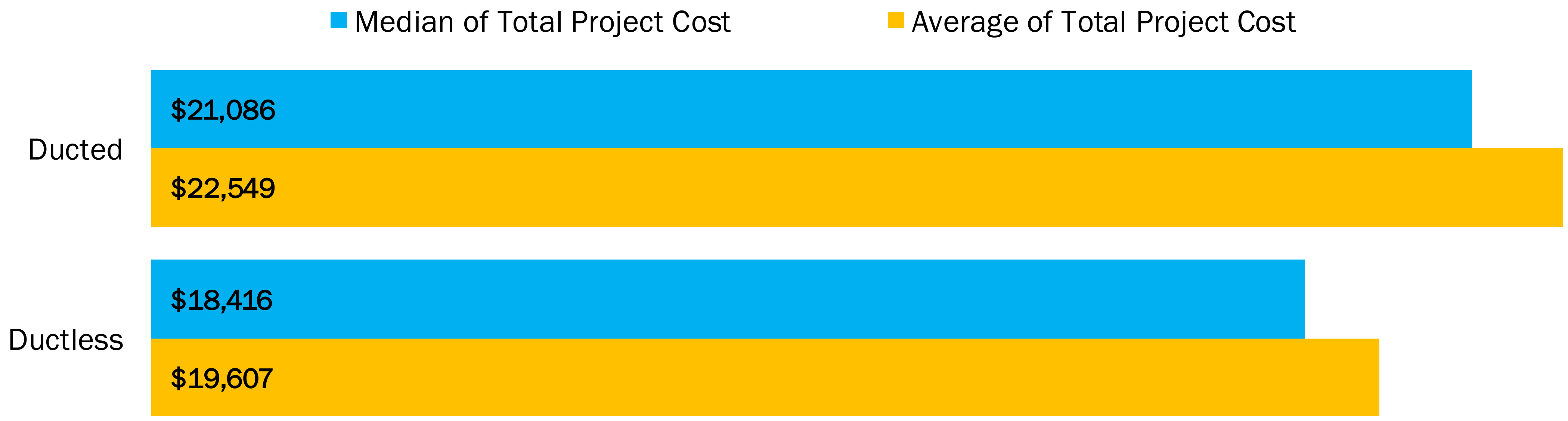
CCAs Zero NOx HP HVAC Costs (Single-family)



CCAs Zero NOx HP HVAC Costs Distribution (Single-family)

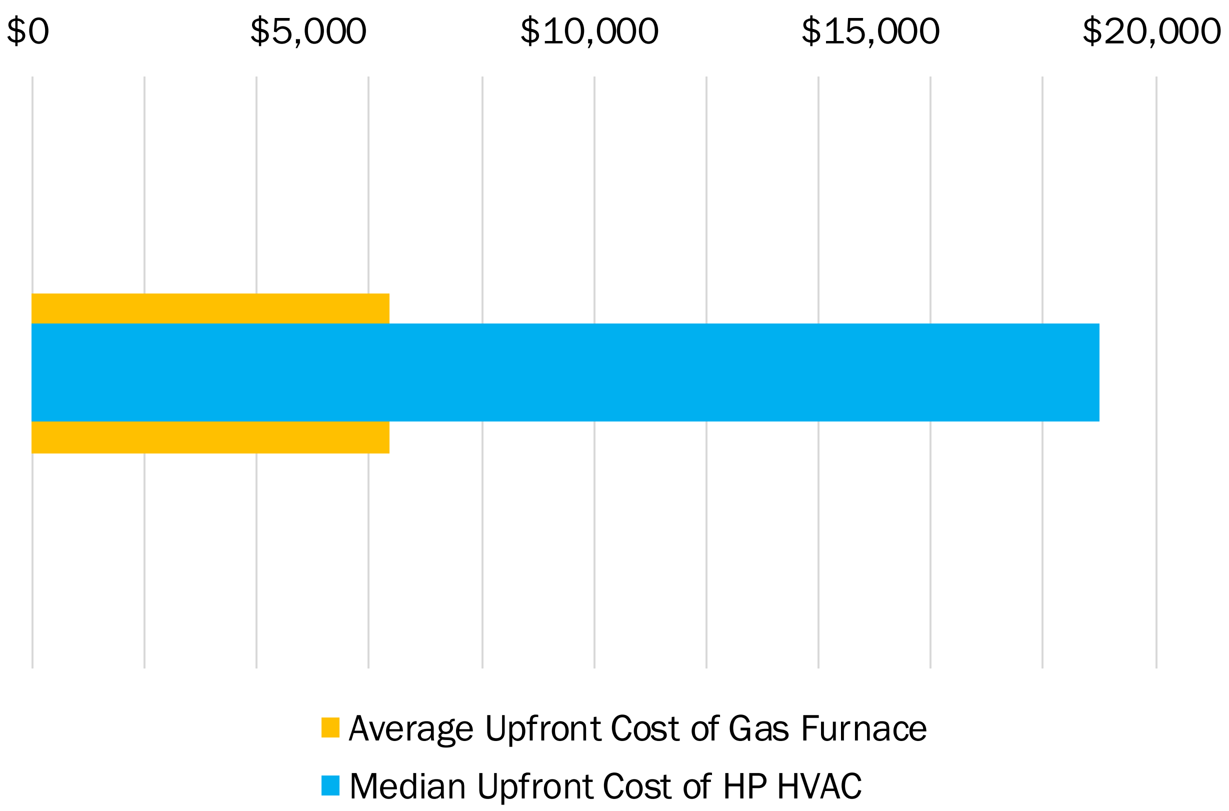


Ducted vs. Ductless Zero NOx HP HVAC Costs (Single-family)



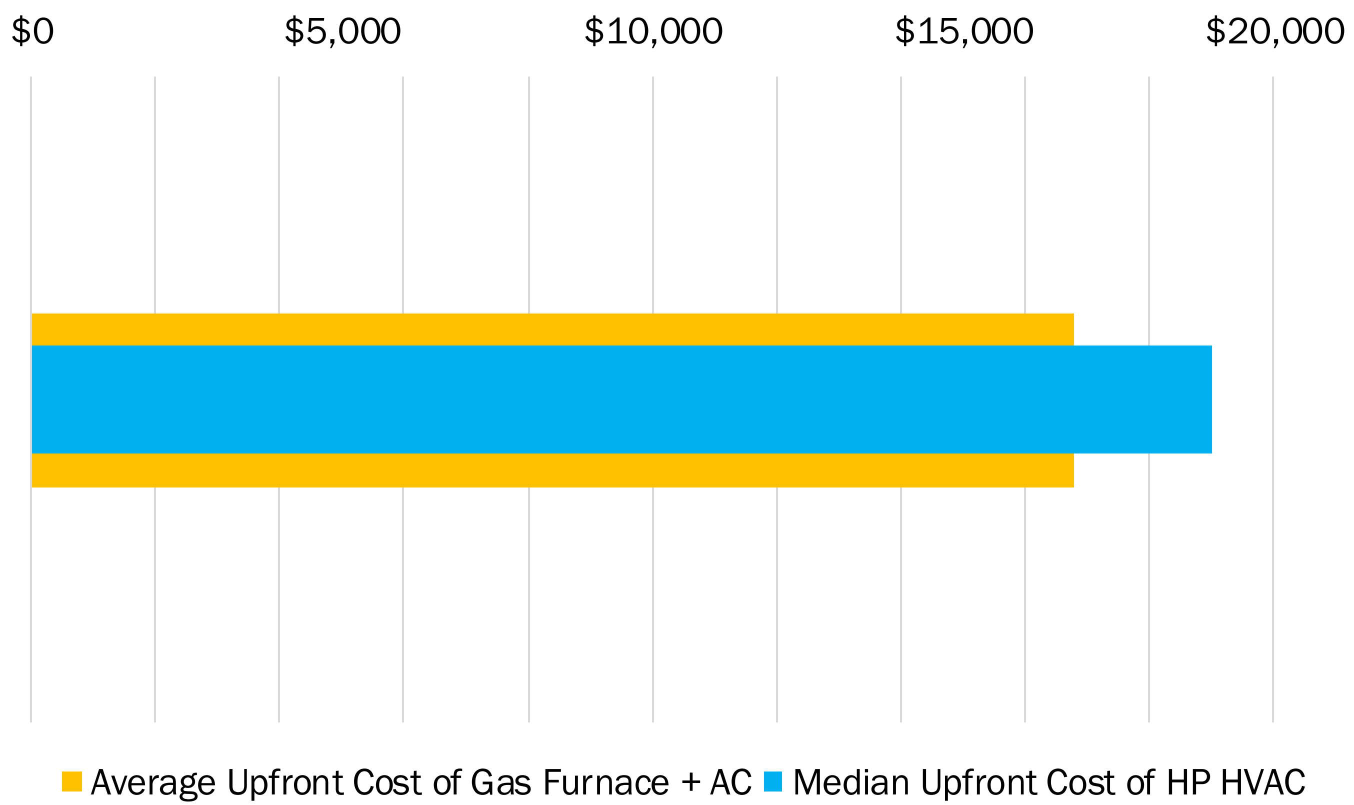
Incremental Costs (Ducted and Ductless)

Incremental Cost: $12,666



Gas Furnace Only (no AC)

Incremental Cost: $2,235



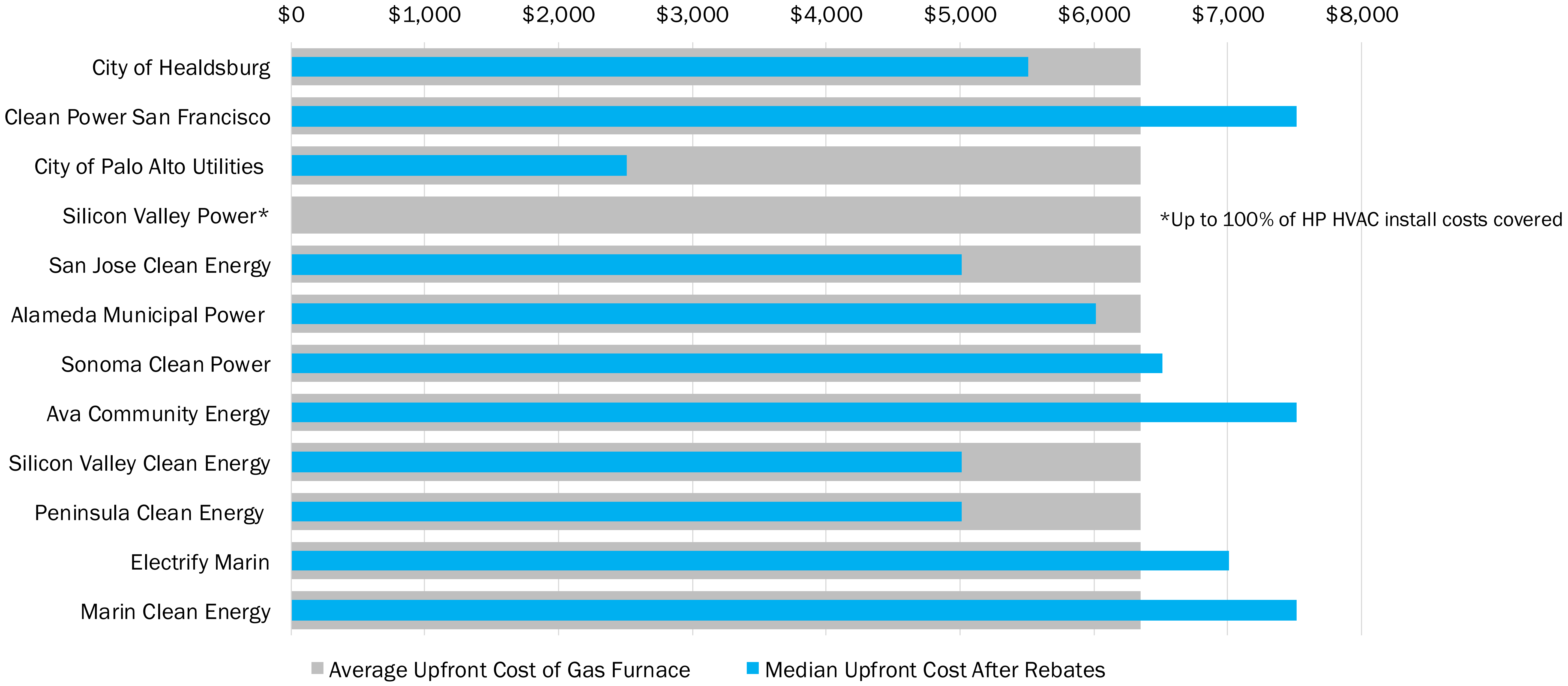
Gas Furnace and AC

Incentives Available as of October 2025

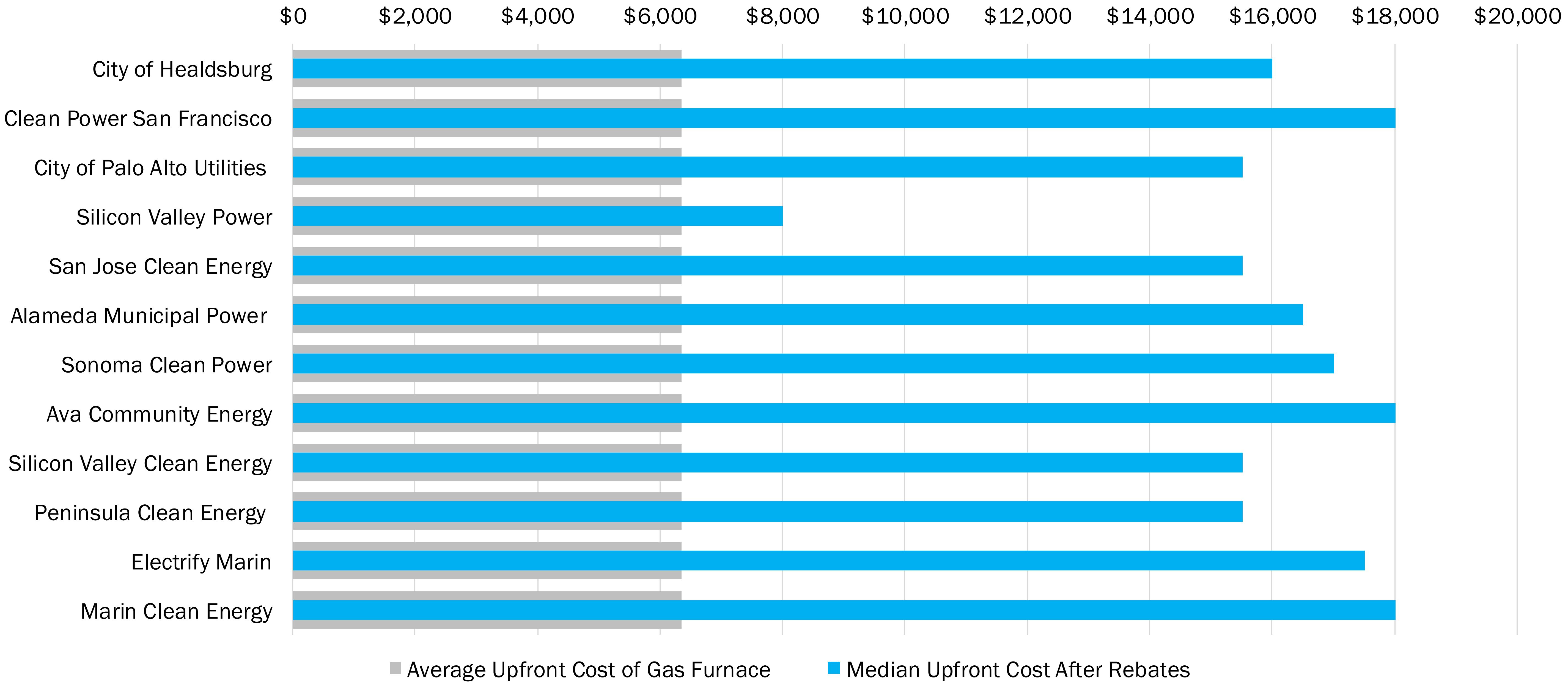
Funder + Rebate	Standard Rebate	Low-income Rebate
Incentives for Zero NOx HP HVACs		
Stackable Incentives – Bay Area Wide		
HEEHRA Rebate	$0	$8,000
TECH Clean California[1]	$1,000	$3,500
Local Incentives: CCAs and POUs		
Electrify Marin	$500	$500
Peninsula Clean Energy	$2,500	$2,500
Silicon Valley Clean Energy[2]	$2,500	$2,500
San Jose Clean Energy[2]	$2,500	$2,500
Sonoma Clean Power[3]	$1,000	$1,000
Alameda Municipal Power	$1,500	$1,500
Silicon Valley Power[4]	$10,000	$11,000
City of Palo Alto Utilities	$2,500	$5,000
City of Healdsburg	$2,000	$2,000

Notes:
1. TECH Clean California offers an additional $500 rebate for customers replacing both an A/C and furnace unit with an HP HVAC.
2. Enrollees in CARE and FERA can receive an additional $1,000 rebate.
3. Enrollees in CARE and FERA can receive rebates equaling 50% of project costs (up to $10,000).
4. $3,000 per ton rebate, up to $10,000 (up to $11,000 for income-qualified customers).

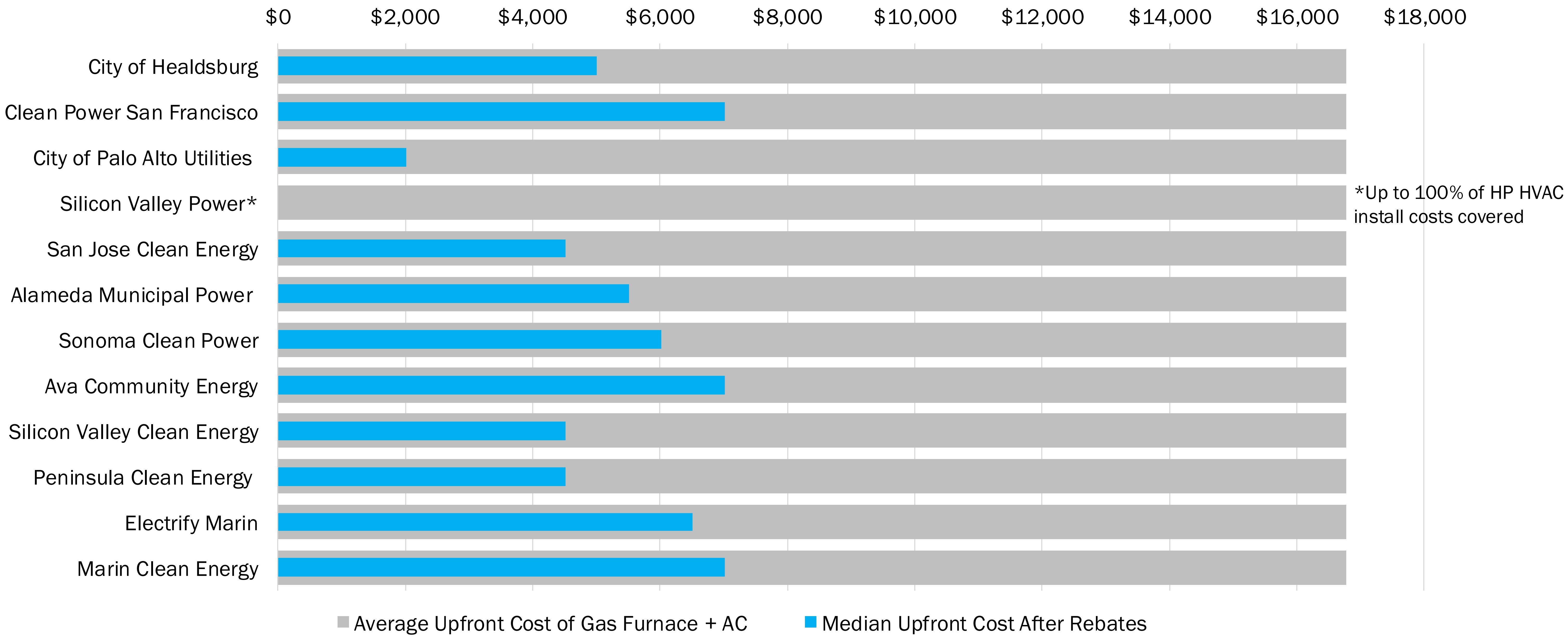
Zero NOx HP HVAC Costs <150% AMI – no AC (Single-family)



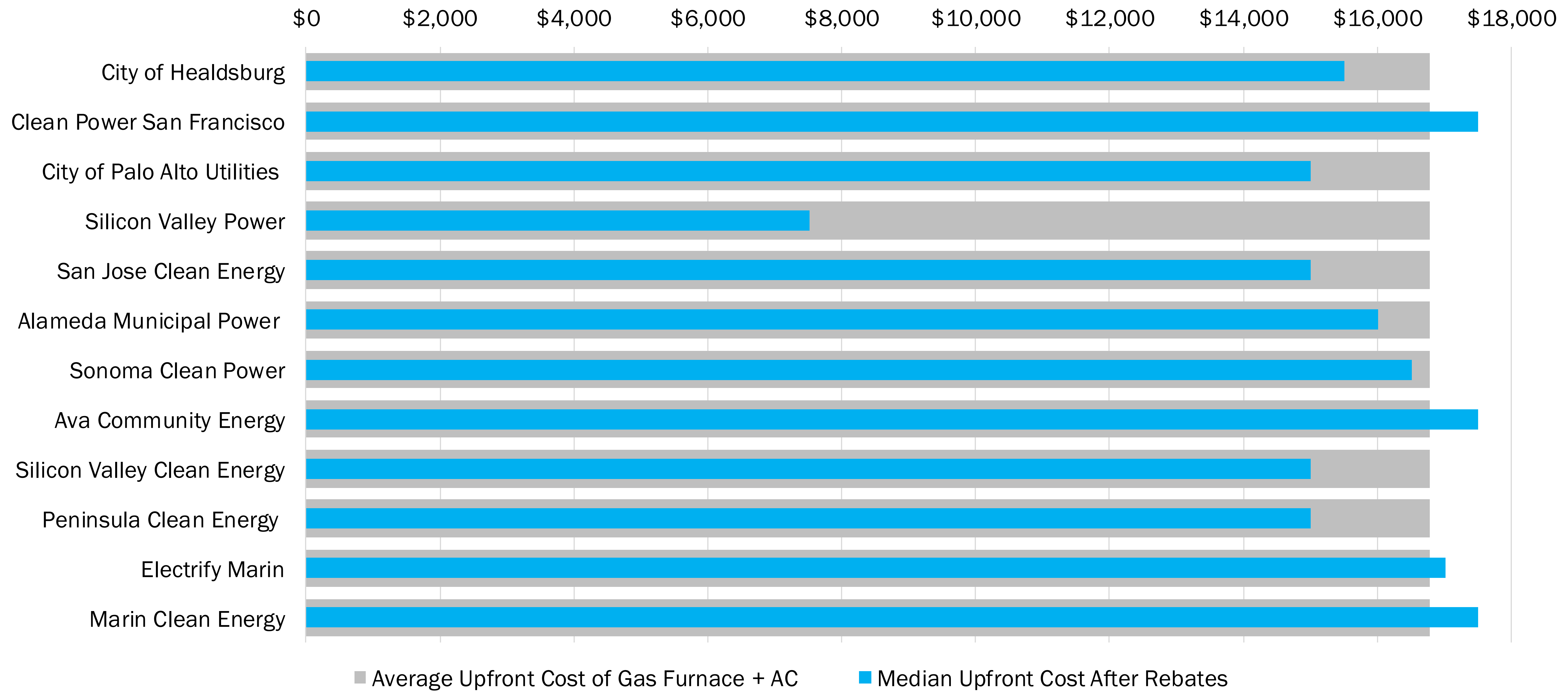
Zero NOx HP HVAC Costs >150% AMI – no AC (Single-family)



Zero NOx HP HVAC Costs <150% AMI – with AC (Single-family)



Zero NOx HP HVAC Costs >150% AMI – with AC (Single-family)



Zero NOx HP HVAC Costs Takeaways

- If <150 AMI, switching from a gas furnace to a HP HVAC is cost effective with current rebates
- If owners have or want AC, switching from a gas furnace to a HP HVAC is cost effective without rebates and cost saving with current rebates
- If >150 AMI, without AC, switching from a gas furnace to a HP HVAC costs about $9,500 more on average with current rebates
- Findings point to the:
  - Continued need for financing and funding options
  - Added benefits of cooling which will increase in value with extreme heat days and wildfire smoke

Multi-family/Commercial HVAC Considerations

- Fewer overall data points
- Less clarity on types of systems (unitary vs. central)
- More diversity of systems covered under regulation
- Costs span single family range with ductless being less expensive

Zero NOx HP HVAC Costs by Duct Type (Multi-family)

Duct System	Number of Projects	Weighted Average Upfront Cost	Weighted Median Upfront Cost
HP HVAC - Ductless	13	$11,816	$11,873
HP HVAC - Ducted	29	$24,647	$28,665

Project costs from TECH Clean California datasets.

Thank you!

Ryan Gardner, Director of Climate Action and Adaptation,
rgardner@rinconconsultants.com

IWG Member Q&A

Public Q&A

Questions Related to Items on Today's Agenda

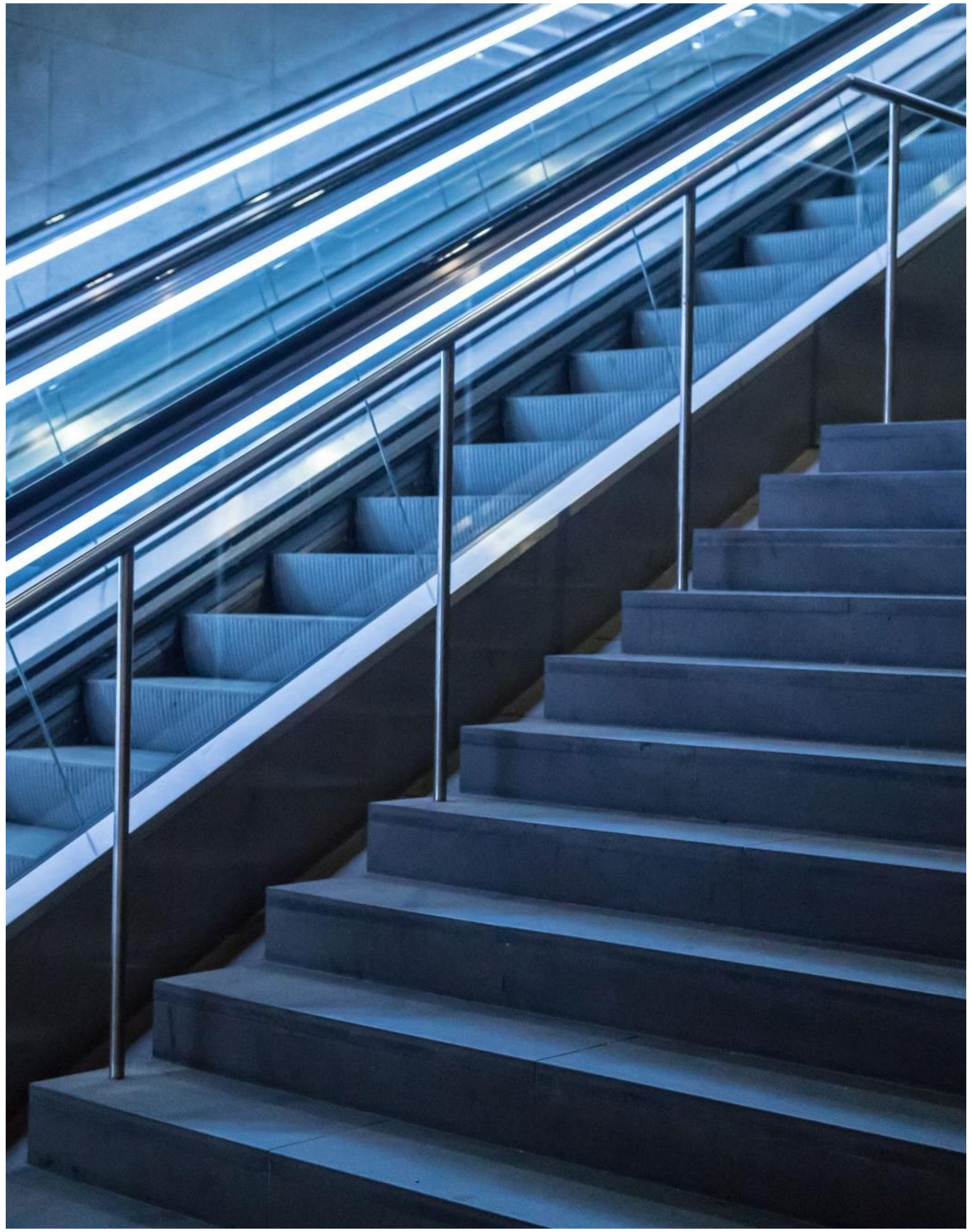
IWG Member Q&A

Questions Not Related to Items on Today's Agenda

What's Coming Next for the IWG?

Next Steps

- Scheduling Poll
- Meeting Invites for Subcommittees



Thank You!

Questions? Other comments?
Email planning@baaqmd.gov