



Zero-Emission Space and Water Heater Standards

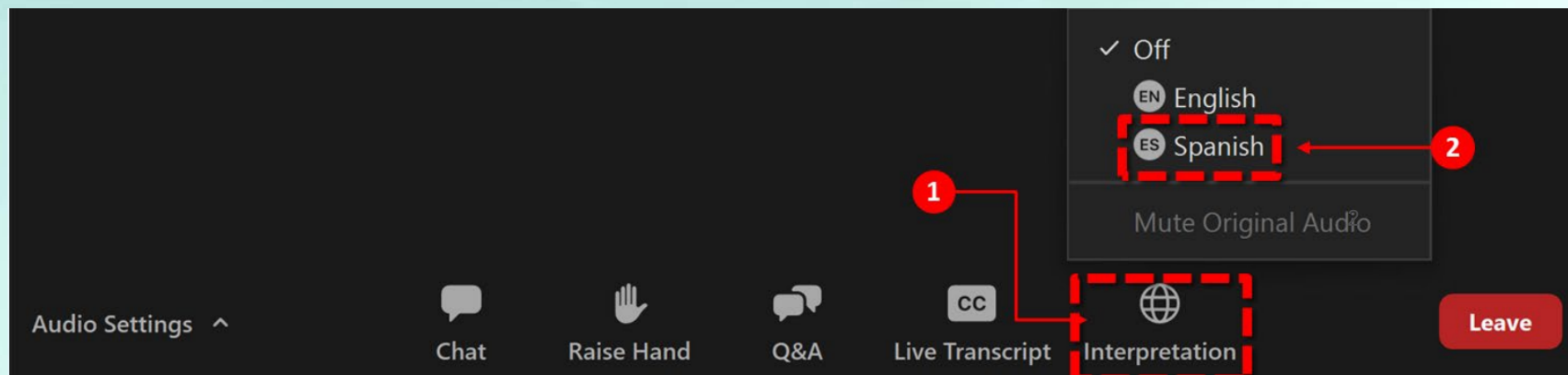
Public Workshop

May 29, 2024

9:00 a.m. - 12:00 p.m.

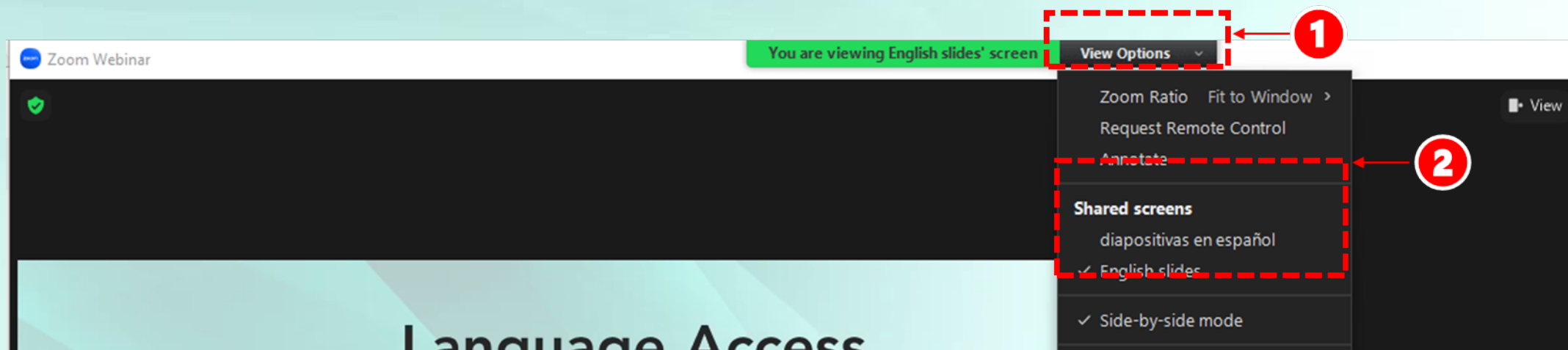
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Introduction

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

Climate, Air Quality, and Health:

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

Why space and water heaters?

- Represent about 80% of GHG emissions from buildings

Zero-Emission:

- Zero GHG emissions emitted during operation.



Timeline & Regulatory Milestones



Today's Workshop Goals:

Consult Public:

- Draft Regulatory Proposal
- Technology and Cost Modeling
- Request for Alternatives

Consult Public Agencies:

- Serve as Scoping Meeting for Environmental Impact Analysis

Regulatory Package:

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

Today's Agenda

- 1) Draft Regulatory Proposal**
- 2) Zero-Emission Technology and Cost Modeling
- 3) Request for Regulatory Alternatives
- 4) Environmental Analysis
- 5) Public Comments
- 6) Next Steps

Draft Regulatory Proposal Today's Goals

- **Respond to Public Comments:**
 - Provide a response to comments received following 2/28/24 public workshop.
- **Consult Public On:**
 - Draft Regulatory Proposal
 - Request feedback on rural and under-resourced areas, "dual fuel" systems, high temperature technology, and manufactured housing.



Summary of Regulatory Concepts Presented at 2/28/24 Public Workshop

- **Both Concepts:**

- New sales of space and water heaters for residential and commercial buildings would need to be zero-emission.
- Would not limit use or repair of existing space and water heaters.

- **Concept A:**

- Compliance starting in 2030 for all equipment.
- Equipment of all sizes would be covered.

- **Concept B:**

- Staggered compliance dates based on equipment type and capacity/size limits based on feasibility.
- Align with Bay Area (adopted) and South Coast (proposed) NOx rules for statewide consistency in implementation timelines.

Summary of 2/28/24 Public Workshop Comments: Scope of Regulation

- **Concept B**

- Some requested changes mainly to align dates and thresholds.
- Response to Comment: Moving forward with a refined Concept B.

- **Include All End-Uses**

- Include all end-uses for comprehensive decarbonization solution to allow for “zonal” electrification.
- Response to Comment: Regulatory proposal will remain focused on space and water heating as those are the largest sources of emissions.

- **Exemptions Requested**

- Develop a process to allow an off-ramp to account for implementation issues, including projects that reasonably demonstrate “infeasibility.”
- Response to Comment: Continuing to evaluate further.

- **Allow for “Dual Fuel” Systems**

- Where appropriate and cost effective.
- Response to Comment: Continuing to evaluate this further and welcome related references and data.

Summary of 2/28/24 Public Workshop Comments: Equipment Size and Effective Dates (1 of 2)

- **Align Compliance Dates for Units Serving the Same Segment**
 - Request to not stagger compliance dates for storage water heaters and instantaneous water heaters since both serve the same market, residential dwellings.
 - Response to Comment: CARB would like to provide more time for instantaneous waters because some currently installed units may be in small spaces, which may complicate replacement with zero-emission units. Proposal is aligned with air districts to move toward statewide consistency.
- **Extend Compliance Dates**
 - 2027 compliance date for boilers and water heaters with capacity less than 75,000 British thermal units per hour (Btu/hr) will pose significant challenge for manufacturers to meet demand.
 - Response to Comment: 2027 compliance date is technologically feasible. Delaying implementation to 2029 would delay realization of approximately 2MMT CO₂e annually.

Summary of 2/28/24 Public Workshop Comments: Equipment Size and Effective Dates (2 of 2)

- **Align Boiler Size/Capacity Thresholds with DOE Rules**
 - Distinguish between residential and commercial boilers with a 300,000 Btu/hr heat input rate.
 - Response to Comment: Aligning capacity thresholds with air districts' zero-NOx rules to move toward statewide consistency in implementation.
- **Request for Manufacture Date as Compliance Date**
 - Promotes certainty to the regulated community.
 - Response to Comment: Continuing to evaluate this further.

Summary of 2/28/24 Public Workshop Comments: Implementation Topics

- **Center Equity**
 - Center economic equity in the standard and work with others to develop holistic strategies.
- **Unexpected Loss of Heat or Hot Water**
 - This can be an urgent situation that needs solutions.
 - Request for CARB to conduct a robust barrier and risk analysis to evaluate several factors.
- **Tenant Protections**
 - Conduct analysis of local jurisdiction mechanisms.
- **Ensure No Penalties Accrue to Households**
 - Low-income households and tenants that cannot afford zero-emission space or water heaters or required upgrades should not be penalized.
- **Response to Comments:** Continuing to evaluate further.

Draft Zero-GHG Regulatory Proposal: C) Refined Concept B

- Continue to focus for new sales of requirement on space and water heating.
- Staggered compliance dates based on technological feasibility. Align with Bay Area (adopted) and South Coast (proposed) Air District zero-NOx rules for implementation consistency.

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
2029 TBD	Central Furnaces	≤ 2MM Btu/hr
2031	Boilers and water heaters	≤ 2MM Btu/hr
2031	Instantaneous water heaters	≤ 2MM Btu/hr
2031	Pool heaters	≤ 400,000 2MM Btu/hr
2033	High temperature (>180°F) boilers and water heaters	≤ 2MM Btu/hr

Request for Feedback

- **Rural and/or Under-Resourced Areas:** What are the special considerations of regulating space and water heaters in rural and under-resourced areas?
- **“Dual-Fuel” Systems:** What data or references can identify the fraction of heat pumps sold in California that are installed alongside other heating sources, such as gas furnaces? How often are these used to meet heating needs?
- **High Temperature Technology:** What building types and use cases incorporate high temperature water heaters that produce steam or heat above 180°F? Any data and references related to cost, use, performance, and typical applications?
- **Manufactured Housing:** What are reasonable compliance dates for equipment certified for manufactured housing?

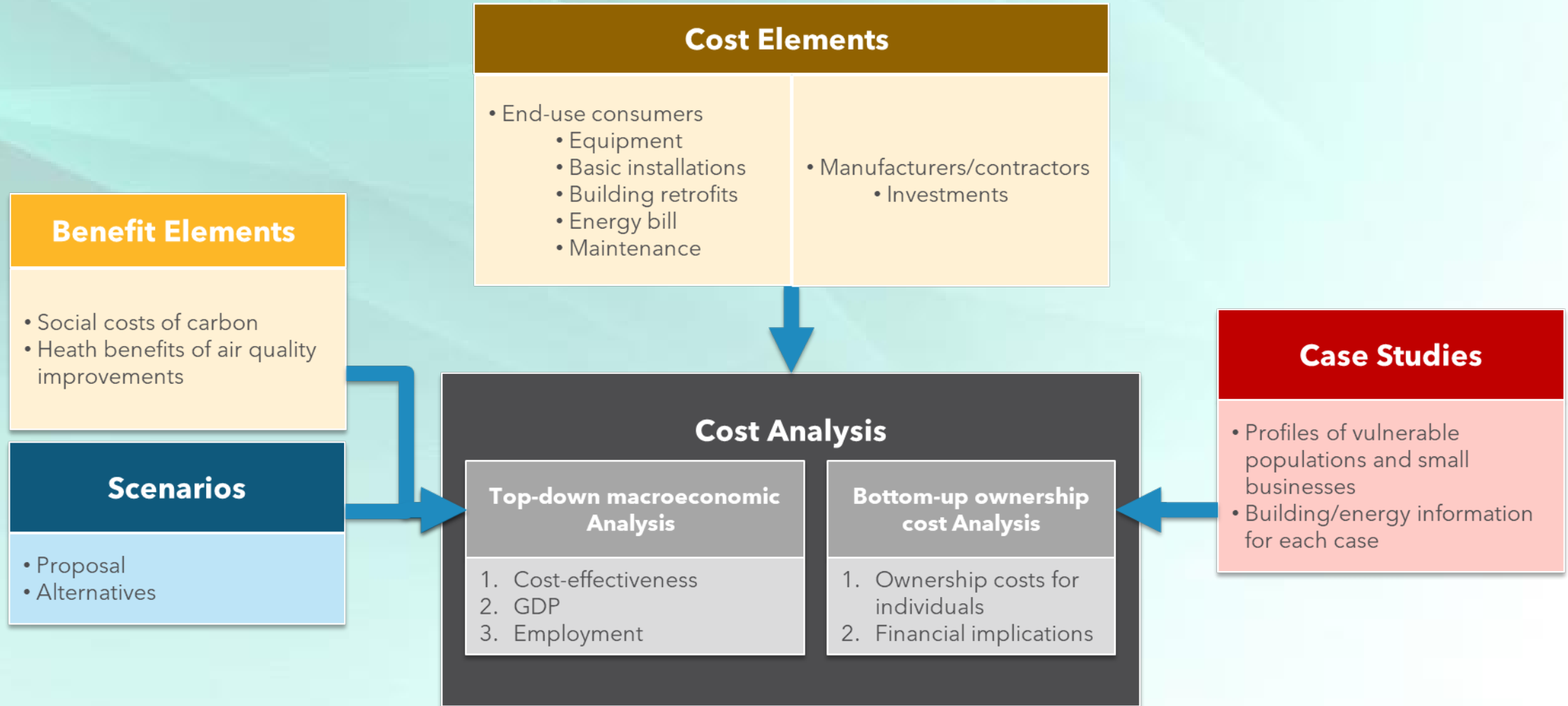
Today's Agenda

- 1) Draft Regulatory Proposal
- 2) Zero-Emission Technology and Cost Modeling**
- 3) Request for Regulatory Alternatives
- 4) Environmental Analysis
- 5) Public Comments
- 6) Next Steps

Zero-Emission Technology and Cost Modeling Today's Goals

- Provide overview of zero-emission technology types, costs, and adoption rates to include in the modeling work for estimating emission reduction and cost impacts for the regulatory proposal.
- Request feedback on proposed percentages and technology types to model.
 - Additional technology types may be used for compliance. The technology types chosen are based on data availability and to simplify modeling assumptions.
- Request feedback on cost assumptions and data sources.

Elements of Cost Analysis



Technology/Cost Assumptions: Space Heating

Baseline Equipment Type	Baseline Technology Costs ^{1,2} (\$/kBtuh)	Zero-Emission Replacements ³ (replacement fraction)	Zero-Emission Technology Costs ^{1,2,4} (\$/kBtuh)	References
Gas Wall or Floor Furnace <175,000 Btu/hr	\$120 - \$122	<ul style="list-style-type: none"> • (45%) Mini-Split Heat Pump • (45%) Packaged Terminal Heat Pump • (10%) Electric Resistance Wall Heater 	\$119 - \$183 \$117 - \$194 \$155	eTRM (SWHC044 , SWHC001 , SWHC050); EIA, 2023
Gas Central Furnaces <175,000 Btu/hr	\$25 - \$54	<ul style="list-style-type: none"> • (90%) Packaged/Split Heat Pump • (10%) Central Electric Furnace 	\$117 - \$194 \$23	eTRM (SWHC011 , SWHC004 , SWHC031 , SWHC045); EIA, 2023
Gas Boiler ≤400,000 Btu/hr	\$27 - \$35	<ul style="list-style-type: none"> • (90%) Mini-Split Heat Pump • (10%) Electric Resistance Boiler 	\$119 - \$183 \$21 - \$23	eTRM (SWHC050 , SWHC004); EIA, 2023
Gas Boiler >400,000 ≤ 2 MM Btu/hr	\$27 - \$35	<ul style="list-style-type: none"> • (90%) Variable Refrigerant Flow • (10%) Electric Resistance Boiler 	\$198 - \$861 \$21 - \$23	eTRM (SWHC004); EIA, 2023 ; NEEP, 2016
Gas Furnace All sizes ≤2 MM Btu/hr	\$35 - \$73	<ul style="list-style-type: none"> • (90%) Unitary Heat Pump • (10%) Electric Resistance Furnace 	\$145 - \$205 \$32 - \$36	eTRM (SWHC014 , SWHC011 , SWHC004); EIA, 2023
Integrated furnace/AC All sizes ≤2 MM Btu/hr	\$112 - \$155	<ul style="list-style-type: none"> • (90%) Packaged Heat Pump • (10%) Electric Resistance Furnace 	\$130 - \$189 \$32 - \$36	eTRM (SWHC046); EIA, 2023

1. Unit for cost assumptions is “**2023 \$/kBtuh**” and the cost data is adjusted to 2023 California level through Consumer Price Index (CPI) and RSMMeans cost index

2. Technology cost includes equipment retail price and basic installation but excludes tax (~10%), the retrofits cost depending on building and infrastructure conditions (e.g., electric/space readiness), and price markups (1.25 ~ 1.50) depending on the market.

3. Additional technology types may be used for compliance. The technology types chosen are based on data availability and to simplify modeling assumptions.

4. For buildings replacing both air conditioner(s) (AC) and furnace(s) with heat pump technologies, the saving on AC replacement is included in the analysis.

Technology/Cost Assumptions: Water Heating

Baseline Equipment Type	Baseline Technology Costs ^{1,2} (\$ per unit)	Zero-Emission Replacements ³ (replacement fraction)	Zero-Emission Technology Costs ^{1,2} (\$ per unit)	References
Gas Tanked Storage Small and Medium Boilers <75,000 Btu/hr ≤400,000 Btu/hr	\$930 - \$3,200 \$13-\$20 (\$/kBtuh)	<ul style="list-style-type: none"> • (65%) 240 Volt Heat Pump Water Heater • (30%) 120 Volt Heat Pump Water Heater • (5%) Solar Hot Water 	\$1,770 - \$4,220 \$2,970 \$9,500	eTRM (SWWH025 , SWWH028 , SWWH006); EIA, 2023
Gas Instantaneous Water Heaters ≤200,000 Btu/hr	\$950 - \$2,700	<ul style="list-style-type: none"> • (75%) 240 Volt Heat Pump Water Heater • (20%) 120 Volt Heat Pump Water Heater • (5%) Solar Hot Water 	\$1,770 - \$4,220 \$2,970 \$9,500	eTRM (SWWH025 , SWWH028 , SWWH006); E3, 2019 ; EIA, 2023
Gas Boiler >400,000 and ≤ 2 MM Btu/hr Instantaneous Water Heater >200,000 and ≤ 2 MM Btu/hr	\$56 (\$/kBtuh) \$13 - 28 (\$/kBtuh)	<ul style="list-style-type: none"> • (50%) Central Heat Pump Water Heater • (50%) Electric Resistance Boiler 	\$167 (\$/kBtuh) \$21 (\$/kBtuh)	eTRM (SWWH025 , SWWH028); EIA, 2023
Gas Pool Heaters ≤400,000 Btu/hr	\$20 - 28 (\$/kBtuh)	<ul style="list-style-type: none"> • (50%) Heat Pump Pool Heater • (50%) Solar 	\$65 - 90 (\$/kBtuh) \$4,000	eTRM (SWRE003 , SWRE004 , SWRE005); Energy Solutions, 2023
Gas High Temperature Water Heaters ≤ 2 MM Btu/hr Gas Pool Heaters >400,000 and ≤ 2 MM Btu/hr				

1. Unit for cost assumptions is “**2023 \$/water heater unit**” or as noted otherwise and the cost data is adjusted to 2023 California level through Consumer Price Index (CPI) and RSMears cost index.

2. Technology cost includes equipment retail price and basic installation but excludes tax (~10%), the retrofits cost depending on building and infrastructure conditions (e.g., electric/space readiness), and price markups (1.25 - 1.50) depending on the market.

3. Additional technology types may be used for compliance. The technology types chosen are based on data availability and to simplify modeling assumptions.

Building Retrofit Cost Assumptions

Building Retrofit Element	Cost range (2023\$) (\$ per unit)	References
Electrical Panel Optimization, Upsizing, and Wiring		
Panel optimization (Install smart splitters, circuit breakers, smart panel, circuit pausers, load-sharing device, smart sub-panel, and meter collars)	\$49 - \$4,500	NV5 Inc., 2022, Simple Switch, 2023, Stop Waste, 2021, Tofel, 2023, Opinion Dynamics, 2024, SMUD, 2023, CPUC, 2024
Increasing amperage up to 150-amp to 600-amp panel, depending on building type and size	\$1,300 - \$45,000	NV5 Inc., 2022 Opinion Dynamics, 2024 CPUC, 2024
Upgrade to dedicated 240-Volt branch circuit, connect to panel	\$250 - \$7,300	NV5 Inc., 2022, CPUC, 2024
Service Entrance Upgrades		
Service connection, equipment service upgrade fees, permitting costs	\$4,425 - \$55,500	Stop Waste, 2021 NV5 Inc., 2022
Space Configuration		
Reconfigure walls to accommodate physical footprint	\$1.95 per square foot	Craftsman, 2023
Relocate to different space to accommodate physical footprint	\$200 - \$10,000	Carthan, 2023
Upgrades to pipe sizing/plumbing modifications and added condensate pan	\$775 - \$1,002	Opinion Dynamics, 2022, Kenney, et al., 2022
Louvered doors for extra ventilation or sound proofing	\$200 - \$505	Opinion Dynamics, 2022

Assumptions for Manufacturers and Supply Chain

Industry	Price markup ^{1,2}
Manufacturer	1.28~1.45 ³
Wholesaler/Distributor	1.447
Retailer (e.g., Lowe's, the Home Depot)	1.510~1.490 (1.500)
Mechanical contractor (replacement)	1.530
Mechanical contractor (new construction)	1.444
Builder (residential)	1.339
Builder (commercial)	1.257

¹. Source of data: [US DOE, 2023](#)

². A price markup as a multiplier that converts the manufacturer, wholesaler/distributor, retailer, mechanical contractor, and builder costs to their selling prices. It is used to determine the inputs or investments to the supply chain in California as fractions of total equipment spendings from end-use consumers.

³. Price markups depend on technology types.

Request for feedback

- **Additional technologies:** Are there other technology types that should be included in the modeling? If so, please share data on usage, performance, and costs.
 - 120-Volt heat pump water heater
 - High temperature water heater
 - Zero-emission alternatives for pool heaters
 - Cold climate heat pump technology
 - Solar water heater
 - Others?
- **Technology modeling assumptions:** What adjustments should be made to the percentages of zero-emission replacements assumed? Please share data to support those changes.
- **Cost assumptions:** Are there suggestions to other cost assumptions including manufacturing costs, especially space heating equipment?

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Request for Regulatory Alternatives Today's Goals

- **Consult Public On:**
 - What alternatives should CARB consider to the Draft Regulatory Proposal?
 - Why?
 - Please provide data to support.



Request for Alternatives (1 of 3)

- Pursuant to SB 617, CARB welcomes public input on alternatives to the draft regulatory proposal discussed in this workshop.
- In particular, CARB encourages public input on alternative approaches that:
 - May yield the same or greater benefits than those associated with the proposed regulation, or
 - May achieve the goals at lower cost.

Request for Alternatives (2 of 3)

- Please ensure the submission discusses the alternative's ability to fulfill the purpose of the draft regulatory proposal as CARB has presented it.
- Please submit the associated cost and benefit information and data sources to enable comparison of economic impacts and also submit a clear description of the basis for any cost calculations

Request for Alternatives (3 of 3)

- The deadline for submission of alternatives relating to economic impacts is June 26, 2024.
- Alternatives may be submitted via email to buildingdecarb@arb.ca.gov

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Environmental Impact Analysis (1 of 2)

- Environmental Impact Analysis (EIA) being prepared analyzing potential significant adverse impacts caused by reasonably foreseeable actions.
- Meets requirements of CARB's certified program under the California Environmental Quality Act (CEQA).
- The CEQA Environmental Checklist (CEQA Guidelines Appendix G) is used to identify and evaluate potential indirect impacts.
- The EIA will be an appendix to the Staff Report

Environmental Impact Analysis (2 of 2)

- The EIA will include:
 - Description of reasonably foreseeable actions taken in response to the proposal
 - Programmatic level analysis of potential adverse impacts caused by reasonably foreseeable actions
 - Feasible mitigation measures to reduce / avoid significant impacts
 - Alternative analysis
- Input invited at this early state on appropriate scope and content of the EIA.
- Draft EIA will be released for 45-day public comment period.

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Overall Questions for the Public

- **Draft Regulatory Proposal:** Any input on alternatives to the draft regulatory proposal?
- **Zero-Emission Technology and Cost Modeling:** Any additional technologies to consider, or changes to the proposed adoption rates used for modeling? Any suggestions to refine the assumptions for cost elements including technologies, building retrofits, other?
- **Environmental Analysis:** Any input on the scope and content of the EIA?

Public Comments via Zoom

Online Attendees

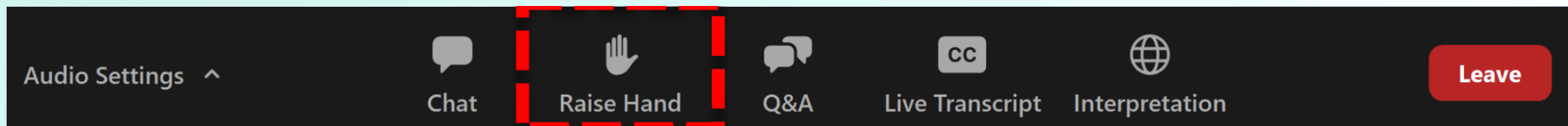
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Timeline: Next Steps

Technical Expert Meetings:

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

Public Listening Sessions:

- Co-hosted with community partners throughout California

Implementation Planning Meetings:

- Housing
- Workforce
- Incentives
- Consumer education



**Assess
& Plan**

Public Engagement

**2023-2024
Public Workshops**

**2025 Board
Consideration**

**2026
Final Rule**

**2027-
2033**
Potential
Compliance
Dates

Next Steps and Staying Connected

- **Written Comments:** submit comments by June 26, 2024.
<https://ww2.arb.ca.gov/public-comments/zero-emission-space-and-water-heater-standards-may-29-2024-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