California Public Utilities Commission

Building Decarbonization Best Practices and Future Pathways Workshop – Day 2

Building Decarbonization Proceeding (R.19-01-011)

January 22, 2026

Welcome & Opening Remarks

UN Sustainability Collaboration

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

Introducing The Enniscorthy International Forum and its Buildings Action Coalition

Tangible Actions to Deliver the 2030 Agenda for Sustainable Development and the Paris Agreement/Climate Agenda

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

BAC Vision

A world that achieves high performance in the built environment to meet climate and resource challenges while delivering quality of life

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

BAC Mission

Raise the performance of buildings and the built environment. Make real and rapid improvements at scale

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

UN environment programme

BAC/UN collaboration:

- Advocate for market transformation
- Catalyze real action.
- Develop specific projects/activities (e.g., best practices).
- Track progress.
- Develop policy guidance and build capacity.
- Support attaining the Buildings Breakthrough Target.

BAC/UN collaboration (cont):

- Advance the science of buildings.
- Comprehensive education of professional communities.
- Extend BAC networks.
- Mobilize resources and develop joint projects.
- Disseminate knowledge, experience and best practices.
- Provide demonstrations and proofs of concept.

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

High Performance Buildings Deliver Quality of Life:

Comfort, Health, Affordability, Efficiency, Sustainability

Envelope
Materials
Design
Construction

Systems
HVAC
Plug-ins

Energy
On-site
Off-site

ICT
Smart Connect
& Monitor

Mobility
City design
Low-C
mobility

Transacting
Financing
Insurance
Realty
Markets

Services
Food
Water
Waste

Planning/
Regulating
Zoning
Inspecting
Certifying

The Enniscorthy International Forum

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Buildings Action Coalition

- International Centres of Excellence in USA Ireland, Scotland, England, Germany, Greece, Canada
- Regional Hubs: Pacific NA; Black Sea; N. Atlantic; N. Sea; Indian Ocean
- Industry Leadership Group: case studies of best practices
- Academic Network
- Monthly webinars to share learnings
- Annual Summit in Ireland; Global Summit in California in 8/26
- Annual meetings in regions
- On going collaboration among Centres/Hubs on specific projects

The Enniscorthy International Forum

SUPPORTING THE UNITED NATIONS AGENDA FOR SUSTAINABLE DEVELOPMENT

Thank you!!!

Come Join the Buildings Action Coalition!

www.enniscorthyforum.org

Contact: ba@enniscorthyforum.org

Phone: +353 87-6736966

EU POLICIES AND SUPPORT INSTRUMENTS ON ENERGY EFFICIENCY OF BUILDINGS

Member of the UNECE Group of Experts on Energy Efficiency

Member of the Advisory Board of the International Passive House Conference

Member of the Consultation Board of the Bulgarian Green Building Council

Member of the National NZEB Council and National Green Deal Council

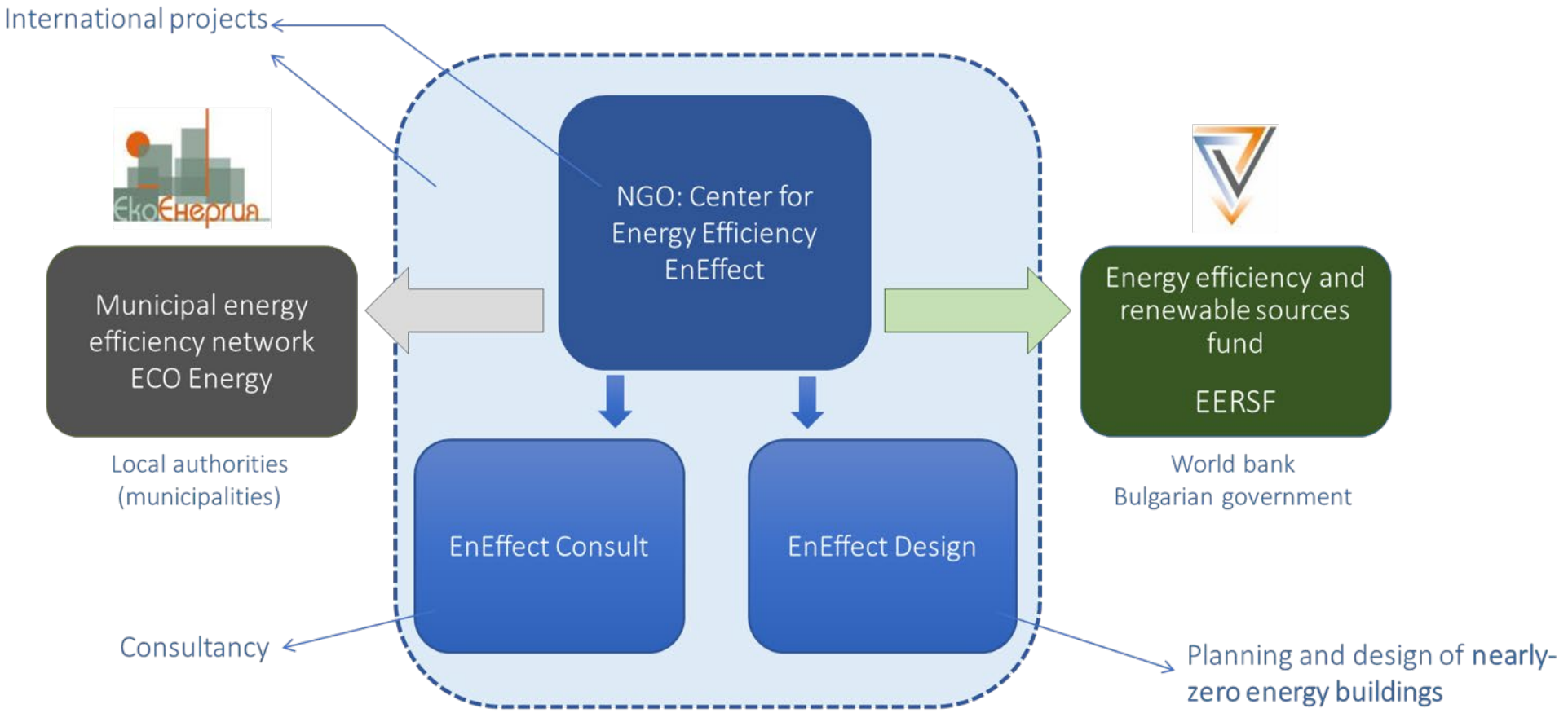
Dragomir Tzanev, Center for Energy Efficiency EnEffect - Bulgaria

Building Decarbonization Best Practices and Future Pathways Workshop

San Francisco and online, 22.01.2021

ENEFFECT

Organisational structure



EU ENERGY AND CLIMATE POLICY

Key facts on energy and buildings and supportive legislation

around 40%
of energy consumed in the EU is used in buildings

over 1/3
of the EU's energy-related GHG emissions come from buildings

+/- 80%
of energy used in EU homes is for heating, cooling and hot water

Sources: 1) *European Commission: Energy performance building directive*; 2) *BPIEs-Guide-to-EPBD-Implementation-final-version.pdf*

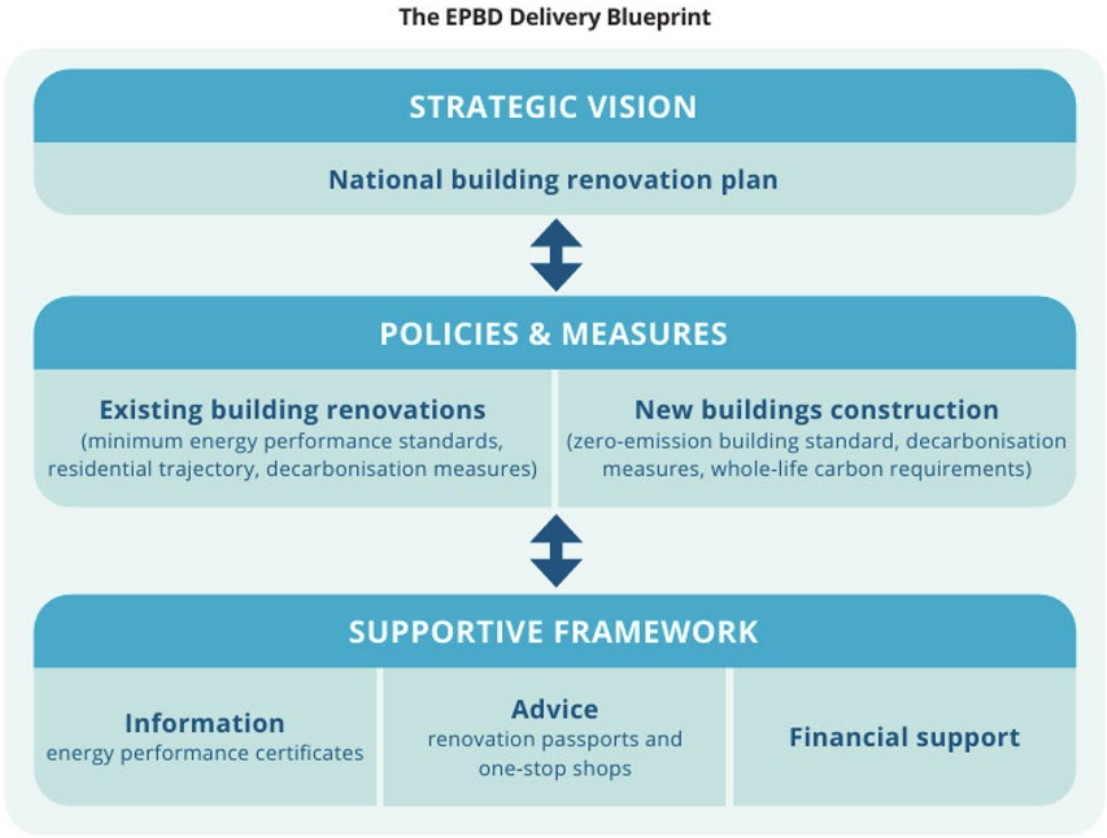
EU ENERGY AND CLIMATE POLICY

Energy Performance of Buildings Directive: Timeline

Source: *European Commission: Energy performance building directive*

EU ENERGY AND CLIMATE POLICY

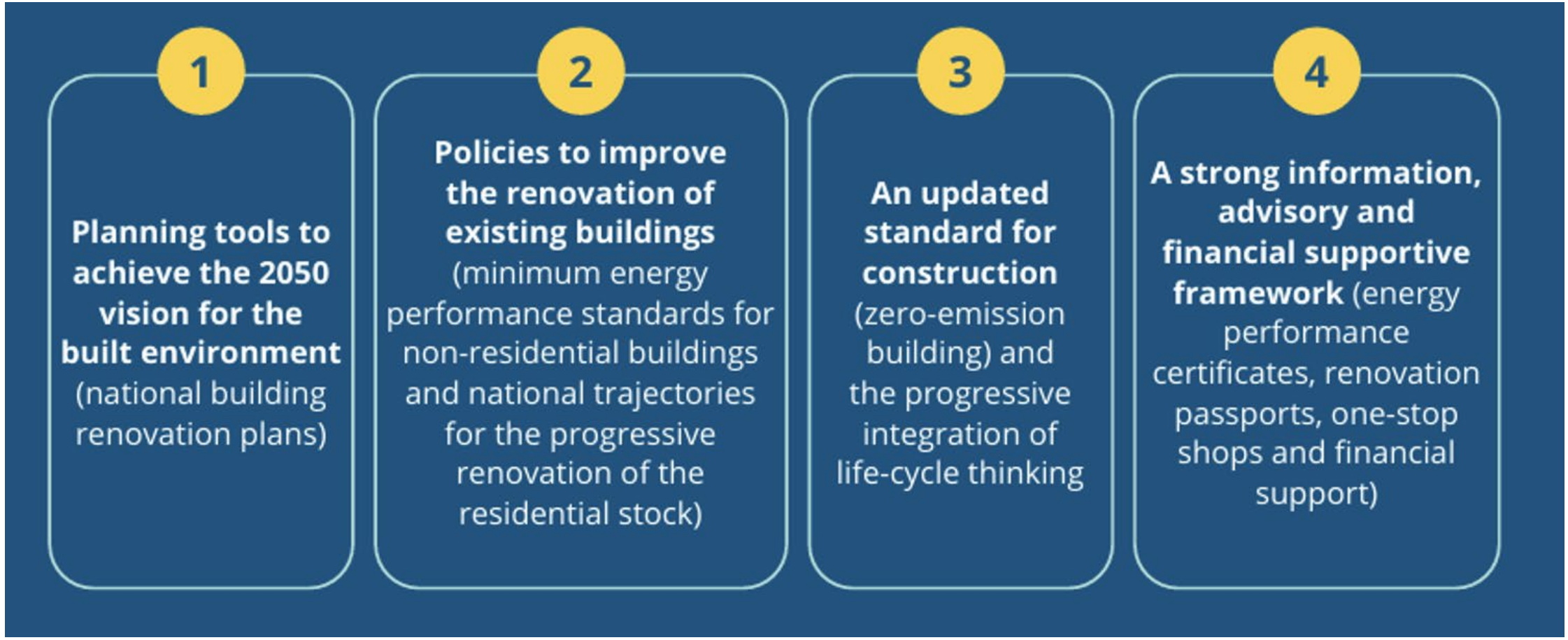
Energy Performance of Buildings Directive: Conceptual Approach



Source: BPIEs-Guide-to-EPBD-Implementation-final-version.pdf

EU ENERGY AND CLIMATE POLICY

Energy Performance of Buildings Directive: Most Impactful Provisions



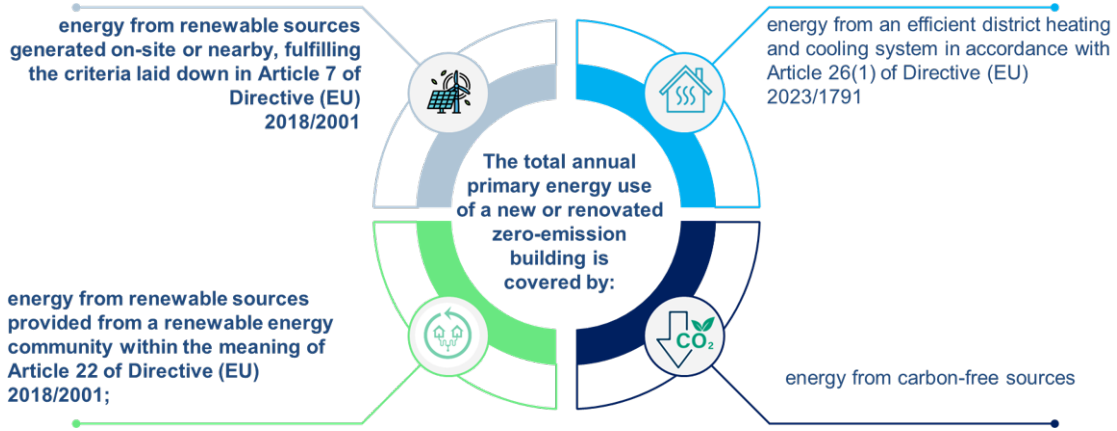
Source: BPIEs-Guide-to-EPBD-Implementation-final-version.pdf

EPBD: DEFINITIONS

Nearly zero-energy (2010) vs. Zero-emission building (2024)

Energy Performance of Buildings Directive 2010/31/EU: "A **nearly zero-energy building** is a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy produced on-site or nearby."

Energy Performance of Buildings Directive 2024/1275/EU: "**Zero-emission building** shall not cause any on-site carbon emissions from fossil fuels. A zero-emission building shall, where economically and technically feasible, offer the capacity to react to external signals and adapt its energy use, generation or storage."



Sources: 1) *European Commission: Energy performance building directive*; 2) *BPIEs-Guide-to-EPBD-Implementation-final-version.pdf*

EPBD: SYSTEMS APPROACH

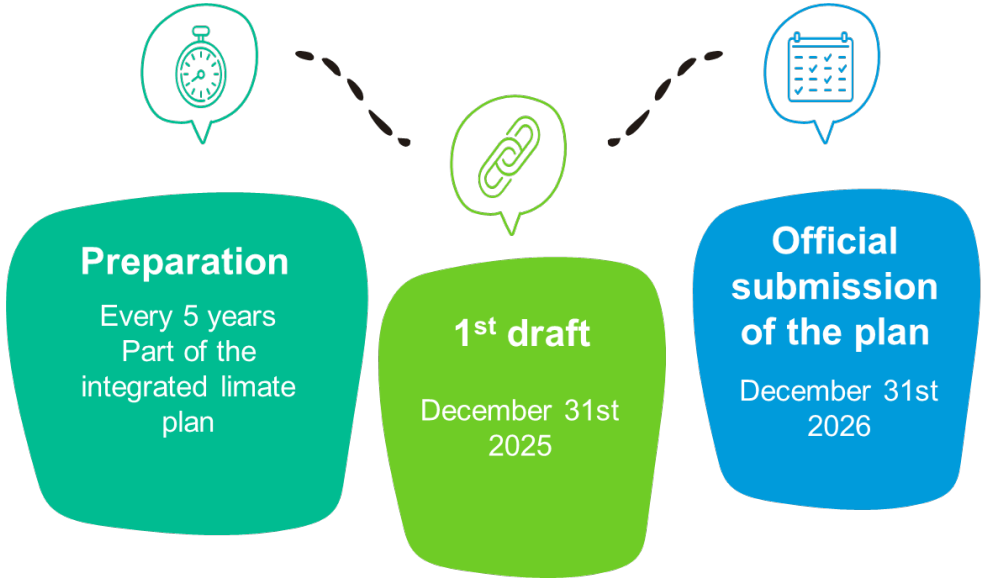
Key articles in the Energy Performance of Buildings Directive

- Article 3. National building renovation plan
- Article 5. Setting of minimum energy performance requirements
- Article 7. New buildings
- Article 8. Existing buildings
- Article 9. Minimum energy performance standards for non-residential buildings and trajectories for progressive renovation of the residential building stock
- Article 10. Solar energy in buildings
- Article 11. Zero-emission buildings
- Article 12. Renovation passport
- Article 14. Infrastructure for sustainable mobility
- Article 15. Smart readiness of buildings
- Article 17. Financial incentives, skills and market barriers
- Article 18. One-stop shops for the energy performance of buildings
- Article 22. Databases for the energy performance of buildings
- Article 26. Certification of professionals
- Article 27. Independent control system
- Article 29. Information

EPBD: DECARBONISATION VISION

National Building Renovation Plans

- **Thresholds of new and renovated zero-emission buildings**, referred to in Article 11: operational GHG emissions thresholds of new ZEBs; annual primary energy use thresholds of new ZEBs
- **Minimum energy performance standards for non-residential buildings**: maximum energy performance thresholds, pursuant to Article 9(1)
- **National trajectory for the progressive renovation of the residential building stock**: including the 2030 and 2035 milestones for average primary energy use in kWh/(m2.y), pursuant to Article 9(2)



POLICY SUPPORT ACTION

What are our projects and activities?

FINANCING, CERTIFICATION, SUPPORT INSTRUMENTS

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
European Climate Initiative EUKI

POLICY SUPPORT ACTION

What are our projects and activities?

MUNICIPAL ENERGY PLANNING AND MANAGEMENT

POLICY SUPPORT ACTION

What are our projects and activities?

TRAINING AND EDUCATION

Train-to-NZEB
The Building Knowledge Hubs

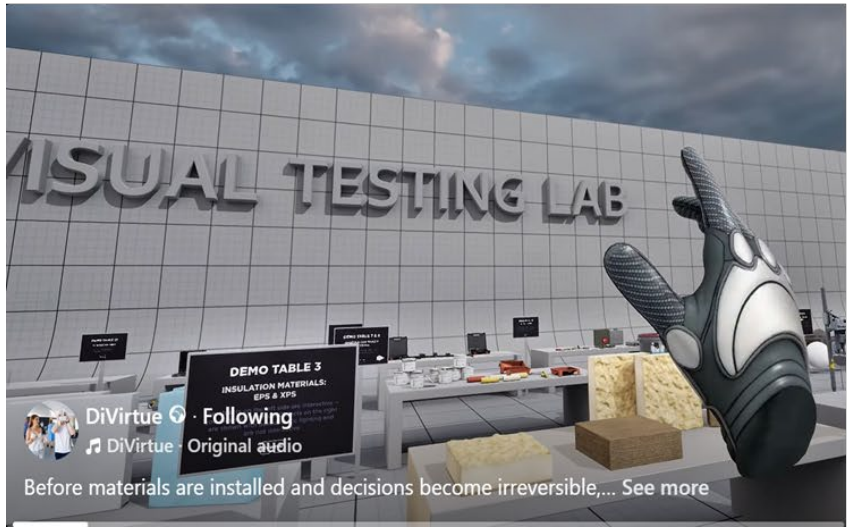
Fit-to-NZEB
Innovative training schemes for retrofitting to nZEB-levels

nZEB Roadshow
Bulgaria | Croatia | Romania | Greece | Italy

CraftEdu

INSTRUCT

BUS GoCircular



BUS LEAGUE

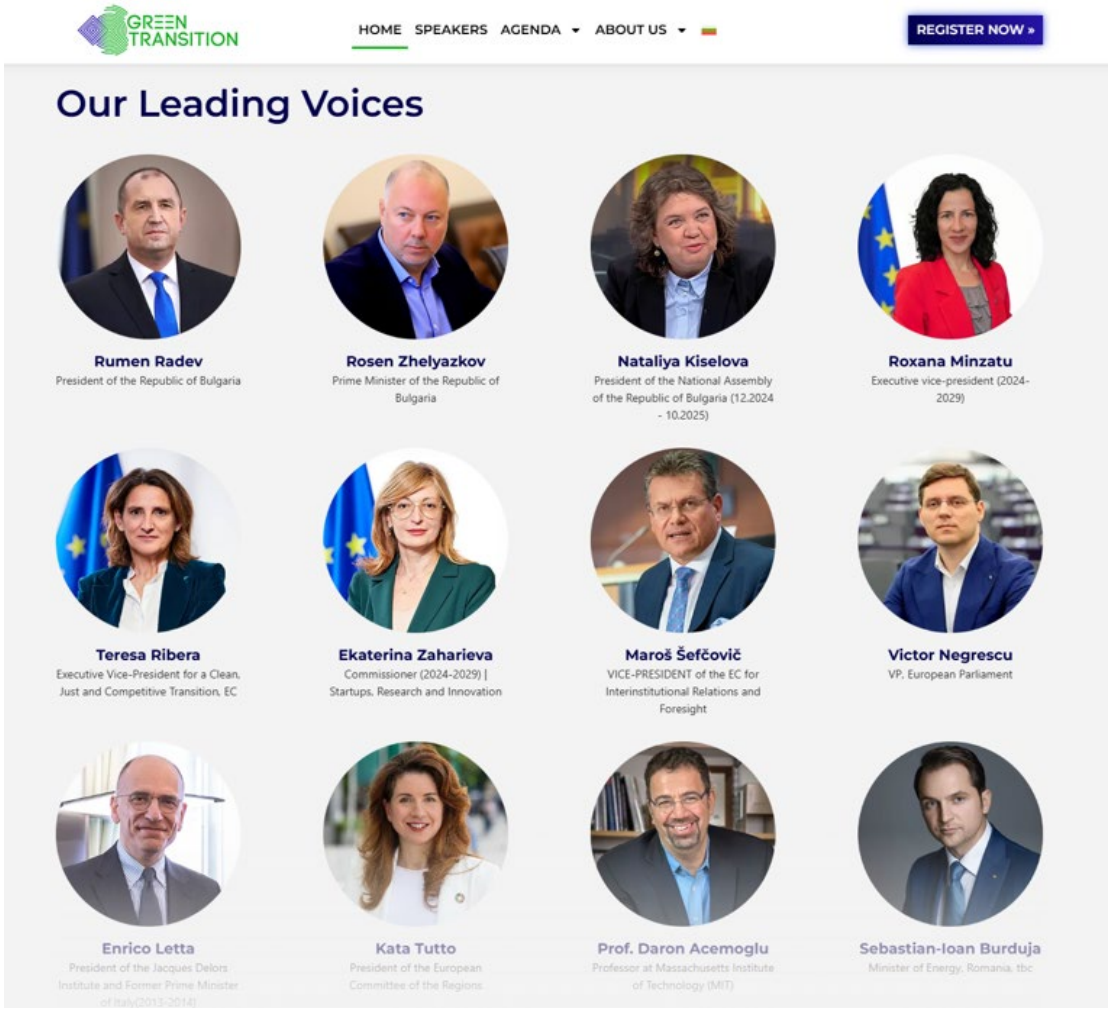
nZEB ready

D!VIRTUE

Co-funded by the European Union

POLICY SUPPORT ACTION

Green Transition Forum 6.0, 1-5th June, Sofia



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Thank you for your attention!

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https://www.linkedin.com/posts/divirtue_divirtue-probujdenie-pgsa-activity-7413905647483772928-R0KO?utm_source=share&utm_medium=member_desktop&rcm=ACoAAANAIAkBnTJZoLjG8nhpQjUdRv1Zj1xcBow

Systems Thinking Applied to Building Decarbonization

Kay Aikin

- Systems Architect – Bachelors of Engineering (Energy) from Penn State
- Electric Grid Visionary
- DOE Gridwise Architecture Council Board Member
- Senior Advisor-UN Environmental Program

Building Decarbonization is a Systems Challenge

Building decarbonization is both grid and systems problem

- Buildings drive emissions, peak demand and grid infrastructure
- Electrification changes when and where energy is used
- Building decarbonization programs succeed or fail at the system level

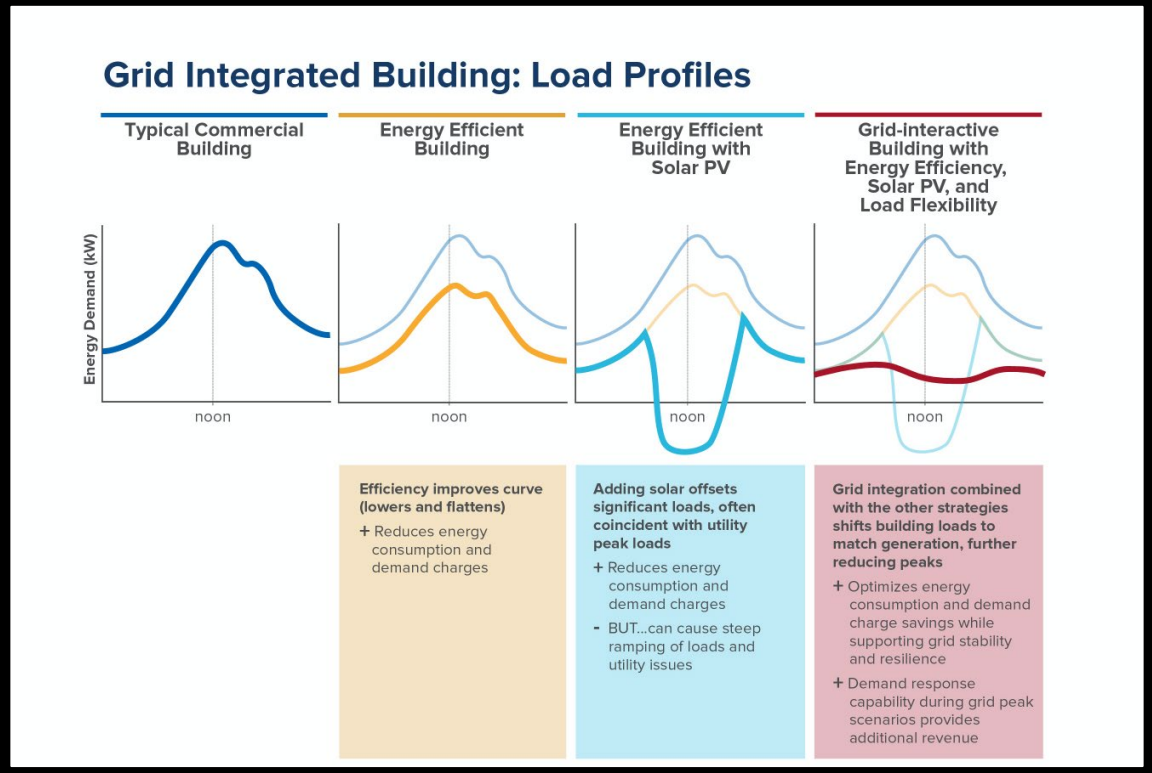
Systems Thinking?

Optimizing Outcomes, not Components

- Focus on interactions and feedback loops
- Account for timing, scale and incentives
- Avoid unintended consequences

Buildings are Dynamic

Electrified Buildings need to be **active grid participants**



Value Potential for Grid Integrated Buildings in the GSA Portfolio, Rocky Mountain Institute p. 10

- Heat pumps, EVs, storage, controls
- Load shape now matters as much a load size
- Location matters
- Buildings can be assets or liabilities

The Distribution Grid Wasn't Designed - it Grew

A mismatch between current grid architecture and the dynamics of buildings

- The old grid – designed for predictable, slow load growth
- Now seeing fast ramps and coincident peaks with damaging and expensive localized effects
- Risk: costly over building and stranded assets

Why Buildings - Grid Integration?

Building Grid Integration is the difference between affordability and energy poverty

- Peak management and local hosting capacity
- Deferred or avoided CAPEX
- Greater DER at the edge
- Improved affordability and resilience
- Risk: poor operational coordination

Australia as a Test Case

What happens when buildings become grid-scale actors

- World-leading rooftop solar penetration
- Rapid electrification and DER growth
- Distribution System now a system constraint
- Response: reframing of problem as a system-design challenge

What Australia Changed?

Replaced technology development centric approach to a system design centric approach

- Shift from passive consumers to participants
- Grid-aware DER integration
- Human-centered, system-level objectives

https://energycatalyst.au/futuregrid/

CSIRO: The Commonwealth Scientific and Industrial Research Organisation is Australia's national science agency,

AEMO: Australian Electric Market Operator

A Systems Thinking Path Forward

Even well intentioned and well-designed programs can create system risks.

- Coordinate building portfolios: incentives, regulation, utility business model reform, and technology.
- Flexible interconnection and Flexible (Dynamic) Operating Envelopes
- Performance-based outcomes

Decarbonization is a Design Choice

We can design for new better outcomes or pay for the consequences for unaffordability that emerge

- Decarbonization is achievable
- Systems design driven by systems thinking determines cost and equity within the system.
- Integration enables scale

Thank you

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- Dynamic Grid
  www.dynamicgrid.ai
- Personal Website
  www.INOV8futures.com

Break – 15 Minutes

State Agency Panel

Equitable Building Decarbonization Direct Install Program

CPUC Building Decarbonization Best Practices and Future Pathways Workshop
January 22, 2026

Building Decarbonization and Equity

Building decarbonization must prioritize low-income, disadvantaged, and tribal communities, who bear the highest energy burden and have suffered the most from historical environmental injustices, economic disparities, and the current climate crisis.

- Equitable Building Decarbonization Statewide Direct Install Program Guidelines

Equitable Building Decarbonization Program Subprograms

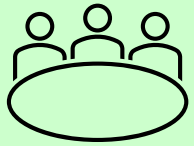
$339.25 million
(State funds)
+
$154.25 million
(Federal HOMES funds)

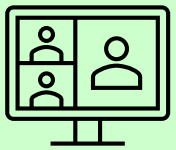
$30 million
(State funds)

$20 million
GoGreen Financing
(State funds)
+
$290 million
(Federal HEEHRA funds)

Statewide Direct Install Program Public Process and Timeline

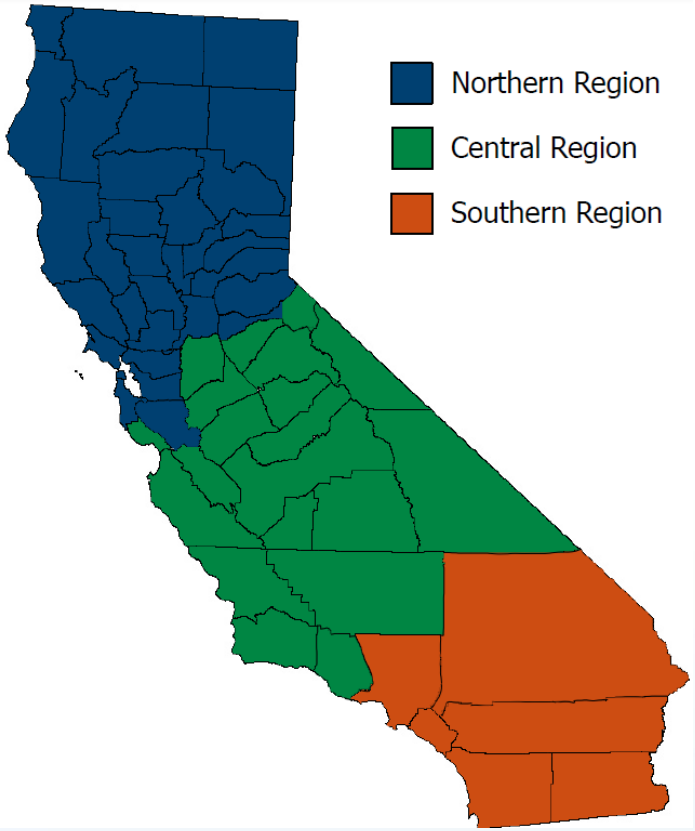
Public Process to Develop Guidelines	Guidelines Adopted	Solicitation for Regional Administrators Released	Approval of Regional Administrator Agreements	Initial Community Focus Areas Announced	Contractor Enrollment Begins *(varies by region)*	Participant Enrollment Begins *(varies by region)*	Retrofits Begin
Dec 2022 – Fall 2023	**Oct 2023**	**April 2024**	**Nov 2024**	**Aug 2025**	**Nov 2025**	**Dec 2025**	**Early 2026**





- 5 regional workshops
  Fresno, Indio, Los Angeles, San Francisco, Santa Rosa
- 5 online-only workshops
  (including evenings and weekend)
- 2 tribal listening sessions
- Interpreters & translation

Regional Administrators



Region	Regional Administrator	% of Funding*	Funding: State	Funding: Federal	Funding: Total
North	Association for Energy Affordability	23%	$78,027,500	$35,478,190	$113,505,690
Central	Center for Sustainable Energy	19%	$64,457,500	$29,308,070	$93,765,570
South	County of Los Angeles	58%	$196,765,000	$89,466,740	$286,231,740
Total	**All Regions**	**100%**	**$339,250,000**	**$154,253,000**	**$493,503,000**

** Funding allocation based on population of underresourced communities in each region*

Statewide Direct Install Program Overview

The direct install program serves…

Low-Income Households

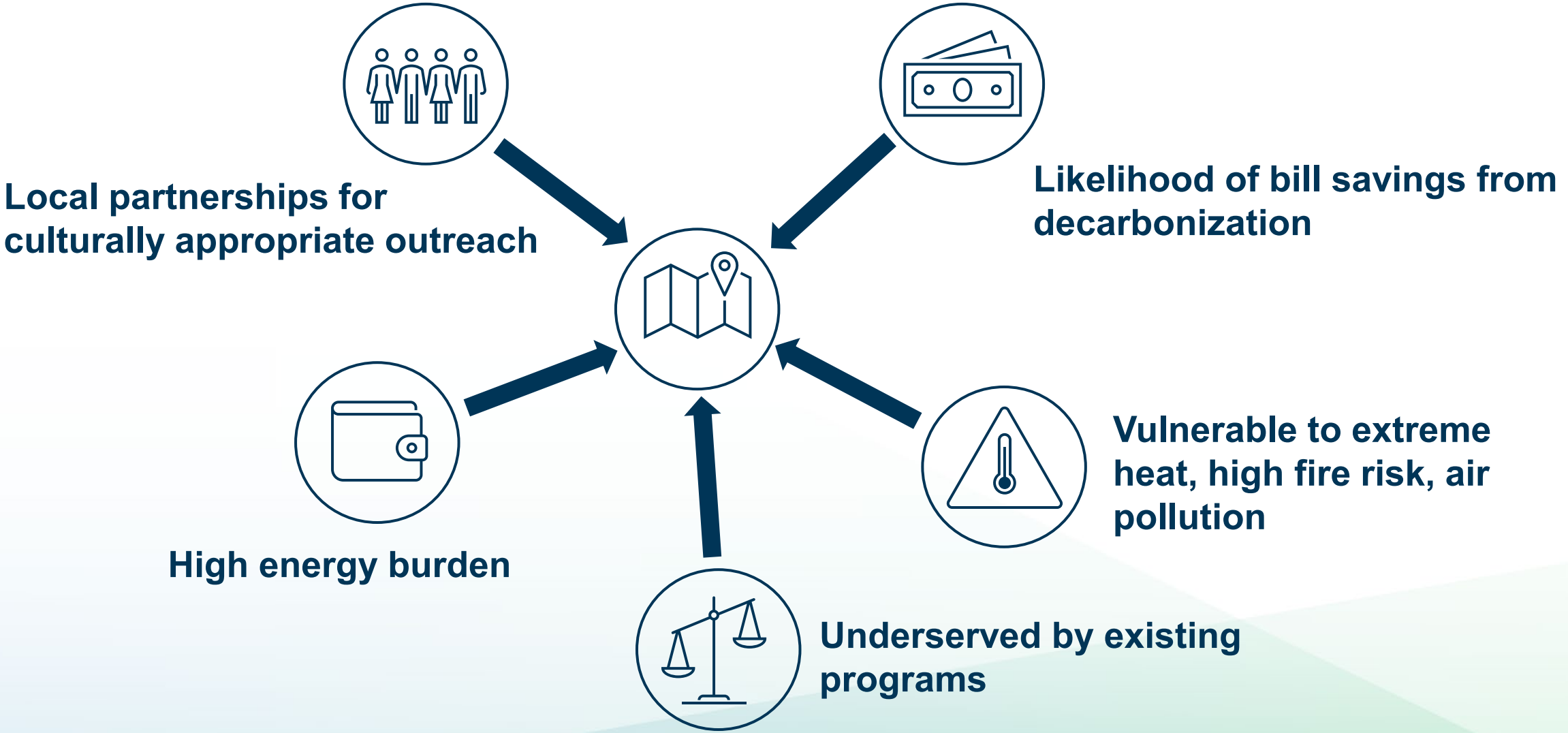
- Single-family
- Multifamily
- Manufactured and mobile homes

Owner-occupied and rented (with tenant protections)

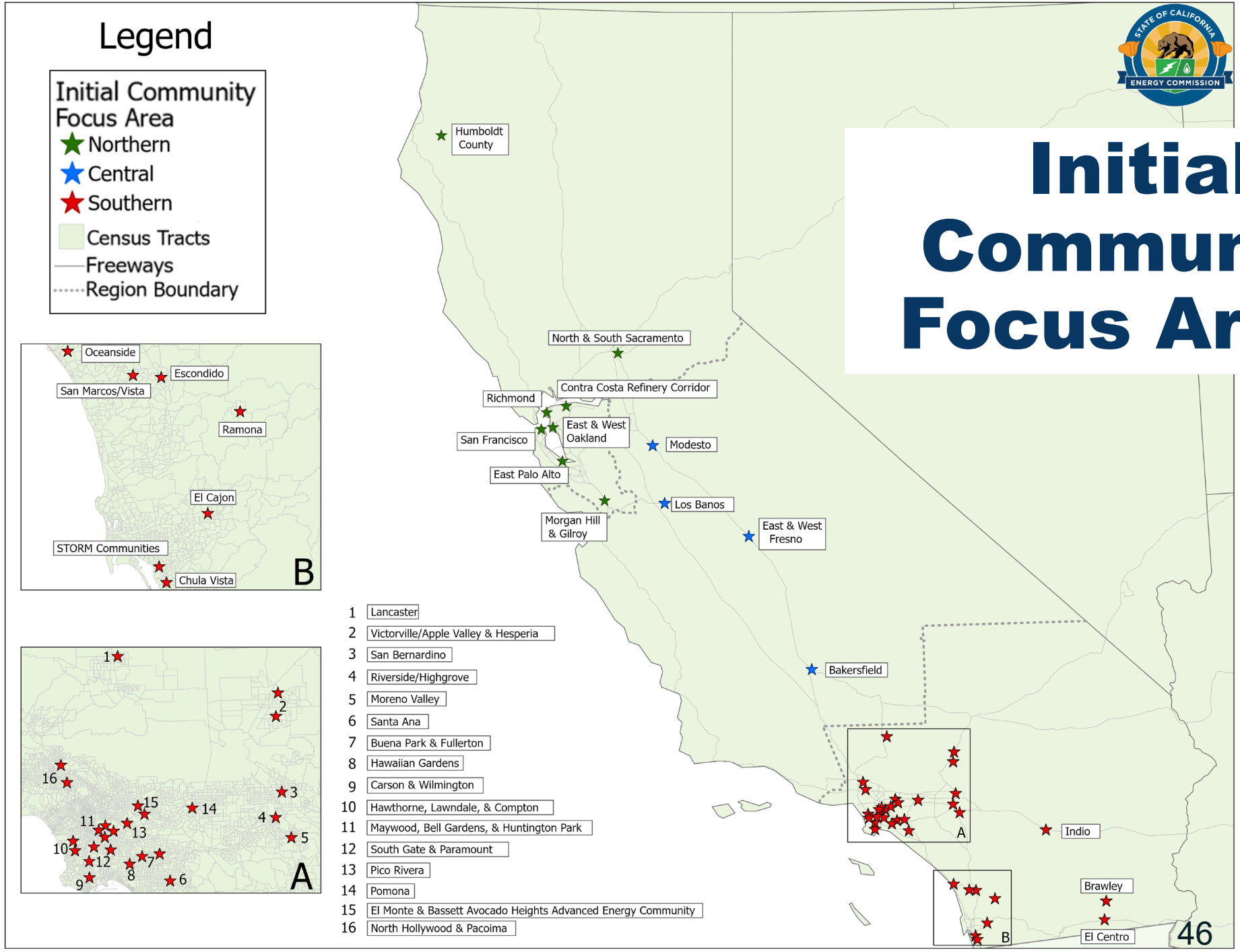
Underresourced Communities

- Disadvantaged communities
- Low-income communities

How Were Communities Selected?



Initial Community Focus Areas



Community Application Process

- Beyond the initial community focus areas, there will be an opportunity for other communities to participate
- Each regional administrator will develop a **community application process** in 2026

Eligible Measures

Heating and Cooling

- Heat pump
- Duct testing/sealing
- Smart thermostat
- Ceiling fan, whole-house fan

Building Envelope

- Insulation
- Air sealing
- Solar window film

Water Heating

- Heat pump water heater
- Low-flow showerheads and faucets

Cooking, Laundry

- Induction range or cooktop
- Electric clothes dryer

Air Quality, Lighting

- Air filtration
- LED lights

Electrical and Remediation

- Electrical wiring and panel upgrades
- Remediation and safety

Solar and storage are not eligible for EBD funding, but regional administrators are encouraged to coordinate with programs that fund these measures.

Using Utility Meter Data to Inform Outreach and Measure Results

- **Customer Targeting**
  - Analysis of customer meter data to identify homes most likely to benefit from retrofits (support from Recurve Analytics)
  - Address lists generated for each regional administrator to inform CBO outreach

- **Measurement & Verification**
  - Meter data will be used to determine weather-normalized energy savings and bill impacts for EBD projects

Contact

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Policy and Technical Lead for Equitable Building Decarbonization Programs

diana.maneta@energy.ca.gov

Website: https://www.energy.ca.gov/programs-and-topics/programs/equitable-building-decarbonization-program

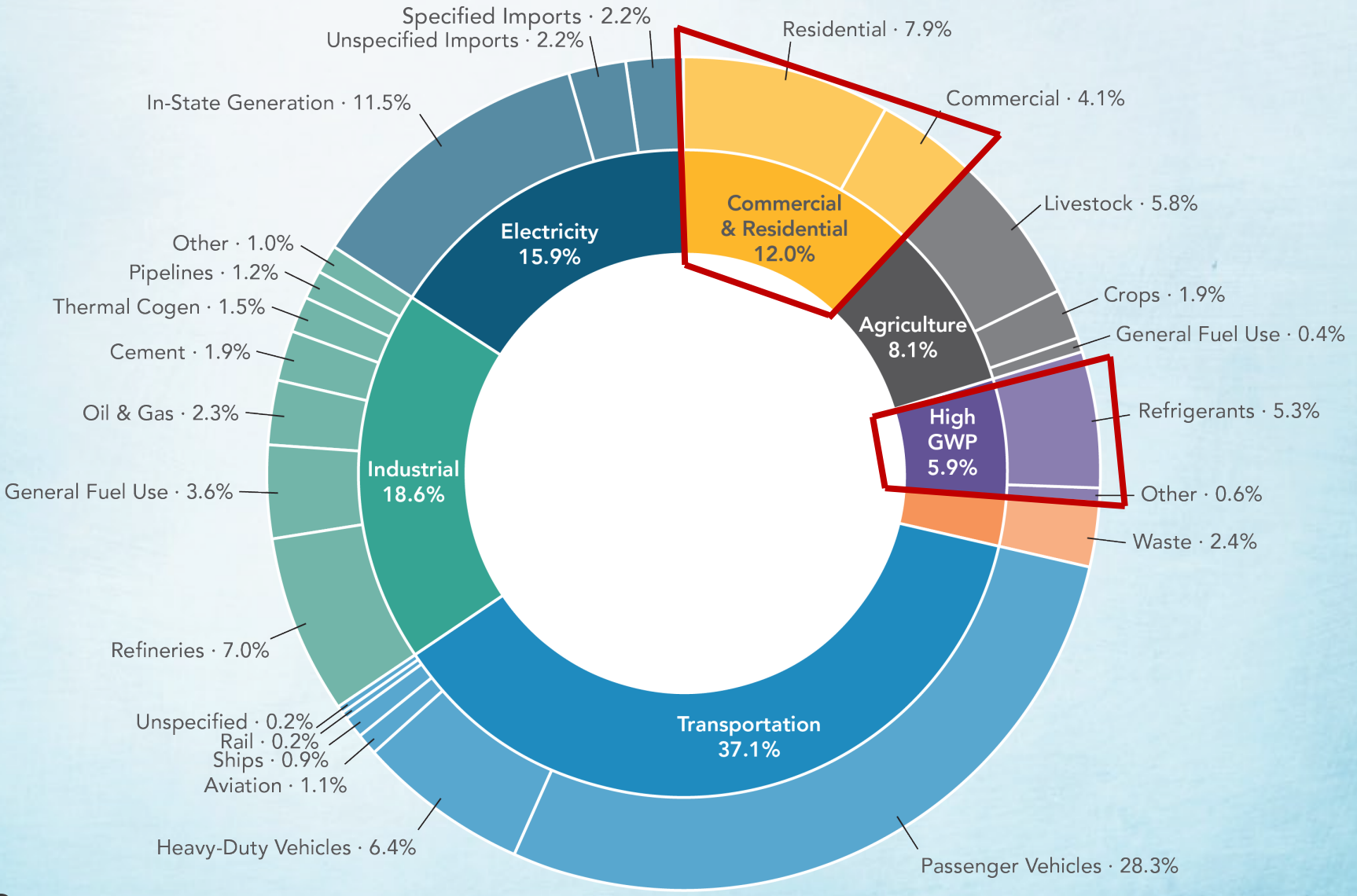
Docket: 22-DECARB-03

CALIFORNIA
AIR RESOURCES BOARD

Zero-Emission Space and Water Heaters + Refrigerants

CPUC Building Decarb Workshop
Jan 22, 2026

Statewide Greenhouse Gas Emissions (2023)



CARB

Zero-Emission Space and Water Heater Regulatory Concept Evolution

2022 State SIP Strategy Concept:

100% sales must meet zero-GHG emission targets starting in 2030

May 2024 Concept:

Different types and sizes of equipment must meet zero-GHG emission targets starting in 2027 and ending in 2033

December 2025 Proposal:

Emissive sales limits combined with a credit system to provide flexibility to address regulated entity and end user challenges

Emissive Sales Limit
Revised Regulatory Proposal

Emissive Equipment Sales $_{\text{Manufacturer}}$ ≤ Total Equipment Sales $_{\text{Manufacturer}}$ x Emissive Sales Limit (%)

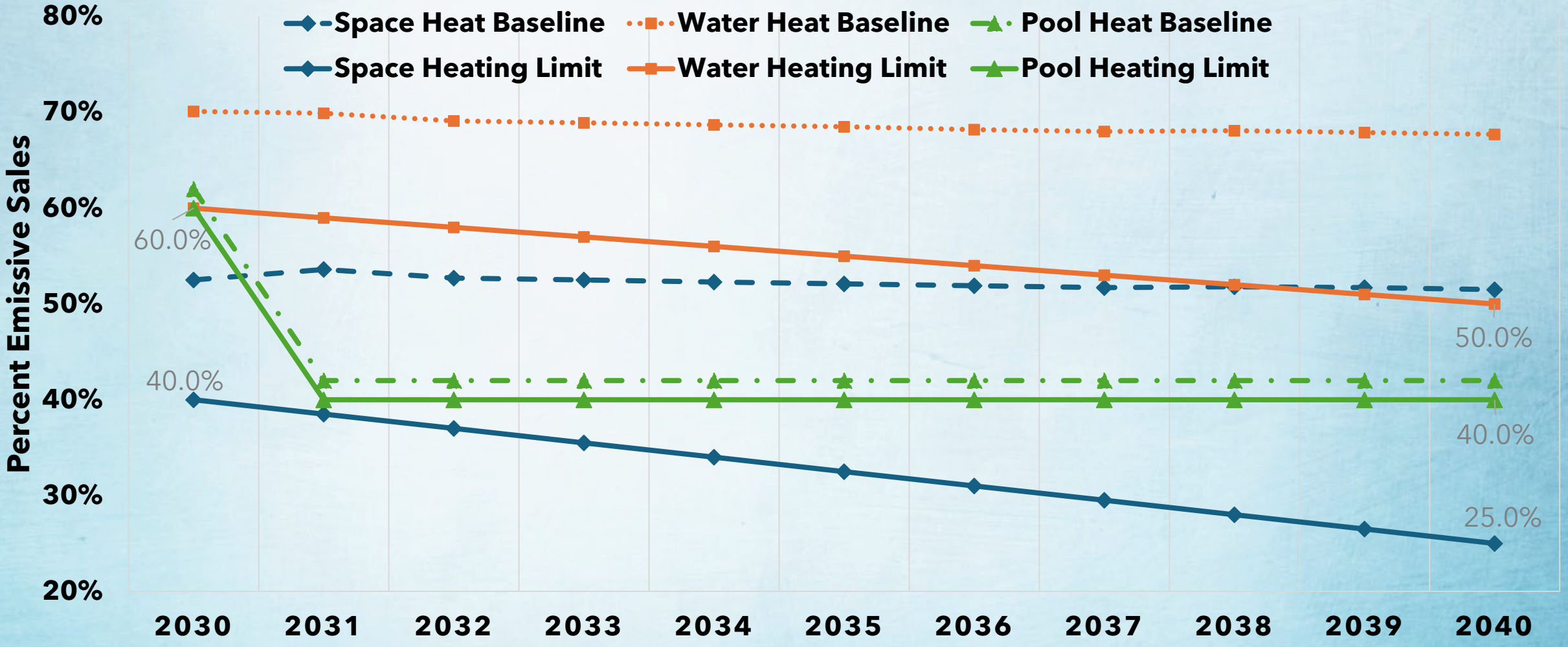
Where sales refers to equipment produced and delivered for sale or sold in California.

Equipment with a rated heat input capacity up to 2,000,000 Btu/hour must comply with emissive sales limits (%) starting on January 1, 2030.

Proposed Statewide Emissive Sales Limits

Year	Space Heating	Water Heating	Pool Heating
2030	40%	60%	60%
2031	39%	59%	40%
2032	37%	58%	40%
2033	36%	57%	40%
2034	34%	56%	40%
2035	33%	55%	40%
2036	31%	54%	40%
2037	30%	53%	40%
2038	28%	52%	40%
2039	27%	51%	40%
2040+	25%	50%	40%

Emissive Sales Baseline and Proposed Emissive Limits



CARB

Potential Credits
Focused Primarily on Emission Reductions

Credit Earning Actions	Rationale	Proposed Value of Credit
Pre-2030 Early Compliance	Reduces emissions prior to target date	1.0
Emissive Sales Below the Limit	Encourages fewer emissive sales below limit	1.0

Potential Credits
Focused Primarily on End User Issues and Equity

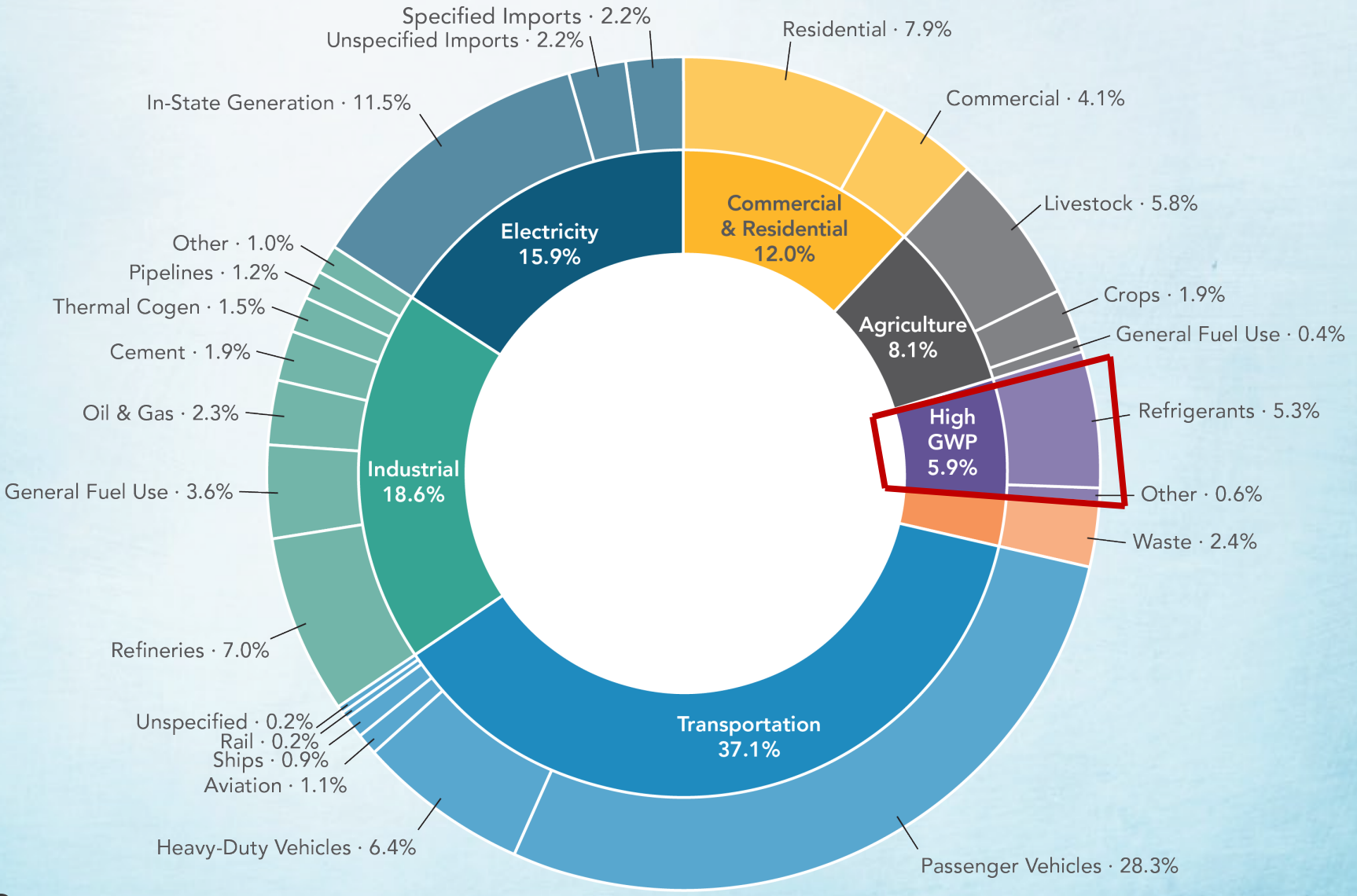
Credit Earning Actions	Rationale	Proposed Value of Credit
Innovative ZE Technology: 1. Cold-climate certified heat pumps 2. Low-power (120 Volt) water heater heat pumps 3. Equipment with integrated battery storage 4. Large capacity (>300,000 Btu/hr) packaged rooftop units	Addresses some end user issues: 1. Supports heating in cold climate regions 2. Addresses electrical panel constraints; may reduce retrofit costs 3. Improves resiliency and reduces retrofit needs 4. Helps decrease retrofit costs in large buildings	1.05 – 2.5
Donate: Donate or discount ZE equipment to equitable decarbonization incentive programs (e.g., California Energy Commission's Equitable Building Decarbonization program.)	Addresses equity by reducing upfront costs in priority communities	2.5

Potential Credits
Focused on Reducing the Impacts of Refrigerants

Credit Earning Actions	Rationale	Proposed Value of Credit
1. New equipment using refrigerants with ultra-low GWPs (GWP<10 as defined in SB 1206). 2. Reclaimed refrigerants for new equipment.	1. Reduces short lived climate pollutants 2. Encourages recovery of HFCs from existing equipment, limiting the production of new HFCs	Up to 2.5 (scaling based on refrigerant charge size)

- Credit generating actions would encourage further reductions of HFC emissions beyond those required by existing statute, such as using refrigerants with GWP levels lower than those currently found in equipment available on the market.

Statewide Greenhouse Gas Emissions (2023)

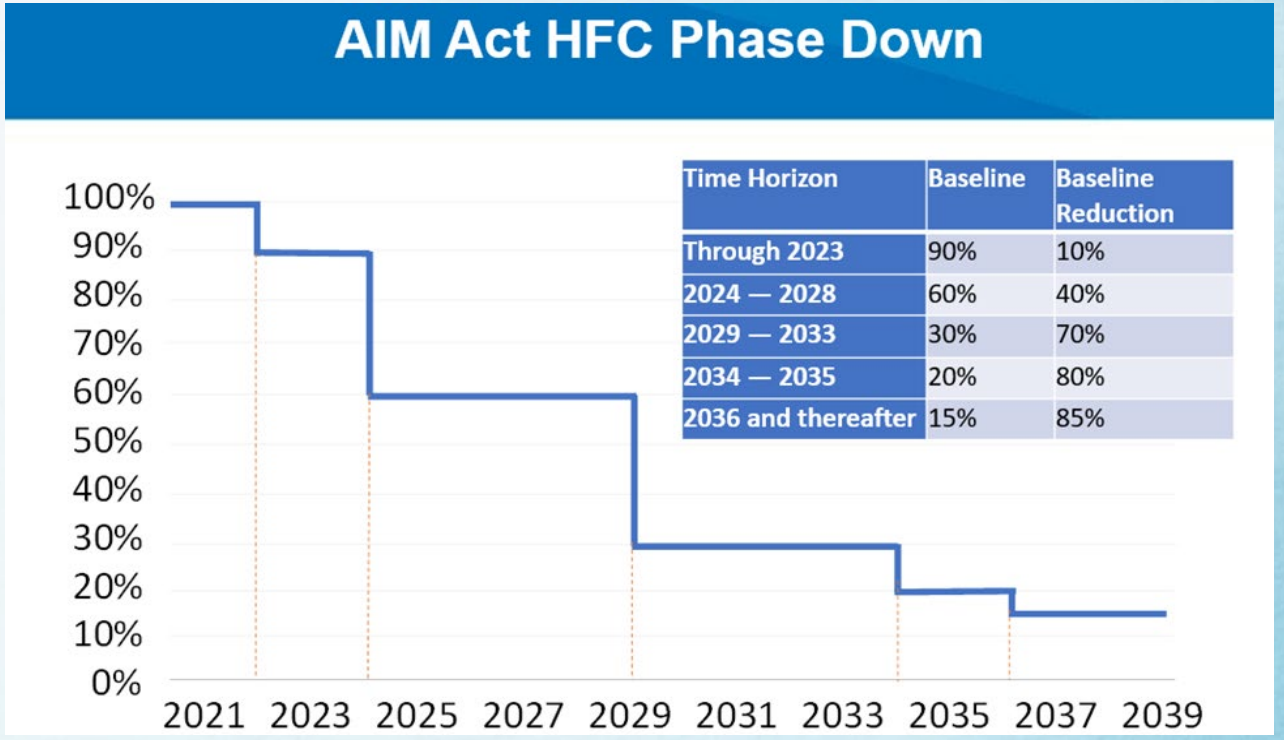


CARB

CARB's HFC Regulation (2020) and the National HFC Phasedown

Stationary HVAC
GWP < 750

Stationary Refrigeration (> 50 lbs.)
GWP < 150



Time Horizon	Baseline	Baseline Reduction
Through 2023	90%	10%
2024 — 2028	60%	40%
2029 — 2033	30%	70%
2034 — 2035	20%	80%
2036 and thereafter	15%	85%

Similar GWP limits were adopted by the U.S. EPA under the AIM Act

FRIP | F-gas Reduction Incentive Program

- **Commercial and Industrial (C&I) Refrigeration:** funding grants for existing facilities to install ultra-low-GWP (<10 GWP) technologies.

Number of Projects Awarded	Total Incentives Awarded	Total $MTCO_2e$* Emissions Reduced	% of Projects in Priority Communities	$/$MTCO_2e$ Reduced
45	$13M	381K	76%	$34

- **Workforce Development:** Increase recruitment and train 500+ technicians in ultra-low-GWP refrigeration technologies.
- **Risk assessment of A3 monobloc air-to-water heat pumps.**
- **Literature review of the environmental and health impacts of HFOs and other byproducts synthetic refrigerants.**
- **Residential air conditioning recovery and reclamation pilot (REFRESH).**

REFRESH Pilot Program: Refrigerant Recovery Process

Technician or contractor recovers refrigerant from decommissioned equipment into a refrigerant cylinder.

Recovery rates in the residential HVAC sector are low.

Refrigerant cylinders are uniquely barcoded.

Reclaimers receive the cylinders, process the recovered refrigerant, and send technician or contractor an empty cylinder in exchange.

After processing refrigerant purity, money is sent to the technician or contractor.

Technicians and contractors used to be charged for "dirty" gas.

Monthly report with cylinder and refrigerant data shared with CARB and CEC.

CARB

FRIP | F-gas Reduction Incentive Program

fripfunding.com

California SB 1206 (2022): The Future of HFCs in California

Assessment report with plan to transition HFC sectors to ultra-low-GWP (<10 GWP) and no-GWP alternatives by 2035.

- Sector specific approach
- Maximize recovery and reclamation
- Increase the adoption of new technologies
- Workforce development
- Identify demonstration projects and incentives

Thank you

ZESWH Team:
buildingdecarb@arb.ca.gov

- Draft Regulatory Language shared publicly in first quarter of 2026.
- Economic analysis released in first quarter of 2026.

CARB HFC Reduction Program:
HFCReduction@arb.ca.gov

CARB FRIP Incentive Program:
FRIP@arb.ca.gov

info@fripfunding.com

Publicly Owned Utility and Community Choice Aggregator Panel

January 22, 2026

Building electrification in the Sacramento region

Jennifer Venema, Senior Strategic Business Planner

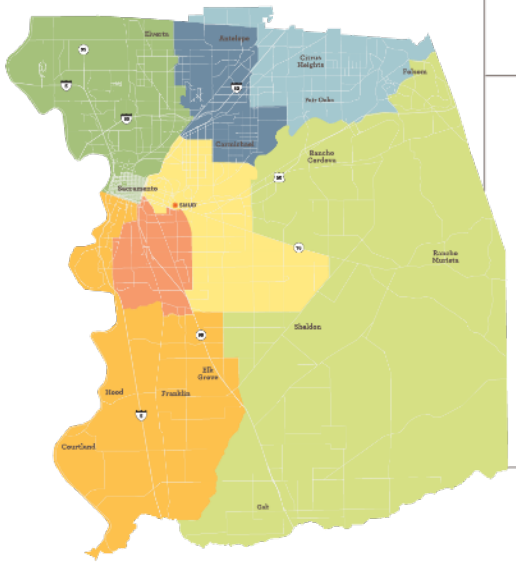
Powering forward.
Together.

SMUD®

About SMUD

SMUD is your community-owned, not-for-profit electric service.

6th largest community-owned **in the U.S.**



75+ Years
Est. 1946

2024 Power mix
62%
carbon-free

100%
Zero carbon by 2030

The most ambitious goal of any large utility in the United States

~645,000 Customers

~2,300 Employees

7 member
Elected Board of Directors

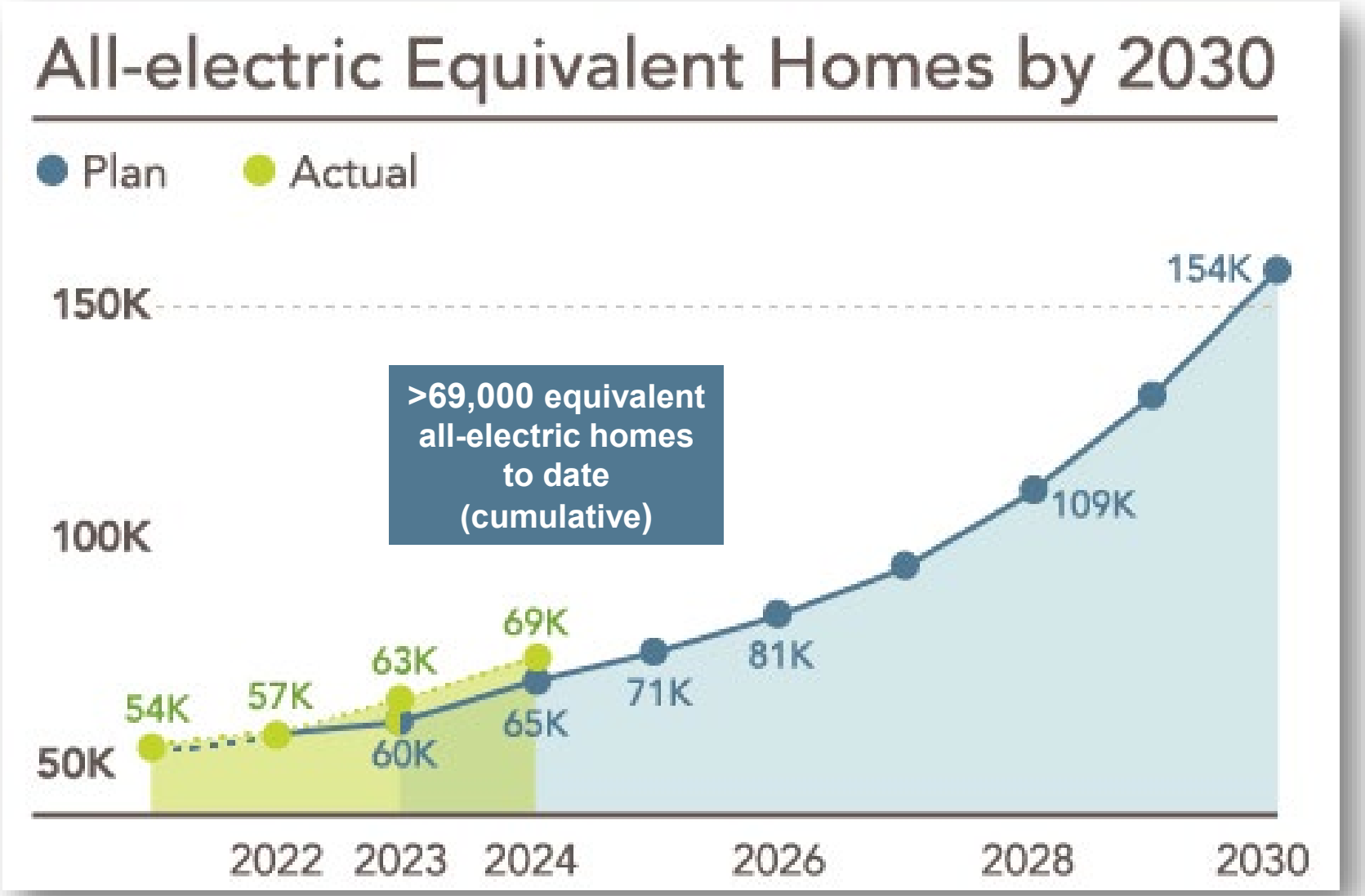
SMUD's rates are among the lowest in California,
and on average more than **50% lower** than our neighboring investor-owned utility.

SMUD®

Zero Carbon Plan

SMUD®

Building electrification goals



Aiming to electrify the equivalent of 154,000 homes by 2030.

SMUD

Early wins in single-family electrification

Over 20,000 residential heat pumps incentivized since 2018 supported by SMUD's Contractor Network.

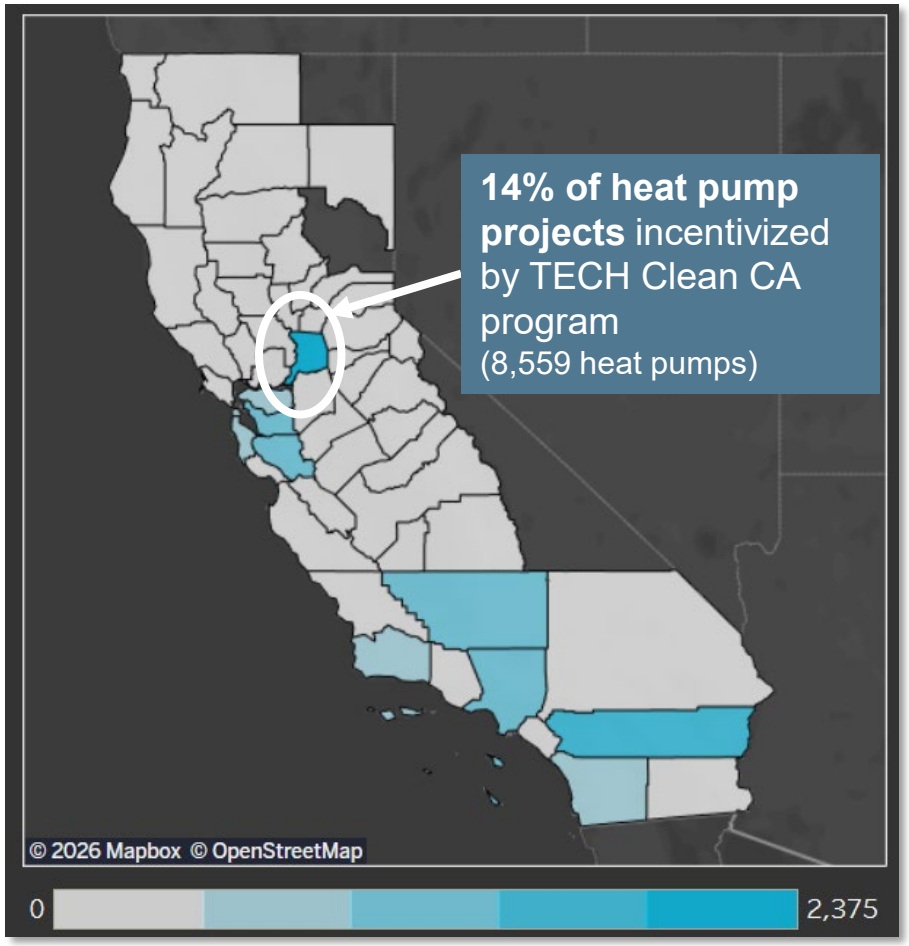
SMUD.org/GoElectric

Estimated residential savings in SMUD territory:

Up to **$500 energy savings/year** today

When replacing conventional water and space heating equipment with heat pumps

TECH Clean California Project Installs*



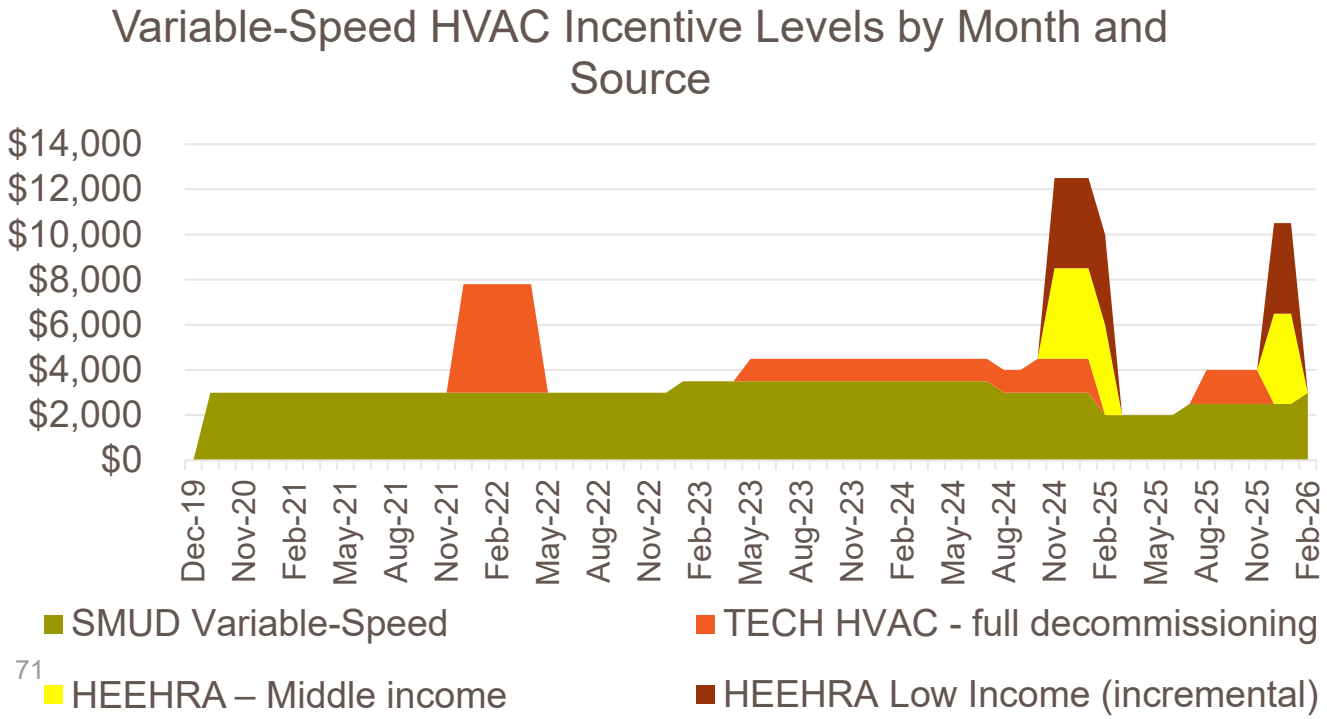
*For single-family installs through 12/31/25. Image and data accessed 1/15/26: TECH Clean California (2025). *Heat pump data visuals*. Heat pump data. https://techcleanca.com/heat-pump-data/heat-pump-data-visuals/.

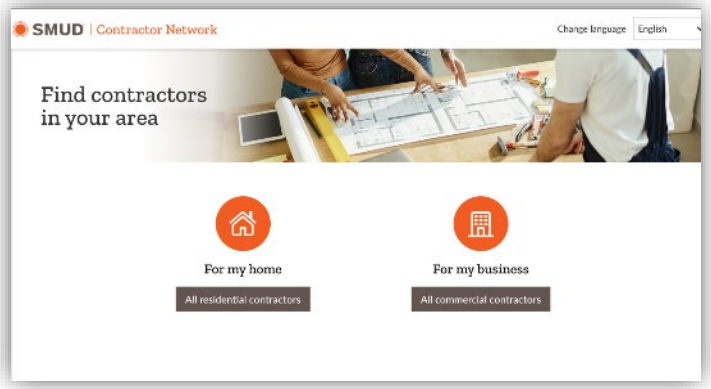
SMUD

Maximizing the impact of the trade ally network and external funds

- Importance of the contractor
- Planning for and maximizing impact of external funding
- Optimizing the customer adoption journey and energy benefits

SMUD Contractor Network 2024 End-of-Year Event

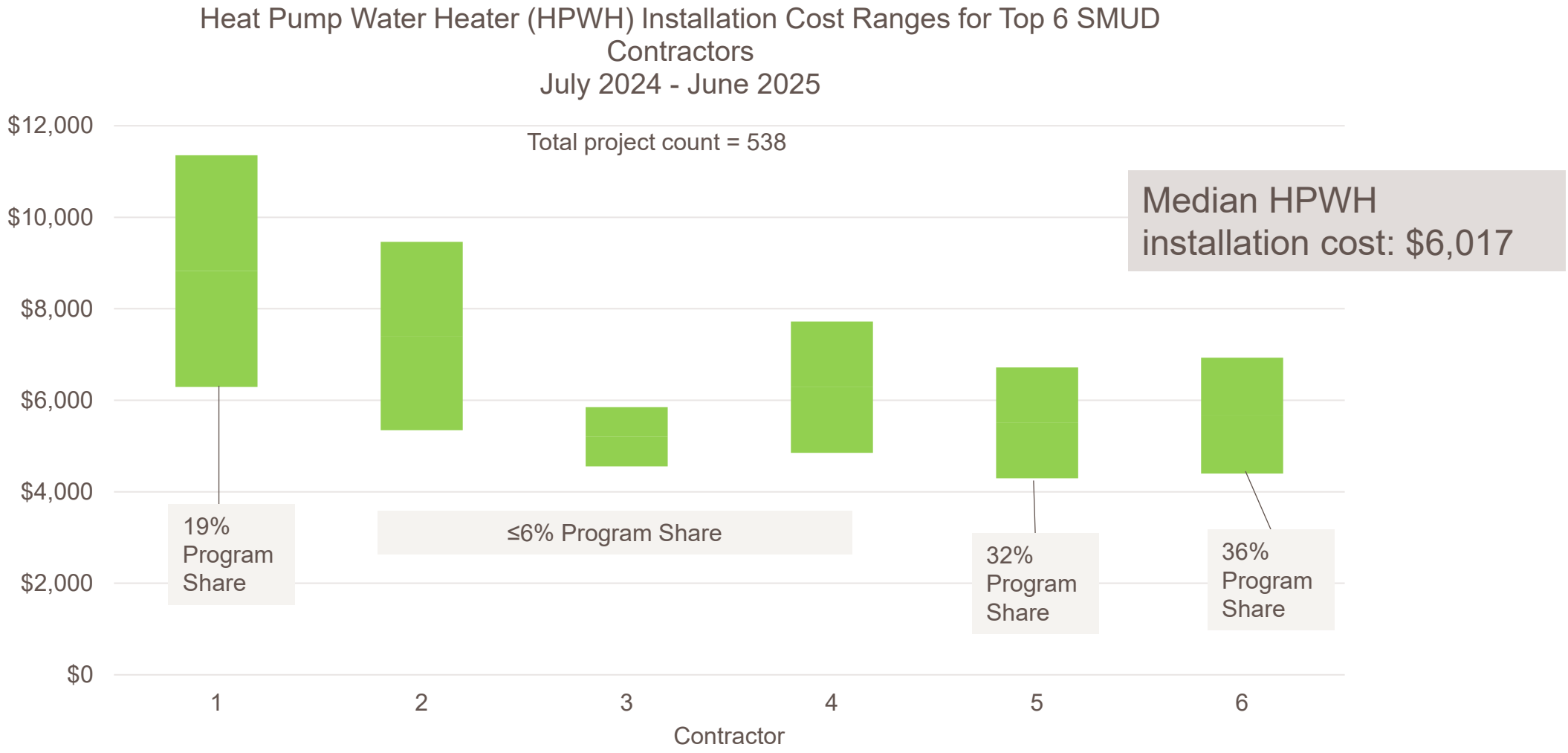




SMUDContractorNetwork.org

402 approved contractors

Finding opportunities for cost efficiencies

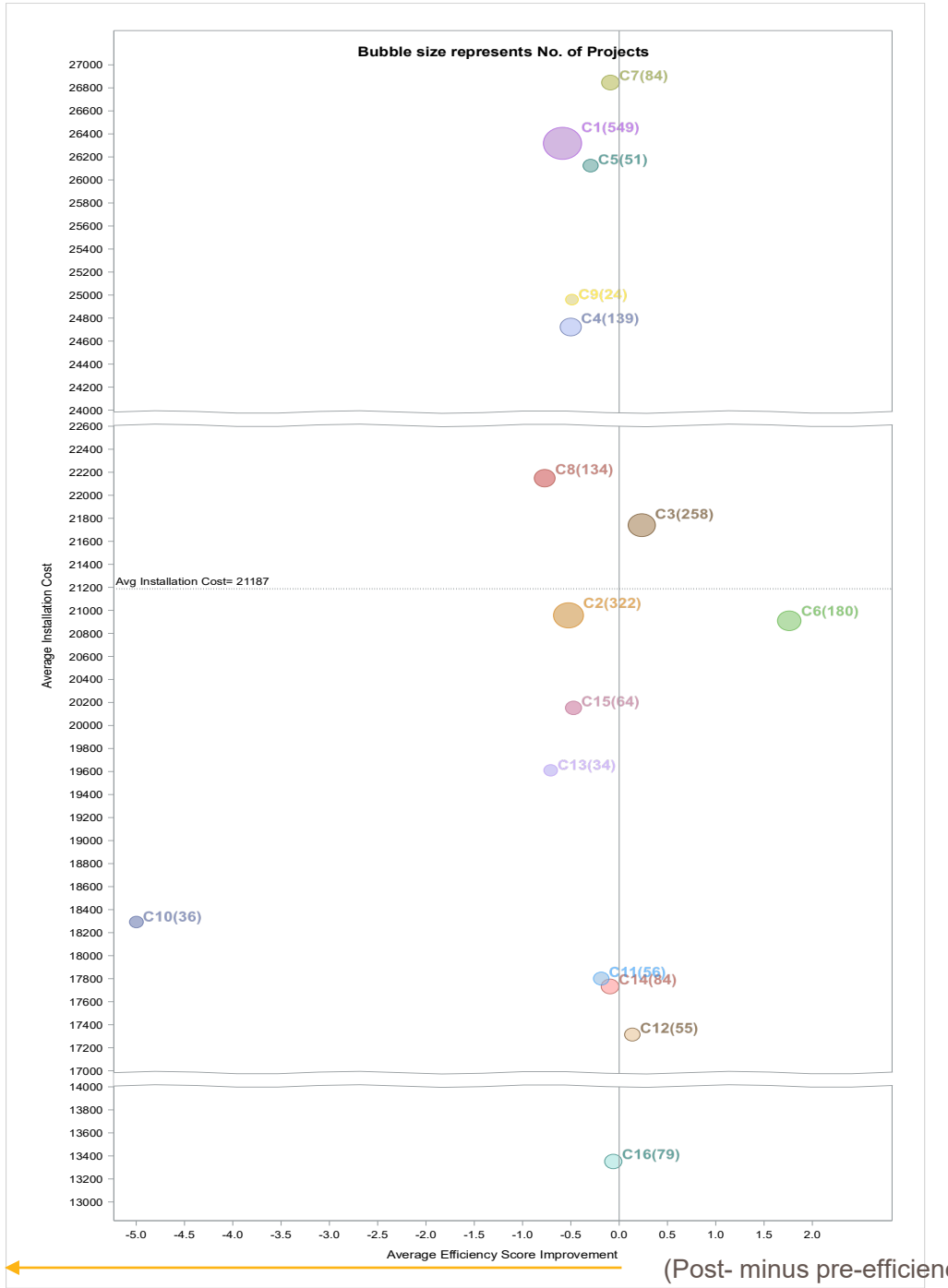


Median HPWH installation cost: $6,017

SMUD

Variation in cost and performance by installer

Variable speed heat pump HVAC installation cost and improvement in energy efficiency by contractor:

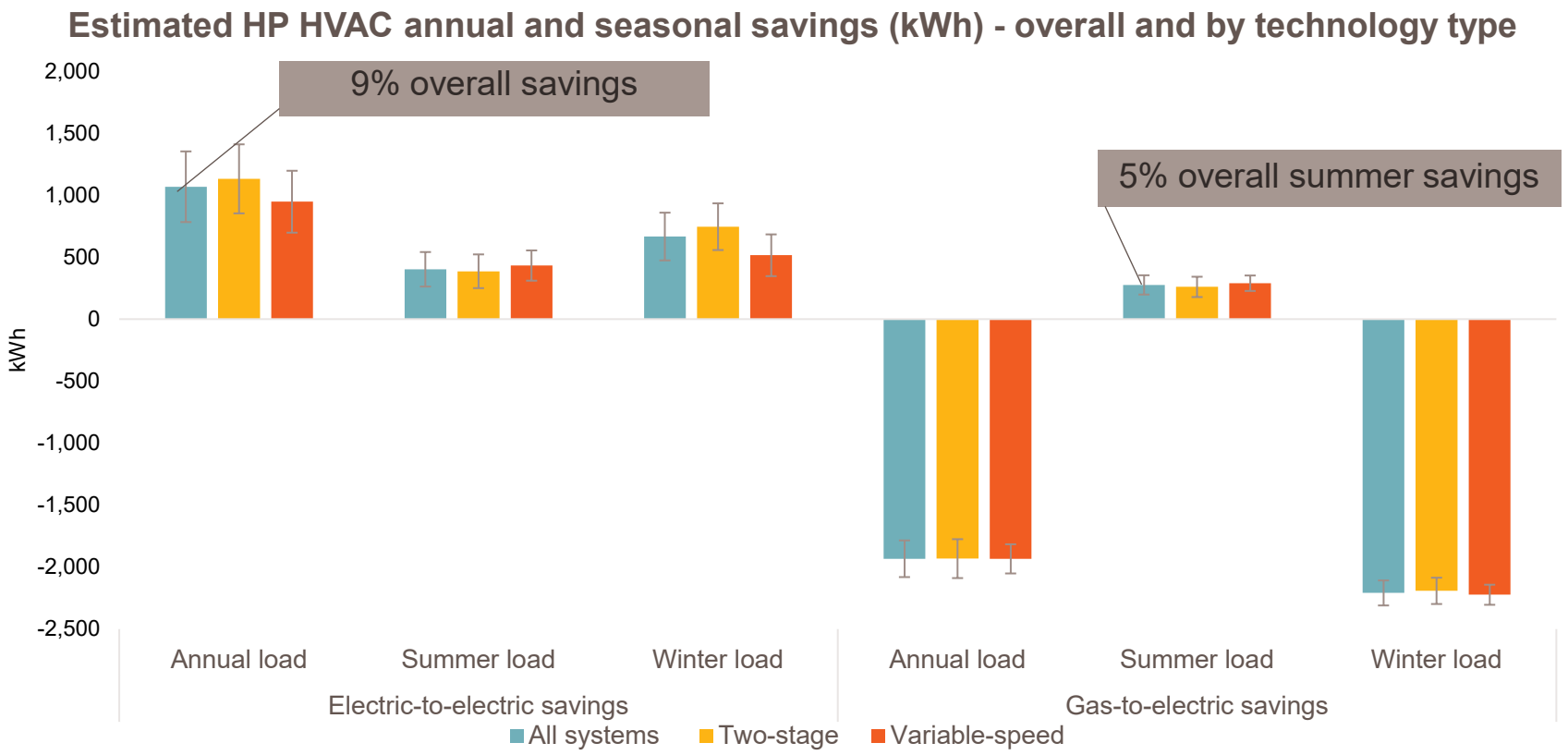


Below average install costs

Improvement in efficiency

SMUD®

Understanding technology impacts and installation practices of heat pump HVACs



90% confidence interval

Statistical evaluation included matched comparison groups, site-level weather modeling, difference-in-difference model, and pre- and post-analysis.

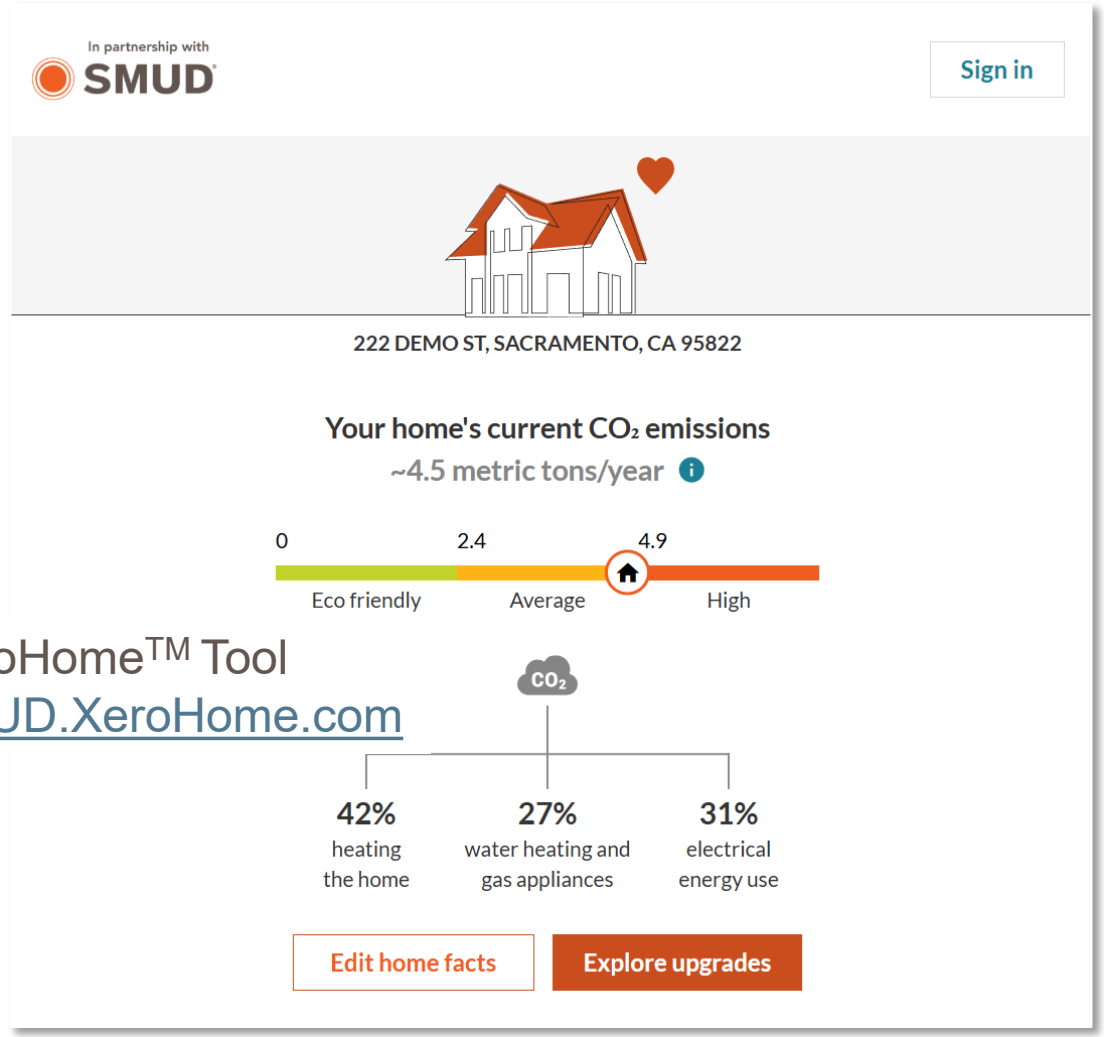
Highlights:

- Evaluation of ~ 4K installs 2020 – 2022
- No significant difference in savings or new winter load between two-stage and variable-speed heat pumps
- Wide variation in energy outcomes by installer

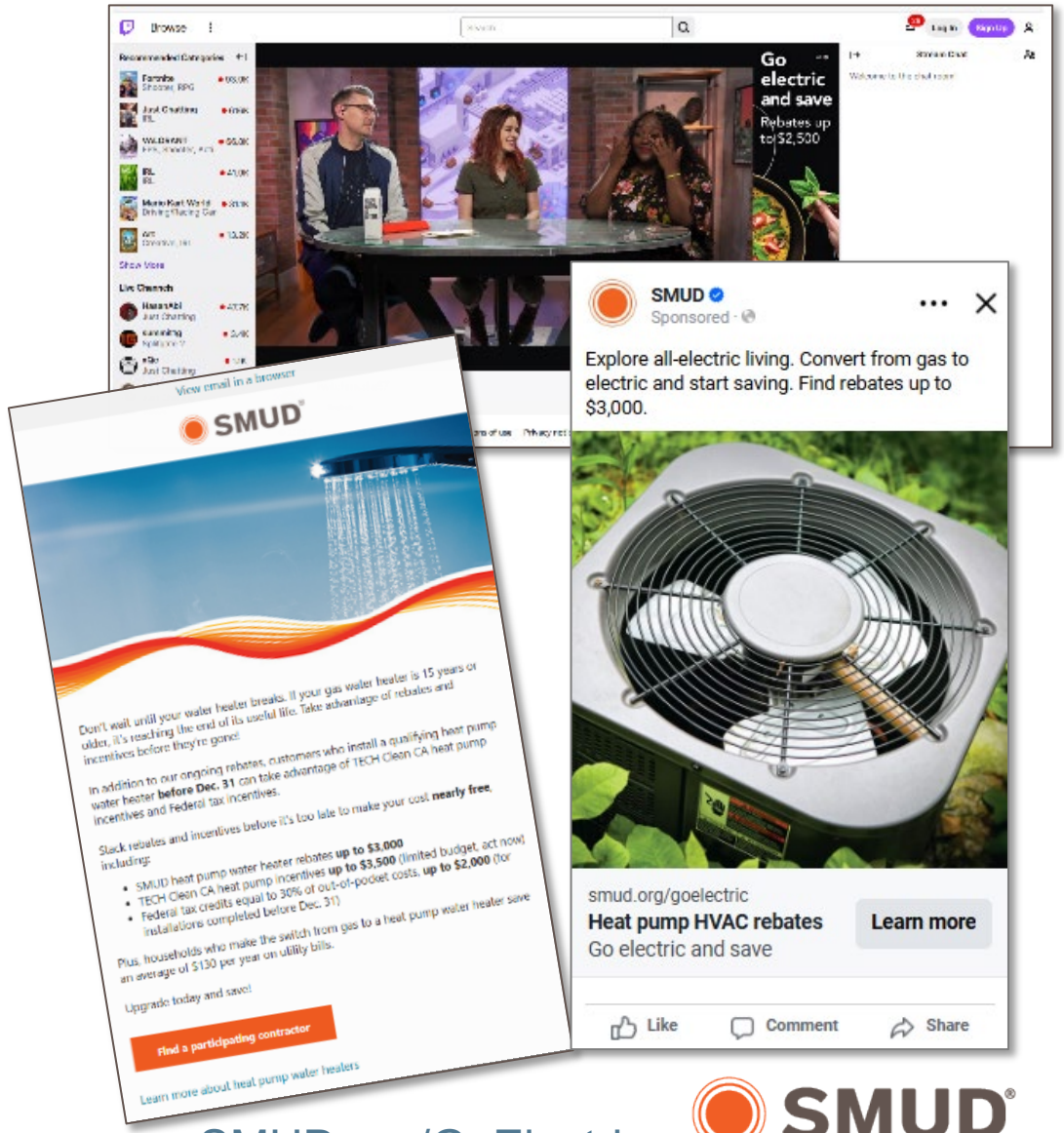
SMUD®

Scaling marketing and engagement

- Targeted marketing and collaboration
- Customer education



XeroHome™ Tool
SMUD.XeroHome.com



SMUD.org/GoElectric

SMUD

Neighborhood Power Partners
Curtis Park Electric Stars

SMUD

Leaving no community behind

- >1,600 heat pumps installed through income-eligible direct install since 2023
- Meadowview Neighborhood Electrification project in-350 homes (including efficiency and weatherization) and over 1K measures installed
- Collaboration with nonprofits and agency partners to leverage resources

BEFORE

AFTER

"Prior to having this unit, we were cold during the winter and hot during the summer… I suffered the most, having high blood pressure and osteoarthritis."

SMUD

Working with community

- Free is not enough
- Community-based outreach and engagement with trusted leaders
- In-language while finding the right message

SMUD.org/Meadowview

SMUD®

Take-aways

“Free” is not enough to help vulnerable neighborhoods: Partnership, trust, early market research

Importance of external funding and planning certainty

Role of tools and data, to help residents and businesses understand operational and energy bill impacts

Opportunity for targeted offerings, cost efficiencies, and outreach

Continued focus on growing the active contractor base, improving performance, and reducing costs

Creative collaboration for broader market awareness, customer education, and support on the adoption journey

SMUD®

Wrap-up

Thank you

Jennifer.Venema@SMUD.org

CITY OF PALO ALTO

Decarbonization in Palo Alto

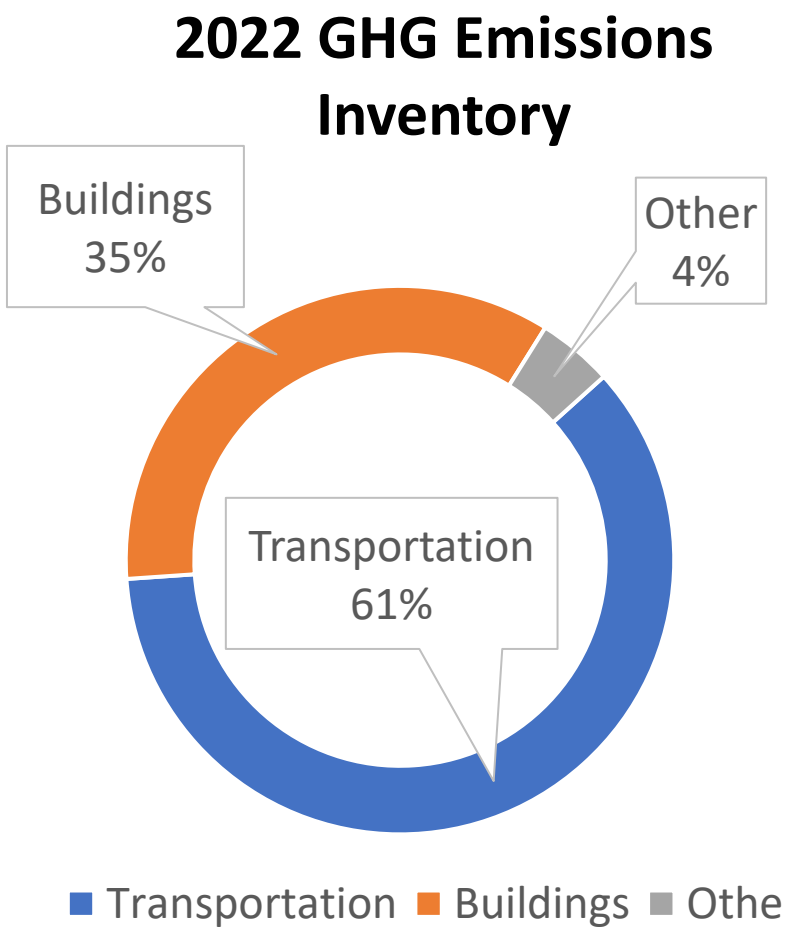
California Public Utilities Commission Building Decarbonization Proceeding

January 22, 2026

PaloAlto.gov

About the City of Palo Alto

- Electric and gas utilities (and water, sewer, dark fiber)
- Carbon Neutral Electric Portfolio since 2013
- 2023 Sustainability and Climate Action Plan with goal of 80% reductions in carbon emissions by 2030 (80x30)
- Progress to-date: 47% reductions (2022 inventory)



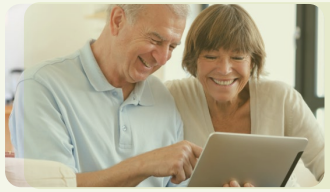
Results To-Date

750+ HPWH (heat pump water heaters), ~ **20%** of turnover

Over **300** all-electric single-family homes (**2%** of total)

EV chargers serving over **1,300** multi-family units (**12%** of total)

About **20%** of Palo Altans commuting via bikes/walking/transit



20+ HPWH in income-qualified single-family homes

10+ rooftop HVAC electrification projects in progress

Affordable housing building and vehicle electrification pilots

Over **20%** of Palo Alto cars are EVs (**55%** of new sales)

Current Decarbonization Programs

New Construction Requirements
Hourly source energy requirements (replaced all-electric requirements)

Single-Family Buildings
Rebates, assessments, direct install, on-bill financing, EV promotion

Multi-Family Buildings
EV chargers and EV promotion, affordable housing grants, rebates

Non-Residential Buildings
Packaged HVAC pilot, custom electrification rebates, technical assistance

Permit Streamlining
Instant online permits for heat pump water heaters, solar, and mechanical, electrical, and plumbing permits

Grid Modernization Program

- Long-term program to modernize electric grid – improving reliability, adding capacity:
  - Reconductoring sub-transmission line
  - Converting 4kV lines to 12kV
  - Substation reconstructions
  - Upgrading line transformers, strengthening feeder ties
- Completed a 900-home pilot upgrade area in mid-2025
- Reviewed program approach, discussing with policy makers focusing on aging infrastructure, with capacity additions to manage electrification as needed, in a timely manner
- Cost-efficient approach

Grid Modernization Program

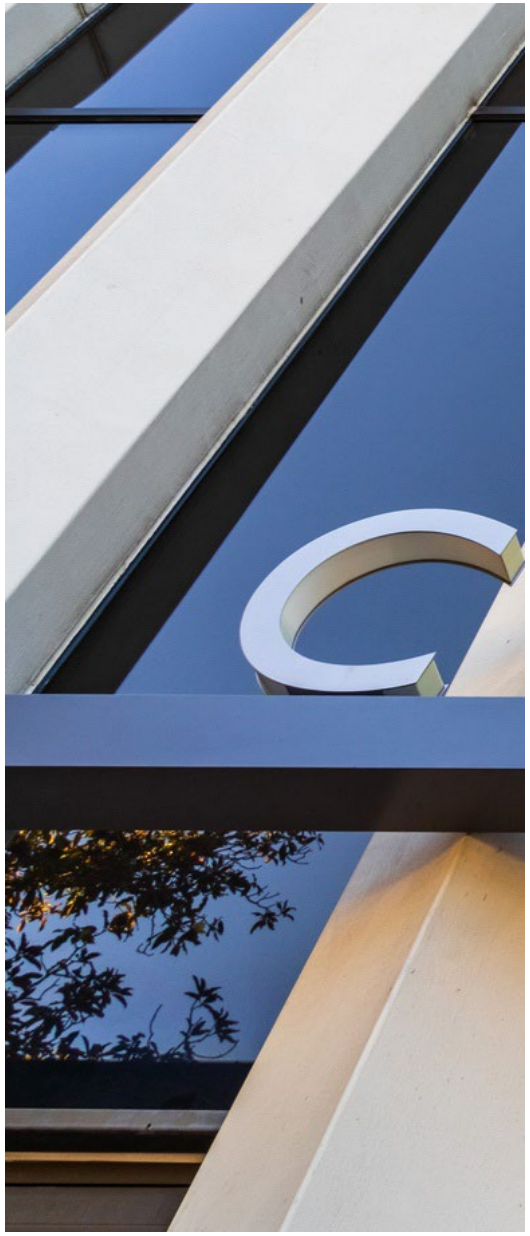
- Completed cost-benefit analysis of using batteries to defer distribution investment
- Costs exceeded benefits at this time
- Continuing to promote and reduce barriers to voluntary adoption of distributed energy resources

Gas System Transition Study

- Identify physical and financial impacts of widespread building electrification on the gas utility and identify mitigations
- Methodology:
  - Use gas usage patterns to predict equipment in homes
  - Simulate future gas use patterns under various high electrification scenarios
  - Use gas system model to evaluate physical impacts of high electrification scenarios
  - Use financial models to evaluate financial and rate impacts
- Note: City of Palo Alto gas utility is highly networked – valves at nearly every intersection, easy to isolate blocks

Gas System Transition Study

- Preliminary results presented in fall 2025:
  - More electric equipment predicted than had been expected, especially in multi-family
  - About 40% of gas utility costs are fixed
  - With random electrification, little gas main abandonment seen until reaching very high levels of electrification
  - Still analyzing financial impacts, but simulation results imply non-trivial potential rate impacts if not mitigated
- Next steps: improved simulations, physical/financial modeling
- Brainstorm mitigations, discuss with policy makers



Future Decarbonization Strategic Planning

- Planning and research studies in progress over 2024-2025, final drafts to our City Council in February
  - Funding source survey
  - Funding model
  - EV charging needs assessment
  - Studies of single-family, multi-family, non-residential electrification opportunities
- Plan to use models to develop policy options with varying paces, levels of assistance, and funding/financing needs
- Piloting different cost-efficient program models and financing strategies in 2026-2027

CITY OF
PALO
ALTO

Jonathan Abendschein
Assistant Director for Climate Action
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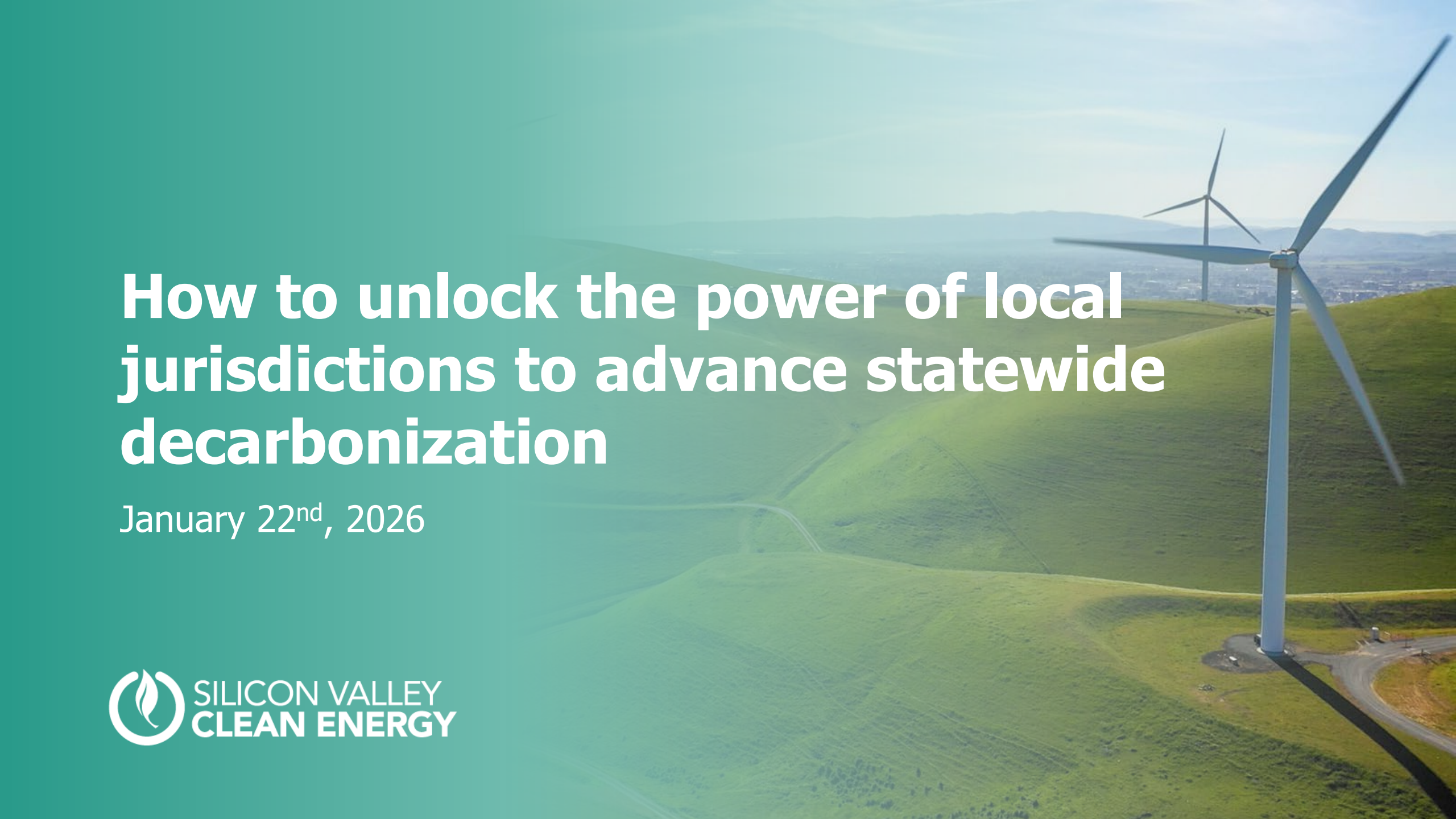
How to unlock the power of local jurisdictions to advance statewide decarbonization

January 22nd, 2026



SILICON VALLEY CLEAN ENERGY

Local jurisdictions are key to achieving building decarb goals but often lack the technical resources to fully leverage their power.

SVCE is the Community Choice Aggregator for 13 Santa Clara County communities.

Mission: Reduce dependence on fossil fuels by providing carbon free, affordable, and reliable electricity and innovative programs for the SVCE community.

Campbell | Cupertino | Gilroy | Los Altos | Los Altos Hills

Los Gatos | Milpitas | Monte Sereno | Morgan Hill

Mountain View | Santa Clara County | Saratoga | Sunnyvale

Best Practices SVCE Has Gathered

Strategic coordination with local building departments can catalyze electrification.

1. Provide technical training to empower building officials to support right-sized panels and best practices for heat pump installs.
2. Support building officials to adopt electrification readiness codes to drastically reduce the cost and time for emergency replacements.
3. Leverage utility allowances for affordable housing (through county Housing Authority).

Training for local building officials and permitting staff has streamlined

Challenge: Data supports right-sizing panels for more cost-effective electrification but building departments who are charged with protecting health and safety often push for panel upgrades.

Solution: SVCE has provided training and resources for all 13 member jurisdictions:

- Education and resources on panel right-sizing
- Training on emerging technologies (e.g., 120V HPWHs, circuit-splitters, automated EV load management systems)
- Best practices for heat pump installations

SVCE has been able to empower city and county staff because of the strong relationships it has built by providing ongoing support.

Electrification readiness codes pave the way for future neighborhood decarbonization.

Challenge: In "emergency" situations electrification is more expensive, complicated, and time consuming, but it is very difficult to get people to proactively prepare.

Solution: SVCE provided technical support to city staff and building officials.

- Five out of thirteen jurisdictions have adopted electric readiness codes that will lower cost and reduce common barriers to electrification.
- Several agencies also provide handouts on prewiring and preparing for air district rules at their permit counter.
- SVCE provides incentives for prewiring ($500-750 per circuit/device).

Removing barriers to decarbonizing affordable multifamily housing.

Challenge: County Utility Allowance Schedule did not include heat pumps and penalized affordable housing property owners for installing them.

Solution: SVCE worked with the Santa Clara Housing Authority to add heat pump space heating to the 2026 Utility Allowance Schedule, with HPWH to follow.

2026 Utility Allowances Schedule - Effective 10/01/2025

Locality: Santa Clara County; San Jose

Unit Type: Semi-Detached, Rowhouse, Townhouse		Description:	Includes structures with two to four units side-by-side and under one roof, duplexes and two-family homes								
		Monthly Dollar Allowances; Number of Bedrooms									
Utility or Service		SRO	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR	6 BR	7 BR	8 BR
Heating	a. Natural Gas	20	27	36	38	42	45	49	N/A	N/A	N/A
	b. LPG/Propane	40	53	64	67	73	78	87	N/A	N/A	N/A
	c. Electric	18	24	28	33	39	45	50	N/A	N/A	N/A
	d. Electric Heat Pump	13	17	20	23	26	29	32	N/A	N/A	N/A
Cooking	a. Natural Gas	5	6	6	9	11	15	17	N/A	N/A	N/A
	b. LPG/Propane	6	8	8	14	20	25	28	N/A	N/A	N/A
	c. Electric	6	8	9	14	18	22	26	N/A	N/A	N/A
Other Electric/Lighting		27	36	43	60	80	99	119	N/A	N/A	N/A
Air Conditioning			No Allowance								
Water Htg.	a. Natural Gas	10	13	17	24	31	39	44	N/A	N/A	N/A
	b. LPG/Propane	17	22	28	39	53	64	73	N/A	N/A	N/A
	c. Electric	27	36	43	60	80	99	119	N/A	N/A	N/A
Water		53	71	72	89	108	128	149	N/A	N/A	N/A
Sewer		53	71	71	71	71	71	71	N/A	N/A	N/A
Trash Collection		45	60	60	60	60	60	60	N/A	N/A	N/A
Range/Microwave		11	11	11	11	11	11	11	N/A	N/A	N/A
Refrigerator		12	12	12	12	12	12	12	N/A	N/A	N/A

This barrier was identified through our Multifamily Direct-Install program's Property Owner Listening Sessions.

As a locally governed agency, SVCE has been able to build key relationships and provide technical support that unlocks the superpowers of building officials.

Strategies to Leverage

Streamline decarbonization by providing education and resources to building officials and permitting staff:

- Reduce wasteful service upgrades saving ratepayers time and money.
- Advance local policy that aligns with state goals and prepares communities for zonal decarb through preparation.
- Uncover hidden barriers to electrification and quickly advance solutions like modernized utility allowances.

Peter Mustacich, PE

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Technical Manager of Decarbonization Strategy and Planning

SILICON VALLEY CLEAN ENERGY

Lunch

Ratepayer Advocate and Community-Based Organization Panel

California Public Advocates Office

Stephen Castello

BEEP Community Listening Sessions Findings

Hallazgos de las Sesiónes de Escucha Comunitaria de BEEP

CPUC Building Decarbonization Best Practices and Future Pathways Workshop

January 22, 2026

BUILDING ENERGY EQUITY & POWER

Background Antecedentes

- In-person and/or virtual sessions have been held in the San Joaquin Valley, San Francisco Bay Area, and Los Angeles. We also held one virtual “statewide” session that everyone was welcome to join.

- We have heard community members concerns around accessibility to energy programs, energy pollution inside & outside of homes, and the electrification impact on bills and affordability

- Se han llevado a cabo sesiones presenciales y/o virtuales en el Valle de San Joaquín, el Área de la Bahía de San Francisco y Los Ángeles. También llevamos una sesión “estatal” que todos estuvieron invitados a unirse.

- Hemos escuchado las inquietudes de los miembros de la comunidad en torno a la accesibilidad a los programas energéticos, la contaminación energética dentro y fuera de los hogares, y el impacto de la electrificación en las facturas y la asequibilidad.

CARB: Regulates **air quality** by setting plans for emissions reductions by the local Air Quality Management Districts (AQMDs).
CARB: Regula **la calidad del aire** estableciendo planes de reducción de emisiones por parte de las AQMD locales.

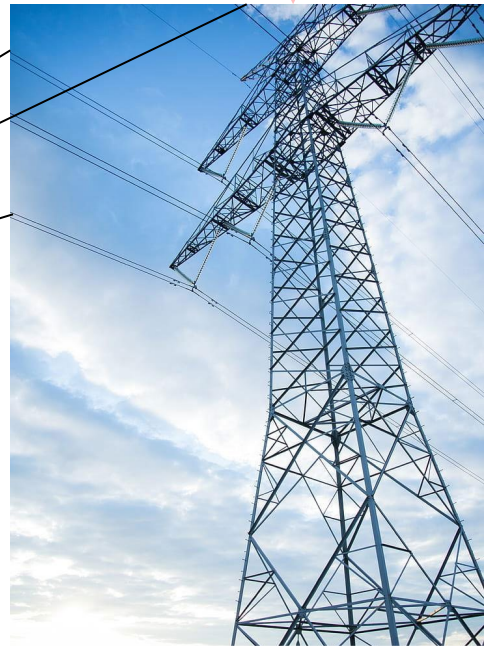
CPUC: Regulates **energy service** (via utilities & energy providers) provided to buildings, incl. costs, infrastructure, & externalities of the energy system. **CPUC:** Regula **el servicio energético** (a través de empresas de servicios públicos y proveedores de energía) prestado a los edificios, incluidos los costes, la infraestructura y las externalidades del sistema energético.

BEEP targets

- Indoor air quality & emissions reduction through the appliance standard rulemaking
- 'Whole' home retrofits through the Equitable Building Decarbonization Program to provide electric appliances & home upgrades.

BEEP se dirige a

- La calidad del aire interior y la reducción de emisiones a través de la normativa sobre electrodomésticos y
- La modernización integral de viviendas a través del Programa de Descarbonización Equitativa de Edificios para proporcionar electrodomésticos y mejoras domésticas.



CEC: Covers **energy system planning, building performance**, & budgets for programs and regulations like codes & standards.
CEC: cubre **la planificación de sistemas energéticos, el rendimiento de los edificios** y los presupuestos de programas y regulaciones como códigos y normas.

Concerns
Inquietudes

Energy Pollution Inside & Outside Homes	Contaminación Energética fuera de los hogares
Accessibility to Energy Programs	Accesibilidad a Programas
Electrification Impact on Bills & Affordability	Impacto de la electrificación facturas y la asequibilidad

Preliminary Solutions
Soluciones preliminares

Solutions for Energy Pollution Inside & Outside Homes (Cumulative Effects)

Soluciones para la contaminación energética dentro y fuera de los hogares (efectos acumulativos)

- Electrification and decommissioning gas systems when we can, especially when gas systems are right in front of community homes
- Address what powers, integration of other clean energy pieces
- Energy programs need to address asbestos, mold, other sources of toxic pollution

- **Electrificación y desmantelamiento de los sistemas de gas cuando sea posible, especialmente cuando estos se encuentren justo frente a las viviendas de la comunidad.**
- **Abordar las fuentes de energía y la integración de otras fuentes de energía limpia.**
- **Los programas energéticos deben hacer frente al amianto, el moho y otras fuentes de contaminación tóxica.**

Solutions for Accessibility to Energy Programs

Soluciones para la accesibilidad a los programas energéticos

- One-stop place for people to get information on decarbonization technologies. All this information is hard to understand for someone that's not in this space
- Funnelling existing rebate/incentives funding into an EBD type approach
- Clear points of contact for questions/issues pre and post installation
- Increasing quality/accountability of contractors
- Evaluation periods for energy programs to ensure goals are being met
- One/simple application form for multiple programs: unified applications
- Tenant protections: coordination at state level, enforcement, issue of tenants being informed
- Partnership with CBOs to help with outreach and support

- **Un lugar centralizado donde las personas pueden obtener información sobre tecnologías de descarbonización. Toda esta información es difícil de entender para alguien que no está familiarizado con este campo.**
- **Canalizar los fondos existentes para descuentos/incentivos hacia un enfoque de tipo EBD.**
- **Puntos de contacto precisos en caso de preguntas o problemas antes y después de la instalación.**
- **Aumentar la calidad y la responsabilidad de los contratistas.**
- **Períodos de evaluación de los programas energéticos para garantizar el cumplimiento de las metas.**
- **Un único formulario de solicitud sencillo para múltiples programas: solicitudes unificadas.**
- **Protección de los inquilinos: coordinación a nivel estatal, aplicación de la ley, asunto de la información a los inquilinos.**
- **Asociación con organizaciones comunitarias para ayudar con la divulgación y el apoyo.**

Solutions for Electrification Impact on Bills & Affordability Soluciones para el impacto de la electrificación en las facturas y la asequibilidad

- Holistic installation approach to entire home to reduce energy consumption and minimize impact on residents
- Neighborhood/zonal approach to maximize cost efficiencies, ensure grid capacity upgrades are happening
- Ensure folks are enrolled in CARE/FERA and Emergency resources for folks who are at risk of having power turned off

- **Enfoque de instalación integral en toda la vivienda para reducir el consumo energético y minimizar el impacto en los residentes.**
- **Enfoque por vecindarios/zonas para maximizar la rentabilidad y garantizar que se realicen las mejoras necesarias en la capacidad de la red eléctrica.**
- **Garantizar que las personas estén inscritas en CARE/FERA y en los recursos de emergencia para aquellas personas que corren el riesgo de que les suspendan el suministro eléctrico.**

Next Steps from Listening Sessions Próximos pasos tras las Sesiones de Escucha

A report on these sessions will be published early this year.

BEEP will continue to use your input to advocate for equitable building decarbonization across California!

Join our email list if you want to stay informed at beepcoalition.org

A principios de este año se publicará un informe sobre estas sesiones.

¡BEEP continuará aprovechando sus aportaciones para promover la descarbonización equitativa de los edificios en toda California!

Si desea mantenerse informado, suscríbase a nuestra lista de correo electrónico en beepcoalition.org

Thanks! Gracias!

Stay in touch! **¡Manténgase en contacto!**

info@beepcoalition.org
beepcoalition.org

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Investor-Owned Utility Panel

Building Decarbonization Best Practices & Future Pathways

January 22, 2026

Leah Catanzarite, Building Electrification and Efficiency Strategy, Principal

PG&E

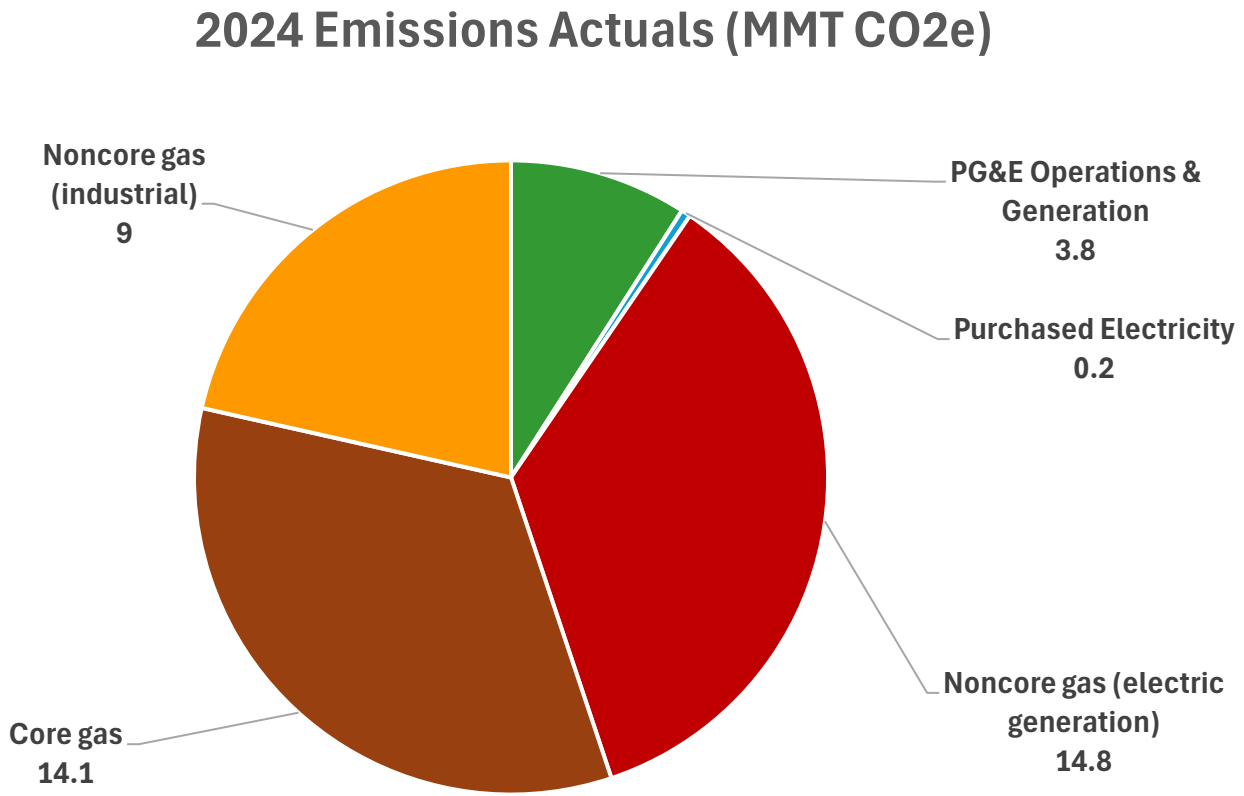
Purpose of Presentation

- Share PG&E's **mid- to long-term vision** for building decarbonization
- Summarize **lessons learned** gained from past and present building decarbonization initiatives and **best practices** to carry forward
- Highlight **future opportunities** to help unlock building decarbonization at scale

Building decarbonization at PG&E

Building decarbonization is a critical component of PG&E's decarbonization strategy

- PG&E has a goal to achieve a net zero energy system by 2040
- Core customer gas usage constituted ~35% of PG&E's scope 1-3 greenhouse gas emissions in 2024
- Appliance electrification and replacing natural gas delivery with clean fuels can reduce building emissions



Building electrification (BE) vision

Electrification & Decarbonization Vision Statement

We're creating an electrified California where customers choose efficient and decarbonized buildings.

2026

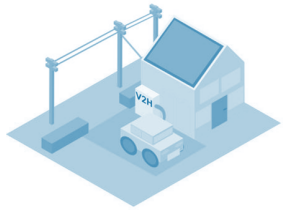
Immediate Actions
Simplify Customers' Electrification Journey

Design a building electrification experience that enables an **easy and timely transition** for customers

---

Focus on existing **pilots and programs where PG&E can drive near-term BE adoption**, test and learn rapidly, and generate insights to scale

2027-2030



Medium Term Plan
Adapting Based on Learning & Testing

Improve the **economics** of building electrification

Leverage learnings to **scale successes** and **continuously improve customer experience**

Collaborate with local partners & leverage data-driven tools to pursue **cost-effective zonal electrification** projects

2030+

Potential Future State
Scaling a Managed Transition

Electrification is **fast, easy, affordable, and accessible** to all customers

---

Electrification contributes to a **managed transition** of the gas system

---

Building electrification is **integrated into gas and electric planning** and **enabled by policy**

PG&E is the trusted BE energy advisor

Where we are today & lessons learned

Key PG&E BE Initiatives*

Closed | Active | Future

- San Joaquin Valley Pilots ($20M over 7 years)
- CSUMB Application ($17M proposed)
- Alternative Energy Program ($30M over 2 years)
- Electrify My Block ($6M over 3 years)
- SB 1221 Pilots (budget TBD)
- Empower My Home ($9M over 3 years)
- Energy Savings Assistance (ESA) BE-related Programs ($97M over 6 yrs)
- Santa Nella Mobile Home Electrification ($4M over 2 years)
- Powerful Neighborhoods ($6M over 3 years)

*this is a sample of PG&E's BE initiatives, not an exhaustive list

Lessons Learned

- Successful customer engagement varies greatly; there is no one-size-fits-all
- Customer acceptance barriers are diverse
- Remediation is expensive and common
- Every building is unique, making scaling a challenge
- Regulatory certainty and reliable cost-recovery mechanisms are crucial for effective program design

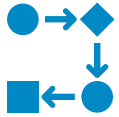
Supporting customers every step throughout the electrification journey

	Pre-Installation			Installation			Post-Install		
Customer Action	Awareness	Consideration	Decision	Load Evaluation	Service Upgrade	Panel/Appliance Upgrade	Rate Update	First Bill	Ongoing Experience
Vision	Choosing electric is simple, transparent, and affordable			Installation without unnecessary delays, confusion, or rework			Customers are satisfied with their electric appliances		
How PG&E intends to support customers	Support customers early with resources & tools to inform their decision			Deploying solutions to reduce costs & install time			Continuing to evolve electric rates to improve affordability		

Opportunities to scale building decarbonization

External funding pathways to address full cost of electrification

Innovative solutions for challenging electrification situations



Flexible long-term asset management framework

Coordinated statewide implementation framework

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead℠

Building Decarbonization Workshop

January 22, 2026
Presented by: Melodee Black

Current Efforts

SCE supports Building Electrification (BE) by:

1. Conducting and supporting pilots and programs that advance BE, including Energy Savings Assistance (ESA), ESA BE Pilot, TECH, Energy Efficiency (EE), and Clean Energy Optimization Pilot among others
   - Installed over **28,894 residential and 3,044 commercial heat pumps**
   - **Retrofitted 470 single-family homes** for income-qualified customers
2. Offering classes and workforce training
   - Discuss heat pump space and water heaters in related training courses offered at our Energy Education Centers
   - Offer a Contractor Demand Building Program that educates licensed contractors on the proper installation and benefits of heat pump water heaters
3. Collaborating on codes and standards
   - Provide BE and flexible demand technical assistance to regulatory agencies and interested jurisdictions
   - Developing the Building Inventory Geospatial database to characterize regional electrification and flexible demand potential and energy needs, providing inputs to CEC initiatives such as **Building Performance Standards** (BPS) and **Home Energy Rating and Labeling** for existing buildings

Lessons Learned & Opportunities

1. Durable incentive funding for BE is needed, but must be balanced with affordability
    - TECH program had 30+ start/stops across all categories (statewide), a significant pain point for customers and contractors
    - Opportunities
        - Leverage multiple funding sources and stacking incentives whenever possible
        - Consider opportunities to modify existing rules/requirements that make it challenging to offer BE measures within existing IOU Energy Efficiency programs

2. Coordination across utilities and programs can help increase alignment and avoid barriers
    - Barriers may include inconsistent requirements, such as requirements that contractors participate in training deemed appropriate by the program – instead of having a standardized training requirement
    - Opportunities
        - Collaborating across programs and with IOUs and relevant stakeholders on future program design and BE activities
        - Align training curricula
        - Streamline governance and simplify program and technical rules

Lessons Learned & Opportunities continued

3. Greater awareness is needed on the advantages and benefits of decarbonization
    - ESA BE Pilot found that consumers were initially apprehensive to participate due to perceived upfront and longer-term operating costs
    - TECH Solar campaign found that personalized outreach that reflects individual usage patterns enhances engagement
- Opportunities
    - Continue to use bill and rate analysis (and associated tools) to help customers make informed decisions
    - Support customer and contractor understanding how electrification impacts them (dispel myths)
    - Collaboration with multiple stakeholders can also help create awareness of benefits

Conclusion

There is a mix of short- and long-term opportunities for advancing BE:

Short Term

- Leverage multiple funding sources and stacking incentives whenever possible
- Continue to educate workforce/contractors on the installation and benefits of electrification
- Collaborate with multiple stakeholders on program development and awareness
- Coordinate with agencies and programs to advance BE codes to achieve decarbonization targets

Longer Term

- Addressing challenges that prevent existing programs from being used to advance BE
- Collaborating with IOUs and relevant stakeholders on future program design and BE activities
- Simplify program and technical rules
- Developing a framework that provides an expedited process for proposing BE programs (SB 1221, etc.)

Thank you.

For additional information contact, Melodee Black at Melodee.Black@sce.com

CPUC Building Decarbonization Best Practices and Future Pathways Workshop

Alton Kwok, Decarbonization & Resiliency Portfolio Manager

Current Landscape and Programs

Incentive Programs

Assistance Programs

Pricing Plans

Building Electrification Support

Challenges and Lessons Learned

- High Upfront Costs
- Process Complexity
- Electrical Capacity Limits
- Equity and Access Issues
- Limited Awareness or Understanding
- Contractor Capacity and Quality Variability
- Uncertainty About Bill Impacts

Opportunities and Vision

Customer Home Electrification Readiness Program (CHERP)

Electric Program Investment Charge (EPIC) Project:
Zonal Electrification with Distributed Energy Resources for Operational Flexibility project

Break – 15 Minutes

Gas Utility and Networked Geothermal Panel

GAS DECARBONIZATION AND NON-PIPELINE ALTERNATIVE DISCUSSION

Building Decarbonization Workshop

January 22, 2026

SDGE™ SoCalGas™

Economy-wide Decarbonization Requires Economy-wide Solutions

- The interconnectedness of our energy system requires careful planning on both the integrated gas and electric grids to optimize reliability and resiliency while facilitating an affordable transition to more renewable energy
- Meeting California's decarbonization goals will require a diverse set of tools and strategies
- A holistic combination of solutions is key to achieving a safe, reliable, resilient, and affordable energy transition

Non-Pipeline Alternatives (NPAs) May Offer a Nexus for Gas Utilities to Explore Zonal Decarbonization

Comparing gas investments against zonal decarbonization require a proper design to support long-term success

SAFE

- Safety is a leading driver for gas infrastructure investments and is the primary driver for proactive investments with the highest potential for NPA review.
- How can NPA review be designed to streamline project approvals and not negatively impact the timing of the investment?

RELIABLE

- As California's energy system is interconnected, it will be crucial to understand direct and indirect impacts to customers and to both the integrated gas and electric grids.
- What controls are needed to ensure viable and cost-effective NPAs can be pursued while maintaining a reliable and resilient energy system capable of serving all Californians?

AFFORDABLE

- The program should be designed to prioritize affordability including to identify the most cost-effective opportunities, while supporting potential co-benefits, like decarbonization.
- How can the NPA funding be designed to protect ratepayers and energy affordability for all customers?

SoCalGas™

SDGE™

Tapping the Thermal Energy Opportunity

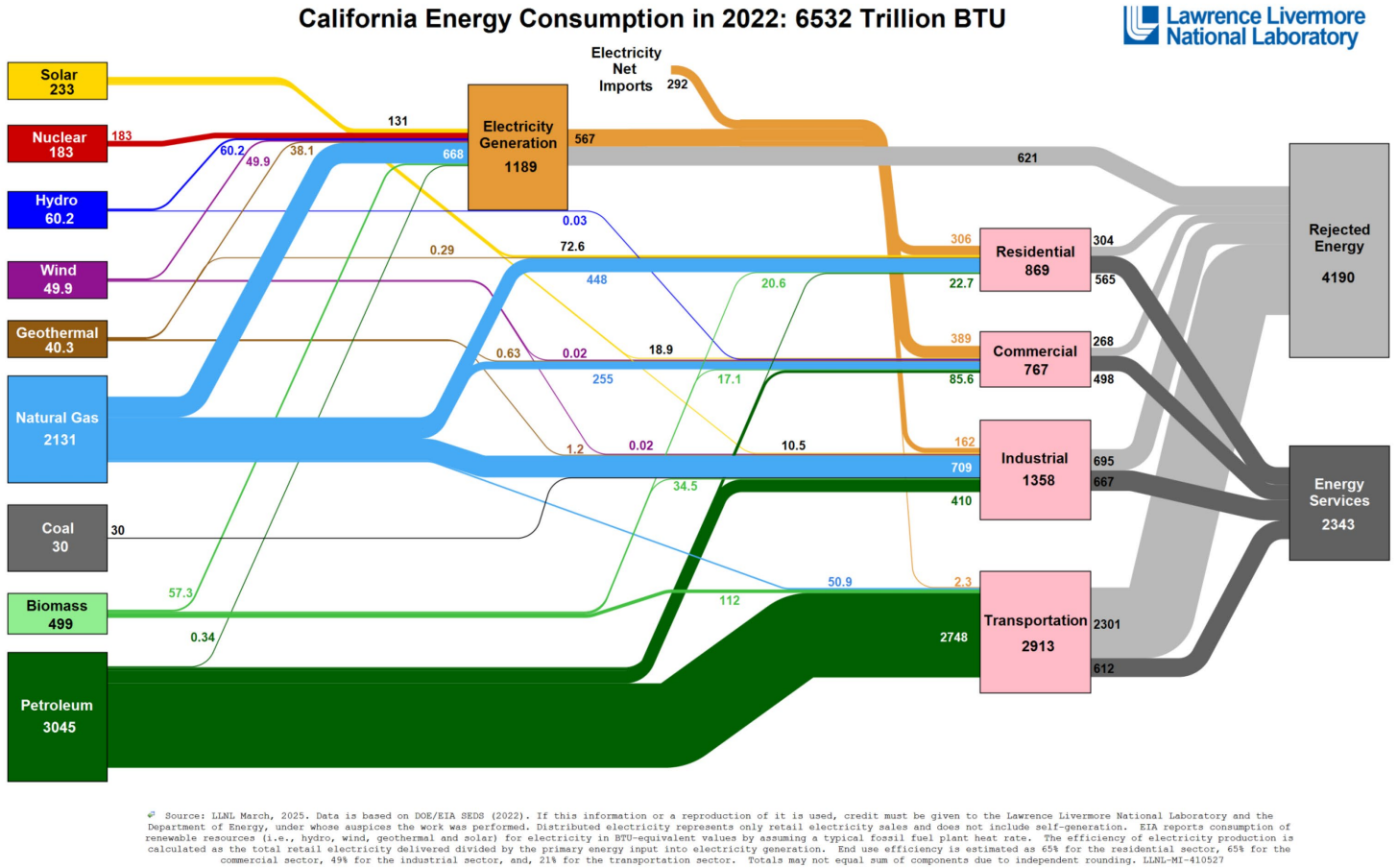
Zeyneb Magavi, CPUC Workshop, 01/21/2026

WHAT IS ANTHROTHERMAL ?

All the thermal energy resulting from human activity including:

1. The waste thermal of our energy system, buildings, sewage, and industrial processes (yes, data centers too!)

2. The excess thermal energy absorbed by the earth – which annually exceeds all energy humanity uses

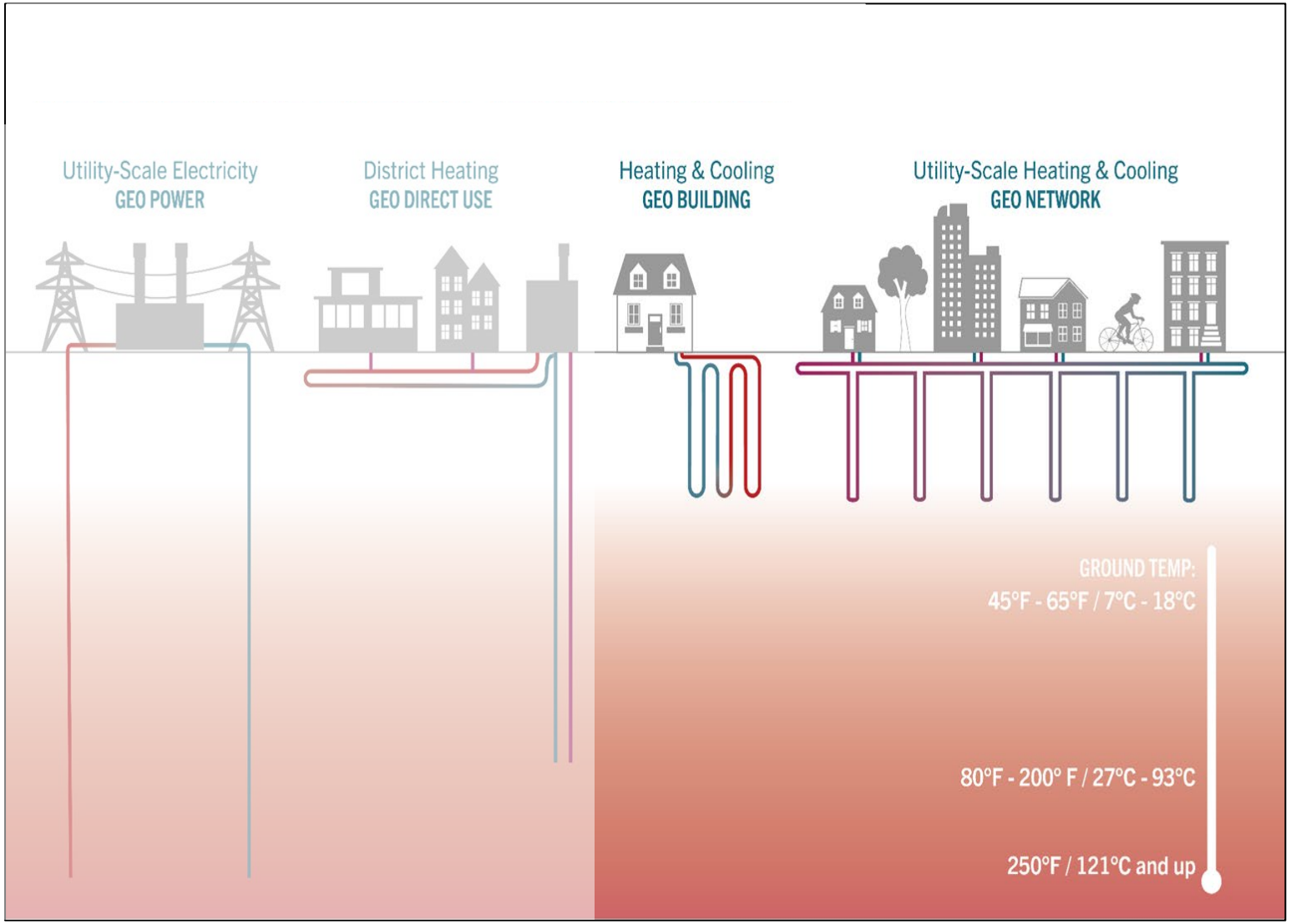


WHAT IS GEOTHERMAL ?

All the natural thermal energy at or below the surface of the earth.

Geothermal Technologies use this STABLE ‘rock-solid’ non-intermittent Geothermal Energy.

Ambient (a.k.a. shallow) geothermal energy is everywhere and technologies that tap it can provide heating and cooling nearly anywhere on earth with zero emissions.

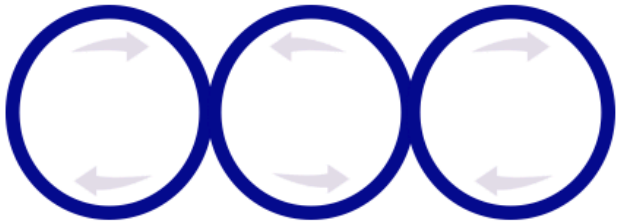


WHAT IS A THERMAL ENERGY NETWORK ?

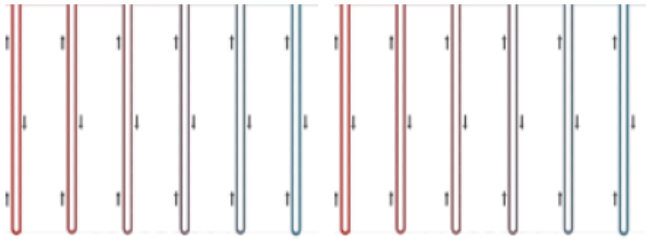
An evolution of district energy that taps ambient thermal and moves it between buildings in pipes filled with water. Every component of a Thermal Energy Network contributes efficiencies. Together they are the most efficient heating and cooling.

Each component is OLD TECH. Together they are NEW TECH.

BUILDINGS:
(GEOTHERMAL HVAC)



DISTRIBUTION:
(THERMAL ENERGY NETWORK)



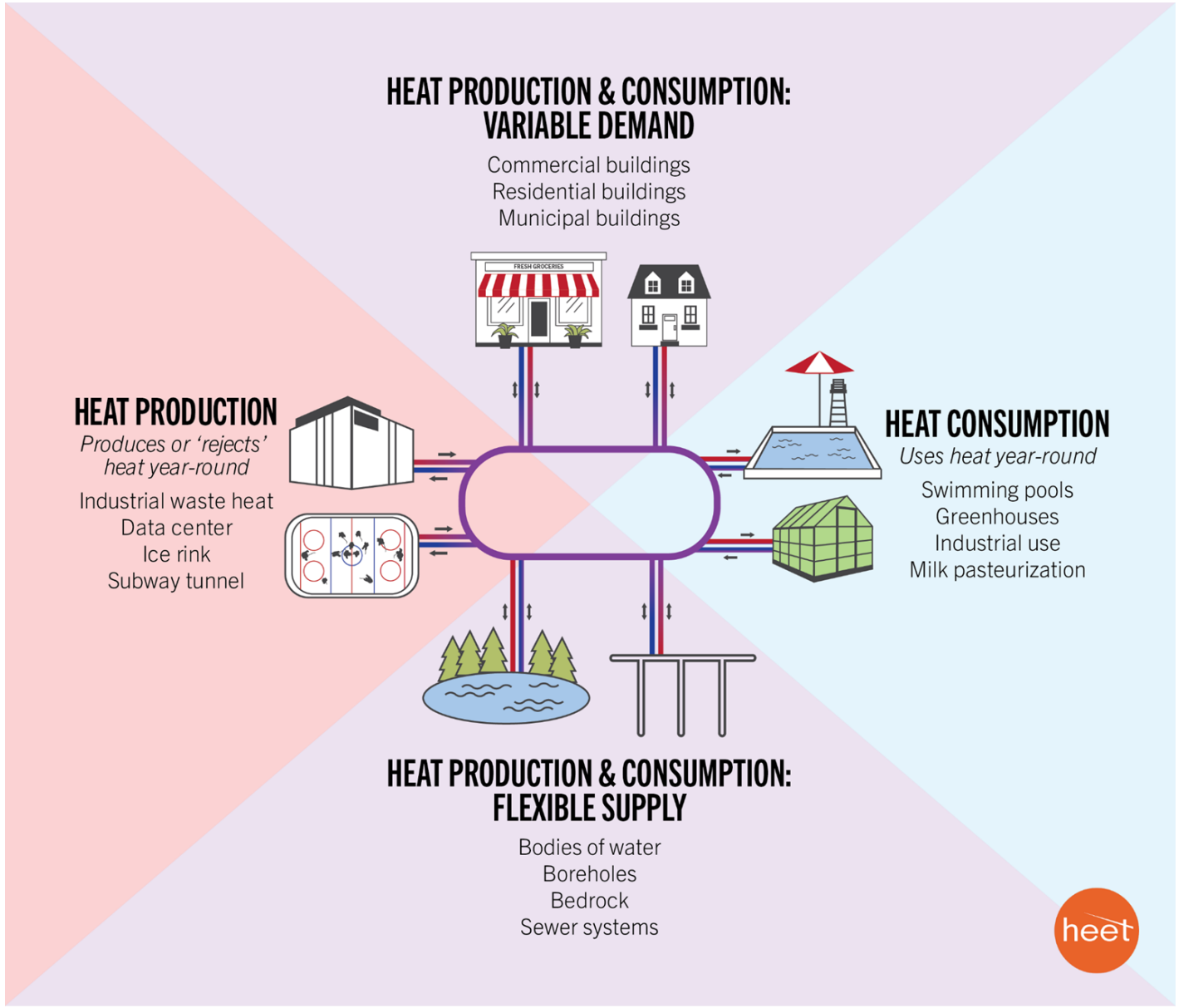
THERMAL RESOURCES:
(GEOTHERMAL BOREHOLES)

Also . . .
WASTEWATER EXCHANGE
INDUSTRIAL WASTE HEAT
LAKES, RIVERS, PONDS
OTHER THERMAL . . .

WHAT IS A THERMAL ENERGY RESOURCE ?

A thermal utility is responsible for optimizing the interconnection of thermal resources to thermal demands across space and time.

It should prioritize closest, least cost thermal resources. The defining parameters are illustrated in four quadrants. The flexible supply quadrant is the MOST valuable resource.



heet

WHAT IS A THERMAL UTILITY?

This technology is a natural monopoly, making it a ‘utility’ whether owned by investors, by municipalities, or others. By investing in street-scale thermal energy infrastructure (TENs) and interconnecting them over time to increase efficiency any allowed entity can grow a regional thermal utility.

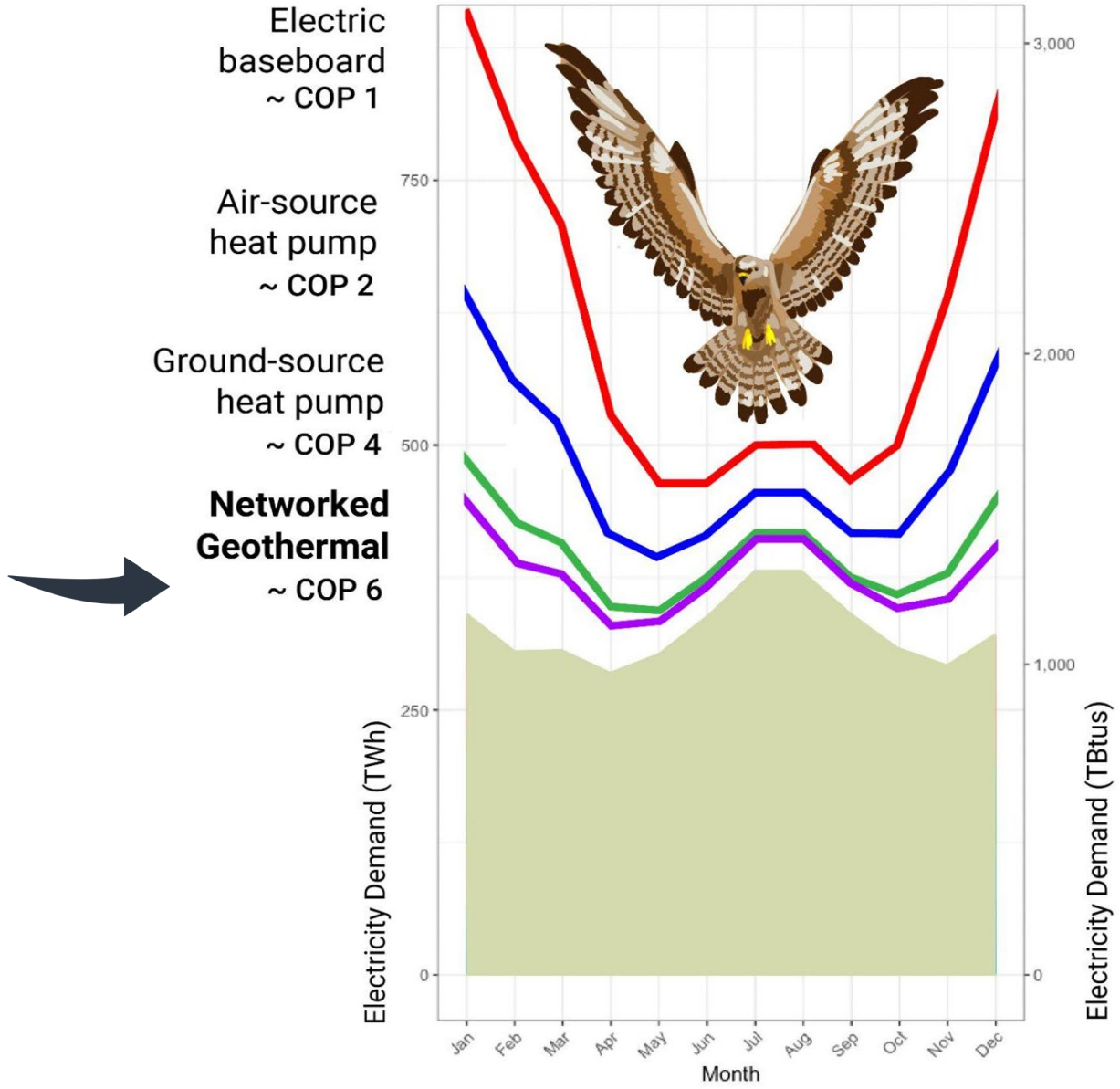
This creates a thermal market, transforming the ambient thermal energy all around us, including waste, into assets or thermal resources.

WHY BOTHER WITH A THERMAL UTILITY?

- ☑ High Safety & Security
- ☑ 100% Combustion-Free
- ☑ Reliable & Resilient
- ☑ Scalable & Adaptable
- ☑ Workforce Transition
- ☑ Ethical Access
- ☑ Affordable for consumer
- ☑ Economic for utility
- ☑ Speed & Scale needed
- ☑ Benefits Electric Grid

GRID BENEFITS

The Falcon Curve illustrates why higher efficiency technologies with flatter annual load profiles save money on the electric grid. A 2024 Oak Ridge National Lab analysis calculated a $1.6 Trillion (NPV) electric grid benefit by 2050 in an ‘all electrification’ scenario with geothermal heating and cooling as compared to air-source heat pumps..

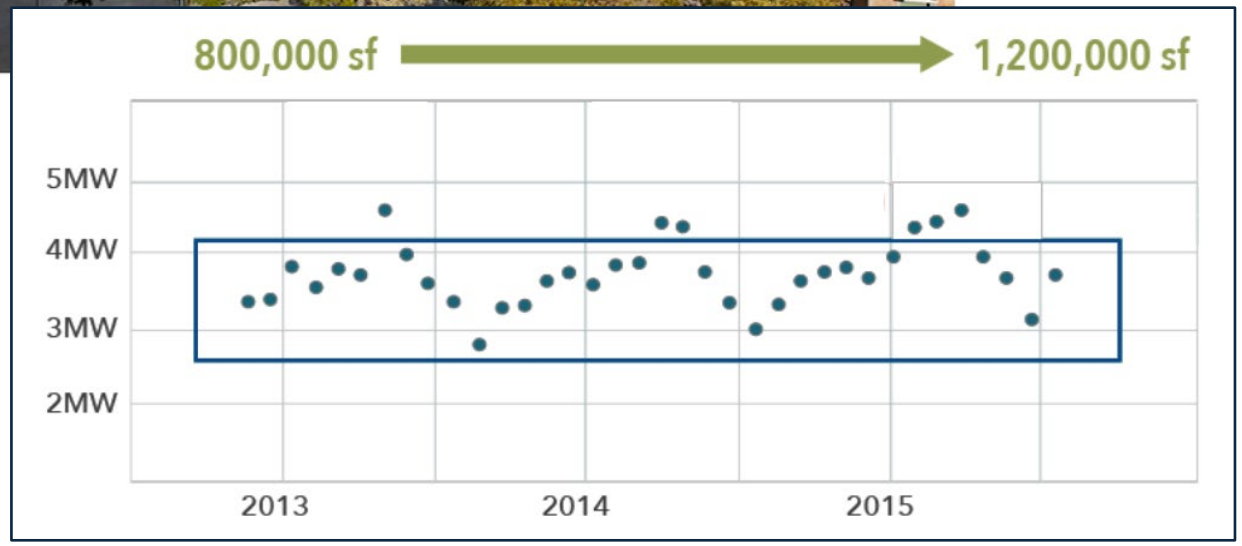


Buonocore, J. J., Salimifard, P., Magavi, Z., & Allen, J. G. (2022). Inefficient Building Electrification Will Require Massive Buildout of Renewable Energy and Seasonal Energy Storage. *Scientific Reports*, *12*(1), 11931–11931. https://doi.org/10.1038/s41598-022-15628-2

COLORADO MESA PROJECT

The oldest and largest operating single-pipe ambient-temperature geothermal network, this campus system is now in it's sixth phase of expansion since 2008. Growth increased efficiency, decreased costs, all while grid load remained flat.

Initial Cost/ton: $7,400
Additional Cost/ton: $3,284



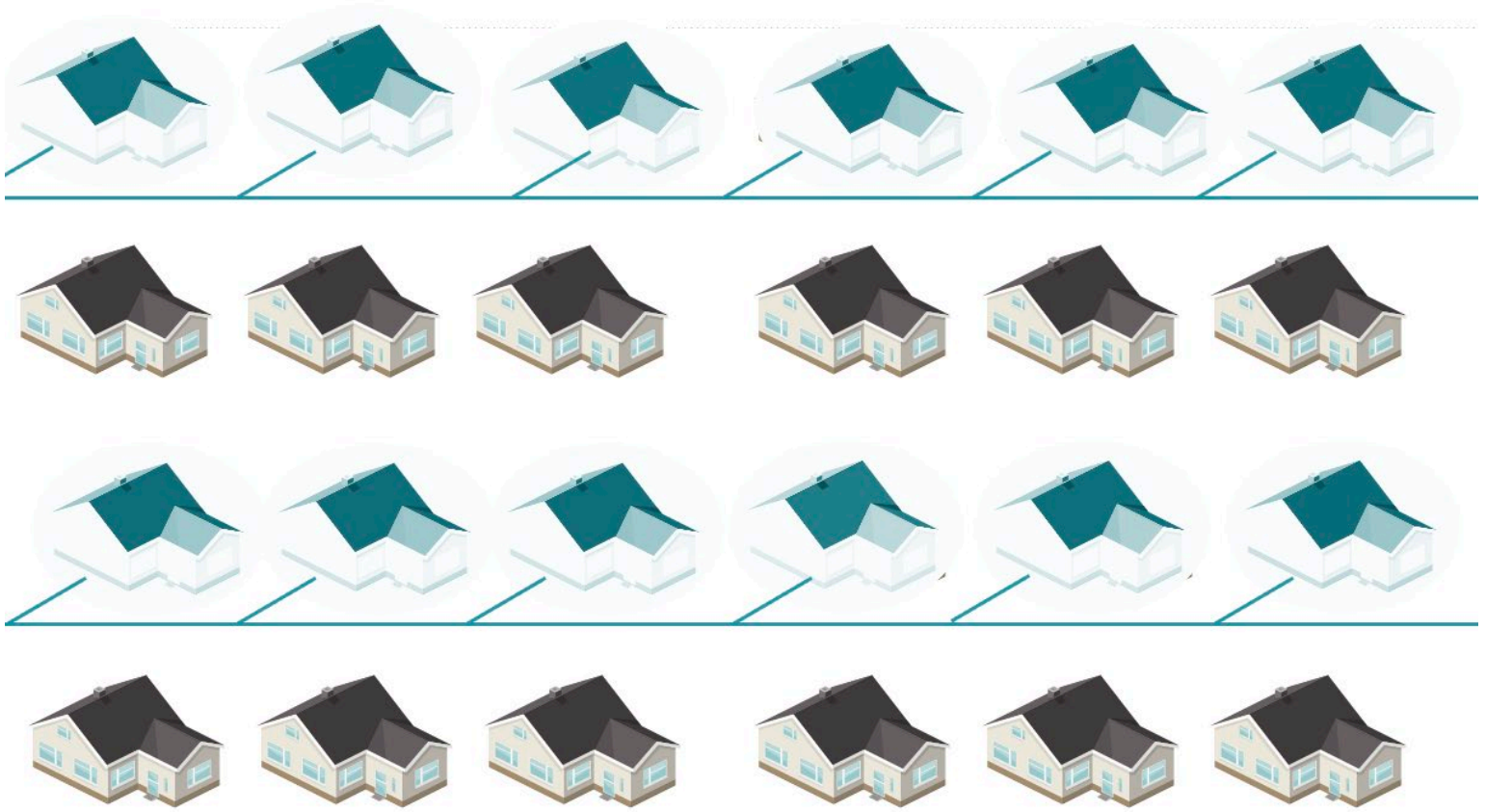
WORKFORCE

Gas utility workforces can transition to marketing and installing geothermal networks with less than a day of training. Water well and geotechnical drillers need a few weeks. One union leader described thermal networks as the first viable workforce transition pathway they had encountered in the decarbonization space. Unions have supported this tech across the country.

GAS TO GEO

The upgrade of a branch of the gas system to geo is similar to the upgrade from coal gas to natural gas – it increases safety, reliability and affordability. A path to zonal building modernization.

This evolutionary business model strategy also allows for the stabilization of the gas ratepayer base and planned or managed system-wide upgrades that include all.

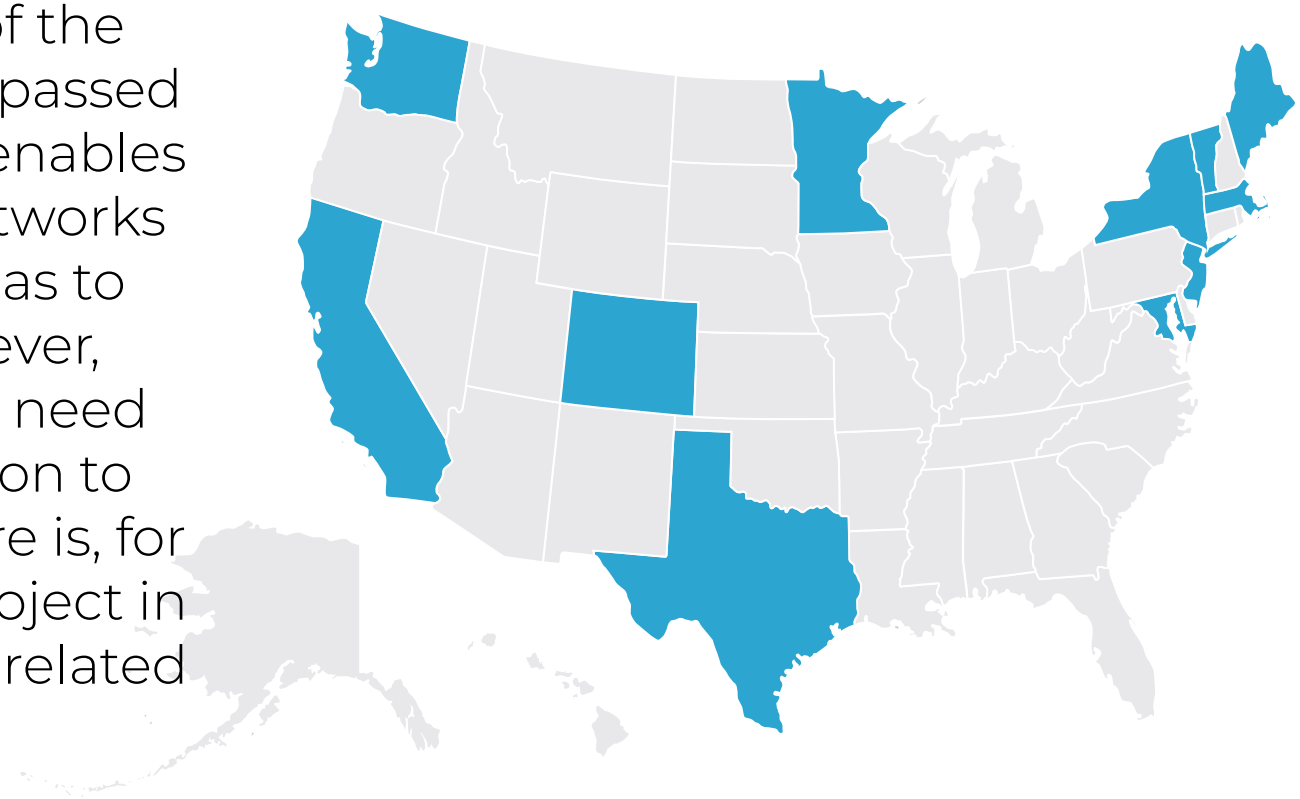


GAS UTILITY INTEREST

This is a late 2025 snapshot of the gas utilities participating in the Utility Networked Geothermal Collaborative. There are two regional subgroups that meet regularly as well. Purpose varies by region from expanding customer base under gas capacity constraints to expanding business model to cooling to addressing legislative or regulatory electrification requirements.

POLICY PATHWAY: LEGISLATION

This is a snapshot of the thirteen state laws passed by late 2025. Each enables thermal energy networks or specifically the gas to geo pathway. However, some states do not need legislative permission to move forward. There is, for example a great project in Oklahoma with no related policy changes.



MA - 2021, 2022, 2024, **2025**

MN - 2021, 2024, **2025**

NY - 2022, **2025**

CO - 2023, 2024

WA - 2024, 2025

MD - 2024

VT - 2024

CA - 2024

NJ - 2024 (study)

ME - 2025 (study)

TX - 2025

POLICY PATHWAY: REGULATION

A NY Commissioner described this as the first new utility in 100 Years. The technology is proven but there is no proven regulatory framework to ensure cost and service optimization. As Massachusetts moves from Demonstration to Development they have written a geo pipeline safety ruling and are now considering the first geothermal ratecase:

Eversource / NSTAR Gas Proposed Geothermal Tariff Analysis (MA D.P.U. 25-86)

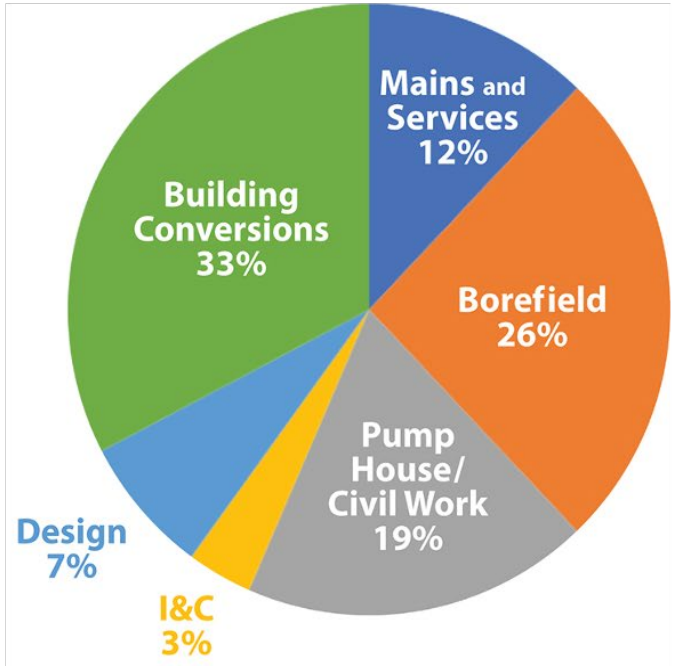
FRAMINGHAM PROJECT

Eversource Gas installed a geothermal network connecting 140 residential and commercial customers to a one mile loop of pipe in the street. It has successfully met the coldest and hottest days since commissioning at the end of 2024, using only 90 boreholes for 375 tons of load.

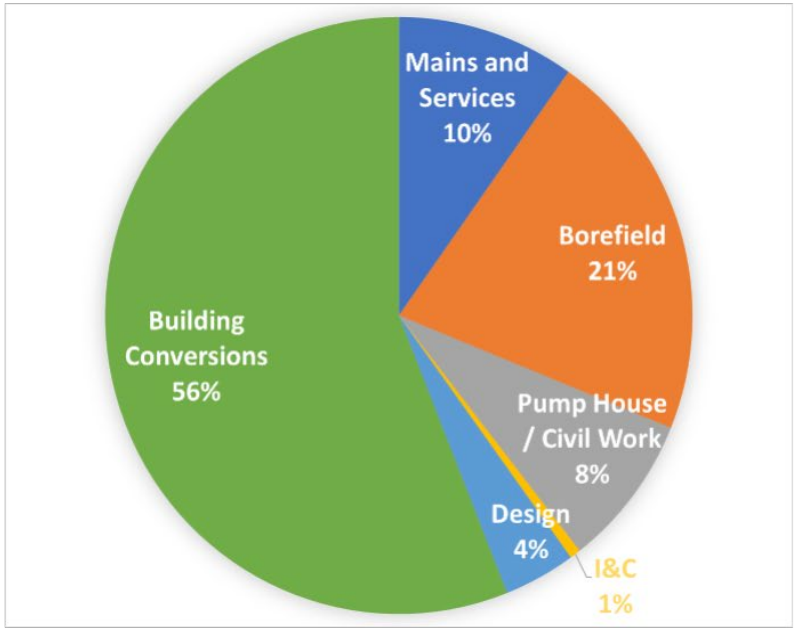
FRAMINGHAM EXPANSION PROJECT

HEET, with Eversource Gas and partners, was awarded $8.5 million for an expansion project, demonstrating utility growth by interconnecting the two ‘loops’ to increase efficiency. The system cost dropped 40% despite a 120% increase. The loop and borefield went from $12M to $6M. Fewer boreholes, more load!

Initial Project Cost Breakdown



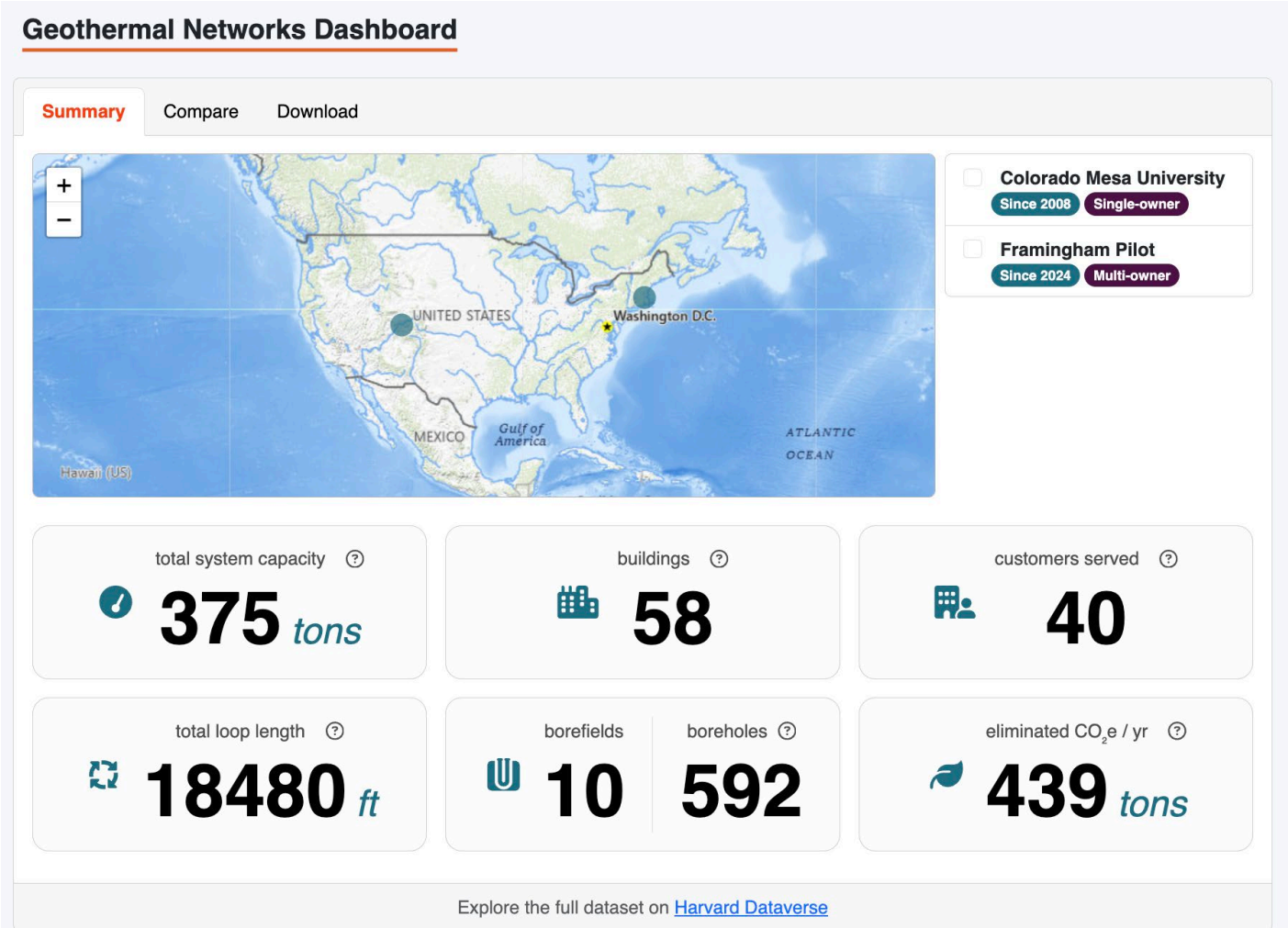
Expansion Cost Breakdown



DATA? DATABANK!

Consistent and comparable data across every project is necessary to maximize the cost margin between geo and alternatives, to optimize deployment and scale, and to ensure prudent and fair regulation and ratemaking.

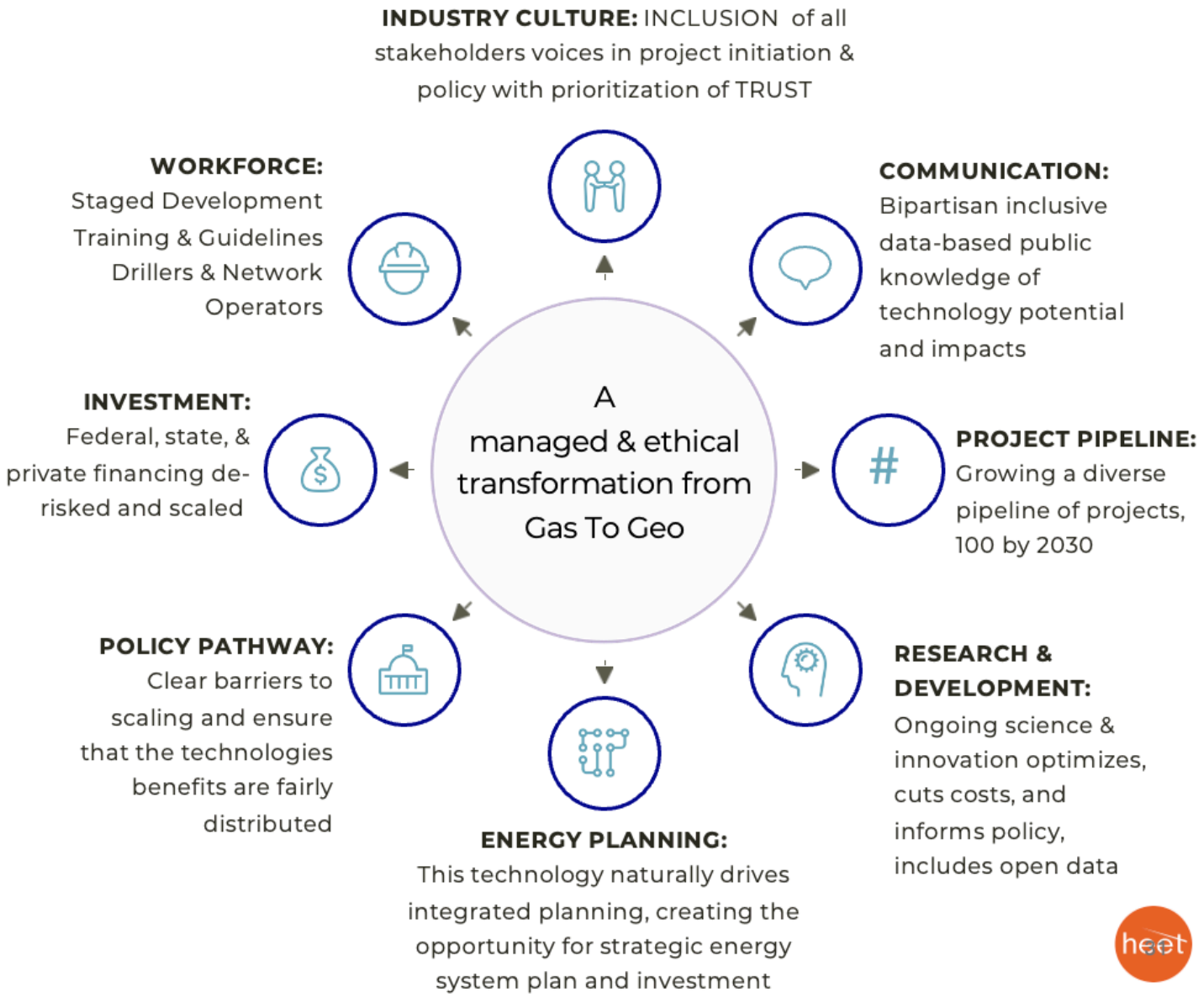
Massachusetts funded HEET's LeGUp Research Consortium which recently launched a national Databank hosted on Harvard's Dataverse. Other states have begun to require submission.



SCALING ?

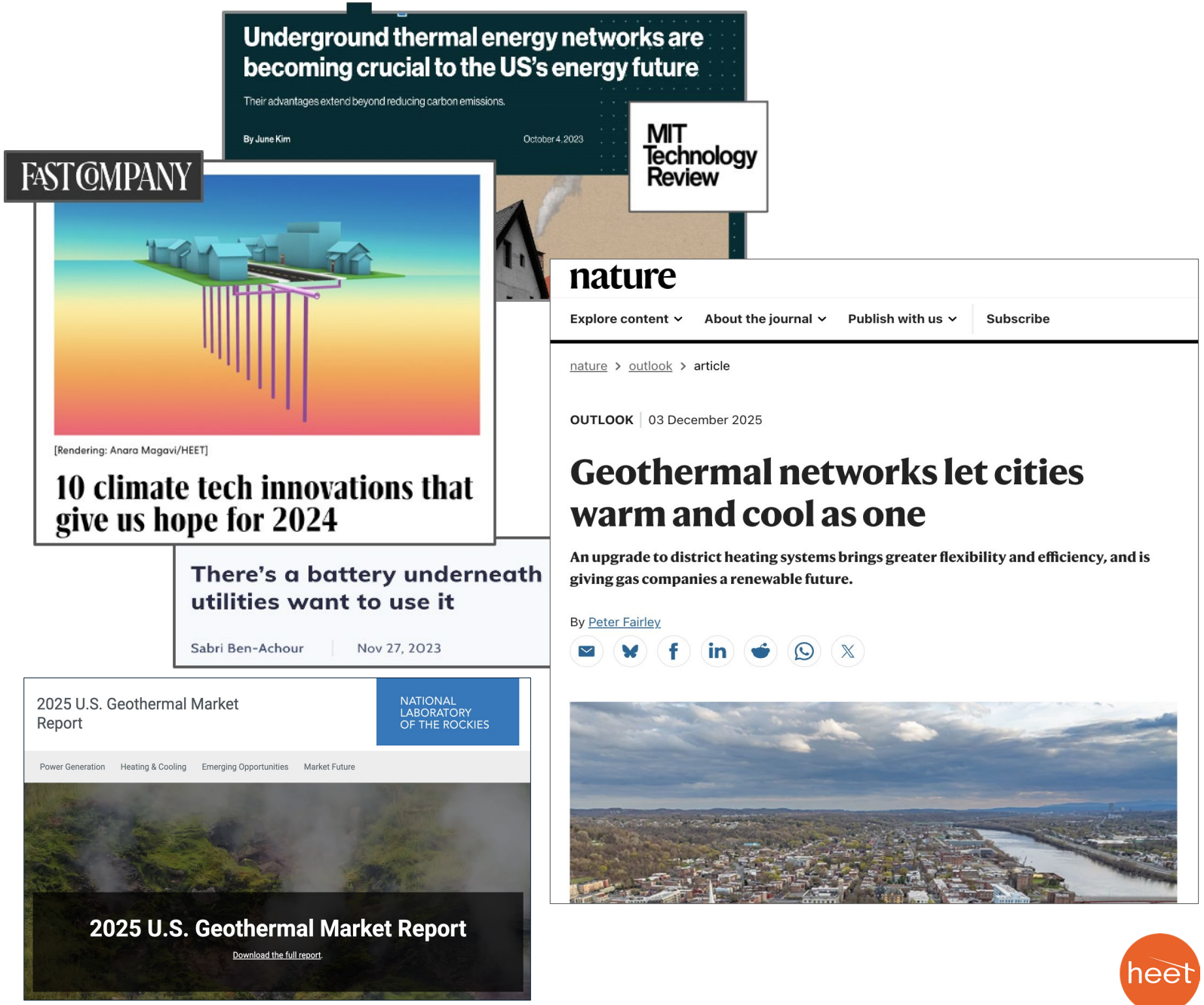
Scaling requires coordinated effort across multiple sectors.

To provide some sense of scale, very roughly, based on the #s from the Merrimack Valley Gas Collapse, it would take 377K workers to replace all 2 million miles of gas pipe in the U.S. with geo pipe by 2050. Which decarbonizes approximately 40% of U.S. energy use.



THERMAL MOMENTUM

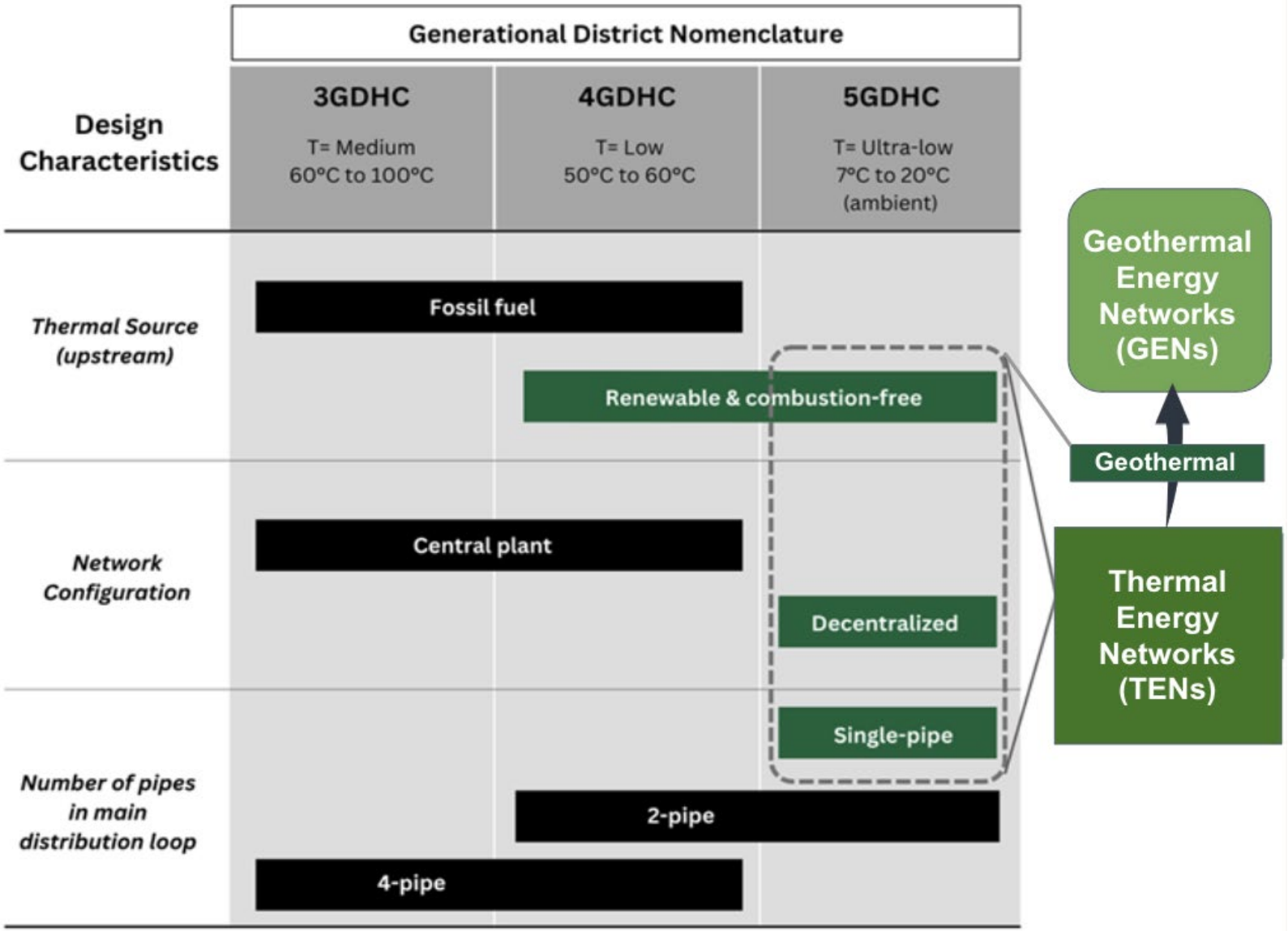
The social feasibility, technical feasibility, together with the possibility of delivering affordable modern thermal at costs lower than gas are all driving a thermal revolution with growing interest globally. The World Bank Group has launched a program for 10,000 building scale geothermal networks for in the Middle East and Central Asia.



#ThinkThermalTogether

APPENDIX SLIDES

UA National support for electrification by thermal networks, check out the great video



CLARIFYING NOMENCLATURE BETWEEN DISTRICT ENERGY & TENS!

Geothermal Energy Networks (GENs)

are a subset of

Thermal Energy Networks (TENs)

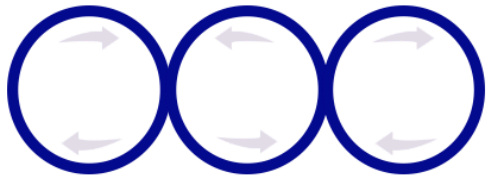
which are a subset of

5G Districts.

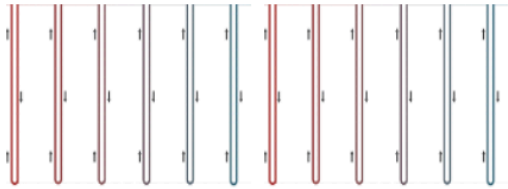
CLARIFYING COST COMPARISONS:

These components are essential to understand costs and benefits and how to compare apples to apples as we make infrastructure investment decisions.

BUILDINGS:
(GEOTHERMAL HVAC)



DISTRIBUTION:
(THERMAL ENERGY NETWORK)



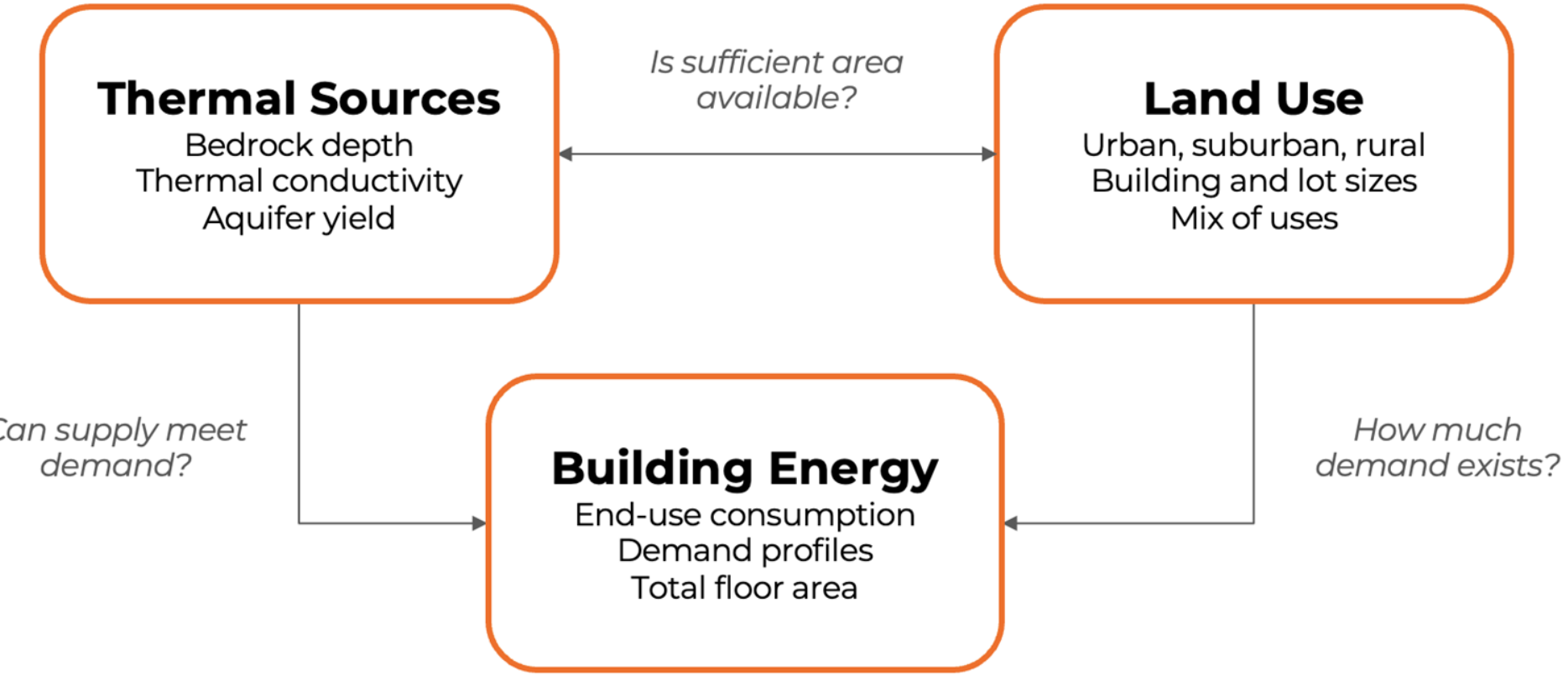
THERMAL RESOURCES:
(GEOTHERMAL BOREHOLES)

Also . . .
WASTEWATER EXCHANGE
INDUSTRIAL WASTE HEAT
LAKES, RIVERS, PONDS
OTHER THERMAL . . .

BUILDING INVESTMENT

UTILITY INVESTMENT

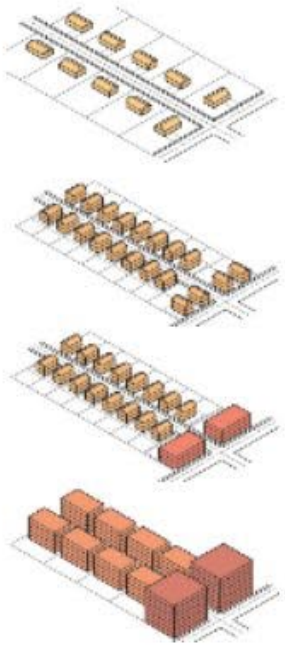
SYSTEM INVESTMENT

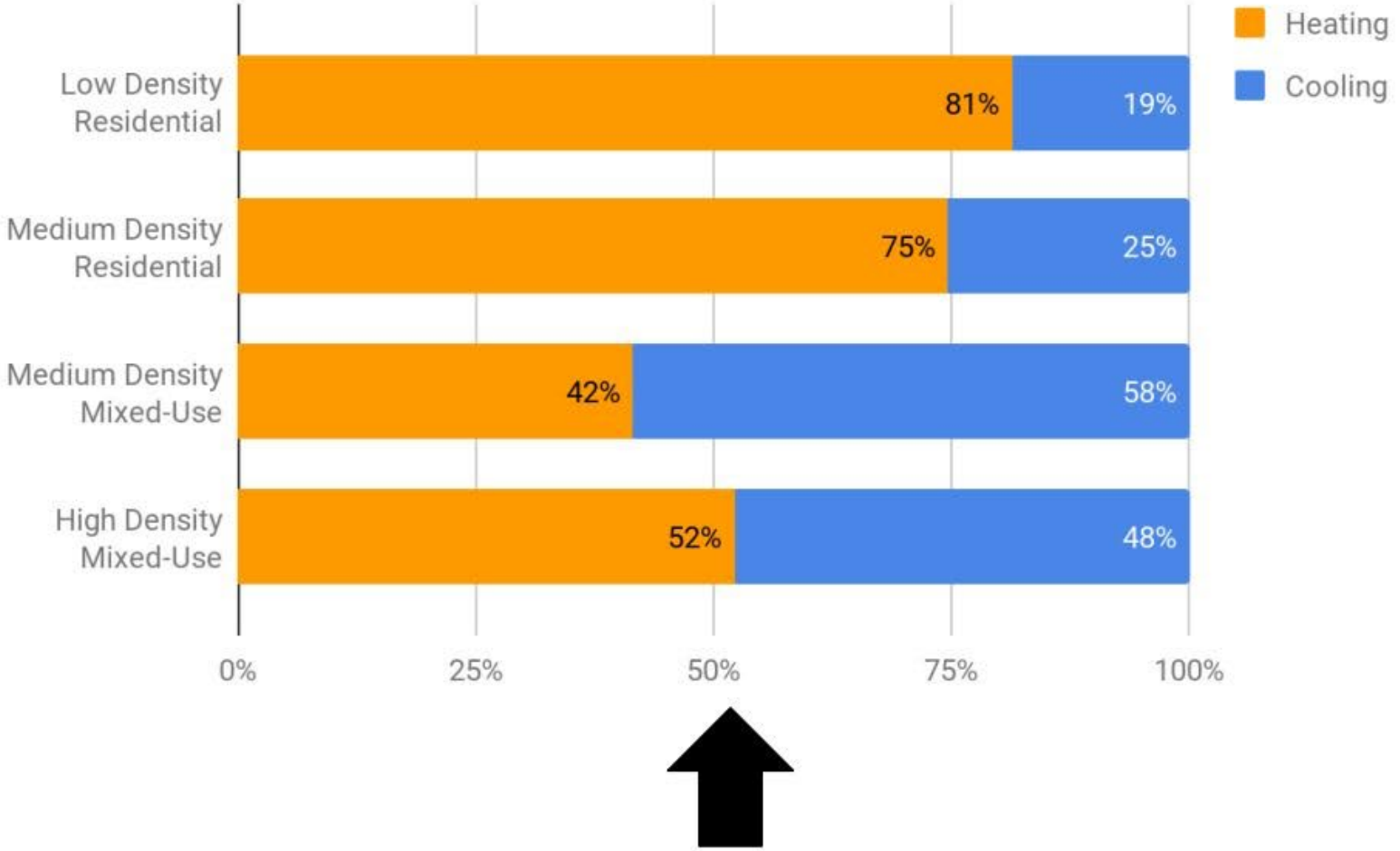


This is an Engineered Solution not a product.

So the first step is a location-specific feasibility study

Like the one BuroHappold Engineering did for Massachusetts



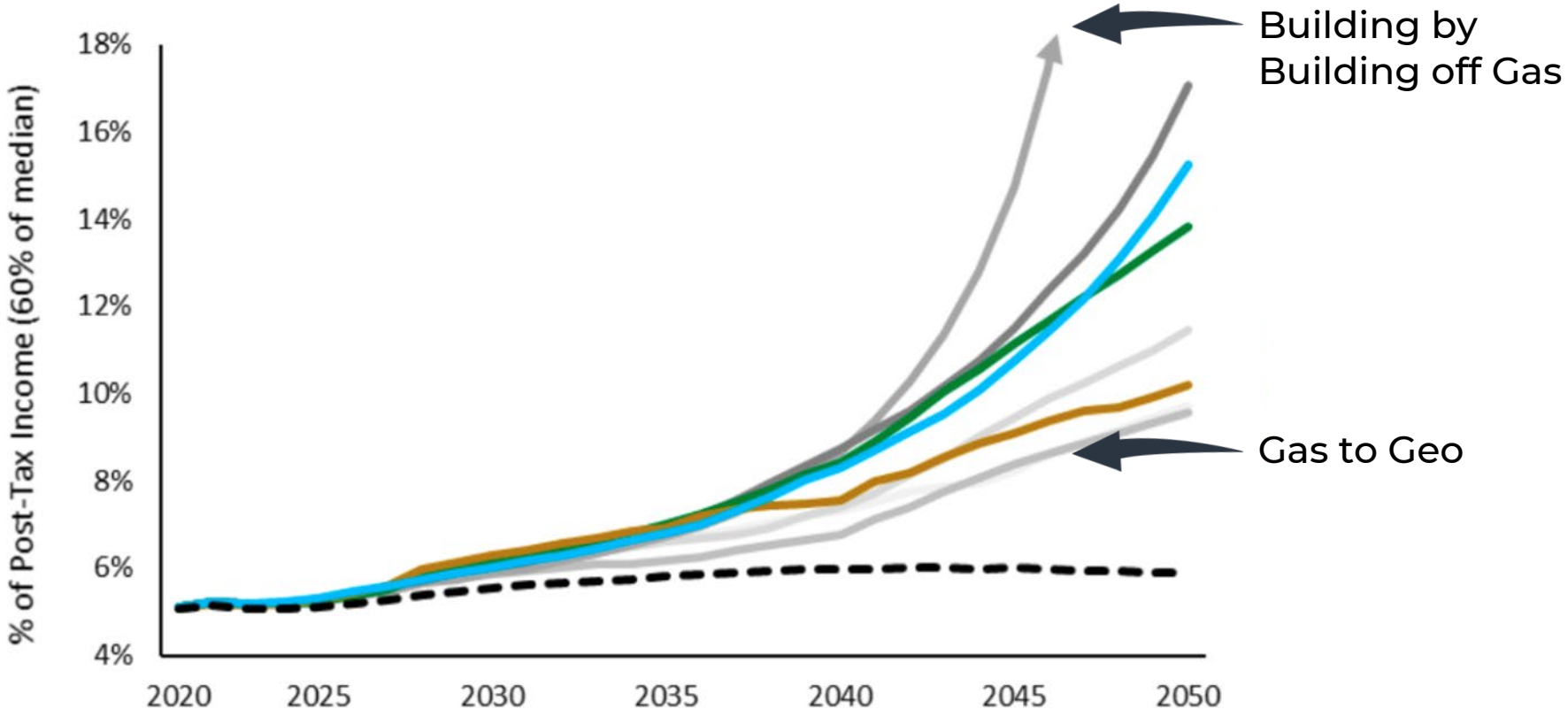


Technical Feasibility: Largest opportunity is in areas with annually balanced load

BUROHAPPOLD ENGINEERING heet

A Gas to Geo pathway can minimize energy burden for the low-income

Future Energy Burden for Low-Income Customers

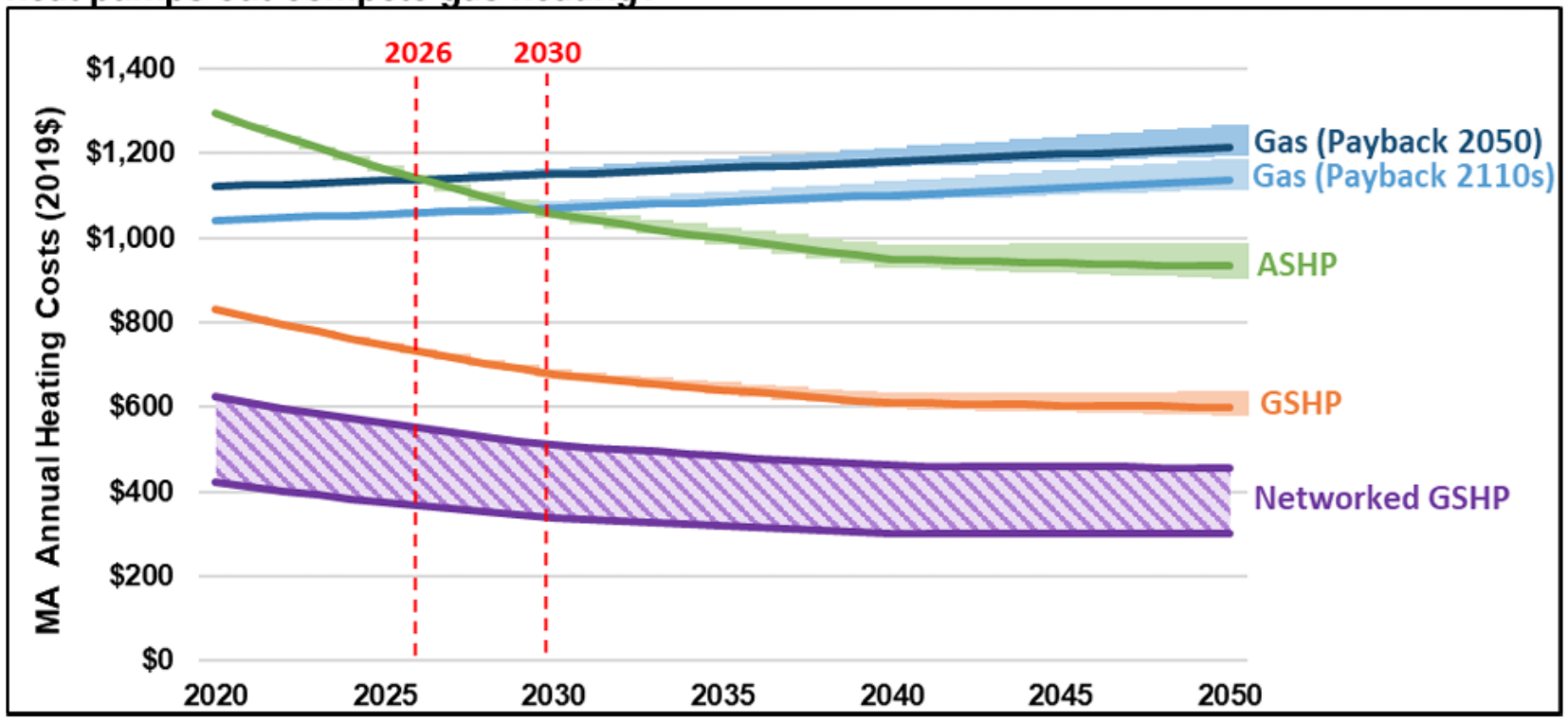


Source: E3, Report for Massachusetts Gas Utilities, 2022

An out of date Massachusetts Energy Bill Projection

Gas vs. Networked Geothermal

Figure ES-1. Inflection points for an average-sized Massachusetts home: When do electric heat pumps out-compete gas heating?



Castigliego, J., Alisalad, S., Stanton & E. (2021). When heating with gas costs more. Applied Economics Clinic. https://aeclinic.org/publicationpages/2021/01/13/inflection-point-when-heating-with-gas-costs-more

Cumulative U.S. savings > $1 Trillion

CO_2E SAVED
7.34 MMTs

Fewer Transmission lines
38% reduction

Less Generation Needed
13% reduction

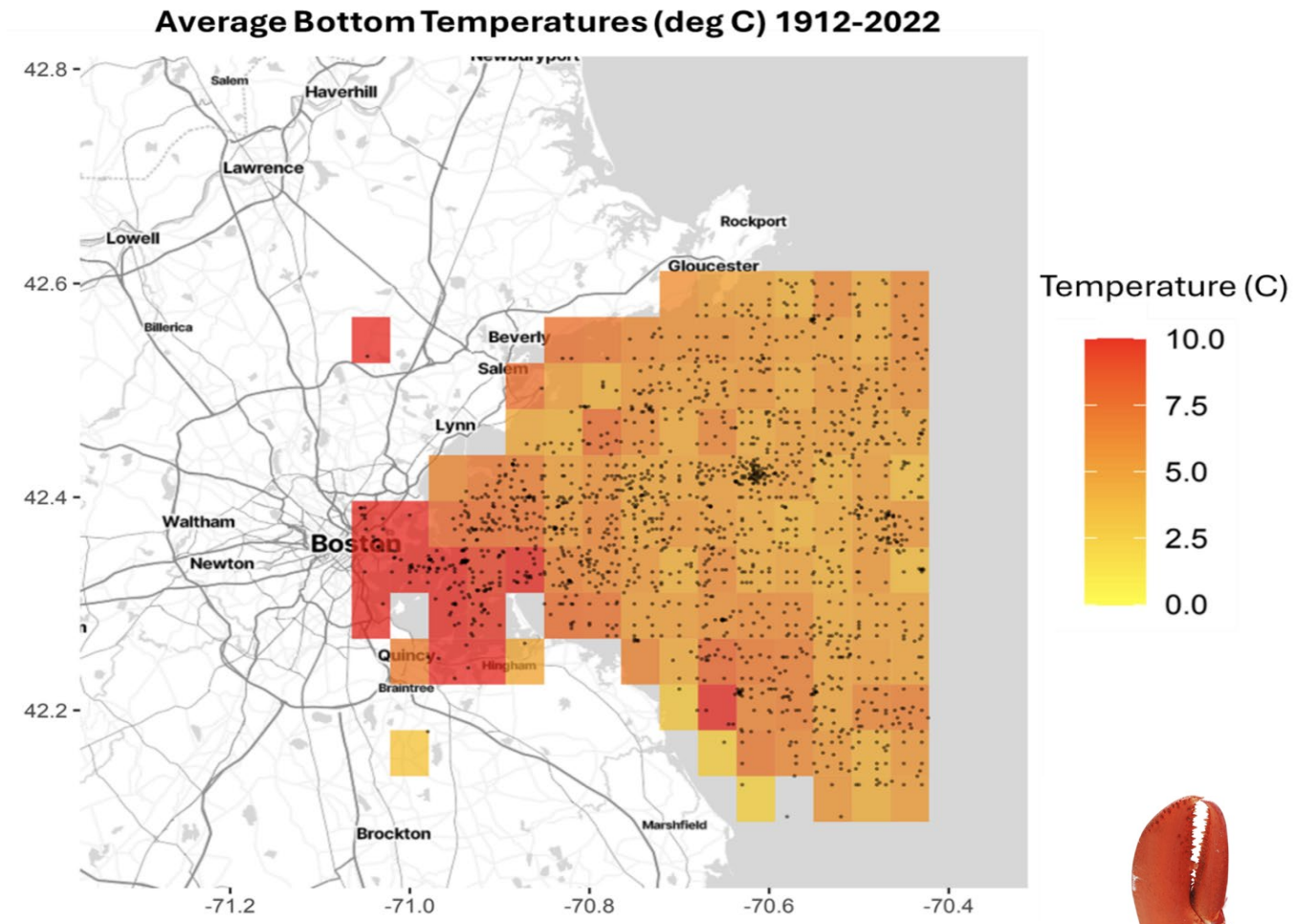
Fuel Cost Savings
$19 Billion/year

Cheaper Whole Sale Electricity
12% reduction

Liu, X., Ho, J., Winick, J., Porse, S., Lian, J., Wang, X., ... Liu, W., ... Malhotra, M., Li, Y., ... & Anand, J., ... Grid Cost and Total Emissions Reductions Through Mass Deployment of Geothermal Heat Pumps for Building Heating and Cooling Electrification in the United States. United States. https://doi.org/10.2172/2224191

Recent DOE study on GRID IMPACT of Geothermal Heat Pump 'Mass' Deployment

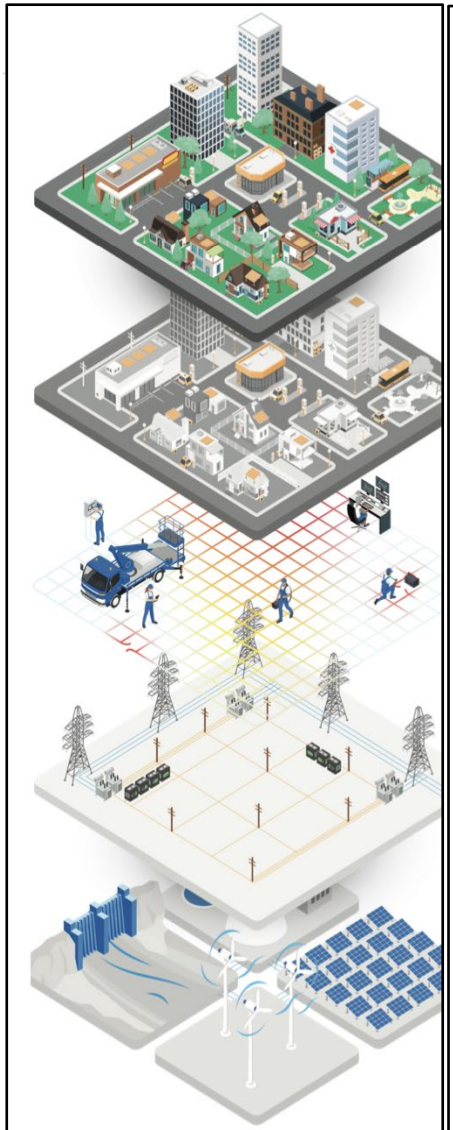
heet



According to NOAA data, Boston Harbor is 3.4 degrees Celsius warmer than in 1912.

That is enough heat in the ‘Thermal Commons’ for over 1 Million homes annually.

It might even make lobsters think Boston is cool again.



Tactical Thermal Transition planning requires:

1. **Transparent Values:**
   Cost Distribution
   Benefit Distribution
   Equity of Access
   Environmental Justice
   Generational Justice

2. **Data Layers:**
   Gas data
   Electric data
   Thermal Data
   Building Data
   Social Data

3. **System Interactions**

4. **Integrated Interface to explore values & data driven evolution paths**

System-scale planning process needed:

Tactical Thermal Transition Tool Needed

Open Forum

Next Steps (Post-Workshop)

- Workshop Report *(approximately late February to early March)*
- Stakeholder Feedback on Workshop Report *(2-week comment period)*
- CPUC develops a Proposed Decision
- Party comments and reply comments on Proposed Decision
- Best Practices and Future Pathways Final Decision *(Q3 2026)*

Closing Remarks

Resources:

- **CPUC Building Decarbonization webpage:** https://www.cpuc.ca.gov/about-cpuc/divisions/energy-division/building-decarbonization
- **CPUC Building Decarbonization proceeding:** https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:R1901011

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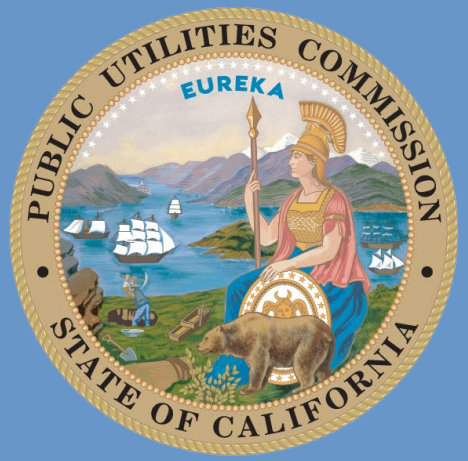

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