Proposed Amended Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters

Working Group Meeting #2

June 7, 2023, 9:00 AM (PDT)

Join Zoom Meeting:

https://scaqmd.zoom.us/j/92823189689

Meeting ID: 928 2318 9689

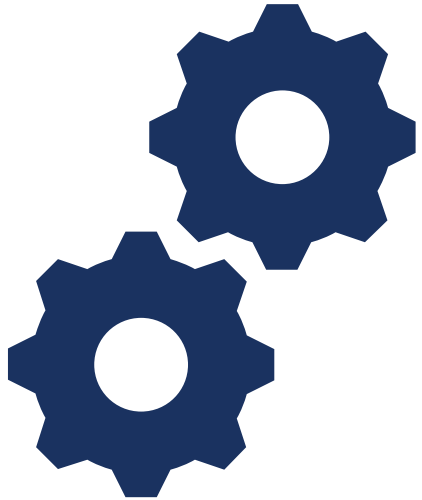
Agenda

- Overview of Rule Applicability, Approach, and Current Status
- Alignment with Rules and Strategies of Other Agencies
- Stakeholder Comments from Working Group Meeting #1
- Cost of Zero-Emission Technology
- Electric Grid Infrastructure
- Manufacturer Survey
- Next Steps and Staff Contact

PAR 1146.2 Working Group Meeting #1

In the first Working Group Meeting, Staff provided background on:	Control Measure C-CMB-01 in the 2022 Air Quality Management Plan
	Rule 1146.2 applicability and emission limits
	Preliminary schedule for building appliance rulemaking
	Zero-emission commercial water heating technology
	Rule approach for PAR 1146.2
	Draft manufacturer survey to gather information on zero-emission technologies

Overview of Rule Applicability, Approach, and Current Status



Rule 1146.2 Applicability

Control measure C-CMB-01 is focused on commercial units

Rule 1146.2 is focused on **rated heat input capacity** for units primarily used in commercial buildings

- NOx emissions from natural gas-fired water heaters, boilers, and process heaters with a rated heat input capacity ≤ 2,000,000 Btu/hr, excluding units subject to Rule 1121
- Applies to manufacturers, distributors, retailers, re-furbishers, installers, and operators
- Last amended in 2006 to lower NOx emission limit from 30 to 20 ppm

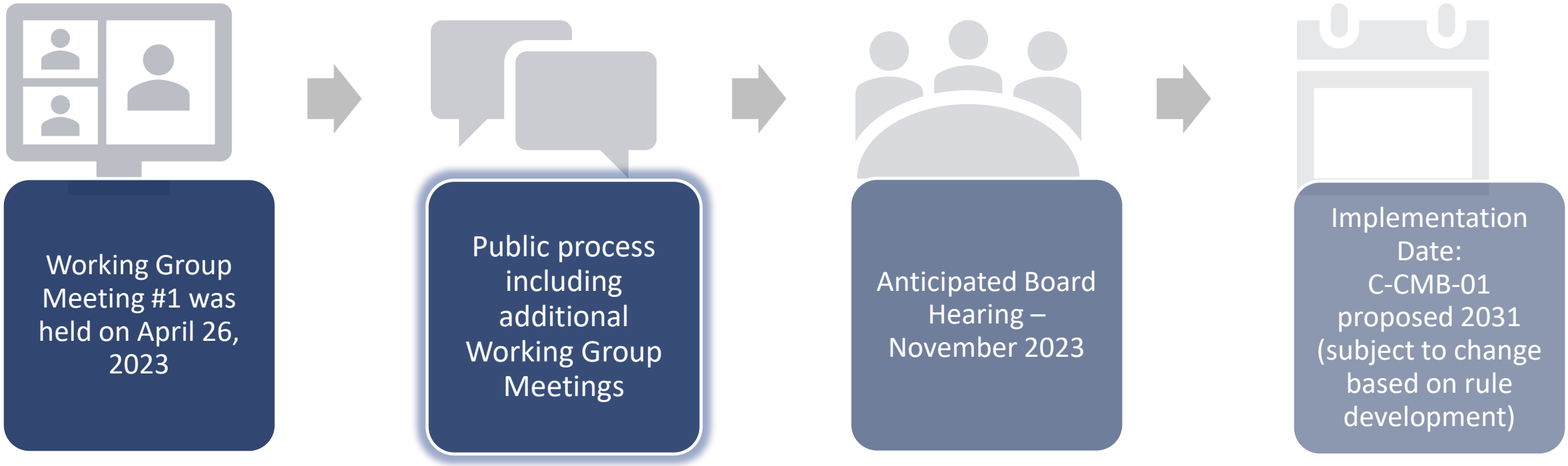
Rule Approach for PAR 1146.2

Staff will conduct a BARCT analysis to implement control measure C-CMB-01 from the 2022 AQMP

The rulemaking process will evaluate and address:

- Technology development (technology neutral)
- Feasible and cost-effective emission limits
- Potential implementation timeline
- Impact assessment
- Upcoming state and federal regulations
- Stakeholders' concerns

Current Status



Alignment with Rules and Strategies of Other Agencies

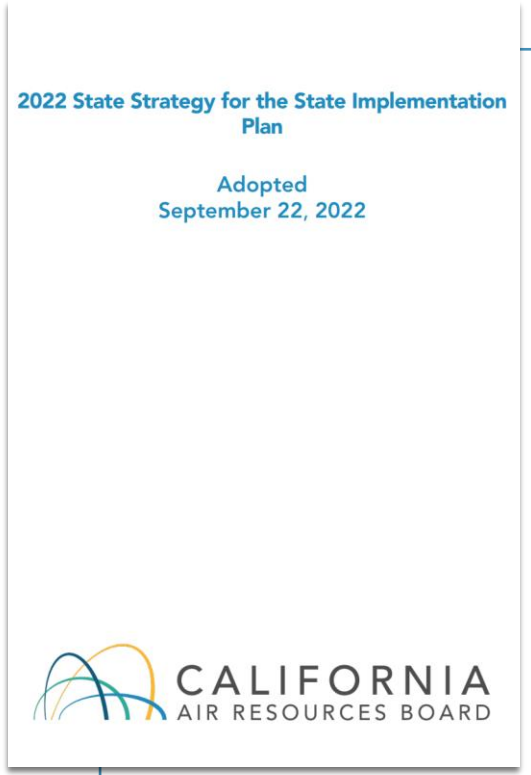
Alignment with Rules and Strategies of Other Agencies

Other state and local agencies are considering or have already adopted similar rules

- South Coast AQMD rule cannot be less stringent than a state-wide rule

	California Air Resources Board	Bay Area AQMD Rule 9-6	South Coast AQMD Rule 1146.2
Board Consideration	Anticipated 2025	Adopted March 2023	Anticipated November 2023
Implementation Date	**Anticipated 2030** - New equipment and appliances sold for use in both residential and commercial buildings	**2031** - Natural gas-fired water heater, rated heat input capacity 75,000 – 2,000,000 Btu/hr	**Control Measure C-CMB-01 2031 Goal** - Natural gas-fired water heaters, boilers, and process heaters with rated heat input capacity ≤ 2 MMBtu/hr, excluding units subject to Rule 1121
Emission Limit	Anticipated zero-emission (GHG, NOx)	Zero-NOx standard	Evaluating feasibility of zero-NOx-emission
Webpage Link	https://ww2.arb.ca.gov/our-work/programs/zero-emission-appliance-standards	https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances	http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/proposed-rules/rule-1146-2

Alignment with Rules and Strategies of Other Agencies



The California Air Resources Board has commenced its rulemaking process for potential state-wide standards

- Held first Public Workshop on May 10, 2023
- 2022 State Strategy for the State Implementation Plan (State SIP Strategy)* is a planning document that identifies strategies and controls under State authority needed to reduce emissions to reduce ground-level ozone, otherwise known as smog
  - Mentioned potential to "develop and propose zero-emission standards for space and water heaters sold in California"
    - Using regulatory authority for greenhouse gas emissions provided by Assembly Bill 32 (AB 32) - California Global Warming Solutions Act of 2006
      - Includes consideration of related criteria pollutant reduction benefits
  - This measure would be mandated at point of sale

** https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy*

Alignment with Rules and Strategies of Other Agencies *(con't)*

Based on the State SIP Strategy, the California Air Resources Board 2022 Scoping Plan Update* listed potential actions for commercial buildings related to the Scoping Plan Scenario

- "[Table 2-1] shows the types of technologies … needed to drastically reduce [greenhouse gas] emissions from the AB 32 Inventory sectors"
- "includes references to relevant statutes and Executive Orders, although it is not comprehensive of all existing new authorities for directing or supporting the actions described"
- "Each action is expected to both reduce [greenhouse gas emissions] and help improve air quality, primarily by transitioning away from combustion of fossil fuels"

2022 CARB Scoping Plan Table 2-1: Actions for the Scoping Plan Scenario: AB 32 GHG Inventory sectors

Sector	Action	Statutes, Executive Orders, Other Direction, Outcome
Existing Commercial Buildings	80% of appliance sales are electric by 2030, and 100% of appliance sales are electric by 2045. Appliances are replaced at end of life, contributing to 6 million heat pumps installed statewide by 2030.	Reduce demand for fossil gas and GHGs, and improve ambient and indoor air quality. AB 197: direct emissions reductions for sources covered by the AB 32 Inventory In response to Governor Newsom's July 2022 letter
New Residential and Commercial Buildings	All electric appliances beginning 2026 (residential) and 2029 (commercial), contributing to 6 million heat pumps installed statewide by 2030	Reduce demand for fossil gas and GHGs, and improve ambient and indoor air quality. AB 197: direct emissions reductions for sources covered by the AB 32 Inventory In response to Governor Newsom's July 2022 letter

** https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf*

Alignment with Rules and Strategies of Other Agencies *(con't)*

Bay Area AQMD Staff Report for Commercial Zero-NOx-Emission Standard:

- Zero-NOx 240 Volt heat pump water heaters are widely commercially available at sizes equivalent to existing natural gas systems on market for commercial spaces
- Technology development and field testing still needed to bring compliant appliances of larger water heaters and boilers up to 2 million Btu/hr to market
- Time for technology development to occur before 2031 while continuing to prioritize the emission reductions that will be achieved from enacting the rule amendments
- Staff will report to Board on technology developments and availability
  - Staff expects that availability of zero-NOx units will increase and costs will decrease over time
- For any technology categories such that zero-NOx technologies are no longer projected to be available to meet needs, Board may consider amending compliance dates through rulemaking

Alignment with Rules and Strategies of Other Agencies *(con't)*

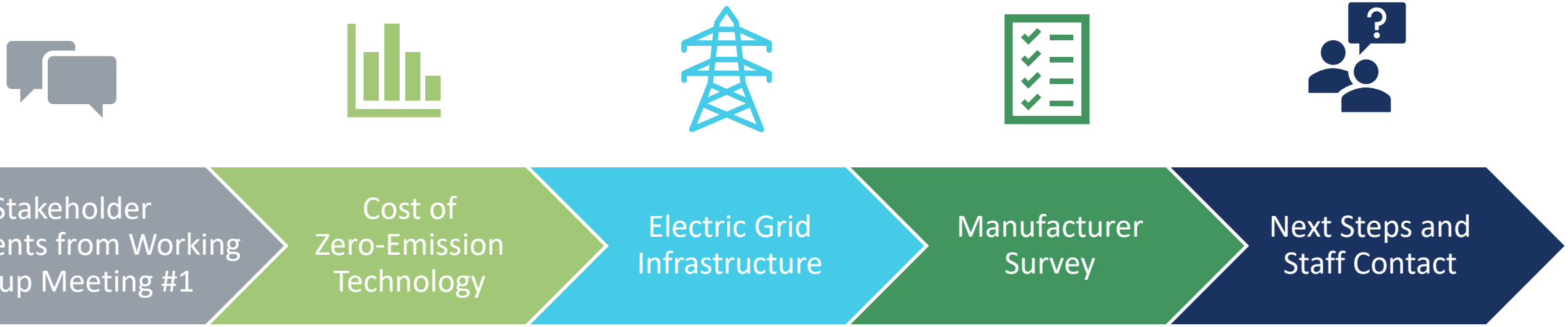
The California Energy Commission "supports an interagency, coordinated approach to the transition away from fossil gas"

California Energy Commission, California Public Utilities Commission, and California Air Resources Board are working to coordinate across efforts, identify issues not covered by ongoing efforts, and assess needed actions to better align the energy system with the state's climate targets

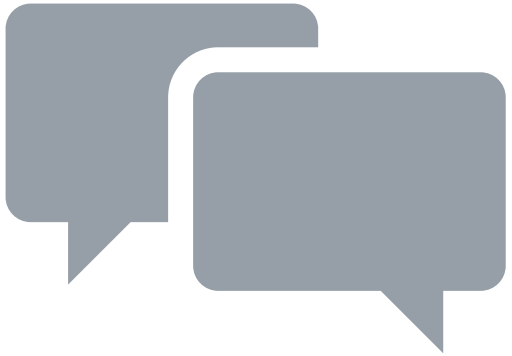
Related initiatives include the California Public Utilities Commission's proceeding to support decarbonizing buildings in California (R.19-01-011), which eliminated gas line extension subsidies for new gas hookups to homes and commercial buildings, effective July 1, 2023

Adopted 2022 Integrated Energy Policy Report Update: *https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update*

Further discussion in this meeting



Stakeholder Comments from Working Group Meeting #1



Stakeholder Comments from WGM#1 – Cost and Spacing

Stakeholders raised concerns during and after the meeting about:

Cost

Initial cost of the unit and overall operating cost, as well as cost of electric upgrades

Spacing

Heat pumps could require more space than natural gas heaters

Socioeconomic analysis will be part of the rulemaking process

Further discussion on cost in later slides

Staff acknowledges the challenge that heat pumps may require more space for operation

Staff will continue to work with stakeholders to better understand spacing challenges

Potential for off-ramp where zero-emission installation deemed infeasible (e.g., structural or sizing challenges)

Stakeholder Comments from WGM#1 *(con't)* – Estimate of Tankless Units

Questioned whether the number of Type 1 water heaters accurately counted residential tankless water heaters

- First Working Group Meeting estimated 40k Type 1 units (≤ 400,000 Btu/hr) and 20k Type 2 units (> 400,000 and ≤ 2,000,000 Btu/hr) based on 2006 rule analysis
- In recent years, adoption of residential tankless units has increased with state and federal energy efficiency regulations
  - Estimate ~300k tankless water heaters in District
    - Survey from 2019 California Residential Appliance Saturation Study (RASS) from the California Energy Commission (CEC): *https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass*
    - Residential Energy Consumption Survey (RECS) from the U.S. Energy Information Administration: *https://www.eia.gov/consumption/residential/data/2020/*

Stakeholder Comments from WGM#1 *(con't)* – Recertification, Test Procedure, Webpage

Questioned why recertification is required every three years and what benefit is conferred

- Re-certification has been in Rule 1146.2 since its adoption in 1998, and in Rule 1121 since 1995
- Re-certification provides confidence that certified units continue to be manufactured in compliance

Suggested to amend test procedure for dual fuel heat pump to limit annual fuel use

- Difficult to ensure NOx emissions reductions are being achieved for dual fuel units as they can exclusively be operated with natural gas
- Staff will continue to work with stakeholders to better understand the options

Asked for information to be made available online

- Webpage for Building Appliances Rules: *http://www.aqmd.gov/home/rules-compliance/residential-and-commercial-building-appliances*

Stakeholder Comments from WGM#1 *(con't)* – Electric Grid Power Supply and Reliability

Stakeholders raised concerns about electric grid power supply

- Further discussion on electricity generation in later slides
  - Agencies including the California Energy Commission continue to conduct analyses

Stakeholders raised concerns about electric grid reliability

- Staff recognizes the importance of electric grid reliability for electric units, but also for natural gas units, which often require electricity to operate
- In 2021, the California Public Utilities Commission created new programs and modified existing programs to reduce energy demand and increase energy supply during critical hours of the day*
- Per Senate Bill 350, the California Public Utilities Commission developed an integrated resource planning process to ensure that California's electric sector meets its greenhouse gas reduction goals while maintaining reliability at the lowest possible costs**
- More discussion on state agency actions in later slides

** https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-ensures-electricity-reliability-during-extreme-weather-for-summers-2022-and-2023*
*** https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-approves-long-term-plans-to-meet-electricity-reliability-and-climate-goals*

Stakeholder Comments from WGM#1 *(con't)* – Emissions from Electricity Generation

Staff recognizes the need for regulation of emissions from electricity generation

Rule 1135 –
Emissions of Oxides of Nitrogen from Electricity Generating Facilities:
http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1135.pdf?sfvrsn=4

There are externalities for both electric and natural gas production and distribution

Natural gas leaks into the atmosphere from natural gas wells, storage tanks, pipelines, and processing plants

- In 2020, methane emissions from natural gas and petroleum systems and from abandoned oil and natural gas wells were source of ~33% of U.S. methane emissions and ~4% of U.S. greenhouse gas emissions
- There have been examples of large leaks (e.g., Aliso Canyon: 109k metric tons of methane emissions released from October 2015 - February 2016)

Staff will not be conducting lifecycle analyses related to the BARCT assessment

Further discussion on grid in later slides

Stakeholder Comments from WGM#1 *(con't)* – Refrigerant Leakage

Stakeholders raised concerns about refrigerant leakage:

- Heat pumps are a closed system, and overall refrigerant leakage is expected to be low
- Very low- or no-Global Warming Potential technologies and solutions are either available or emerging for various heat pump technologies
- California Senate Bill 1206, passed in 2022, prohibits the sale of refrigerants that exceed a specified global warming potential limit beginning January 1, 2025

Stakeholder Comments from WGM#1 *(con't)* – Emergency Replacement, Workforce

Raised concerns about emergency replacement of units

- Staff acknowledges the concern for emergency replacement of units, including 2 MMBtu, and related electric upgrades
- Other agencies have already adopted similar rules or are undertaking the rulemaking process
  - Monitoring progress of technology

Raised concerns about labor workforce readiness

- Informed labor force is required to service zero-emission units
- Potential implementation in 2031 provides opportunity for greater outreach and education
- TECH Clean California* and Southern California Edison provide workshops/ webinars for contractors

** https://switchison.org/contractors/training-hub/*

Stakeholder Comments from WGM#1 *(con't)* – High Temperature Processes

Stakeholders raised concerns about high temperature processes

Higher water temperature requirements for restaurant operations

- Heat pump technology can reach required temperatures

High temperature needs (over 190°F), high outlet water temperatures

- Future implementation date would provide opportunity for technology development including commercial heat pump boilers

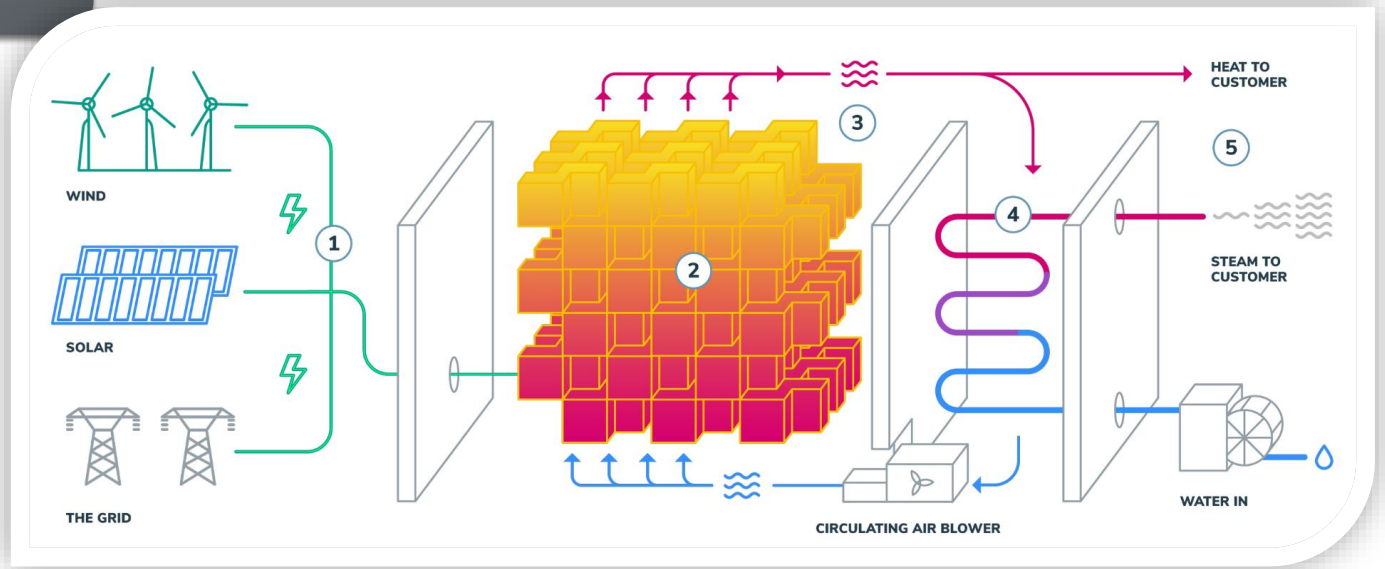
Industrial hot water boilers running at over 200-250°F and high-pressure steam boilers

- Staff recognizes that for steam, heat pump technology may not be viable yet
- Staff recognizes that for certain industrial processes, heat pump technology is not as mature, and electric option could be more expensive
- For many commercial processes, heat pumps are a viable technology
- Heat pumps using waste heat can achieve high temperatures (250°F)

Stakeholder Comments from WGM#1 *(con't)* – High Temperature Processes

Potential Technology – Rondo Heat Battery

- Converts wind and solar power into industrial heat and power
- Drop-in, zero-emission, boiler replacement
- Charge and deliver heat simultaneously
- Scale up or down to meet evolving facility needs and energy goals
- 50-year life and unlimited cycles
- High temperatures up to 1500°C
- High Btu size
- Further information: https://rondo.com/



Stakeholder Comments from WGM#1 *(con't)* – Cold Climates/High Altitudes

Stakeholders raised concerns about heat pump operation in cold climates/high altitudes

There are heat pump products available in the market that can operate at low temperatures
- Northwest Energy Efficiency Alliance's Qualified Products List includes:
  - Heat pump water heater products that are energy efficient in cold climates
  - Products that can produce hot water via heat pump at -25°F

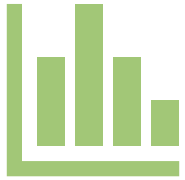
Cold climate heat pumps can pull heat from the air even at below-zero temperatures

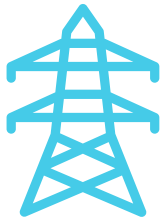
Continue communication with stakeholders to understand the challenge

Stakeholder Comments from WGM#1 *(con't)* – Cold Climates/High Altitudes

Heat pumps have been in use in colder climates:			
Maine has one of highest per capita heat-pump adoption rates, outpacing Scandinavian countries ▪ Rebates incentivized installation of ~116,000 heat pumps in a state that has fewer than 600,000 occupied housing units	Heat pumps also on the rise in places like Vermont and Alaska	According to the International Energy Agency, 60% of Norway's buildings are fitted with a heat pump	In recent state budget, New York adopted first-in-the-nation law prohibiting installation of fossil-fuel equipment in buildings of seven stories or less in 2026; 2029 for larger buildings

Further discussion in this meeting





Cost of Zero-Emission Technology

Electric Grid Infrastructure

Manufacturer Survey

Next Steps and Staff Contact

Cost of Zero-Emission Technology

Cost of Tankless Water Heater Technology

Bay Area AQMD's Rule 9-6 adopted in March 2023 referenced a study from Lawrence Berkeley National Laboratory that included residential tankless cost:

- Median project cost of tankless gas-fired water heater: ~$4,000
- The data includes the cost of the appliance unit as well as installation and other costs

Energy and Environmental Economics (E3), Inc. study cost assumption

- Project cost for tankless gas water heater: $3,700 - $5,700

These costs are not including panel upgrade costs

Cost of Conventional Boiler Technology

An internet search for market costs of 14 **commercial boilers <20 ppm NOx** of different Btu sizes can be used for future price comparison

Btu Size	Price
399,000	$11,700
399,000	$9,600
500,000	$13,100
500,000	$14,600
600,000	$18,200
600,000	$14,600
750,000	$15,800

Btu Size	Price
850,000	$17,100
855,000	$23,500
990,000	$21,800
999,000	$44,900
1,440,000	$26,400
1,500,000	$47,400
2,000,000	$56,500

Cost of Zero-Emission Technology

Third-party study for 2021 Washington State Energy Code Commercial (WSEC-C)

- Total cost is for **173 apartments**
  - ~1.5 people per apartment, 260 people, 25 gallons domestic hot water per day per person
  - Total cost includes costs of heat pump unit, hot water storage, and controls
    - Unit price, installation and markup
  - $263,600 ÷ 173 apartments = **$1,523.70 per apartment**
- Central gas boiler total cost: $132,560
  - Total gas usage: 17,196.99 therms
- These conservative cost numbers can be used for future comparisons

Heat Pump Plant	QTY	Unit Price	Install and Markup	Total Costs
Heat Pumps (2) CXA-15 and (1) CXA-10	1	$79,000	$63,200	$142,200
Hot Water Storage (2000 Gallons)	4	$12,000	$9,600	$86,400
Controls	1	$15,000	$20,000	$35,000
		$106,000	$92,800	$263,600
Central Gas Boiler	**QTY**	**Unit Price**	**Install and Markup**	**Total Costs**
Gas Boiler (275,000 Btu/hr)	1	$6,200	$4,960	$11,160
Hot Water Storage (2000 Gallons)	4	$12,000	$9,600	$86,400
Controls	1	$15,000	$20,000	$35,000
		$33,200	$34,560	$132,560

Cost of Zero-Emission Technology *(con't)*

Market costs for **commercial high temperature heat pump water heaters** can be used for future comparison

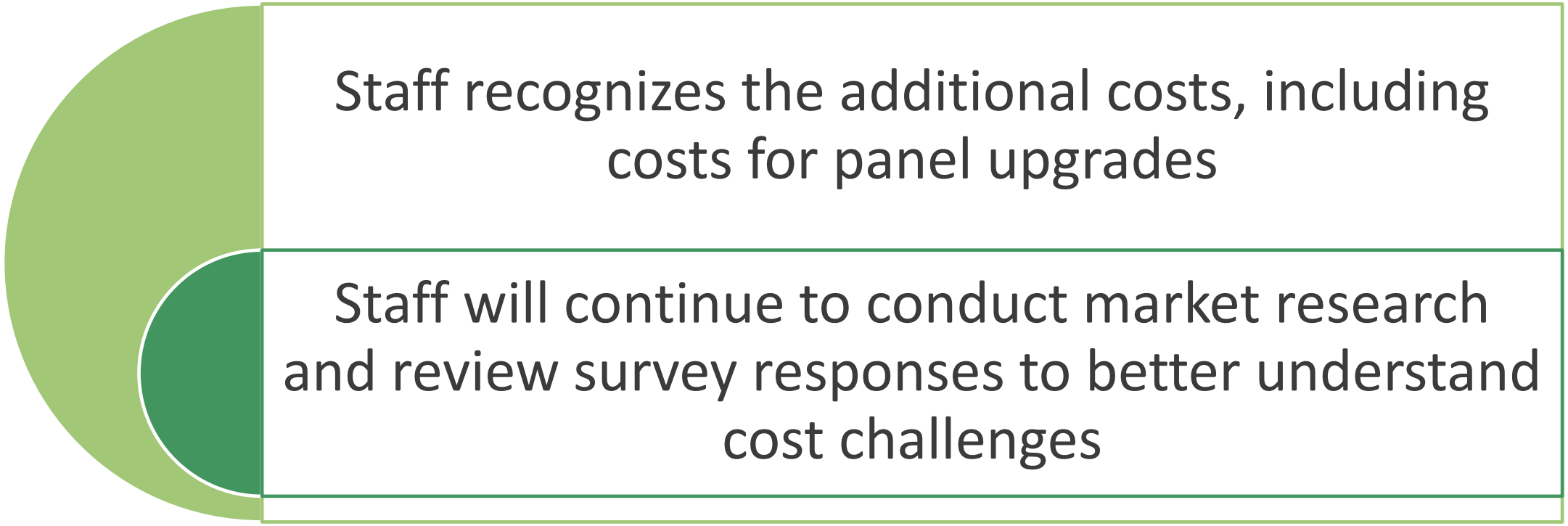
Initial search of commercial **hot water** heat pump water heater market

- Looking at five different models sold or installed in U.S./Southern California with focus on **high water temperatures:**
  - Water temperature 160°F - 248°F
    - Waste heat recycling to achieve up to 248°F
  - Coefficient of Performance 4.3 - 6.0
  - One manufacturer indicated $42K - $140K depending on unit size (waste heat)

Further market research is needed for commercial units, including for high temperature

- Forthcoming survey responses from manufacturers will aid rule development

Cost of Zero-Emission Technology *(con't)*



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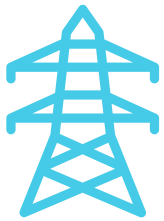

Electric Grid Infrastructure

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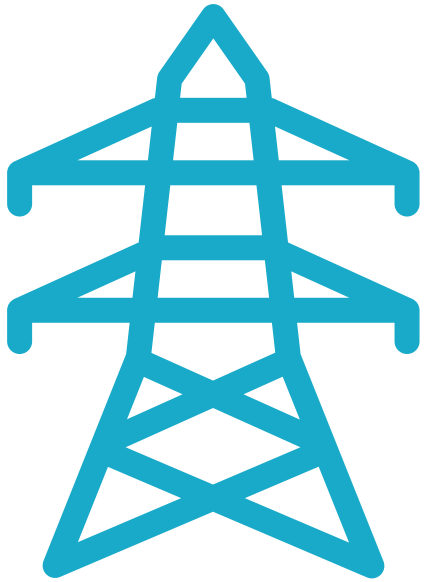


Electric Grid Infrastructure

In 2021, renewable generation accounted for 33.6% of the total California Power Mix

- California Power Mix is the percentage of specified fuel types derived from the California Energy Mix
- California Energy Mix is the total in-state electric generation plus energy imports
- Not including solar photovoltaic systems installed on residential and commercial buildings that are <1 MW, as they are typically considered distributed generation and not required to report to California Energy Commission

There is expected to be more renewables adoption by states in the future

- California Senate Bill 100 called for Renewables Portfolio Standard of **60% by 2030**

Electricity imports account for approximately 30% of total system electric generation

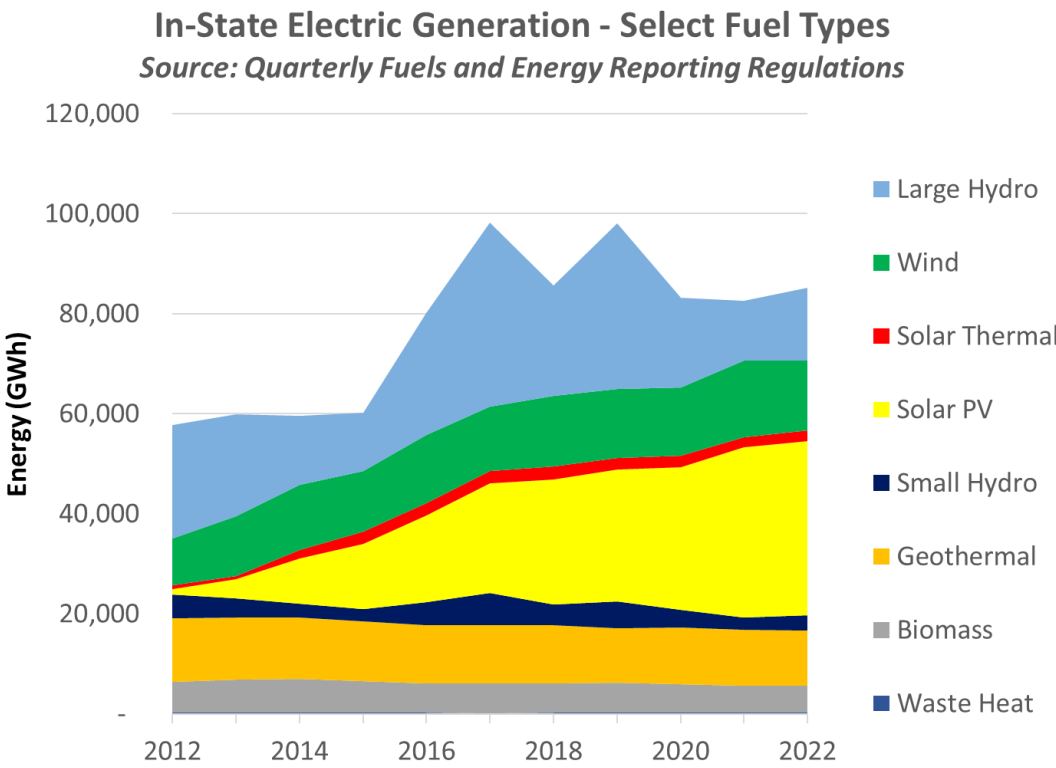
- Other states can also have Renewable Portfolio Standards and energy goals

Further analysis will be needed on renewable electricity generation forecasts and trends

** https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation*

Electric Grid Infrastructure

Solar PV adoption continues to increase*



Solar Photovoltaic (PV) in the Energy Code (Section 140.10)**

- "2019 Energy Code was the first Energy Code update to include **prescriptive** requirements for solar PV, which applied to single-family homes and low-rise residential buildings" (multifamily ≤ 3 stories)***
- 2022 Energy Code added **prescriptive** requirements for solar PV and battery storage for **new buildings**:
  - "High-rise multifamily buildings" (4+ stories);
  - "Selected commercial occupancy types (such as office and tenant spaces, schools, warehouses, retail, grocery, restaurants, medical clinics, theaters/auditoriums, convention centers, and hotel/motels)"
- "Specify system sizes to ensure that most PV generation is used on site"
- "All newly constructed building types specified … shall have a newly installed photovoltaic (PV) system meeting the minimum qualification requirements of Reference Joint Appendix JA11"
- Prescriptive: "each individual component of the proposed building must meet a prescribed minimum energy requirement"

** https://www.energy.ca.gov/media/3757*

*** https://efiling.energy.ca.gov/GetDocument.aspx?tn=238848*

**** https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2021-integrated-energy-policy-report*

California Independent System Operator (CAISO)

The California Independent System Operator is planning $11 billion in transmission capacity projects over the next 20 years, which covers 80% of the entire state service area

- The 20-Year Transmission Outlook document* from May 2022 considers transmission needs to meet load and renewable energy growth aligned with state policy
  - Plan describes $11 billion in upgrades to the existing CAISO transmission footprint

** http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf*

California Energy Commission

The California Energy Commission Adopted the **2022 Integrated Energy Policy Report Update*** addressing the projected electricity demand increase

The Integrated Energy Policy Report provides a cohesive approach to identifying and solving state's pressing energy needs and issues, adopted every two years, updated every other year

Under Assembly Bill 3232, the California Energy Commission must assess the feasibility of reducing **greenhouse gas emissions** in residential and commercial buildings **40% below 1990** levels by January 1, **2030**

Statewide electricity consumption was >280,000 GWh in 2021 and is forecasted to be **358,738 GWh in 2035**

The 2022 Planning Scenario **peak forecast** for the California Independent System Operator, which manages roughly 80% of California's load, reaches **55,117 MW by 2035**

Between 2022 and 2035, behind-the-meter photovoltaic generation grows on average by about 6%, reaching **annual photovoltaic generation of 55,740 GWh by 2035**

** https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update*

California Public Utilities Commission

In February 2023, the Commission ordered load serving entities to procure an additional 4,000 megawatts (MW) of Net Qualifying Capacity for 2026 and 2027

- In addition to the mid-term reliability procurement requirements ordered in 2021 (11,500 MW)
  - 11,500 MW is enough to power approximately 2.5 million homes
- Also approved four energy storage contracts totaling 372 MW for Southern California Edison

The Commission also recommended an electric resource portfolio for use in the California Independent System Operator's 2023-24 Transmission Planning Process

- Recommended portfolio includes > 85 GW of new resources by 2035, including
  - 54,000 MW of renewable resources;
  - > 28,000 MW of batteries;
  - 2,000 MW of long-duration storage;
  - 1,100 MW of demand response

Southern California Edison

Southern California Edison is “expanding and upgrading … transmission and distribution networks to meet the region’s growing demand for electricity”

2021 Sustainability Report*

- Expects to invest > $5 billion annually in grid
- **~3,400 MW of energy storage** installed/contracted
- In 2021, **procured 530 MW of energy storage** through three new contracts from third parties
- In 2021, entered into an engineering, procurement and construction agreement to **construct approximately 535 MW of utility-owned storage**
- Expecting increases in Distributed Energy Resources, such as solar

** https://www.edison.com/sustainability/sustainability-report*

Pathway to 2045**

- Southern California Edison recognizes future load increases due to electrification of state’s economy combined with population and economic growth
- Expectation of **60%** increase in electricity load and **40%** increase in peak load by **2045**
- Building electrification responsible for **15%** of load by **2045**
- Grid will still be summer peaking due to air conditioning

*** https://www.edison.com/our-perspective/pathway-2045*

Electric Grid Infrastructure *(con't)*

Staff acknowledges the concern for electric infrastructure challenges and will continue to communicate with California agencies, utilities, and stakeholders on these topics for further analyses

Manufacturer Survey

Manufacturer Survey

A survey was sent out to space and water heating manufacturers on May 10, 2023

Staff will continue to review survey responses

The survey questions can be found on the webpage: *http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/proposed-rules/rule-1146-2*

Next Steps and Staff Contact

Next Steps

Tentative Schedule for Proposed Amended Rule 1146.2:

- Public Workshop – August 2023
- Stationary Source Committee – September 2023
- Public Hearing – November 2023

Incentives:

- Developing a new rebate program for building appliances, potentially similar to the current CleanAir Furnace Rebate Program

Webpage for more information on Building Appliances Rules:
http://www.aqmd.gov/home/rules-compliance/residential-and-commercial-building-appliances

Sign Up for Notifications

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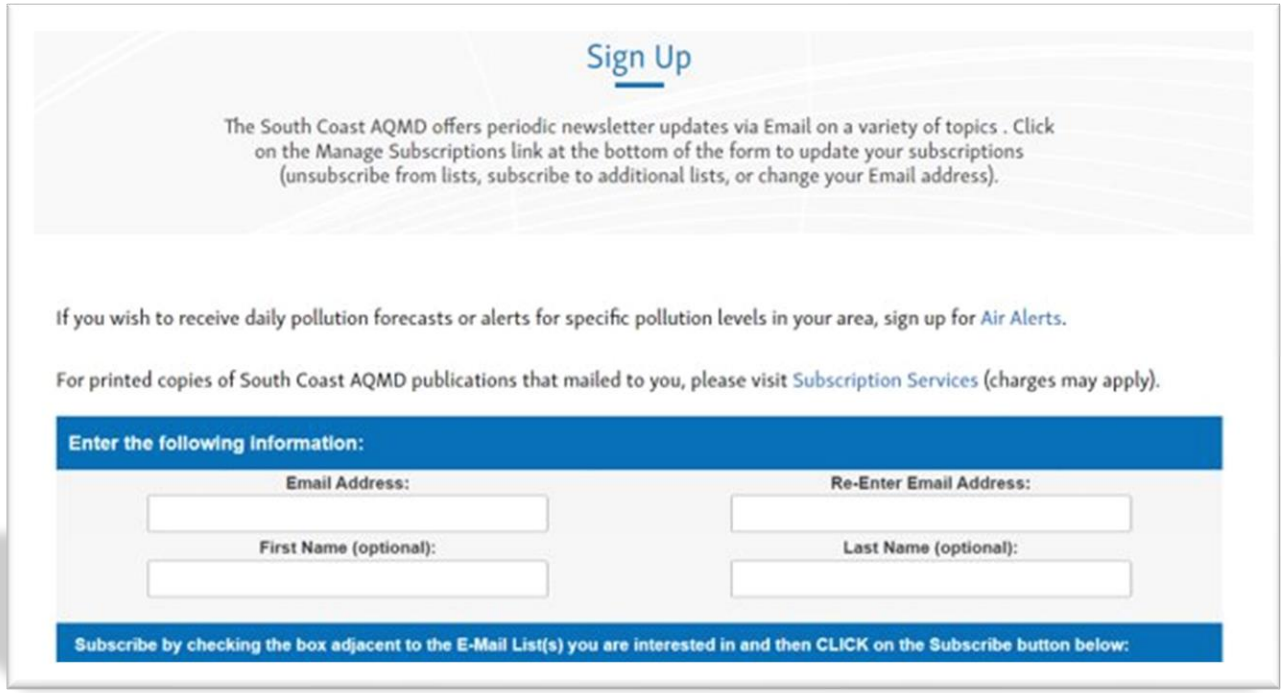

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