

Utility Energy Forum

Wednesday, April 24, 2024 | 1:15-2:15pm

Benjamin Finkelor, Executive Director



The Utility Industry is Going Through a Massive Clean Energy Transition... a Discussion

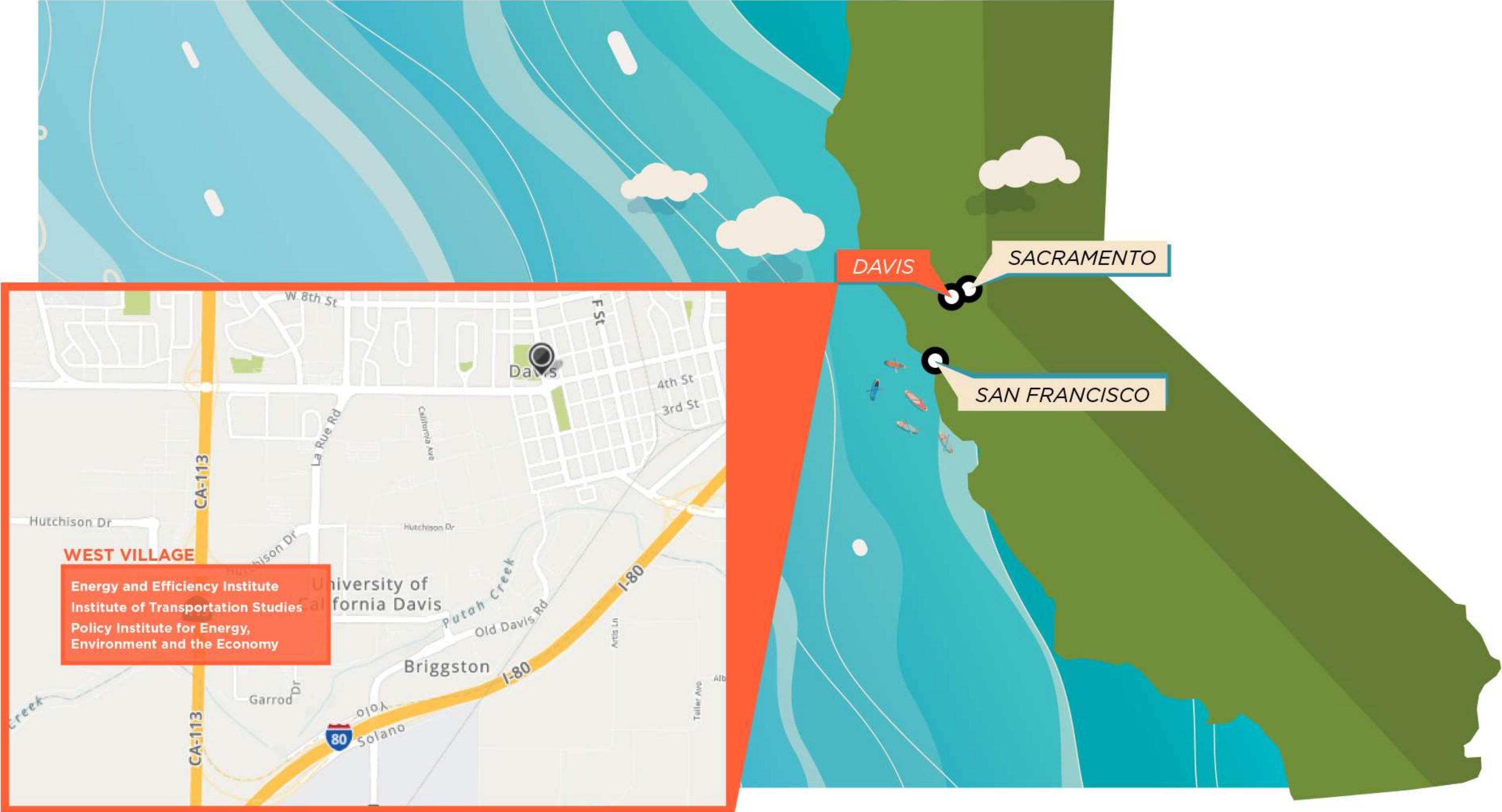
- What UC Davis is doing to help
- What I learned from my time at the CA Energy Commission
- Heat pumps are a microcosm for the challenge ahead



About UC Davis

- » 40,000 students
- » 10,000 faculty, staff, researchers
- » \$1 billion per year in research expenditures
- » #1 in the US for campus sustainability
- » Wall Street Journal ranked 5th among public universities

Davis, Sacramento, and the Bay Area



EEI accelerates the Development and Commercialization of Sustainable Energy Technologies & Solutions and Training Future Energy Leaders



BUILDINGS



TRANSPORTATION



INDUSTRY



WATER

Affiliated Research Centers and Programs



UC Davis Energy and Efficiency Institute

- » First University-based Energy Efficiency Center in the US
- » Founded upon Partnerships with CA utilities and national industry leaders

SPONSORS



Broad Range of Industry Partners



Prestigious Board of Advisors



» Distinguished leaders in industry, government, public interest organizations, and academia

» Provide valuable insight and advice on research opportunities, funding strategies, and outreach

Bipartisan Gubernatorial Support



Former Gov. Schwarzenegger
Launches the “Energy Efficiency Center”
(2006)



Former Gov. Jerry Brown
Visits the Honda
Smart Home (2015)



Gov. Gavin Newsom
Speaks at the UC Davis West Village
ZNE Development Grand Opening
(2011)

Extensive Outreach & Engagement



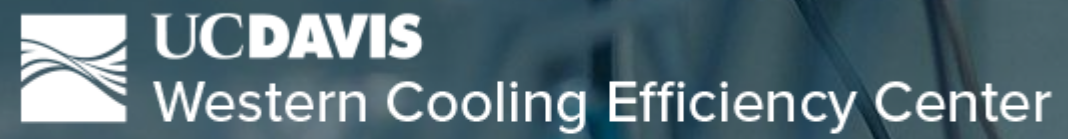
- » 50-60 visits and tours each year with national and international visitors
- » **Weekly seminars** during fall, winter, and spring quarter
- » **Conferences and events** (e.g., Global Energy Managers Workshop and Industrial Decarbonization Symposium)
- » **Emerging Energy Professionals Program** to connect students with alumni mentors as they search for internships and careers
- » **Environmental Justice Leaders Program** to connect university-based research programs & personnel with community expertise & knowledge



Leading Energy Graduate Group

- » Preparing next-generation leadership in government, the private sector, and academia to tackle the energy challenges of the 21st century and beyond.
- » Students conduct interdisciplinary research to address pressing environmental, economic, policy, and social challenges facing California, the U.S., and the world.





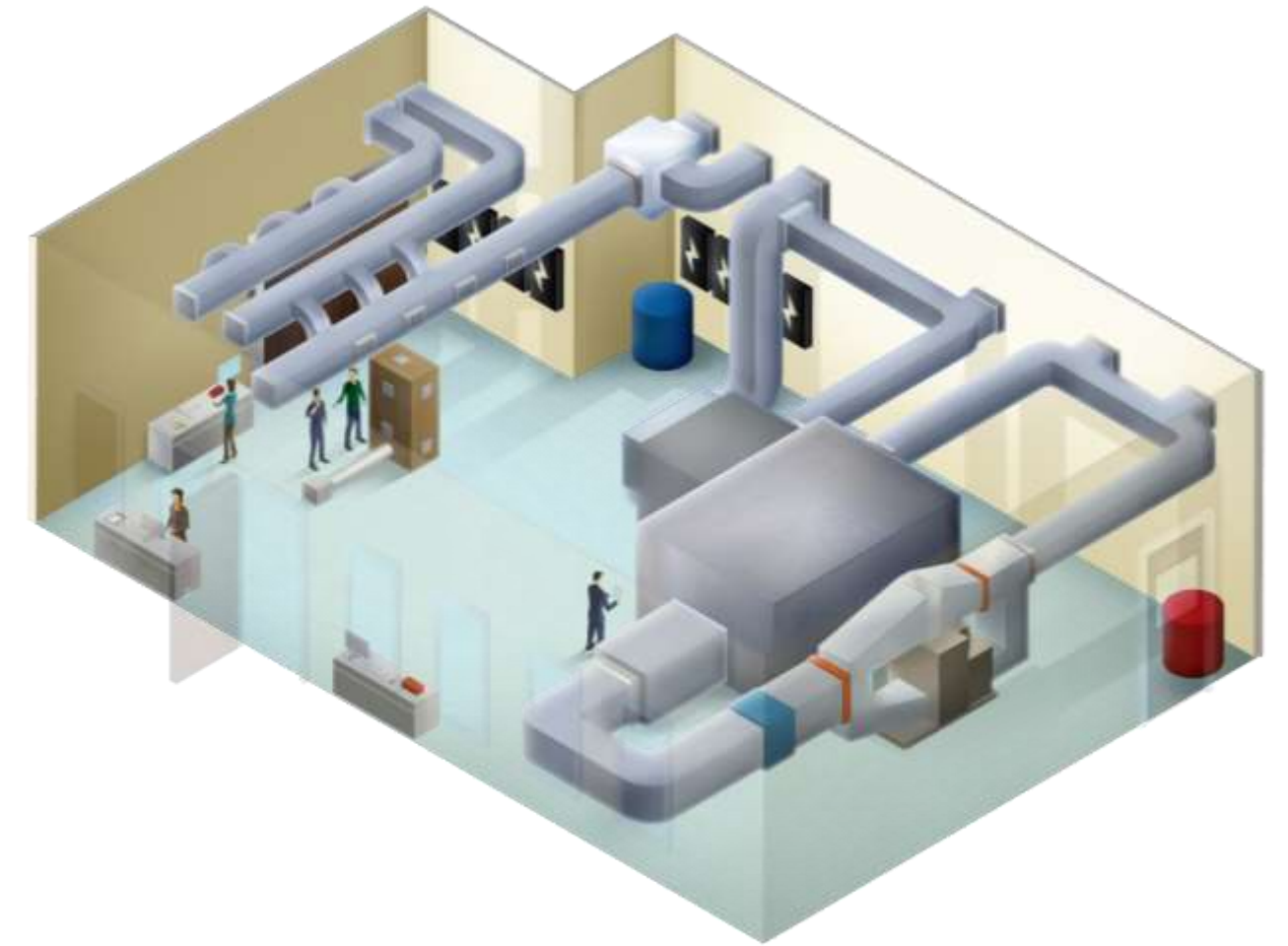
Accelerate the development and commercialization of efficient heating, cooling, and energy distribution solutions.



Western Cooling Efficiency Center




- » Develop and test new and existing HVAC technologies
- » In-house laboratory with environmental chamber capable of re-creating 95% of California's hot/dry climates
- » Green-house gas emissions from residential systems
- » Performance of low global-warming potential refrigerants for heat pumps
- » Whole-house infiltration sealing
- » Indirect-evaporative cooling systems



Improving Indoor Air Quality in California Schools





 **UC DAVIS**
California Lighting Technology Center


*Accelerate the development
and commercialization of
energy-efficient lighting and
daylighting technologies.*

California Lighting & Controls Technology Center

- » Full-scale laboratories for research & development, as well as prototype and product testing
- » Commercialize energy-efficient lighting and daylighting technologies
- » Produce new technologies, inventions, patents, and license agreements
- » Provide engineering specifications, market research, resources, lighting guides, working papers, and white papers
- » Conduct technology demonstrations and publishes reports on these projects
- » Provide curriculum and instruction for education and training courses, workshops, seminars and outreach activities

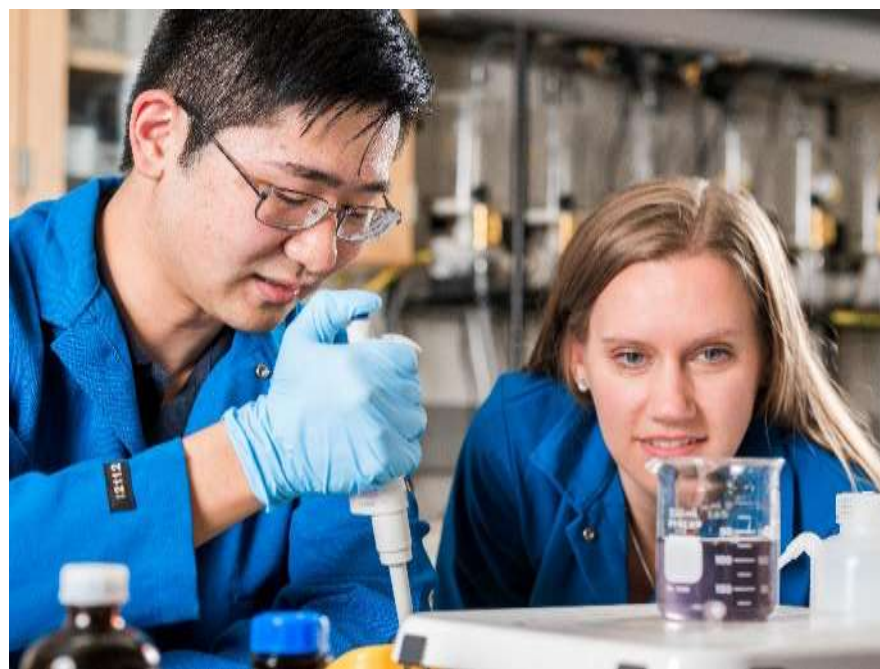




 **UC DAVIS**
Center for Water-Energy Efficiency

Advance water management solutions for the integrated savings of water and energy resources.

Center for Water-Energy Efficiency



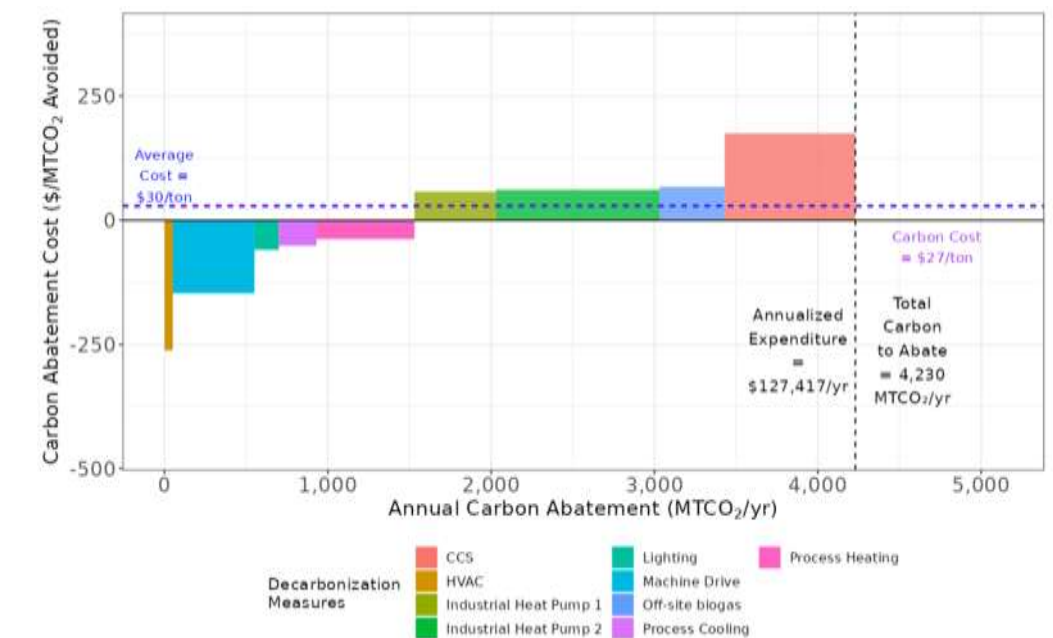
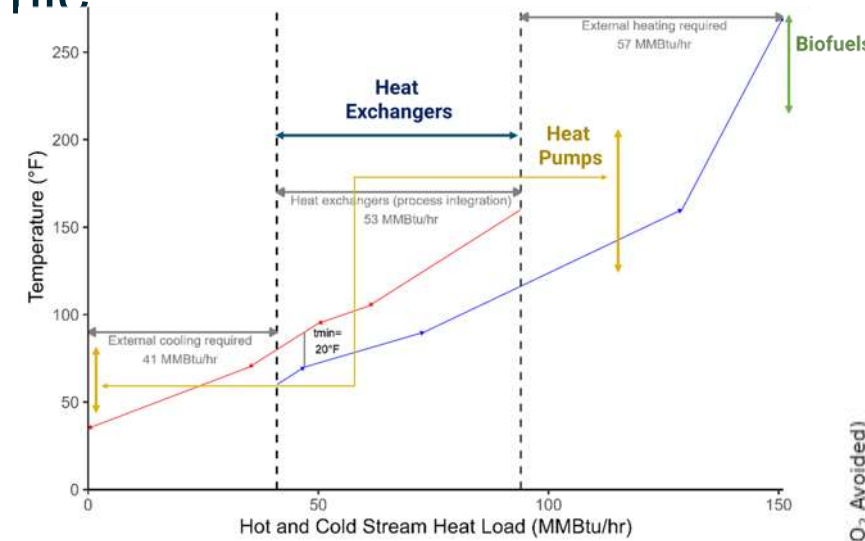
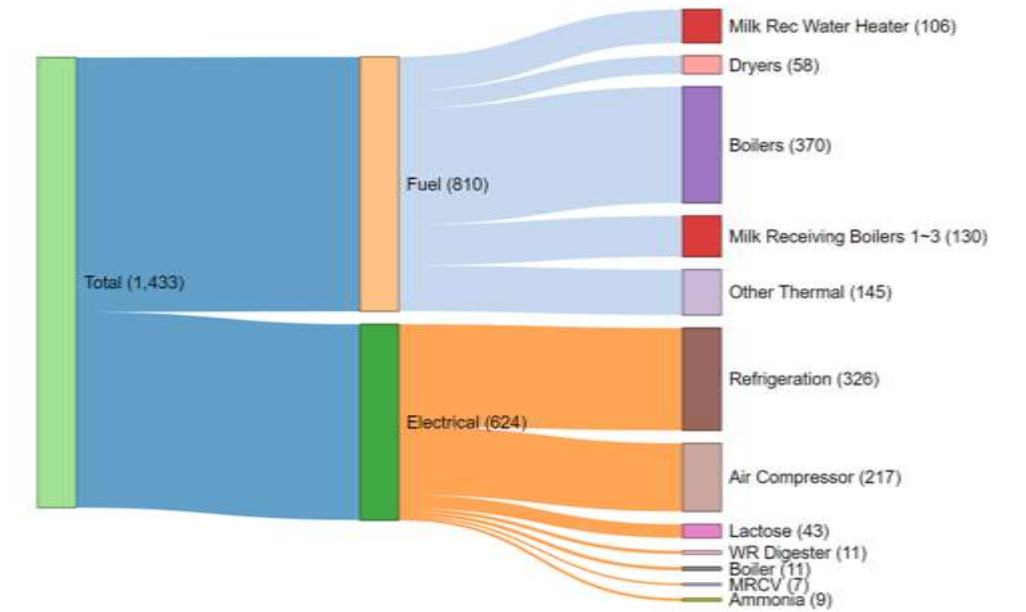
- » Develop strategies, technologies, and policies that achieve mutual benefits of water, energy, carbon, and cost savings
- » Disseminate research results to increase public awareness, stakeholder engagement, and widespread adoption of solutions.

Focal Areas:

- » Water and Energy Efficiency
- » Wastewater
- » Water Loss
- » Smart Water and Internet of Things
- » Data Privacy and Security
- » Education
- » Water System Economics
- » Water Demand Management
- » Energy Demand Management
- » Water Reuse

Industrial Decarbonization Solutions Hub

- » Consortium of public and private sector partners committed to accelerating the development and commercialization of solutions that can improve the efficiency and decarbonization of industry
- » Industry accounts for one-third of total US energy consumption and greenhouse gas emissions, making these decarbonization efforts critical to achieving our collective climate and economic goals
- » 2024 Symposium April 16 at UC Davis.



Materials Decarbonization and Sustainability Program



- » Advances low-carbon cement and steel.
- » Uses a life-cycle approach to comprehensively address sustainability and functionality.

Market Transformation Research Program

Research at the nexus of technology, policy, and human behavior.



- » Support the transition to a clean energy society by providing insights on the human side of technological change.
- » Market outlook research identifies barriers and opportunities for clean technology by considering the economic, technical, and policy landscape, as well relevant behavioral factors that influence stakeholder adoption.
- » Over 20 projects current and completed
- » 35 published papers
- » 3 full-time staff and 3 graduate student researchers

Recently Funded Research

- » \$10M to investigate new energy-efficient technologies as part of CEC-funded State-Wide Energy Emerging Technologies Program
- » \$3M to conduct field demonstrations as part of CEC-funded CalFlexHub
- » \$4M to develop solar powered exterior lighting systems in partnership with disadvantaged communities from CEC
- » \$3M to investigate heavy-duty vehicle electrification for critical operations from the CEC
- » \$500K from Panasonic/NEDO to advance Virtual Home Energy Management technologies
- » \$150K seed funding to investigate industrial decarbonization from DOE - LBNL
- » \$300K from Toyota to investigate color and stress related to small interior environments (patent pending)



The Utility Industry is Going Through a Massive Clean Energy Transition... a Discussion

- What UC Davis is doing to help
- What I learned from my time at the CA Energy Commission
- Heat pumps are a microcosm for the challenge ahead

Augmented from Feb 2022 – June 2023

- » Joined Vice Chair Gunda's office as Special Advisor and Chief of Staff
- » Supported him on all his lead assignments, including:
 - Reliability and Emergency Planning
 - Integrated Energy Policy Report (IEPR)
 - Equity
 - OTC Extensions (including Diablo)
 - SB100 Decarbonizing Electricity
 - Transitioning the Gas System
 - Offshore Wind Planning
 - Oil Refinery Profit Margins
 - Load Flexibility Goals
 - Regionalization

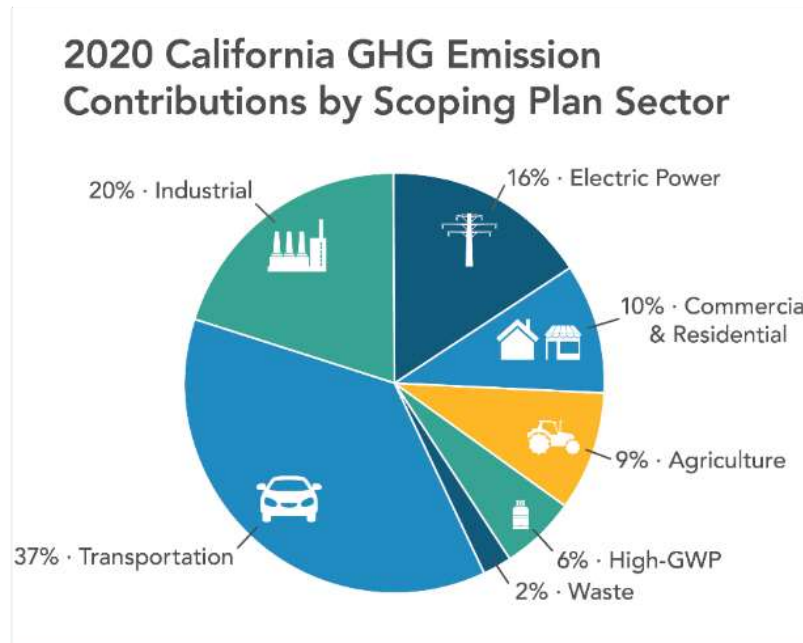


California's has a Robust Climate Policy Framework



GHG Targets & Goals

Legislation & Executive Orders: Total GHGs (AB 32/SB 32/AB 1279) or sector targets (SB 1383/SB 100), etc.



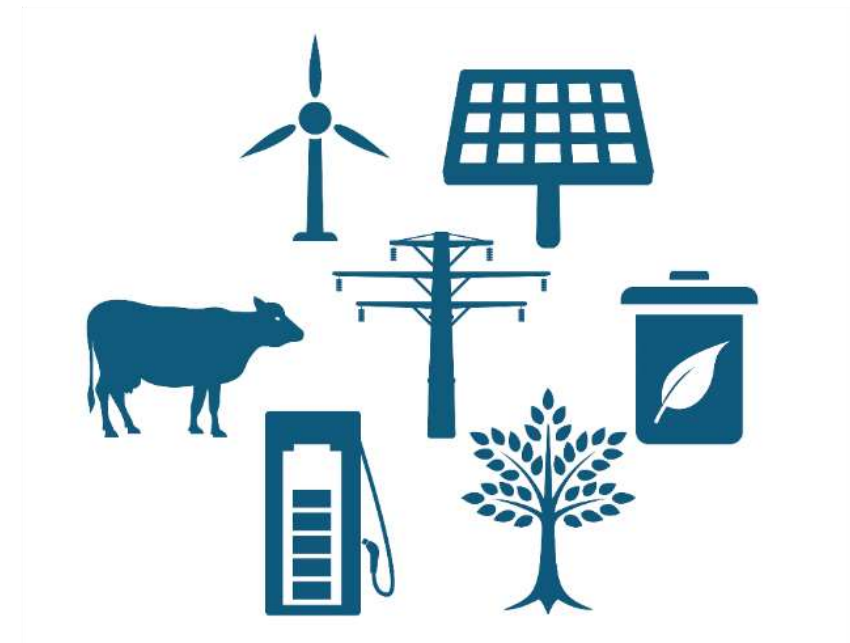
Scoping Plan

Actionable plan across all sectors



Action

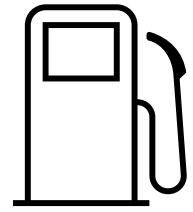
Regulations & Incentives: Advanced Clean Cars, climate change investments, etc.



Projects

Examples: Zero-emission trucks, energy infrastructure and renewables, compost facilities, digesters, etc.

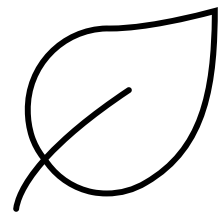
Transition Planning Must Be Holistic



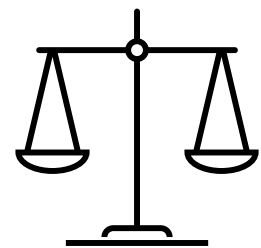
Transition Away from Fossil Fuels: Petroleum, Natural Gas



Electrify End Uses



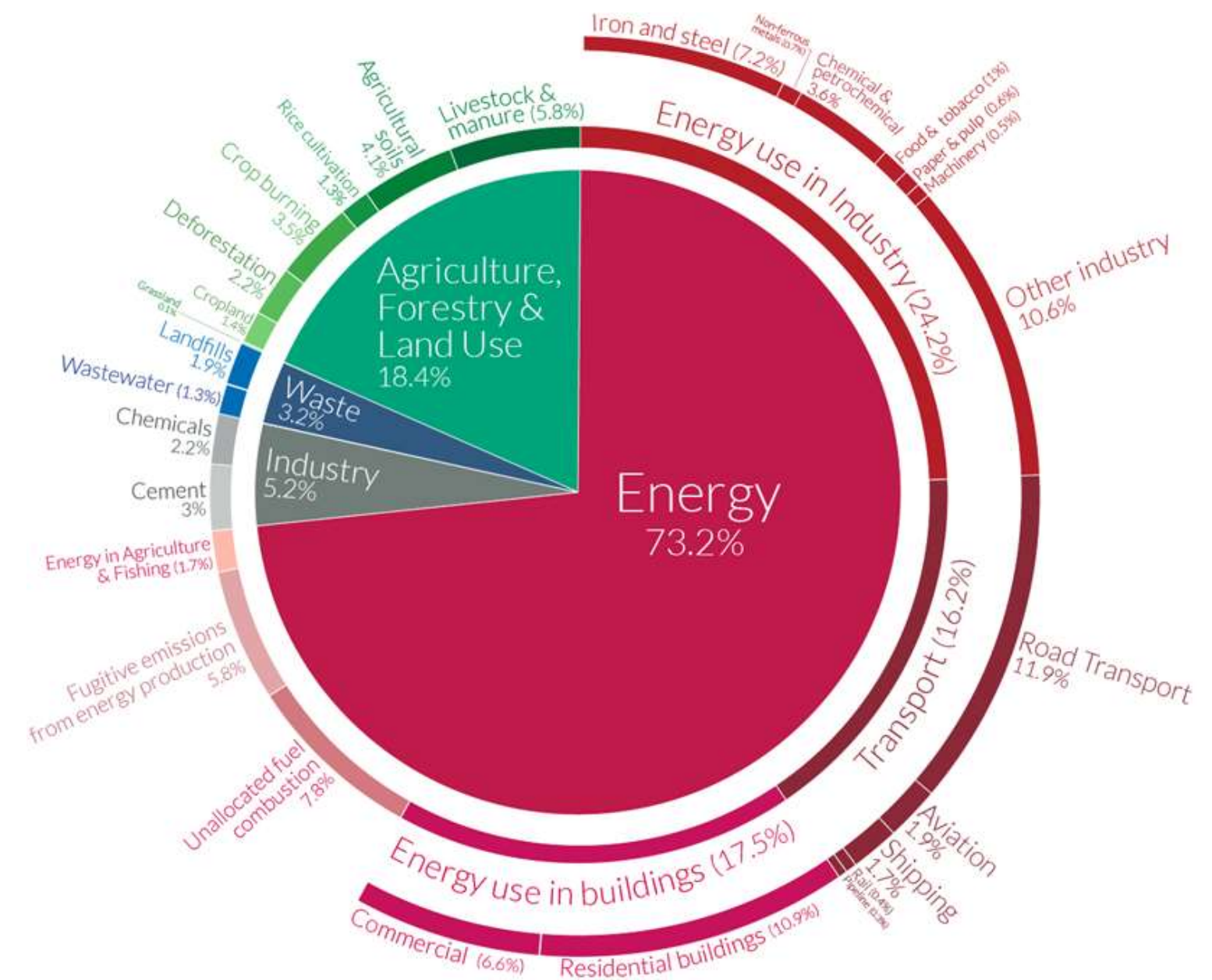
Clean Fuels for Hard to Electrify End Uses



Equitable Transition for All

... within a Complex, Rapidly Changing Environment

- Customers and Supply Chains
- Shareholder and Investor Pressure
- Financing challenges and opportunities
- Technological Innovation
- Fluctuating Energy Prices and Reliability Issues
- Hiring and Workforce Development
- Regulation
- Policy
- Federal, State and Utility incentives



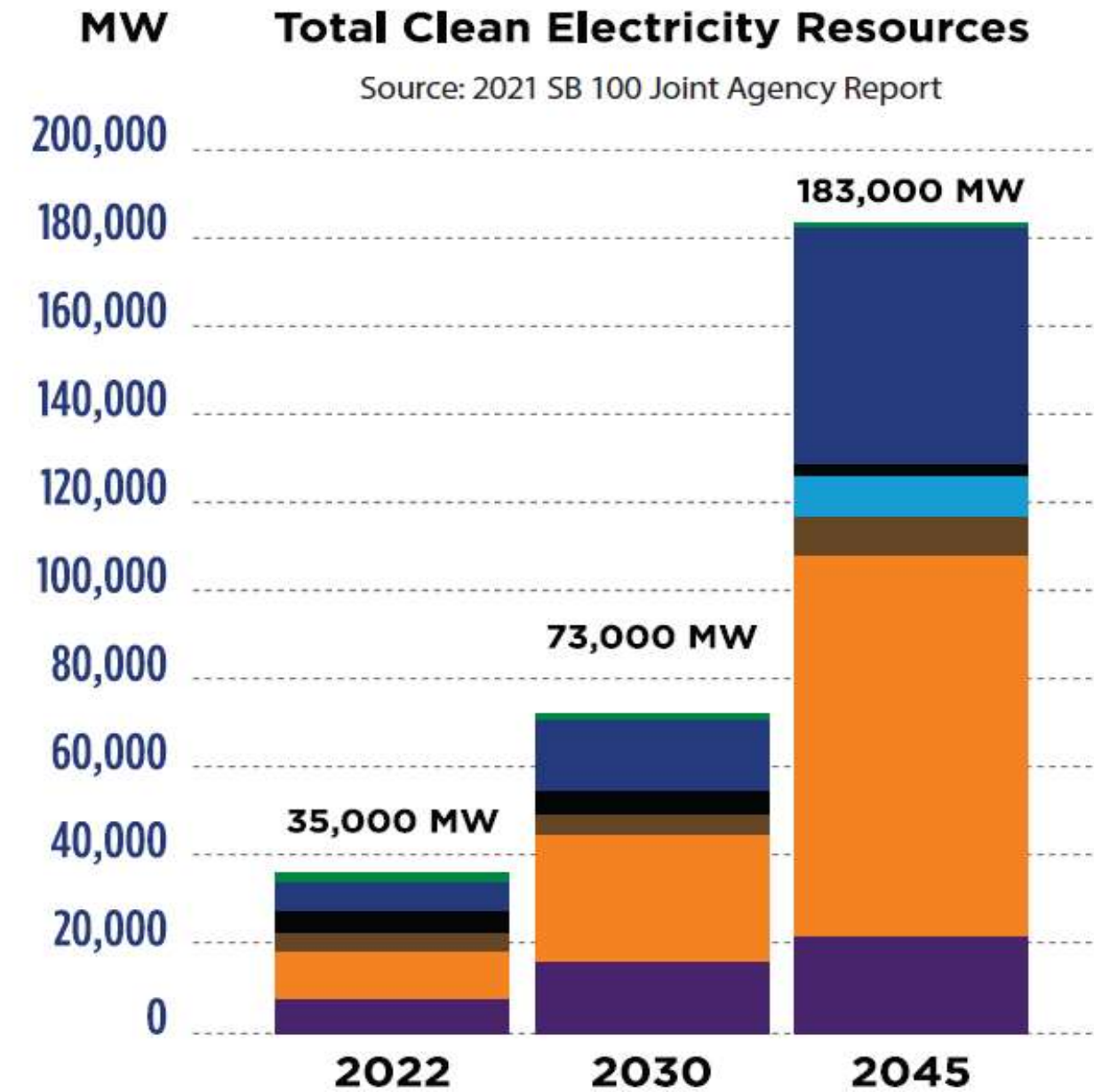
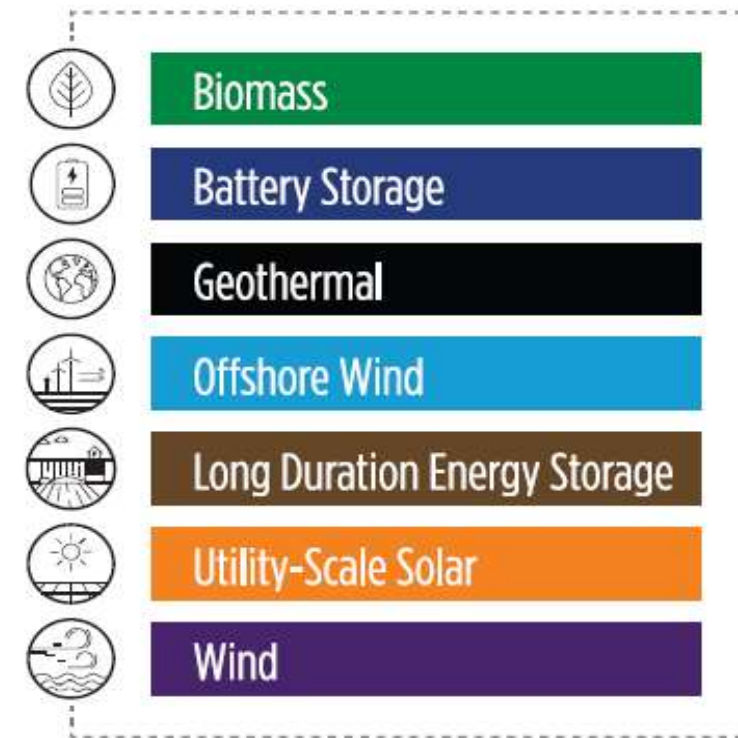
We need to build a lot of new resources, and fast

To provide 100% clean electricity by 2045,

California will build an unprecedented amount of new utility-scale clean energy resources

Totals represent new and existing resources. The 2021 SB 100 Joint Agency Report projects the need for 148,000 MW of new resources by 2045.

In addition, California also expects new capacity from energy efficiency, customer solar and demand response.



To Achieve Clean Energy

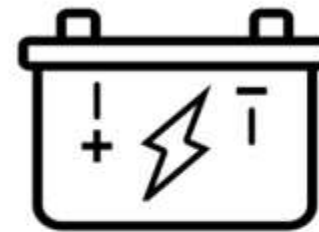
Development Needs To Rapidly Accelerate



Solar & Wind

3X

Solar and wind build rates need to nearly triple*



Battery

8X

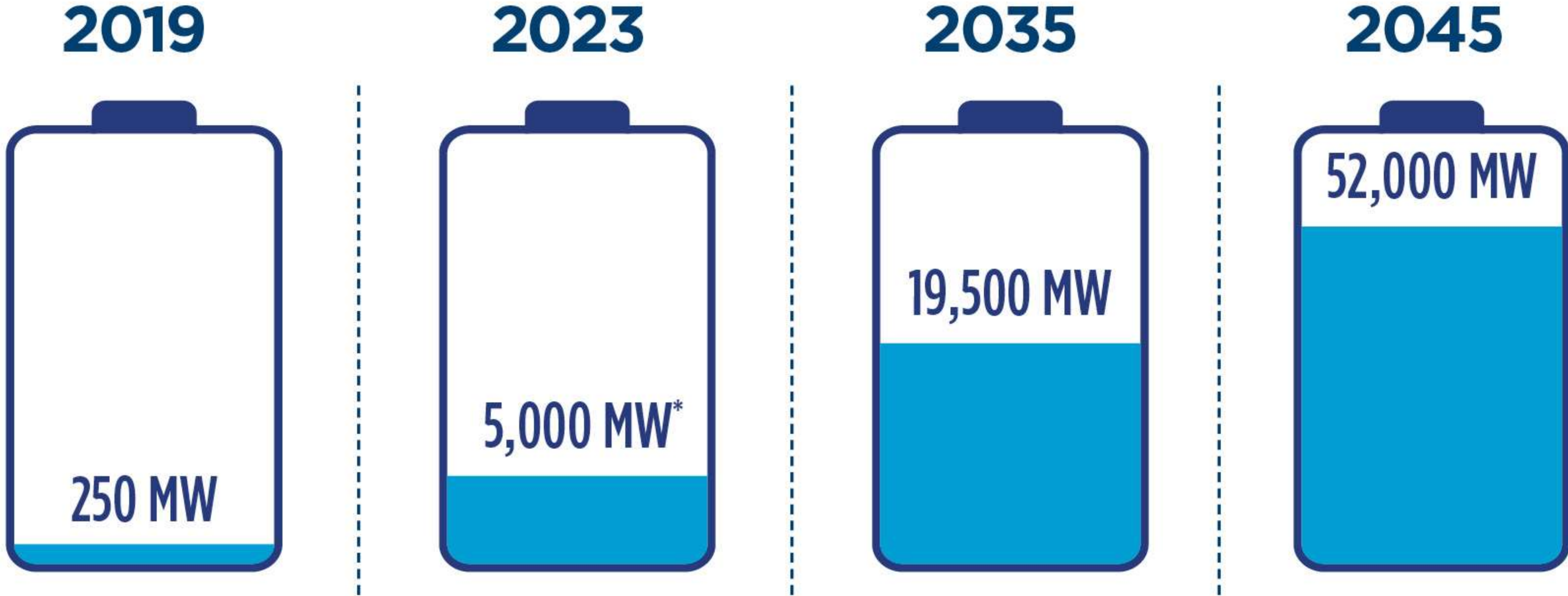
Battery storage build rates need to increase by nearly eightfold**



*Based on 10-year average | **Based on 2020

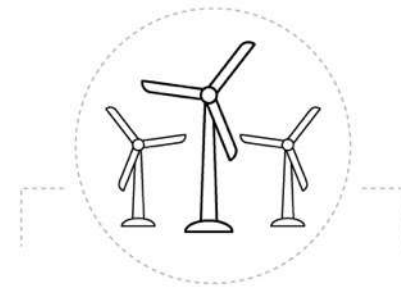
California's growing battery storage capacity

captures the state's abundant renewable resources



*Projected as of June 1, 2023 based on California ISO interconnection queue.

This Includes Long-term Resources too



5 GW

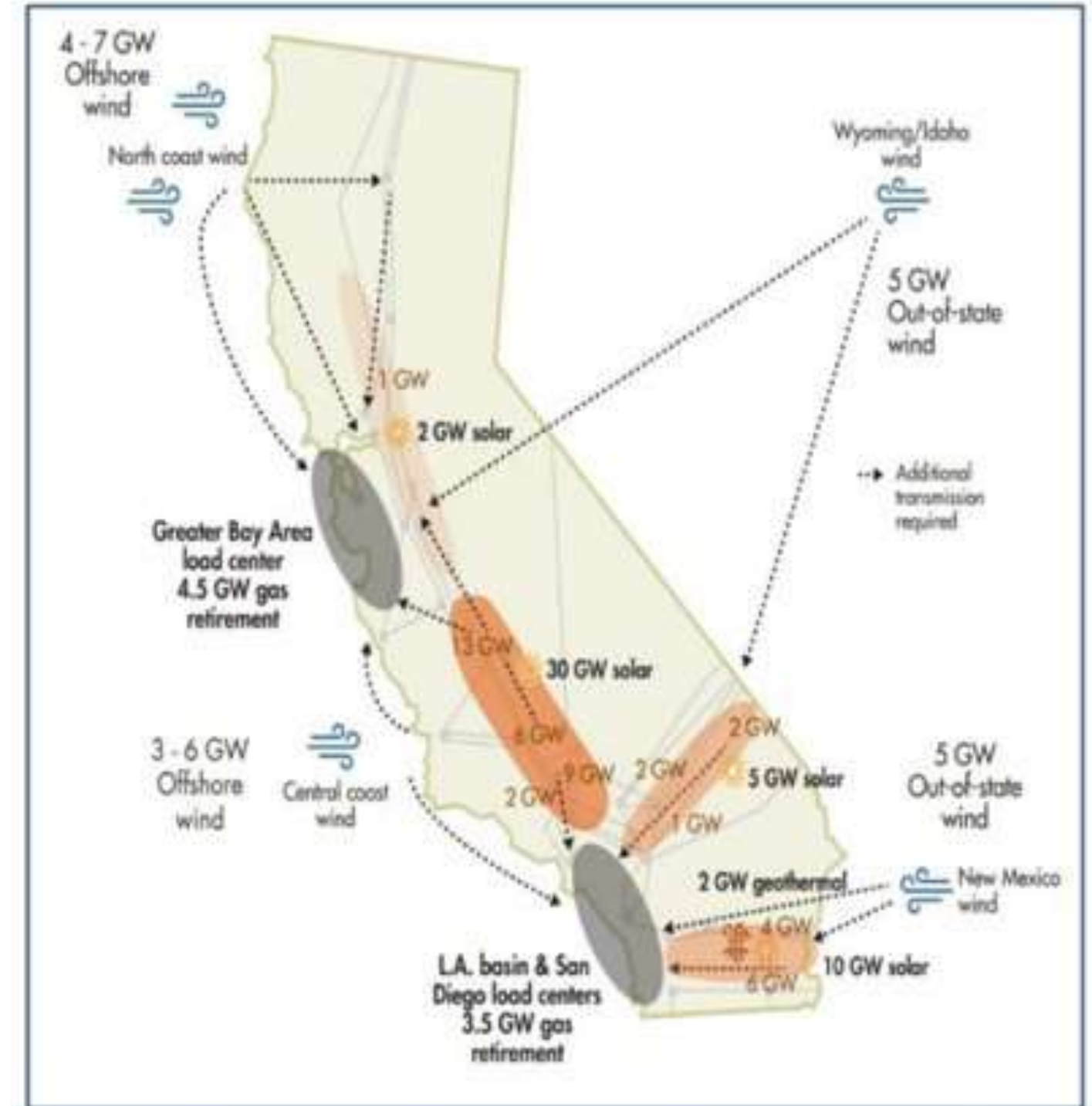
By 2030

25 GW

By 2045

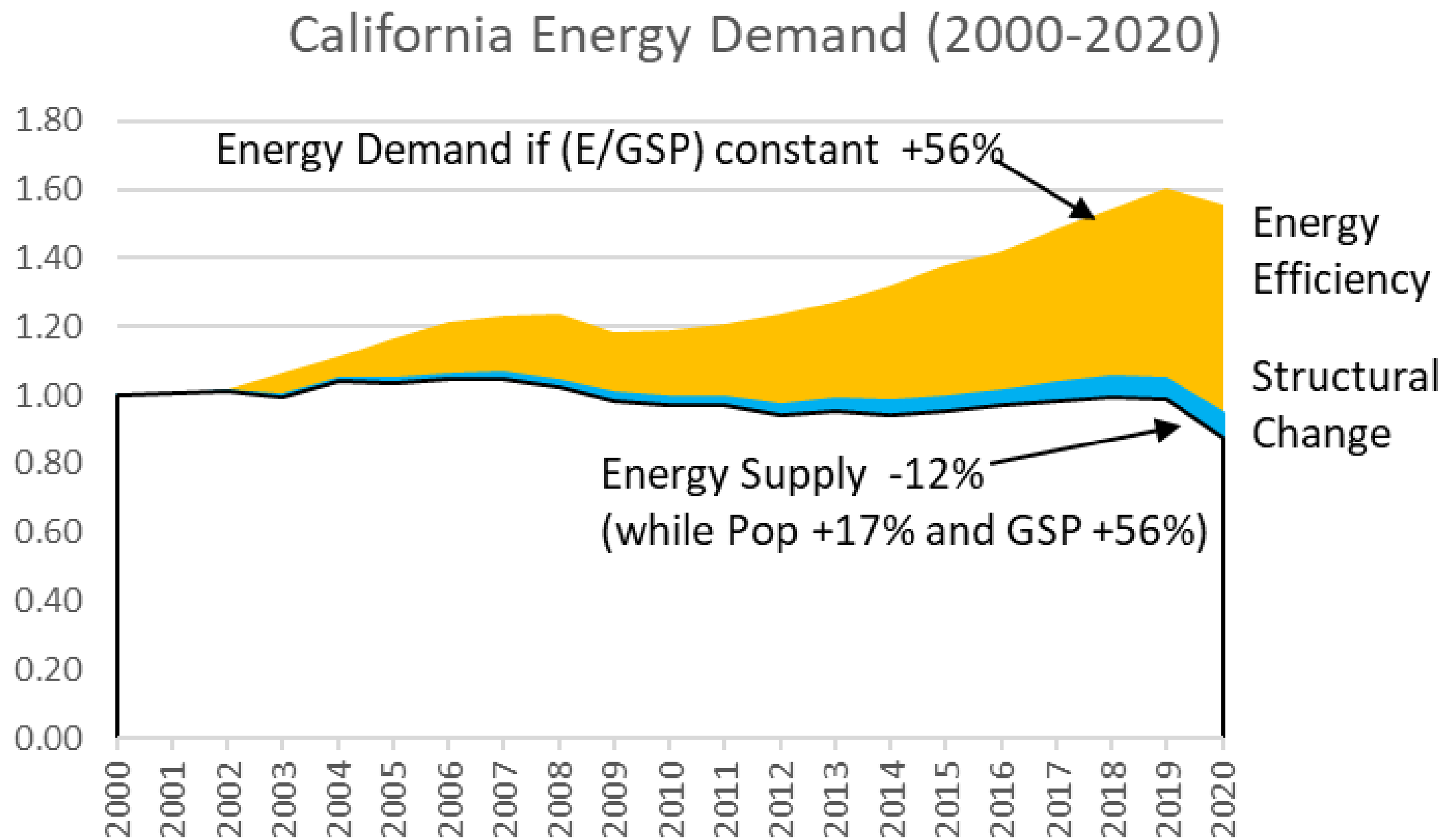


Enough electricity to power 3.75-25 million homes



CAISO 20-year Transmission Outlook - 2022

We Will Also Need Energy Efficiency and Load Flexibility



The New Normal

40% of the Fortune 500 Active
in Climate Based Initiatives

199 Fortune 500 companies have at least one tracked climate initiative, up from 144 companies in 2020. This is 39% of the U.S. Fortune 500.

status. ... Today, the conversation is shifting from whether major companies will ever commit to net-zero emissions to how they plan to achieve such ambitions.

Two thirds of S&P 500 Set Targets To

Committed To Net Zero Target

At least one fifth (21%) of the world's 2,000 largest public companies have committed to meet net zero targets, according to a new report called 'Taking Stock: A global assessment of net zero targets.' The companies together represent sales of nearly \$14 trillion.



implementing science-based targets... in general, most companies did not provide detailed "roadmaps" to net zero goals — which we view as one of the areas most lacking in corporate target setting.

status. ... Today, the conversation is shifting from whether major companies will ever commit to net-zero emissions to how they plan to achieve such ambitions.

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Highlights From Market Research on Heat Pumps



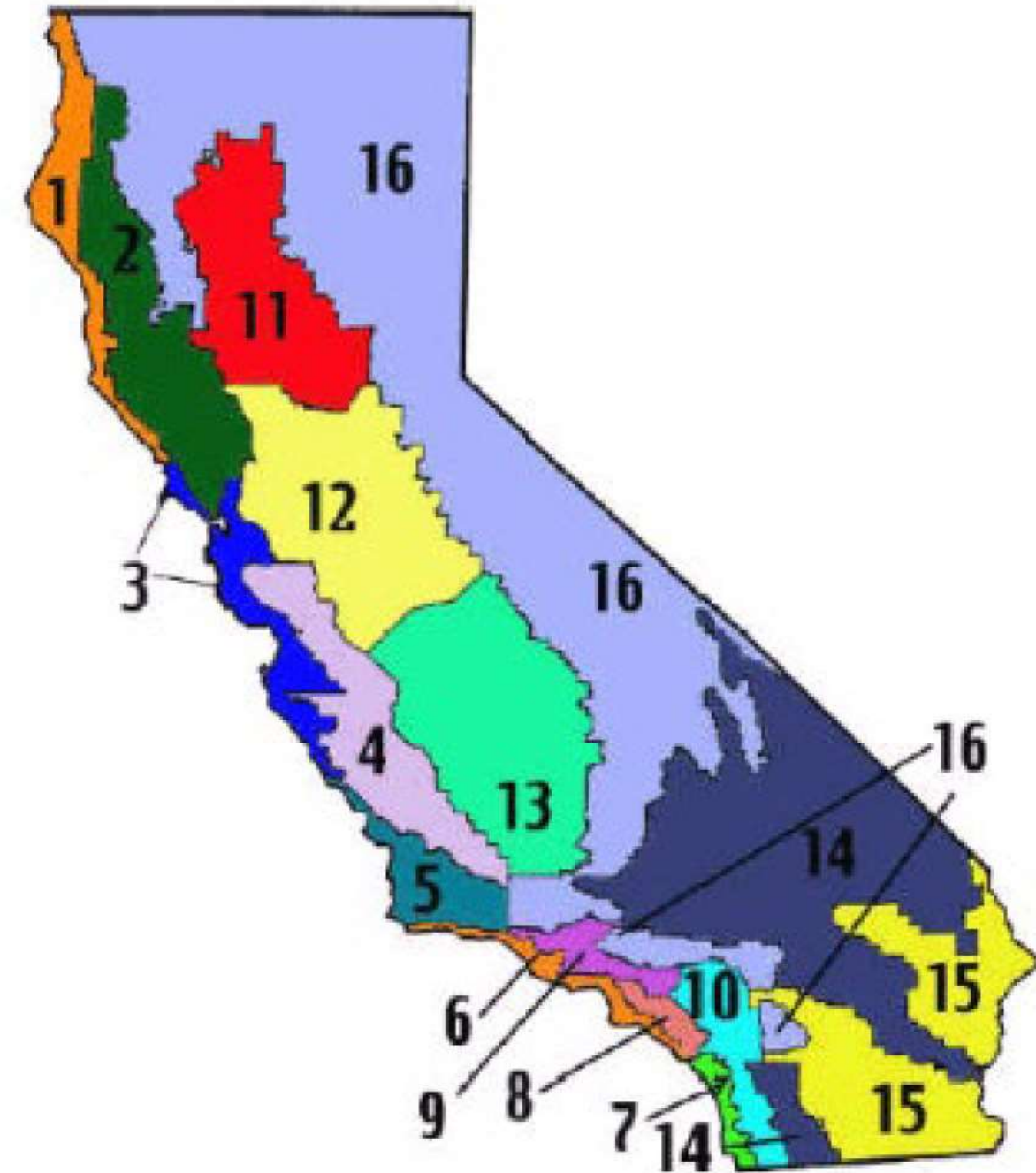
Overview of Market for Residential Heat Pumps in California for NEDO and Japanese Heat Pump Manufacturers

David Vernon and Dr. Sarah Outcault

March 26, 2024

California climate

- California has 16 climate zones that vary by elevation and proximity to the coast
- Generally mild weather conditions



Source: [Title 24 California | Title 24 - Title 24 California Climate Zones \(title24express.com\)](https://www.title24express.com)

Housing stock

➤ New homes

- Roughly 370,000 new housing units built each year 2018-2022
- 55% have space conditioning heat pumps
- 16% have heat pump water heaters

➤ Existing homes

- 14.6 million homes
 - 9.5 million (65%) single-family homes
 - 4.7 million (32%) are in multi-family buildings
- Heat pumps are uncommon



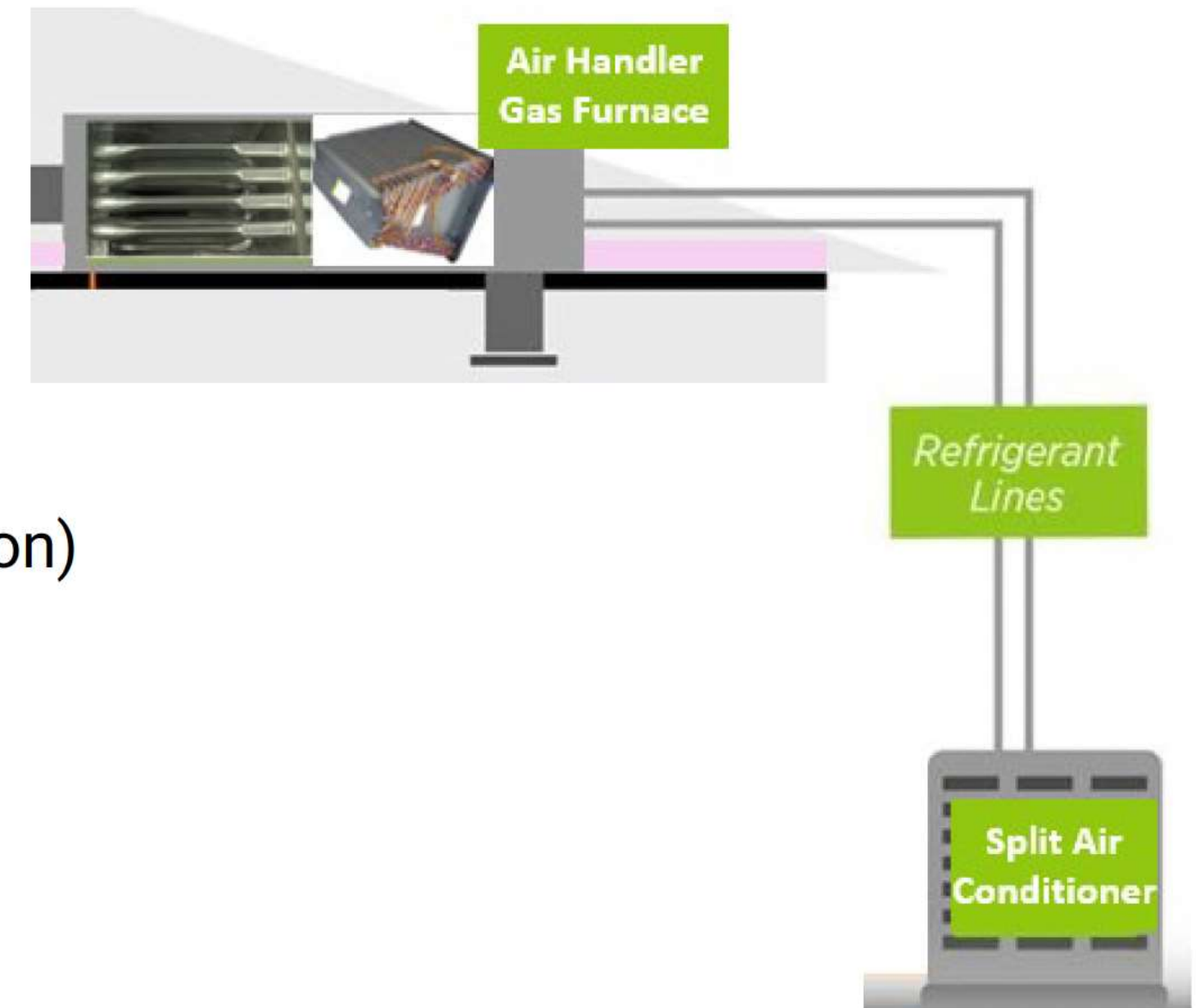
HVAC systems in existing homes

➤ Heating

- 67% have gas-fired furnace (9.8 million)
- 5% have heat pumps (760,000)

➤ Cooling

- 54% have central air conditioning (7.9 million)
- 23% have window air conditioning units (3 million)
- 25% have no air conditioning (~3.6 million)



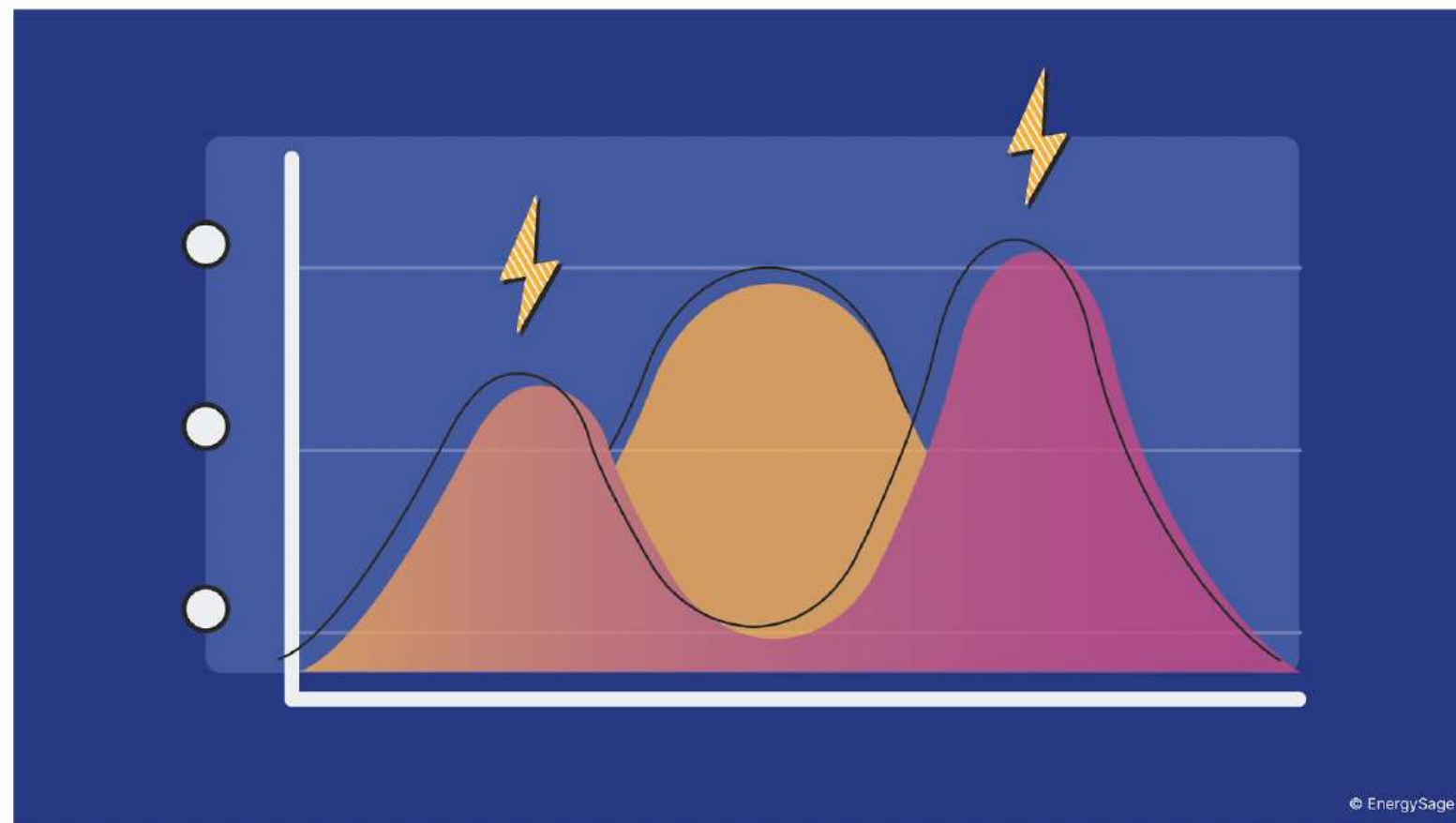
Water heating in existing homes

- Equipment type
 - 80% have gas-fired water heaters (11.5 million)
 - 90% have water heaters with storage tanks (13.2 million)
 - 1% have heat pump water heaters
- Tank size
 - Large storage despite small households (55% have 1-2 people)
 - > 80% hold more than 114 liters (30 gallons)
 - 45% hold more than 189 liters (50 gallons).
 - Tanks holding 114 liters (30 gallons) or less are found in only 8% of homes.



Load management potential

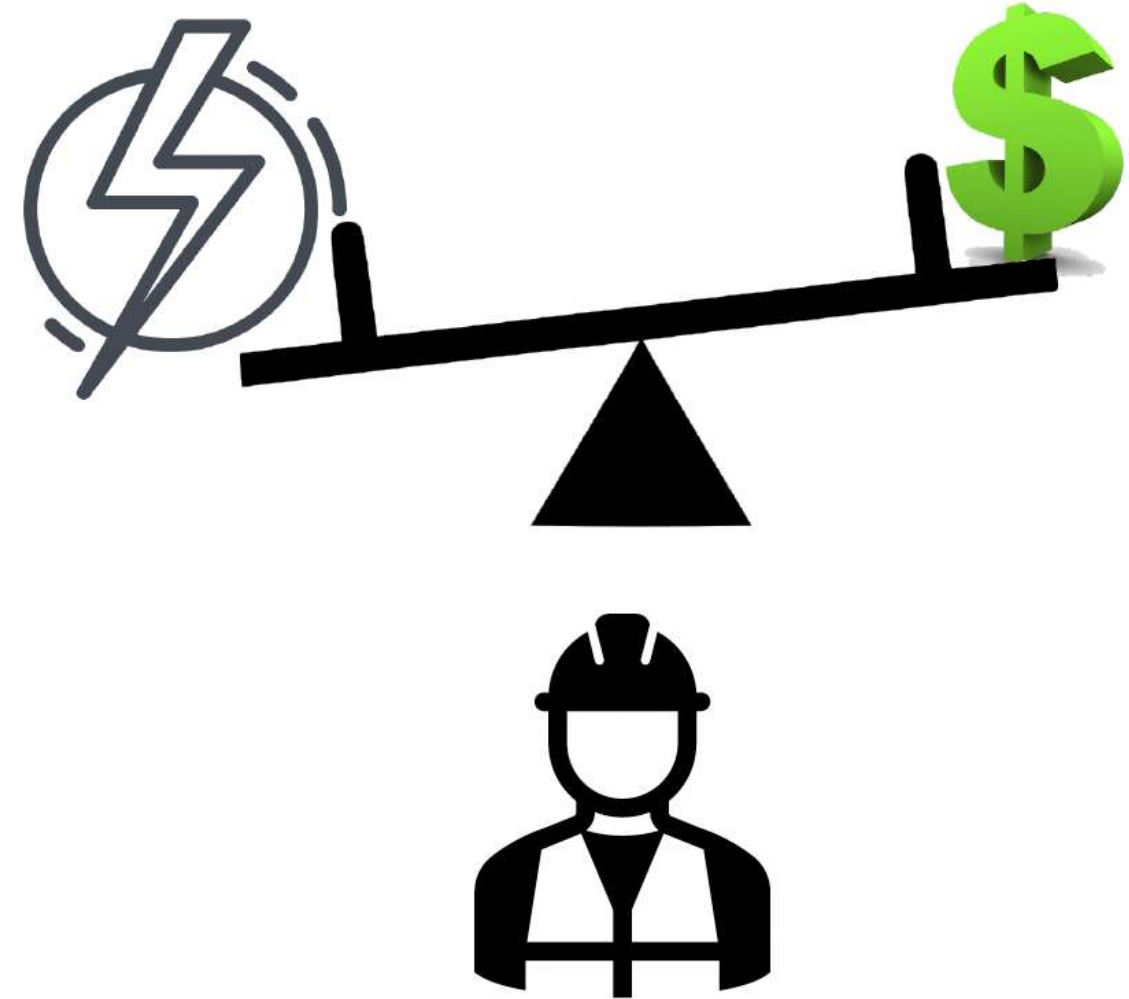
- Heat pumps for space and water heating have been identified as critical tools for achieving California's load management goals
- With advanced controls, heat pumps can enable:
 - Optimization of renewable generation sources (and lower emissions)
 - Grid stability
 - Building electrification
 - Utility bill management



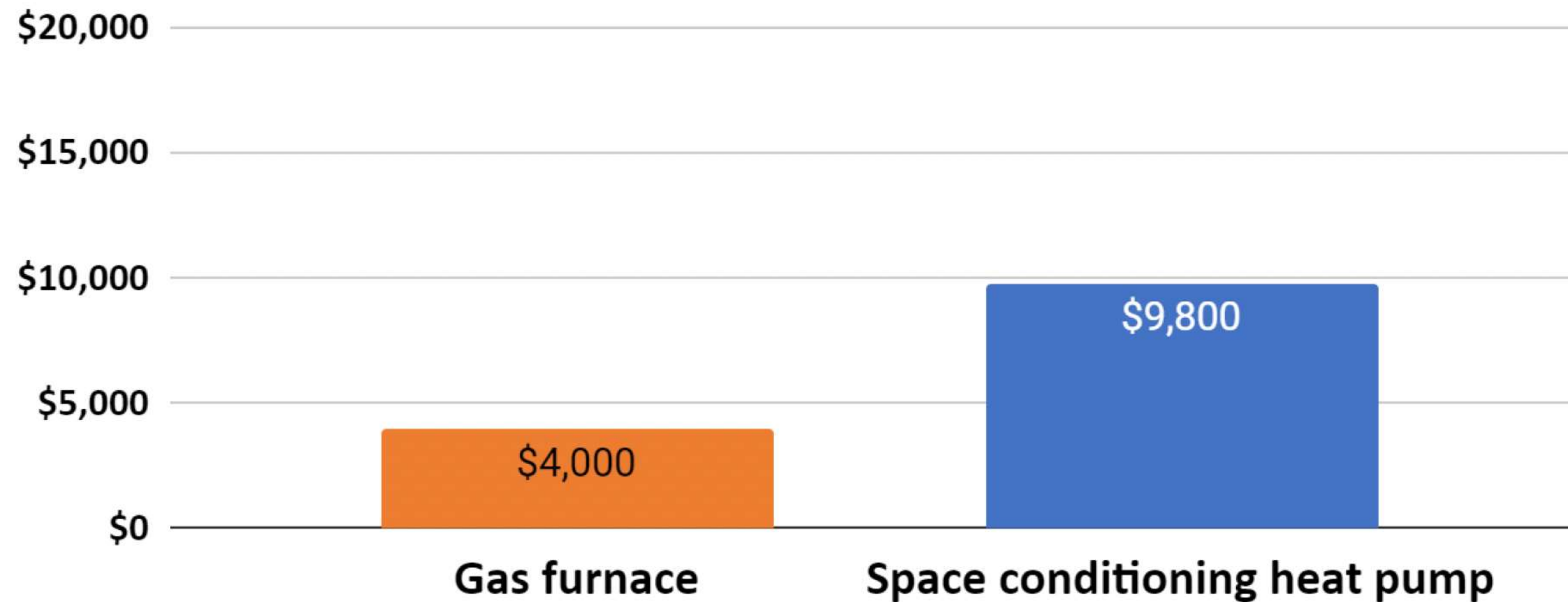
Source: <https://www.energysage.com/energy-management/what-are-flexible-loads/>

Yet California Faces Barriers to Adoption

- » Higher first cost
- » Higher operating cost
- » Installer workforce

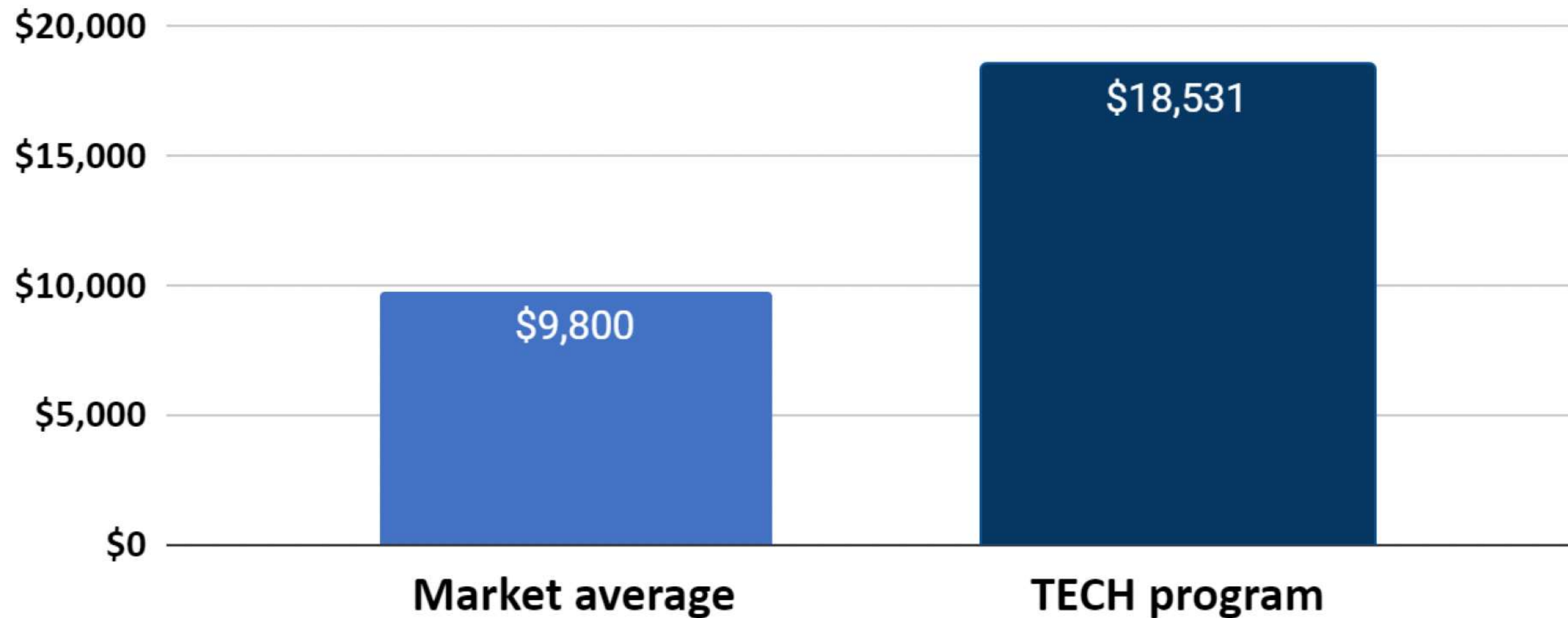


Installed costs: Space conditioning



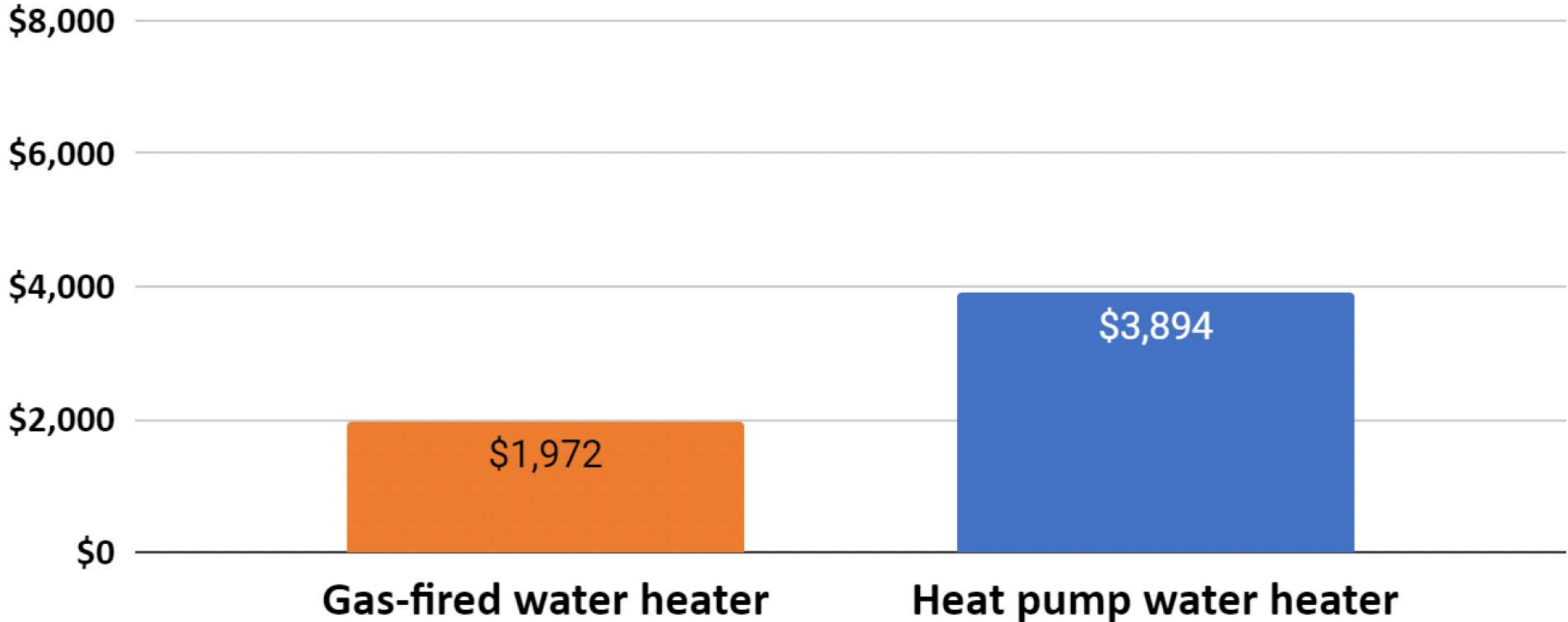
Source: Opinion Dynamics (OD). (2022). *California Heat Pump Residential Market Characterization and Baseline Study* (CPUC Contract 17PS5017).

Installed costs for heat pumps



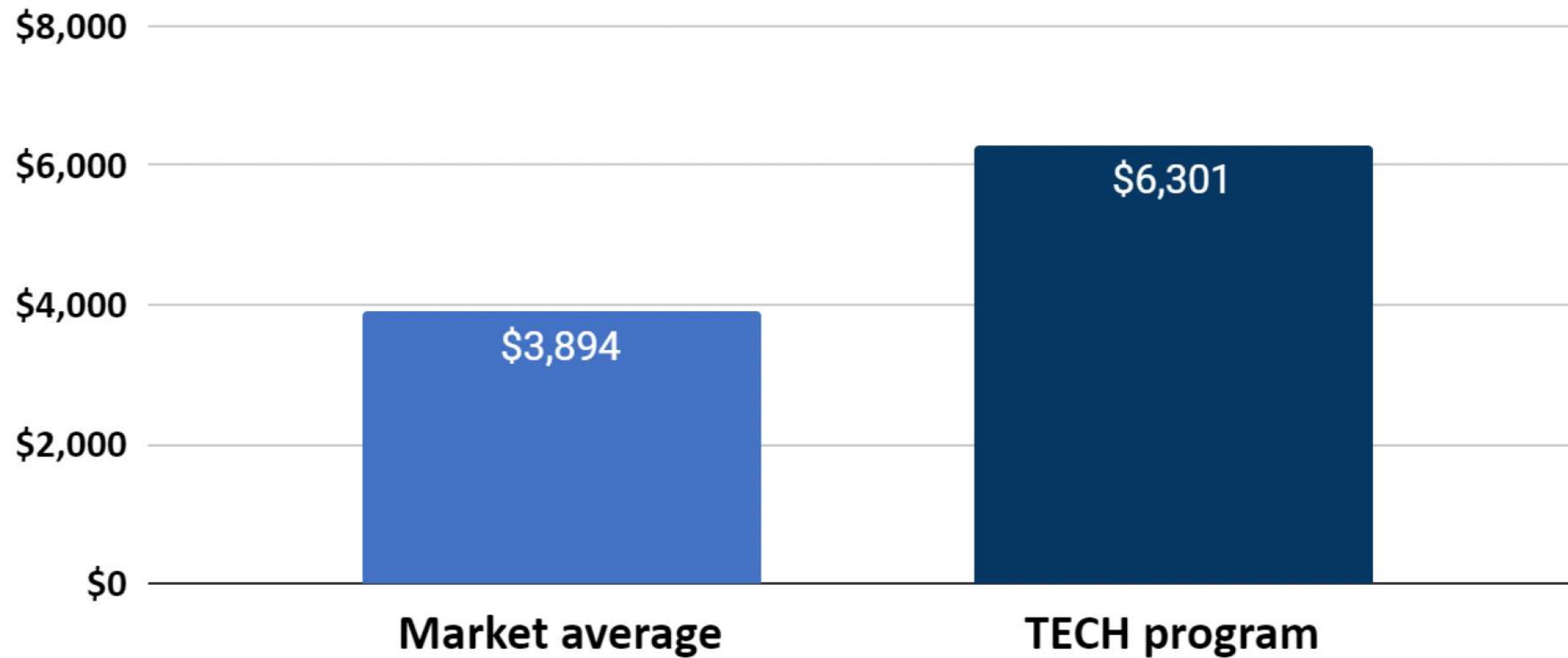
Sources: Opinion Dynamics (OD). (2022). *California Heat Pump Residential Market Characterization and Baseline Study* (CPUC Contract 17PS5017). <https://www.calmac.org/publications/OD-CPUC-Heat-Pump-Market-Study-Report-5-17-2022.pdf>; TECH Clean California. (2024). *TECH Public Reporting Data*. <https://techcleanca.com/public-data/download-data/>

Installed costs: Water heaters



Source: Opinion Dynamics (OD). (2022). *California Heat Pump Residential Market Characterization and Baseline Study* (CPUC Contract 17PS5017).

Installed costs for heat pump water heaters



Sources: Opinion Dynamics (OD). (2022). *California Heat Pump Residential Market Characterization and Baseline Study* (CPUC Contract 17PS5017). <https://www.calmac.org/publications/OD-CPUC-Heat-Pump-Market-Study-Report-5-17-2022.pdf>; TECH Clean California. (2024). *TECH Public Reporting Data*. <https://techcleanca.com/public-data/download-data/>

Operating costs

- Average cost of a kilojoule of energy in the form of electricity is 3.9 times the average cost for natural gas (in California in 2022)
- Some utilities offer reduced electricity rates for heat pumps
- Advanced controls can reduce operating costs by leveraging time-of-use rates and demand response programs
- Smaller utilities (LADWP, SMUD) have cheaper electricity than IOUs

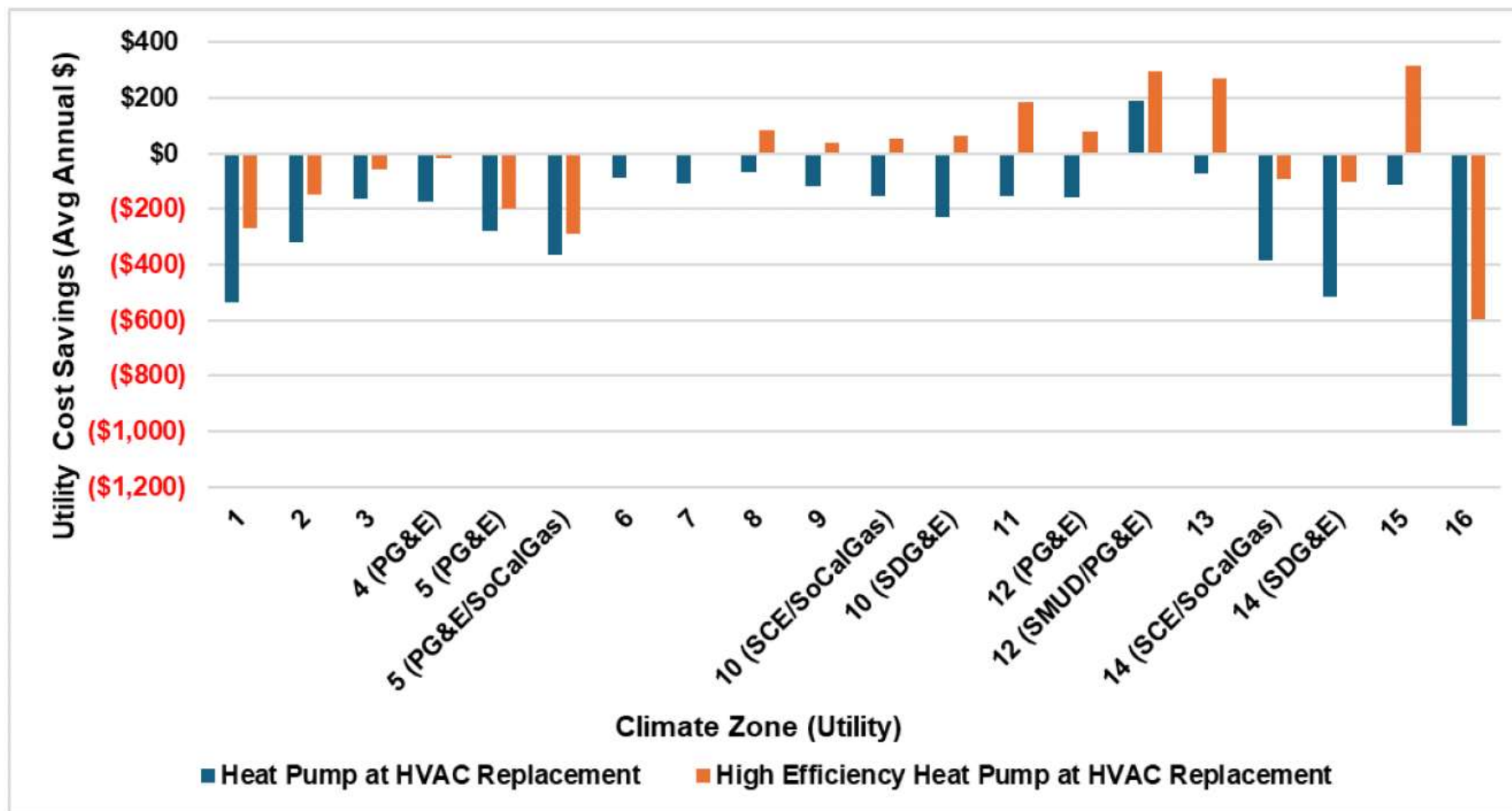


Source: <https://calmatters.org/california-divide/2021/03/california-high-electricity-prices/>

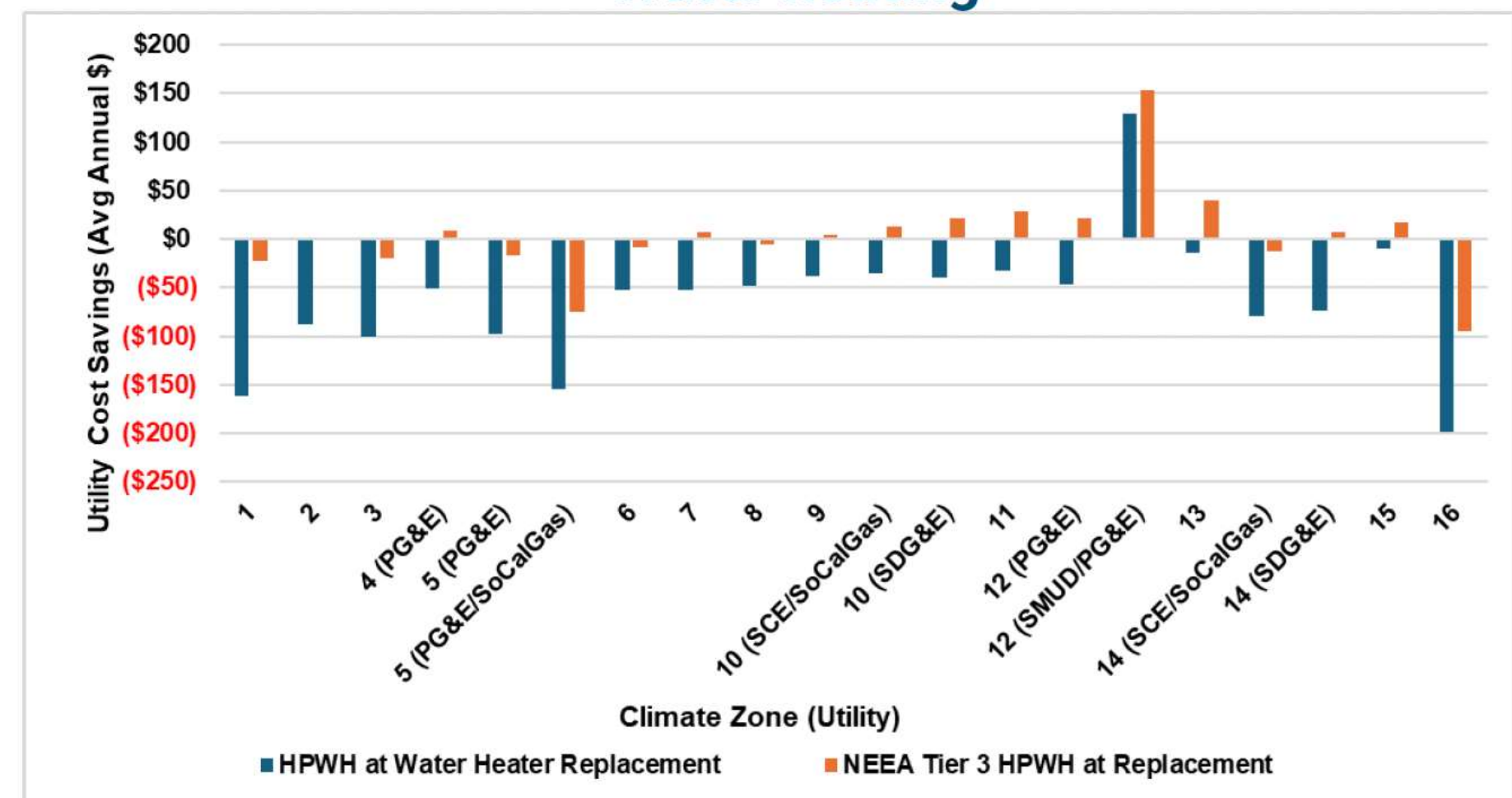
Life cycle costs

- Minimum efficiency heat pumps are more expensive than furnace/AC and gas-fired water heating in all regions of the state except SMUD territory
- High efficiency heat pumps provide modest savings in roughly half of CA climate zones

HVAC



Water heating



Source: Frontier Energy, Inc and Misti Bruceri & Associates, LLC. (2021). *2019 Cost-Effectiveness Study: Existing Single Family Residential Building Upgrades*. California Energy Codes and Standards Program. https://localenergycodes.com/download/875/file_path/fieldList/2019%20V2-Residential%20Retrofit%20Cost-eff%20Report-2021-08-27.pdf

Workforce

- Workforce growth needed to satisfy anticipated increase in heat pump demand
- Additional workforce training is needed
- Coordination across trades poses challenges given business models

Position	2020 Employment Estimate	Additional job opening in 2030	% new entrants 2020 to 2030
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	34,800	4,960	14%
Electricians	73,200	22,110	30%
Plumbers, Pipefitters, and Steamfitters	47,000	10,690	23%
Total	155,000	37,760	24%

Source: California Open Data. (2022). *Long-Term Industry Employment Projections*. <https://data.ca.gov/dataset/long-term-industry-employment-projections>

Customer considerations



Source: <https://bsesc.energy.gov/training-modules/heat-pump-water-heaters-business-development>

- Californians have low awareness and knowledge of heat pumps → Customer education is needed
- Customers report difficulty navigating the process to select contractors and obtain financial incentives → Third party services can help to address these challenges
- Heat pumps deliver a different space conditioning experience and have different user interfaces and controls →
 - Customer education may be needed
 - Improved user interface designs may be needed

Market outlook

- Large potential for heat pump demand in the residential market
- California policy and programs are actively promoting heat pumps
- Installed and operating costs still a barrier
- Supply and demand side need to grow
 - More installers, more training
 - Greater customer awareness

Discussion



THANK YOU

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