



Zero-Emission Space and Water Heater Standards

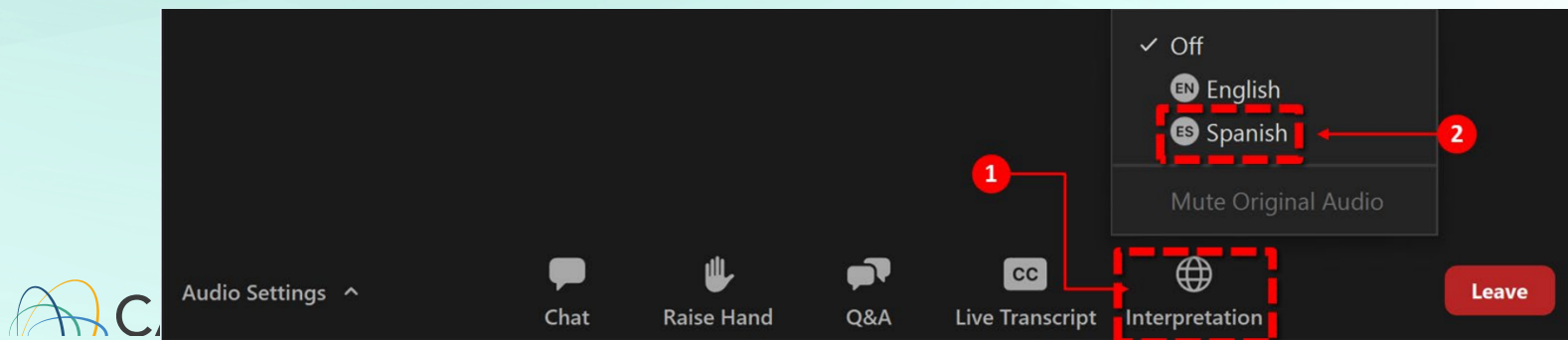
Public Workshop

February 28, 2024

9:00 a.m. – 12:00 p.m.

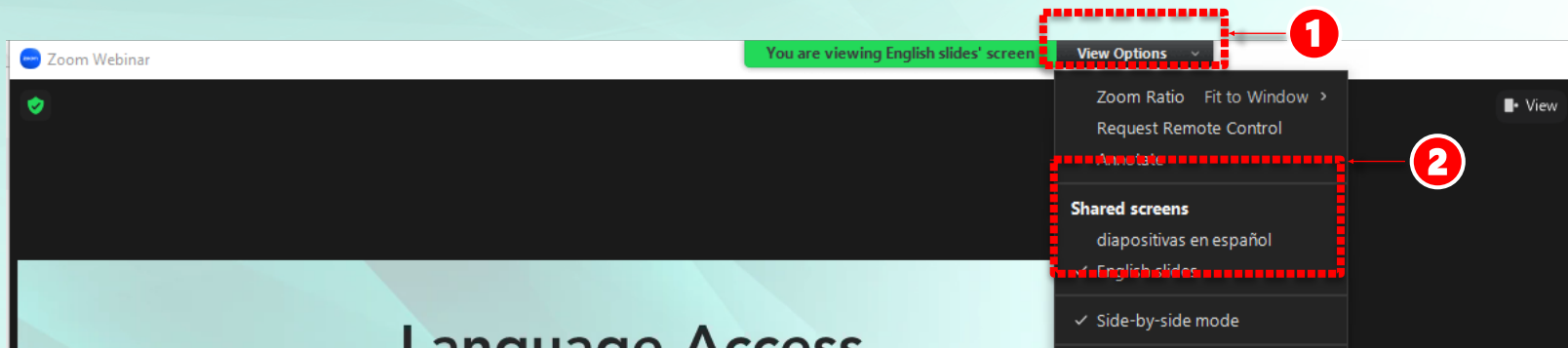
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1) Today's Agenda

1) Introduction

- 2) Public Engagement
- 3) Current Regulatory Concepts
- 4) Key Questions Guiding Staff Work
- 5) Public Comments
- 6) Next Steps

Motivation

Why do we need zero-emission space and water heater standards?

Climate, Air Quality, and Health:

- Buildings contribute significantly to statewide emissions.
- Decarbonization is part of California's climate and air quality strategies.
- Reducing emissions improves public health.

Zero-Emission:

- Zero greenhouse gas emissions emitted during operation.



Guiding Values

- Support climate change mitigation and resilience and public health.
- Evaluate economic and other impacts as they relate to historic and ongoing disparities in clean air, affordable healthy homes and workplaces, and reliable energy.
- Encourage manufacturers and the broader workforce to create affordable, reliable, and convenient solutions that support widespread zero-emission space and water heater adoption.
- Coordinate with public agency partners to ensure clarity, alignment, and long-term feasibility for any proposed standards.
- Create an accessible, transparent, and inclusive process.

For more details on Guiding Values, read:

[CARB's Outreach and Engagement Strategy and Plan](#)

Key Complementary Policies

What are other agencies doing?

CEC: CA Energy Commission || CPUC: CA Public Utilities Commission || HCD: Housing and Community Development
 BSC: Building Standards Commission || CWDB: CA Workforce Development Board



Timeline & Regulatory Milestones

2023-2024
Public Workshops

Engagement Topics & Staff Analysis:

- Data Sources
- Assumptions
- Analysis Methods
- Regulatory Concepts

**2025 Board
Consideration**

Regulatory Package:

- Staff Report
- Economic and Environmental Analysis
- Proposed Regulation Order

**2026
Final Rule**

~2030
Potential
compliance
date

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Initial Engagement Learnings

Big Questions

- What are the emissions and public health benefits from a potential standard?
- Will technologies be ready and available across the state?
- Will buildings be ready to accommodate zero-emission space and water heaters?
- Would a zero-emission standard be affordable?
- How would a regulation impact vulnerable populations?

Requests of CARB process

- Strengthen interagency coordination
- Keep a holistic view in mind: consider public health, emissions reductions, and opportunities for economic benefits.
- Offer compensated opportunities to be involved.
- Combat misinformation: provide clear messaging about potential standards.

Public Engagement Phases

Assess

Interview people from various groups to understand their process-related needs and interests. Apply what is learned to create an engagement plan.

*Completed
October 2023*

Plan

Create a series of activities to address the needs of CARB staff and those learned from the assessment, as feasible.

*Completed by
March 2024*

Engage

Facilitate the planned activities. Track information gathered, and decisions made. Compensate public experts involved in activities, as feasible.

*Current Phase
2024 -2025*

Evaluate

Review and assess effectiveness of the engagement process, and plan for future engagement work.

Ongoing

Analysis
Support

Listening
Sessions

Implementation Planning

Experts invited from public solicitation

Analysis Support and/or Implementation Planning

- Allensworth Progressive Association
- Association for Energy Affordability
- Building Decarbonization Coalition
- Ceres
- Channing Street Copper Company
- Construction Trades Workforce Initiative
- Consultancy to National Propane Gas Association
- Earthjustice
- Energy Solutions
- HPBA - Hearth, Patio, and Barbecue Association
- GRID Alternatives
- Individuals (3)
- Lennox
- Natural Resources Defense Council
- National Propane Association
- Peninsula Clean Energy
- Rinnai America
- Redwood Energy
- RMI
- Southern California Edison
- Silicon Valley Clean Energy
- Strategic Actions for a Just Economy
- TRC
- Tre' Laine Associates
- Western Propane Association

Listening Sessions

- Allensworth Progressive Association (Central Valley)
- Climate Action Campaign (LA and San Diego)
- Climate Resilient Communities (South Bay Area)
- Construction Trades Workforce Initiative (East Bay Area)
- Nevada County Clean Power Cooperative (Northern California and Sierra Foothills)
- SPUR (San Francisco)

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Regulatory Concepts Today's Goals

- **Consult Public On:**
- What aspects of the regulatory concepts seem feasible and challenging?
- Why?
- Please provide data to support.



Regulatory Concept: Overview

a) Statewide Rule as Described in 2022 SIP Strategy Measure

- All new sales of residential and commercial space and water heaters by 2030.
- Would not limit use or repair of existing space and water heaters.

Effective Date	Equipment Type	Capacity/Size Limits
2030	Boilers and water heaters	No Limit
2030	Space heaters	No Limit

Regulatory Concept:

a) Statewide Rule as Described in 2022 SIP Strategy Measure

Benefits

- Meets our emission reduction estimate in the 2022 SIP Strategy.

Challenges

- Currently, limited zero-emission product availability for larger commercial and multifamily buildings and high-heat hot water applications.

Regulatory Concept: Overview

b) Statewide Rule Based on Bay Area and South Coast Measures

- New sales requirement for space and water heaters.
- Scale Bay Area (adopted) and South Coast (proposed) rules statewide using their staggered compliance dates by capacity and application.

Effective Date	Equipment Type	Capacity/Size Limits
2027	Boilers and water heaters	< 75,000 Btu/hr
2029	Central furnaces	< 175,000 Btu/hr
2029	Boilers and water heaters	≤ 400,000 Btu/hr
2029	Instantaneous water heaters	≤ 200,000 Btu/hr
2031	Boilers and water heaters	≤ 2MM Btu/hr
2031	Pool heaters	≤ 400,000 Btu/hr
2031	Instantaneous water heaters	≤ 2MM Btu/hr
2033	High temperature (>180°F) boilers and water heaters	≤ 2MM Btu/hr
TBD	Central furnaces	≤ 2MM Btu/hr

Regulatory Concept:

b) Statewide Rule Based on Bay Area and South Coast Measures

Benefits

- Provides harmonized standards statewide.
- Considerable emission reduction potential.

Challenges

- Staggered implementation dates would delay emission reductions for some equipment types.

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Key Questions Guiding Staff Work



What are the potential emission reductions?



What are the potential public health benefits?



Will the technology be available?



Will buildings be ready?



How much would it cost?



What are the equity implications?

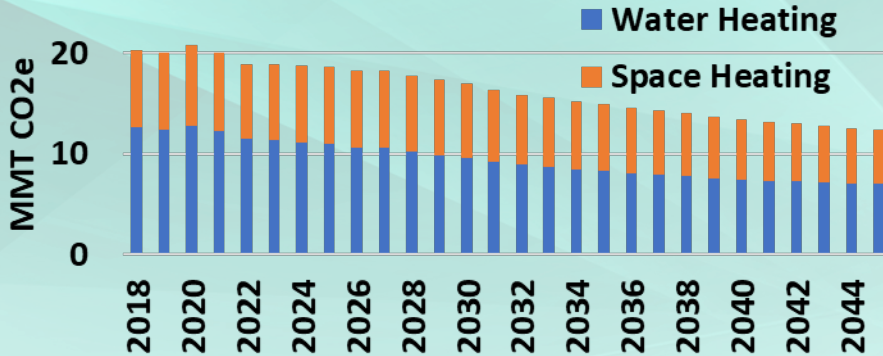
Staff Work

Today's Goals

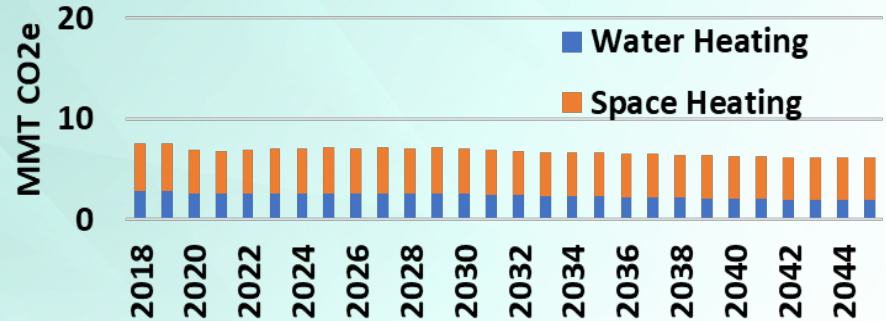
- **Inform the public** on baseline GHG emissions and potential public health benefits
- **Consult the public** on technology, building readiness, costs, and equity analyses
 - Guiding Questions: Are these the right questions?
 - Methods: Any comments on the proposed approach?
 - Data Sources: Any suggestions for other sources to support the analysis?

What are the Baseline GHG Emissions?

Residential GHG Baseline Emissions



Commercial GHG Baseline Emissions



Source: [AB 32 GHG Inventory Sectors Modeling Data Spreadsheet](#) and [Emission Factors for Greenhouse Gas Inventories \(epa.gov\)](#)

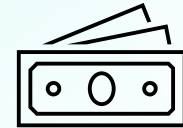
- Space and water heating represent about 80% of GHG emissions in buildings.
- Residential buildings have far more GHG emissions from space and water heating than commercial buildings.

What are the Potential Public Health Benefits?



Health Endpoints

Mortality
Cardiovascular Hospital Admissions
Cardiovascular ED Visits
Acute Myocardial Infarction, Nonfatal
Respiratory Hospital Admissions
Respiratory ED Visits
Asthma Onset
Asthma Symptoms / Exacerbation
Lung Cancer Incidence
Lost Work-Days
Alzheimer's Disease
Parkinson's Disease



Will the Technology Be Available?

Today's Goals: Receive recommendations on data sources for assessing status and availability of emerging zero-emission technologies.

Guiding Questions:

- 1) What zero-emission space and water heating technologies are commercially available?
- 2) What are the special considerations, applications, and limitations of zero-emission technologies available today, and how are these expected to change over time?
- 3) What is the current and future rate of deployment of zero-emission technologies in California?



Image Source: Adobe Stock

Zero-Emission Water Heater Technology

Technology Types	Status	Considerations
Electric Resistance	Technology is ready and widely available.	<ul style="list-style-type: none">• High operating costs.• Moderate capital costs.• Slow heating times.
Heat Pump	120V and 240V technology is available. Central heat pump water heaters emerging as an option for large commercial.	<ul style="list-style-type: none">• Low operating costs.• High capital costs• Larger tanks than traditional units.• Requires condensation removal and adequate ventilation.
Solar Thermal	Technology is Ready.	<ul style="list-style-type: none">• Limited site feasibility.• High maintenance requirements.
Hydrogen Combustion	Not readily available. In development phase.	<ul style="list-style-type: none">• Requires sufficient hydrogen fuel availability.• High operating and capital costs.• May emit NOx.
Hydrogen Fuel Cell	Not readily available in U.S.	<ul style="list-style-type: none">• Requires sufficient hydrogen fuel availability.

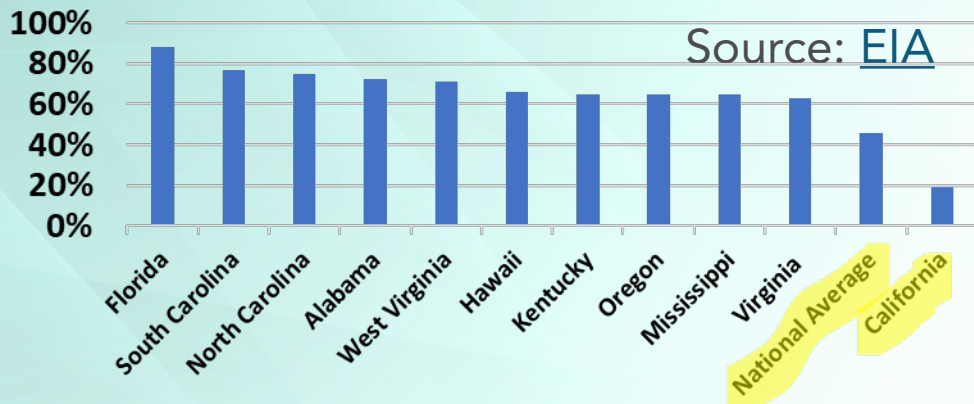
Zero-Emission Space Heater Technology

Technology Types	Status	Considerations
Electric Resistance	Technology is ready and widely available.	<ul style="list-style-type: none">• High operating costs.• Moderate capital costs• Slow heating times.
Heat Pumps	Technology is ready and widely available.	<ul style="list-style-type: none">• Low operating costs.• High capital costs.• Roof area limitations for packaged systems.• May experience efficiency losses in cold weather.
Heat Recovery Chiller	Technology is ready and widely available.	<ul style="list-style-type: none">• Low operating costs.• Requires significant simultaneous heating and cooling loads to be effective.
Hydrogen Combustion	Not readily available. In development phase.	<ul style="list-style-type: none">• Requires sufficient hydrogen fuel availability.• High operating and capital costs.• May emit NOx.
Hydrogen Fuel Cell	Not readily available in U.S.	<ul style="list-style-type: none">• Requires sufficient hydrogen fuel availability.

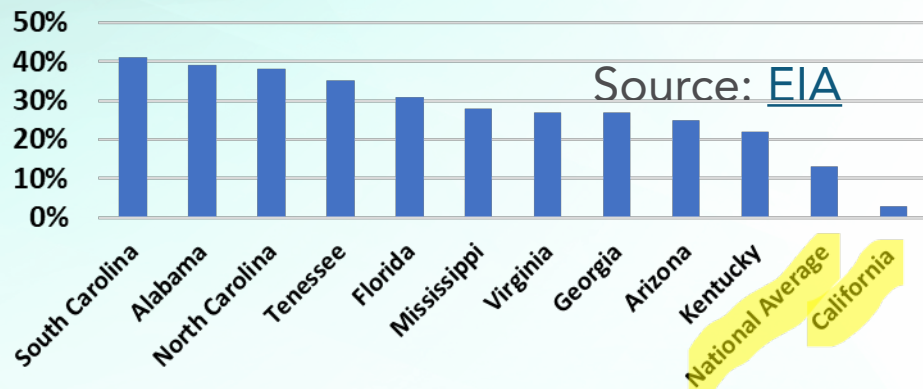
Current Deployment of Zero-Emission Options

- Other states have higher deployment of zero-emission space and water heaters than California.
- Zero-emission water heaters:
 - U.S. average: 46%
 - California: 19%
- Central heat pumps:
 - U.S. average: 13%
 - California: 3%

Housing Units with Zero-Emission Water Heaters as Primary Source



Housing Units with Central Heat Pumps as Main Space Heating Source



Technology Assessment Data Sources

Source	Contents
AHRI	National Shipment Data
RASS	Residential appliance fuel shares in California
California Commercial Saturation Survey	Commercial space heat saturation in California
TECH	<ul style="list-style-type: none">• Market Characterization & Baseline Study• Customer Satisfaction Survey
NBI	<ul style="list-style-type: none">• 120 V Heat Pump Field Study• Technology roadmap/availability
Energy Star	List of HP brands/manufacturers
EIA	Heat Pump Deployments by State
Title 24 CASE Reports	Residential HP Analysis for Energy Code
AWHI	Central Heat Pump Water Heater case studies
CARB Survey	CARB survey of space and water heater manufacturers

Will Buildings Be Ready?

Today's Goals: Receive recommendations on approach, readiness categories, and definitions.

Guiding Questions:

1) What ratio of buildings in California have the following readiness features?

- a) Adequate panel capacity.
- b) Ample physical space at panel.
- c) Adequate electrical wiring.
- d) Service-entrance capacity.
- e) Sufficient physical space.
- f) Structural integrity.

2) How do these features vary by building type, vintage, and region?

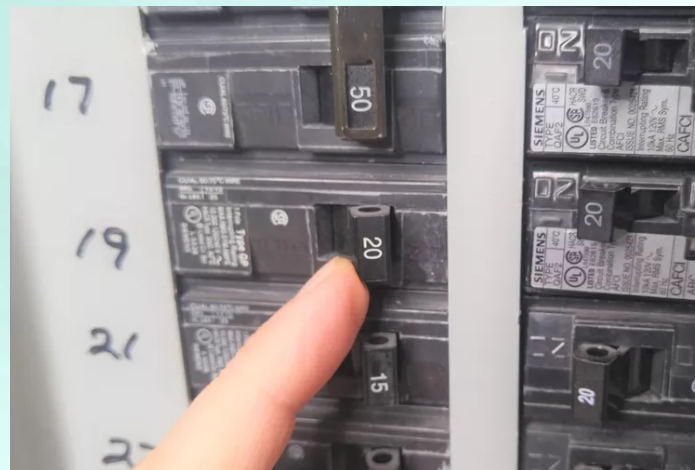


Image Source: [The Spruce](#), 2023

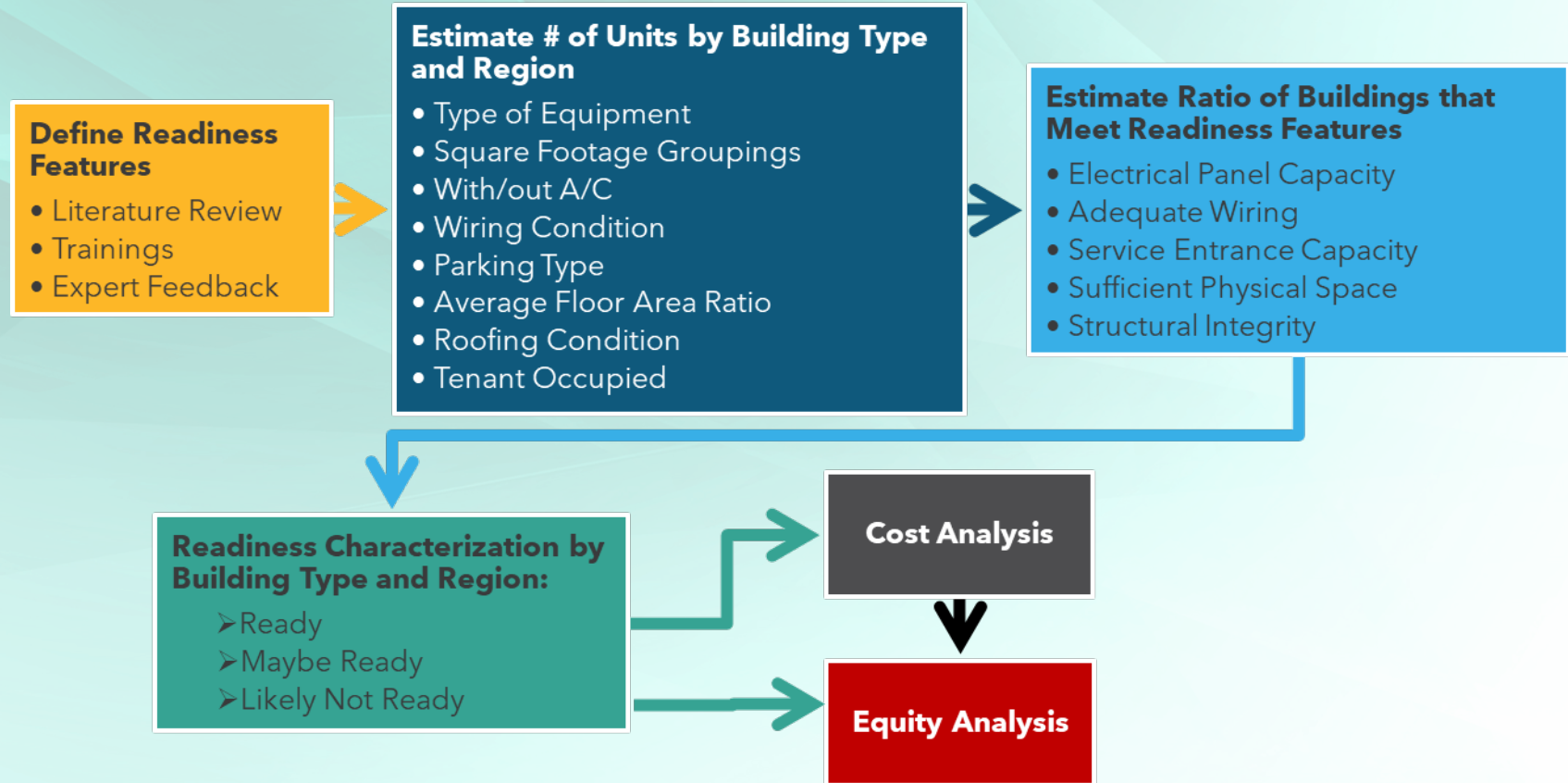
What Do We Already Know about Building Readiness?

- Electrical panel, wiring, and service entrance upgrades may be needed to install some zero-emission options.
- Most homes with 200-amp panels can accommodate zero-emission appliances.
- Homes with 100-amp panels can also install zero-emission appliances with smart solutions like circuit sharing devices.
- Sufficient physical space is needed for efficient operation of heat pump water heaters to provide adequate air flow.









Image Source: [Professional Electric](#), 2023

Method for Building Readiness Assessment



Building Readiness: Proposed Categories and Definitions

Readiness Categories	Definitions	Time	Cost
Ready	Ready to install zero-emission space and water heating with brief action and low cost.	 Short – 1-3 Days	 Low
Maybe Ready	Maybe ready with moderate action and costs to install zero-emission space and water heating	 Mid – On the Order of Weeks	 Moderate
Not Likely Ready	Requires potentially significant action and costs to install zero-emission space and water heating	 Long – At Least Two Months	 High

Building Readiness Data Sources

Contents	Electric Panel	Wiring	Service Entrance	Physical Space	Structural	Source
Total Housing Units & Commercial Floorspace	✓	✓	✓	✓	✓	2019 Integrated Energy Policy Report (IEPR), 2023 Vision
Building Vintage	✓	✓	✓			2023 Vision, 2021 American Community Survey (ACS)
Square Footage Groupings, Units with A/C, Type of Existing Equipment	✓	✓		✓		2019 Residential Appliance Saturation Survey (RASS)
Peak Energy Load, Floorspace with A/C, Type of Existing Equipment	✓	✓		✓		2018-2022 Commercial End Use Survey (CEUS)
Permit Data	✓	✓				Construction Industry Research Board (CIRB)
Housing Permit Model	✓					2023 UCLA
Ratio of Homes Upgrading Electrical Panels and Service Entrance Capacity	✓		✓			10/26/2023 TECH
Wiring Condition, Floor Area Ratio, Type of Parking, Roof Condition		✓		✓	✓	2023 Dunn and Bradstreet (D&B), 2023 Core Logic

How Much Would it Cost?

Today's Goals: Receive recommendations on approach, additional cost elements, and associated data sources.

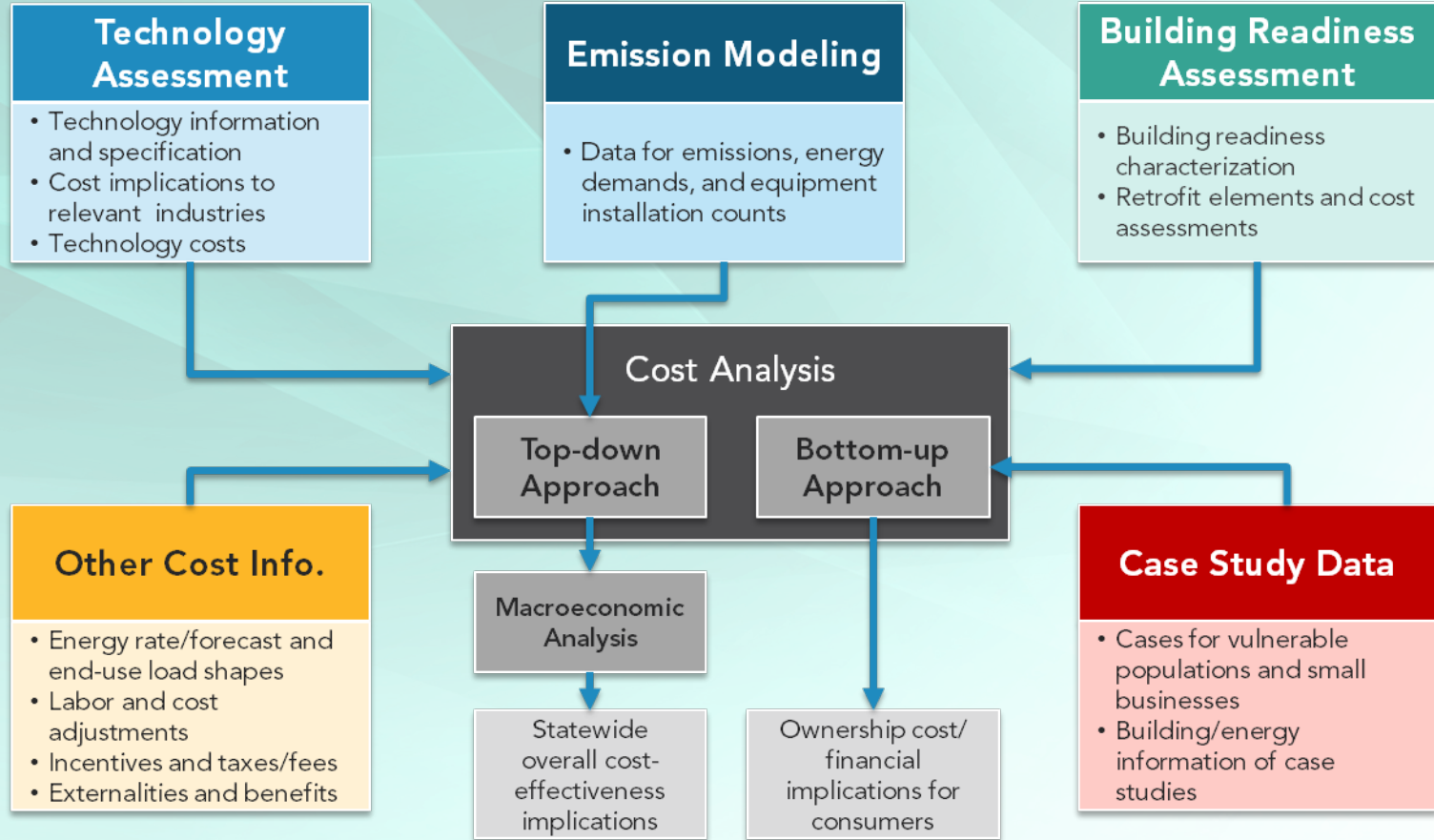
Guiding Questions:

- 1) What are the statewide overall costs/benefits and how cost-effective is the potential regulatory proposal?
- 2) What are the overall ownership costs and financial implications for consumers, including businesses and individuals?



Image Source: Adobe Stock

Cost Method Overview



Cost Analysis Elements and Data Sources

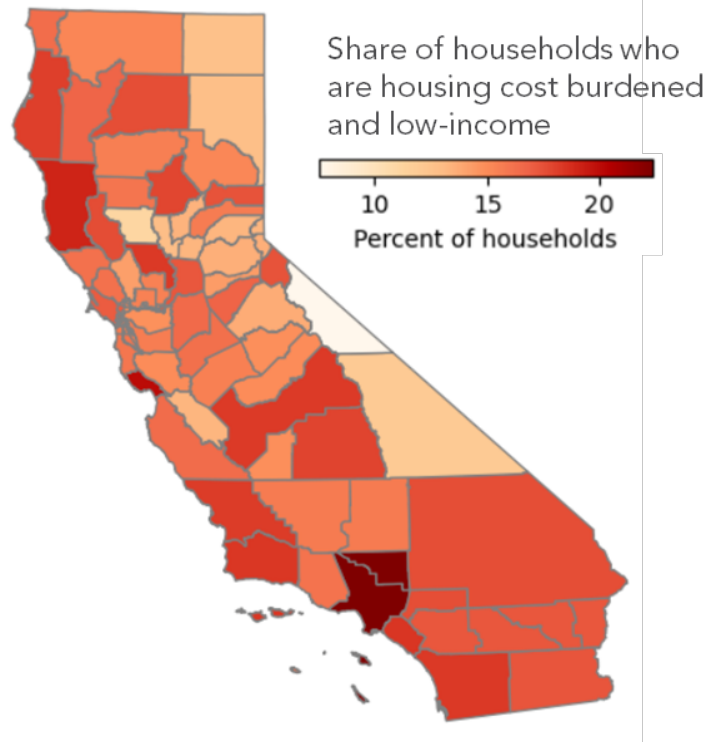
Category	Element	Contents	Source
Upfront	Equipment	Space and water heating equipment; price projection	DOE TSD ; TECH Clean CA ; eTRM
Upfront	Installation	Labor/materials; permit; regional difference	DOE TSD ; eTRM ; RSMMeans
Operation	Maintenance	Maintenance cost including labor/materials	EIA
Operation	Energy bill	Energy load/profiles for appliances	RASS ; CEC ; NREL
Operation	Energy bill	Energy rates	Utilities (current TOU and CARE rates)
Operation	Energy bill	Energy rate forecast	CEC ; EIA
Retrofit	Electric panel	Upsizing; smart breaker/circuit; others	NV5 Inc. ; RSMMeans
Retrofit	Service entrance	Upgrade; connection and permit	NV5 Inc. ; RSMMeans
Retrofit	Wiring	240-Volt circuit; splitter; system conversion	Kenney, et al. ; NV5 Inc. ; RSMMeans
Retrofit	Space configuration	Wall reconfiguration; appliance relocation; plumbing modifications	RSMMeans ; Opinion Dynamics

What Are the Equity Implications?

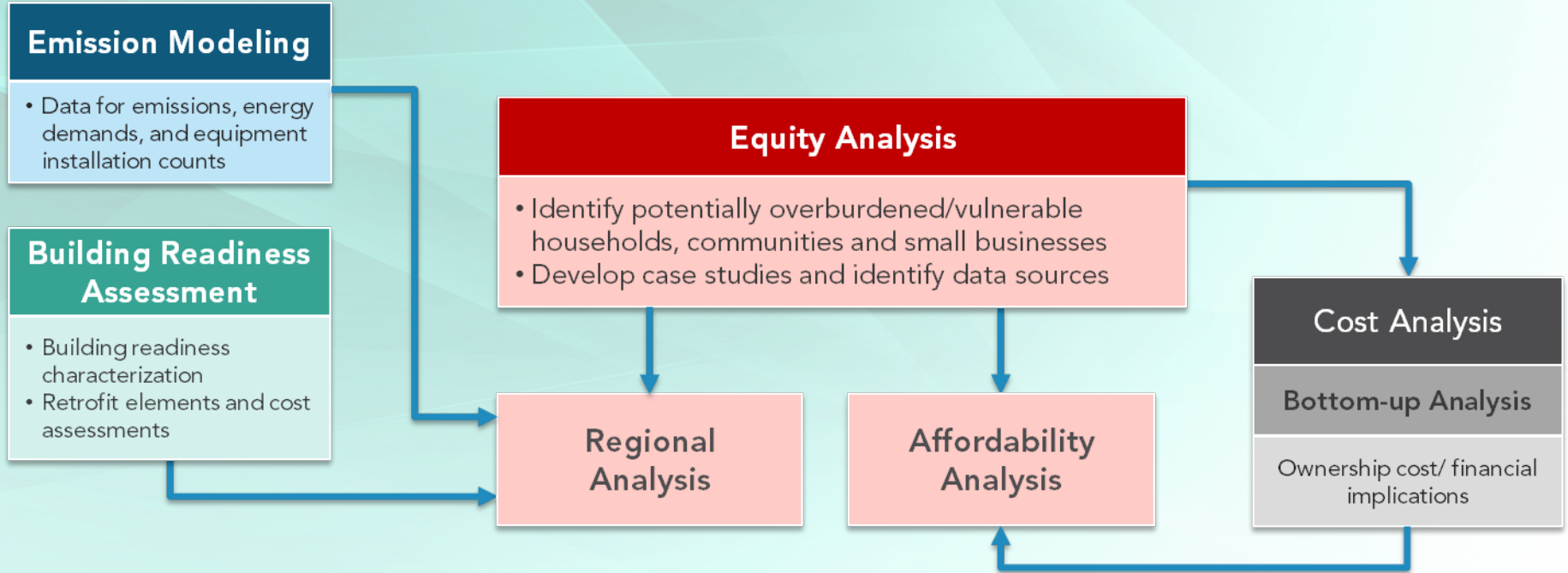
Today's Goals: receive recommendations on vulnerable community definitions and data sources, case study recommendations.

Guiding Questions:

- 1) Share of adoptions in contexts facing challenges such as housing insecurity, building and climate conditions, etc.?
- 2) What will the potential everyday financial impacts look like for households, especially the state's most vulnerable populations?
- 3) What are lessons learned from existing policies/programs, and what may be needed to realize a standard's intended benefits?



Equity Analysis Method Overview



Dimensions for Regional Analysis

Dimension	Features	Data Source	Key questions: What share of adoptions in each GAI* could occur in...
Demographic	Tenure (Rent/Own), Income, Cost Burden, Race/Ethnicity	ACS (summarized in HOPE tool)	... high cost-burdened renter-occupied households? (And what share of those households are BIPOC?)
Building conditions	Building readiness features	UCLA and CARB building readiness analysis	... buildings that are “not likely ready” for zero-emission appliances, and occupied by vulnerable groups (e.g., renters with high housing cost burdens)?
Fuel Sources	Propane, Wood	RASS , ACS	... areas primarily reliant on wood or propane for heating?
Climate	Climate Zone, Heating Degree Days, Cooling Degree Days	NOAA , CalAdapt	... areas where heating or cooling needs are or will be greatest under climate change?
Metrics	CalEnviroScreen Score, Climate Vulnerability Metric	CES 4.0 CVM	... CES 4.0 Disadvantaged Communities? ... areas with the greatest vulnerability to climate change?

Affordability Analysis

- What are the potential everyday financial impacts, especially for the state's most vulnerable populations?
- CARB staff plan to develop case studies to describe total cost of ownership for households and small businesses around the state.
- Case studies
 - Housing and utility cost-burdened renters and homeowners
 - Small "mom and pop" landlords
 - Small businesses
 - Retail
 - Laundry
 - Hotel

Preliminary Implementation Planning

Planned Topics:

- Housing
- Workforce
- Incentives and Funding Support
- Others to be determined

Next steps:

- Learn from existing programs and supportive policies.
- Learn about potential implementation needs and ways to address them.
- Understand adverse unintended consequences and how to mitigate them.

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Overall Questions for the Public

- 1) **Regulatory Concepts:** What aspects of the regulatory concepts seem feasible? And which seem challenging? Why? Please provide data to support.
- 2) **Technology:** Any recommended data sources for assessing status and availability of emerging zero-emission technologies?
- 3) **Building Readiness:** Any comments on the proposed approach, readiness features, categories, and definitions?
- 4) **Overall Cost Analysis:** Are there recommended additions to cost elements and their data sources?
- 5) **Regional Equity Analysis:** Any other recommended questions for staff to explore as they evaluate equity implications, and/or reports and data sources they should reference?
- 6) **Affordability Case Studies:** What specific case studies should staff analyze (i.e., renter, small businesses, etc.)?

Public Comments via Zoom

Online Attendees

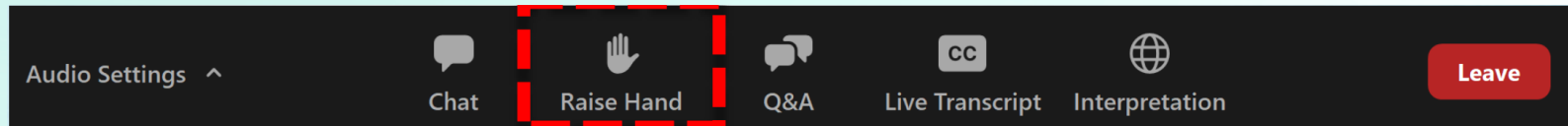
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Timeline & Regulatory Milestones: Next Steps

Technical Expert Meetings:

- Emissions Modeling
- Building Readiness
- Technology
- Costs and Economic Impacts
- Equity Analysis

Listening Sessions

Implementation Planning Meetings:

- Housing
- Workforce
- Incentives
- Consumer education

**Assess
& Plan**

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Next Steps and Staying Connected

- **Written Comments:** submit comments by March 27, 2024
<https://ww2.arb.ca.gov/public-comments/zero-emission-space-and-water-heater-february-28-2024-workshop-public-comments>
- **Website:** background, including FAQs:
<https://ww2.arb.ca.gov/our-work/programs/zero-emission-space-and-water-heater-standards>
- **Listserv:** Subscribe to CARB's Building Decarbonization GovDelivery topic to stay informed:
https://public.govdelivery.com/accounts/CARB/subscriber/new?topic_id=bldg
- **Questions:** email buildingdecarb@arb.ca.gov