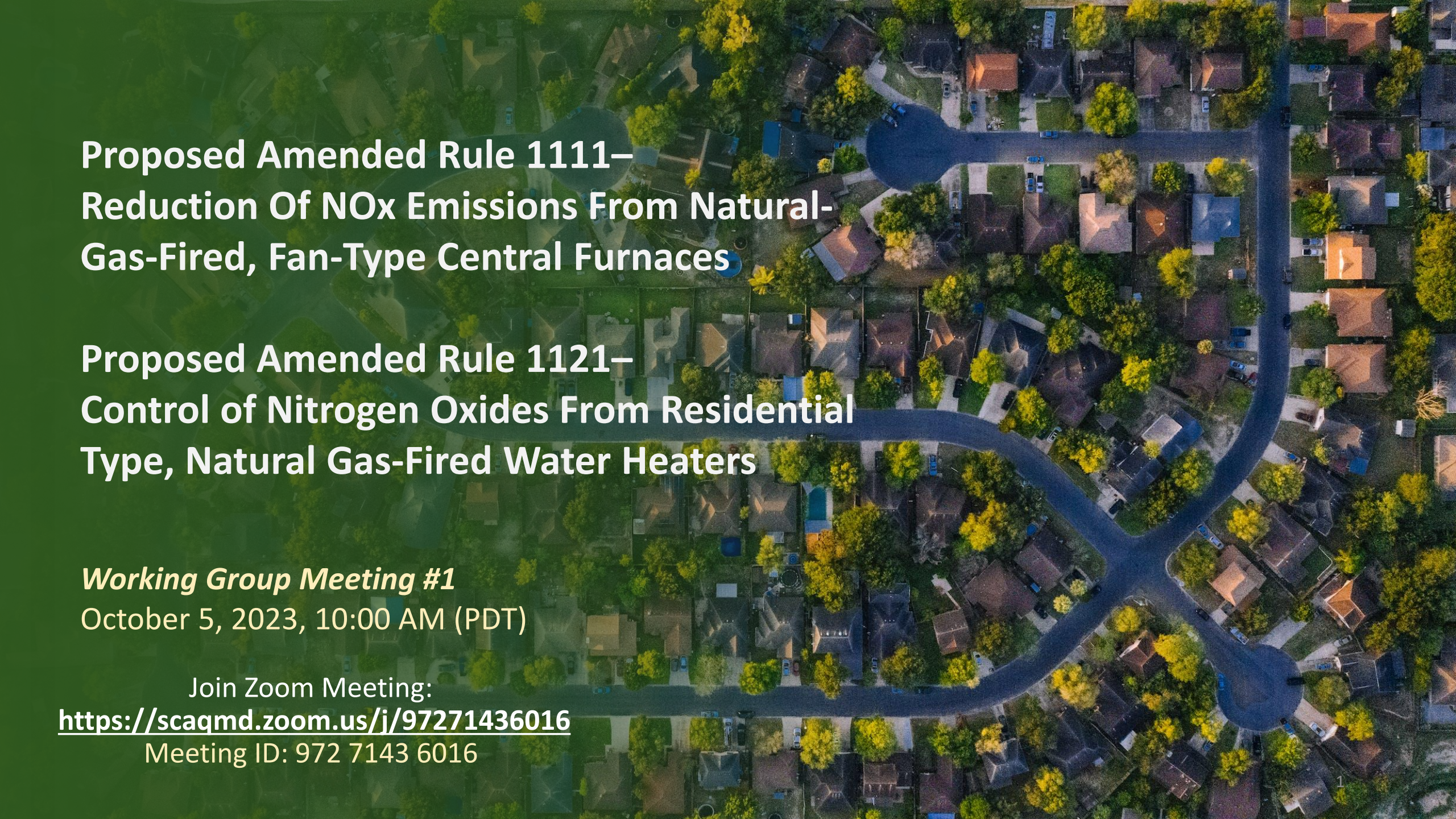


Proposed Amended Rule 1111– Reduction Of NOx Emissions From Natural-Gas-Fired, Fan-Type Central Furnaces

Proposed Amended Rule 1121– Control of Nitrogen Oxides From Residential Type, Natural Gas-Fired Water Heaters

Working Group Meeting #1

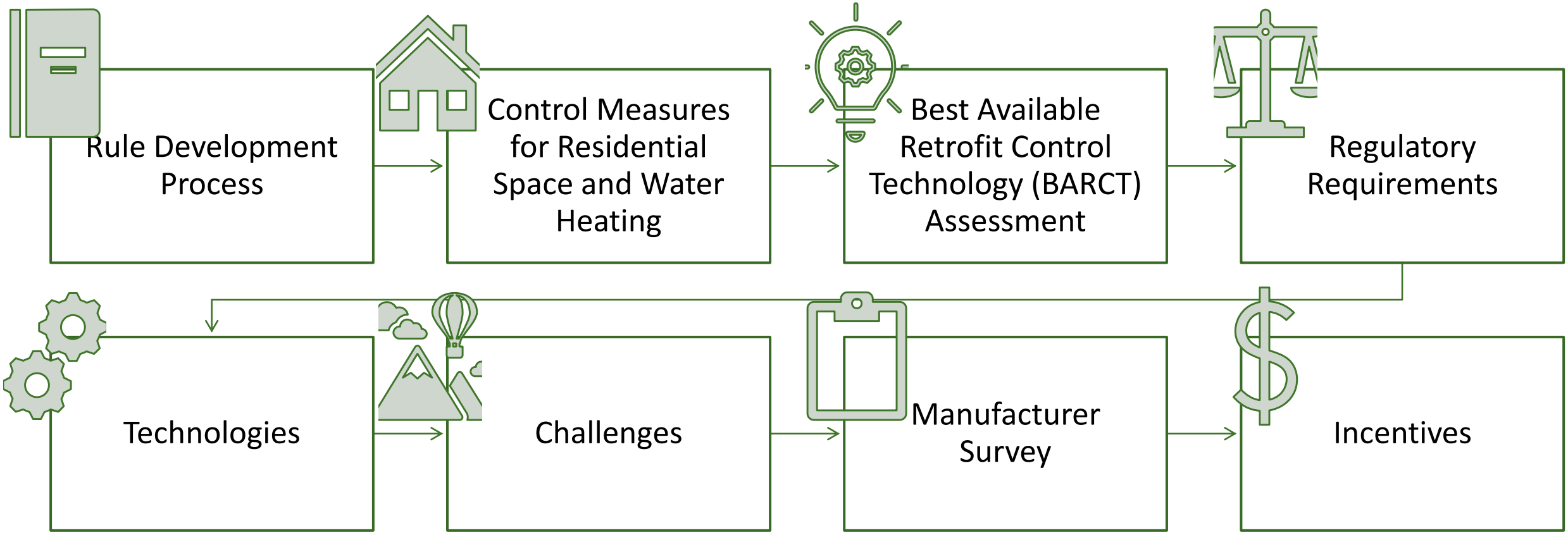
October 5, 2023, 10:00 AM (PDT)

Join Zoom Meeting:

https://scaqmd.zoom.us/j/97271436016

Meeting ID: 972 7143 6016

Agenda


Rule Development Process
Control Measures for Residential Space and Water Heating
Best Available Retrofit Control Technology (BARCT) Assessment
Regulatory Requirements
Technologies
Challenges
Manufacturer Survey
Incentives

Rule Development Process Background

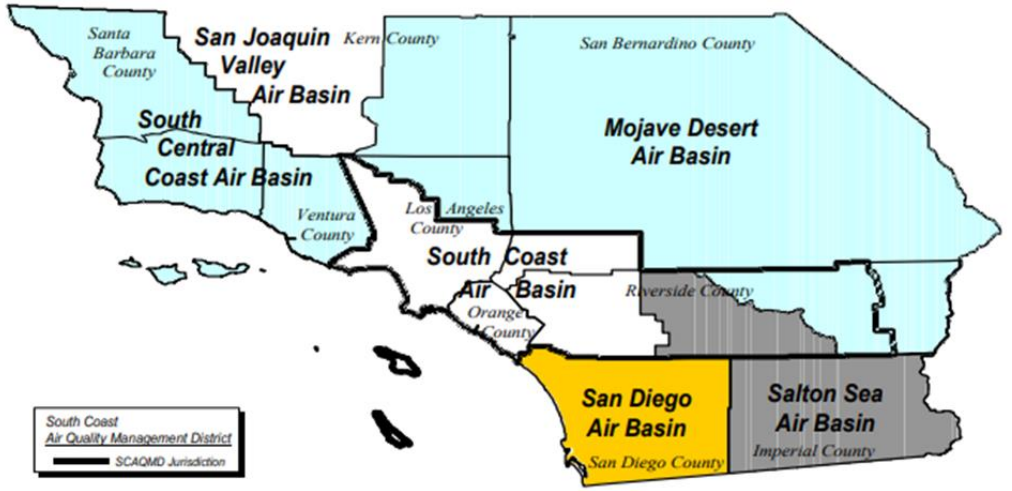
South Coast AQMD

Air Pollution Control Agency

- Orange County and portions of Los Angeles, San Bernadino and Riverside Counties
- Consists of South Coast Air Basin and Coachella Valley Planning Area
  - Classified “extreme” and “severe” nonattainment for 2015 ozone standard

Responsibilities

- Control emissions from stationary and area sources
  - E.g., power plants, refineries, residential buildings, etc.
- Monitor air quality and meet federal and state air quality standards
- Permit and inspect 28,400 affected businesses



South Coast AQMD Rules provide mandatory requirements to:

- Implement control measures identified in the Air Quality Management Plan, Governing Board directives, or administrative needs; and
- Facilitate compliance with the federal Clean Air Act and to implement the state air quality program

Overview of Rule Development Process

Working Group and stakeholder meetings continue throughout process

Working Group Meetings

Comprised of stakeholders, including:
- Industry
- Environmental groups
- Community members
- Public agencies

Meetings are:
- Held throughout rulemaking process
- Open to public

Objective:
- Build consensus, work through issues
- Opportunity for early input
- Solicit feedback from regulated industry

Takeaways for:
- Stakeholders' issues and concerns
- Industry terms, practices, etc.
- Applicable control technologies

Stakeholder Input

- Stakeholders can provide input during working group meetings and the rulemaking process
- Early input is strongly encouraged to help develop proposed rule amendments and to address issues
- Working Group Meetings, individual meetings, and site visits allow staff to speak directly with stakeholders and to discuss individual issues

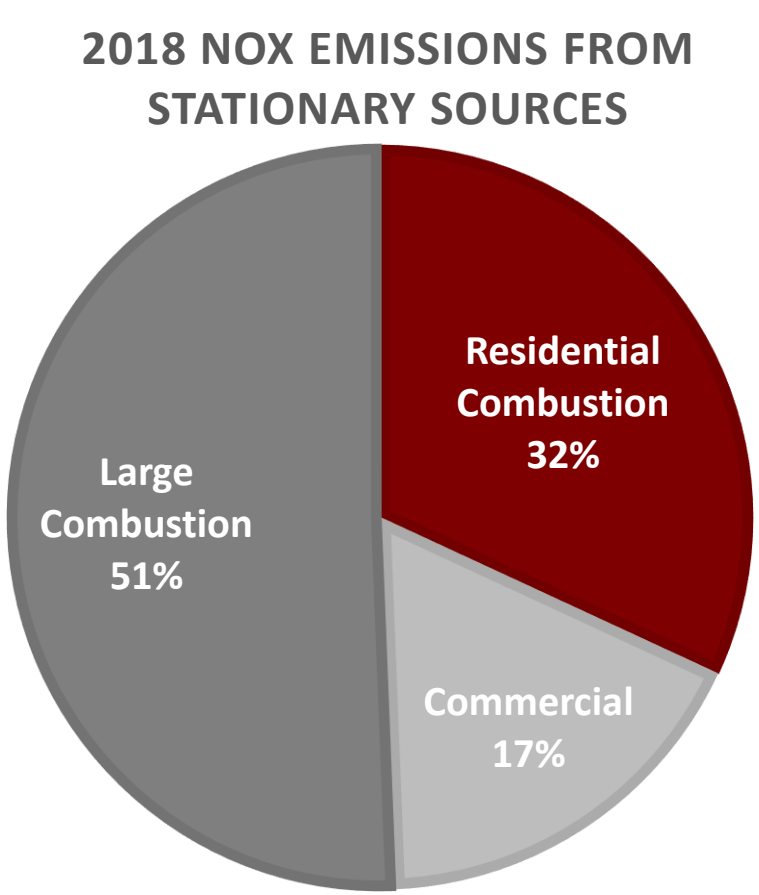
Control Measures for Residential Space and Water Heating

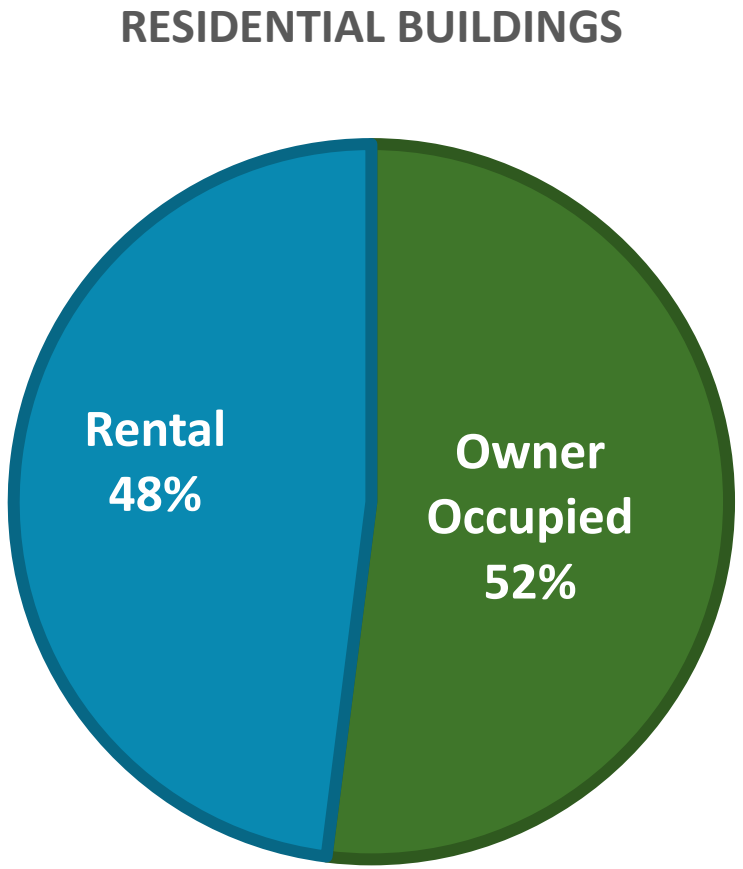
Residential Sector

- The South Coast Air Basin is home to around 17.5 million residents
  - 44 percent of the California population
  - Approximately six million housing units
- Residential buildings differ widely
  - Periods of construction, size, purpose and different climate zones
- Consumption of energy within residential sector results in both direct and indirect criteria pollutants and greenhouse gas emissions

Emission Inventory

- In 2018, residential combustion emitted 19.1 tons of NOx per day, 32% of emissions from stationary sources
- Residential combustion includes space heating, water heating, cooking, and clothes drying
- The AQMP calls for a reduction in residential combustion of 9.6 tons per day
- Approximately 48% of residential buildings are rental



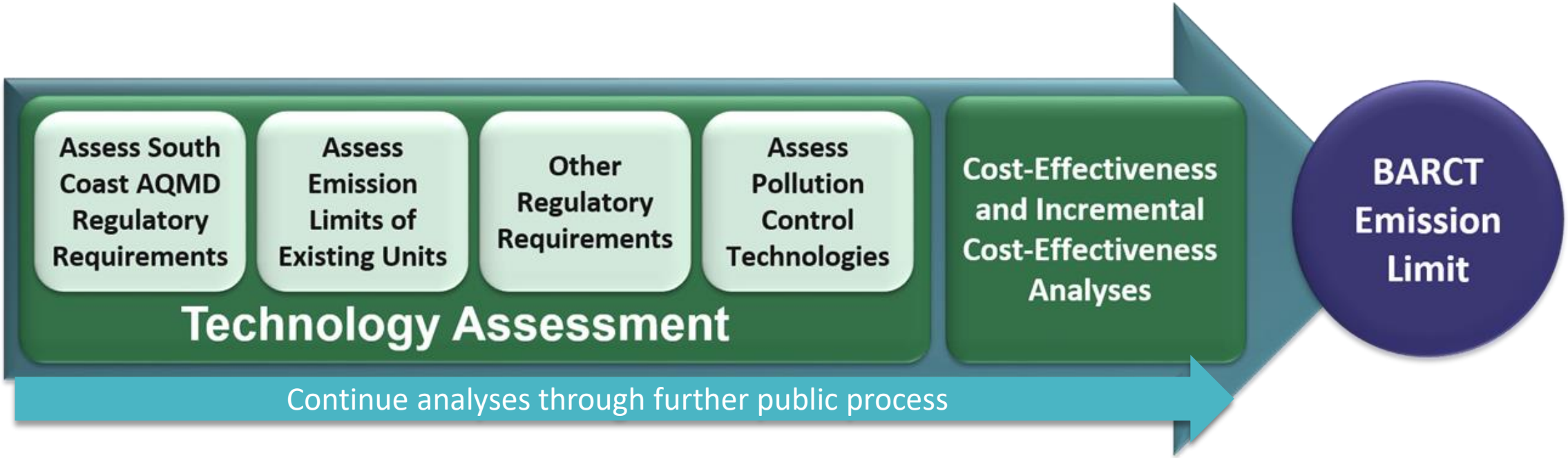


Control Measures for Residential Space and Water Heating

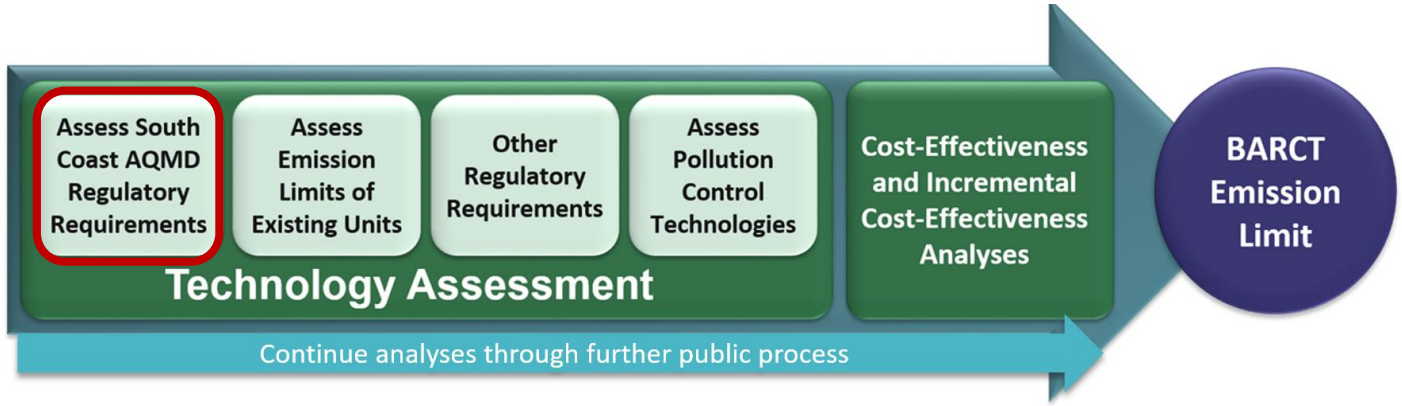
- South Coast AQMD Governing Board adopted the Air Quality Management Plan (AQMP) in December 2022:
  - Including two control measures for residential space and water heating
    - R-CMB-01 – Residential Water Heating
    - R-CMB-02 – Residential Space Heating
  - Control measures strive to establish zero-NOx-emission standards wherever feasible
- Staff has initiated this rulemaking process to implement the control measures for:
  - Proposed Amended Rule 1121 (PAR 1121); and
  - Proposed Amended Rule 1111 (PAR 1111)
- Staff will conduct a Best Available Retrofit Control Technology (BARCT) assessment to identify a cost-effective proposal

Best Available Retrofit Control Technology (BARCT) Assessment

BARCT Assessment



Regulatory Requirements - Rule 1111



Rule 1111 - Regulatory Requirement

- Adopted in December 1978 and established a NOx limit of 40 ng/J
- Applies to fan-type central furnaces less than 175,000 BTU/hr, or with a cooling rate of less than 65,000 BTU/hr for combination heating and cooling units
- Applies to manufacturers, distributors, sellers, and installers of furnaces, **NOT** end users
- NOx limit lowered to 14 ng/J in November 2009 with future compliance dates
  - Mitigation fee alternative compliance option allowed for a limited period
  - Mitigation fee for all categories except mobile homes have expired

Equipment Universe

- U.S. Census American Housing Survey* has estimates of various housing characteristics from 2021, including home heating
- Approximately 5.9 million homes in South Coast AQMD jurisdiction

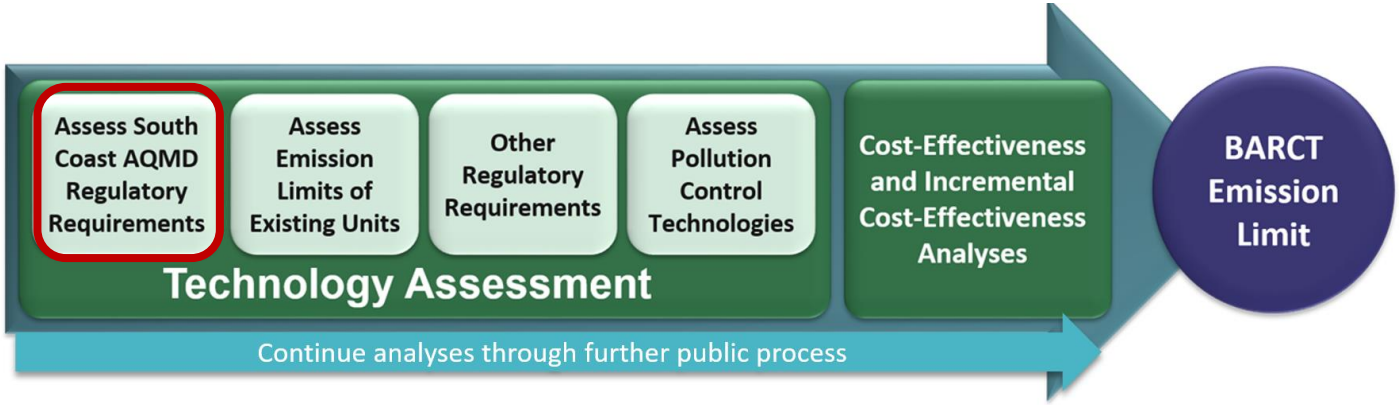
Heater Type	# of Homes	NOx Emissions
Central Furnaces	4.2 million	Yes; Subject to Rule 1111
Floor, wall or other built-in heater	1 million	Yes; Not subject to Rule 1111

*https://www.census.gov/programs-surveys/ahs.html

Equipment Universe - Commercial

- The 2022 AQMP also calls for reductions in space heating above 175,000 Btu/hr and below 2,000,000 Btu/hr for commercial buildings in control measure C-CMB-02
  - Most are package (weatherized) units
- Rule 1111 will be amended to include these units, increasing the equipment universe
- Staff still establishing number of potential package units that could be affected
  - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) directory shows 1,651 certified natural gas furnaces for commercial buildings, vs. 14,968 certified models subject to Rule 1111
  - Need stakeholders' input to estimate actual installations in the South Coast AQMD

Regulatory Requirements - Rule 1121



Rule 1121 – Applicability and Requirements

Assess South Coast AQMD Regulatory Requirements

Applicability

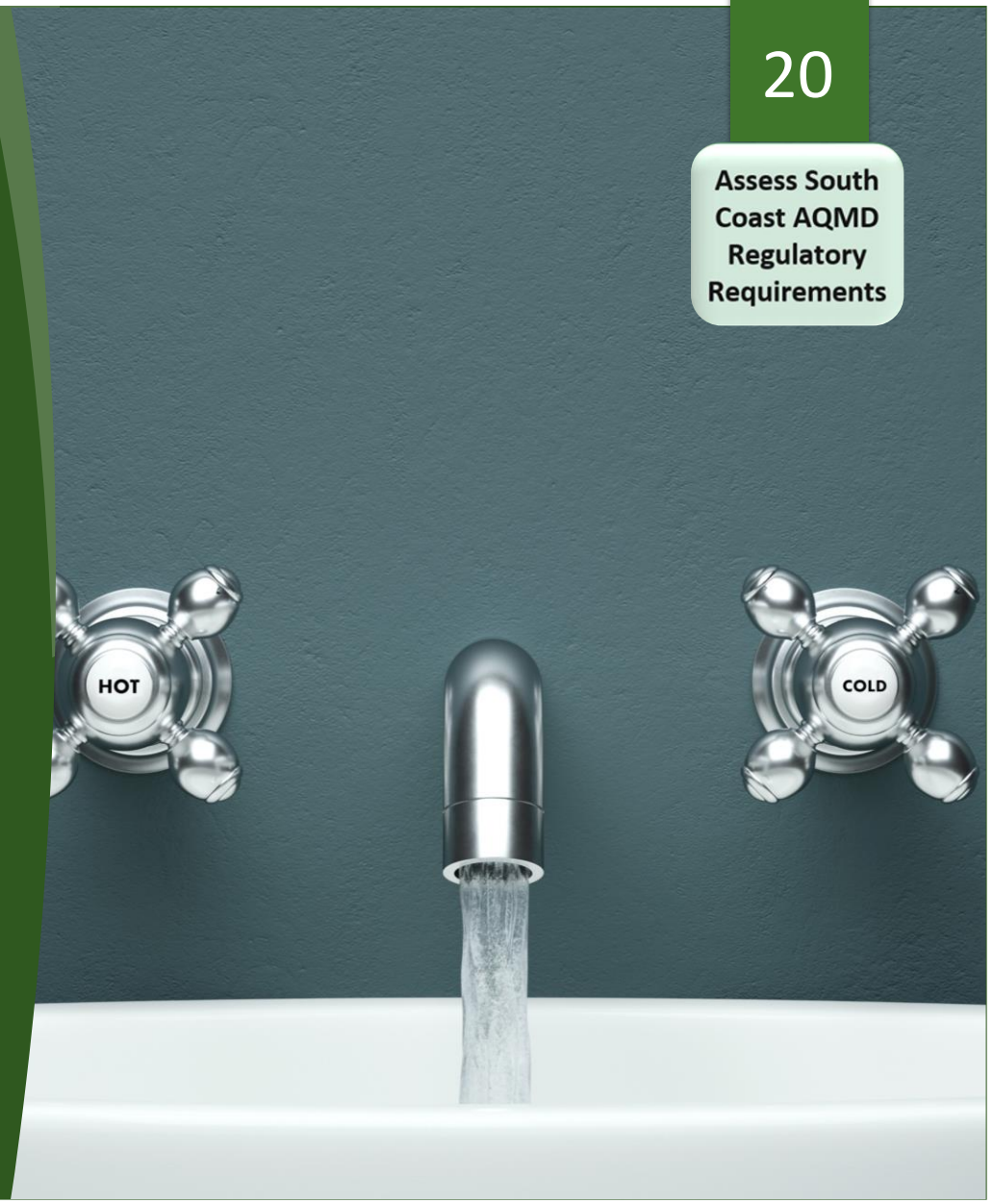
- Water heaters less than 75,000 Btu/hr
  - Usually residential or light commercial
  - Larger residential units may be subject to Rule 1146.2 instead of Rule 1121
- Applies to manufacturers, distributors, installer, etc. **NOT** end users

Requirements

- Requires water heaters emit no more than 10 ng/J (15 ppm) of NOx
- Exempts water heaters in recreational vehicles

Rule 1121 - Universe

- U.S. Census American Housing Survey for residential homes in South Coast: 5.1 million gas water heaters (of 5.9 million homes)
- Tankless water heaters are regulated by Rule 1146.2
  - Staff currently in rule development process evaluating zero-emission technologies

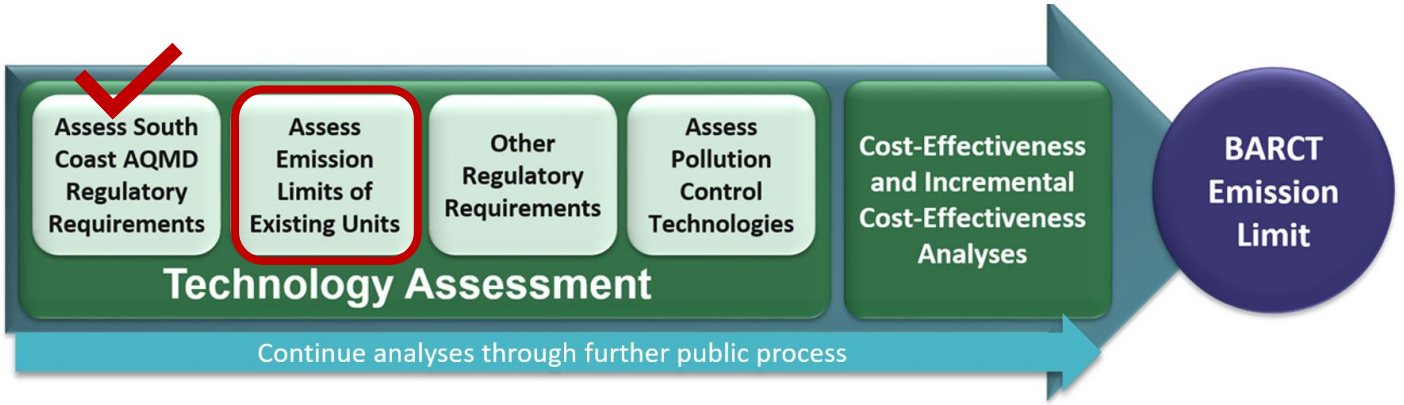


Summary of South Coast AQMD Regulatory Requirements

- Emission limits for the existing units are summarized below:

Equipment Type	Applicable Rule	Emission Limit
Fan-Type Central Furnaces < 175,000 Btu/hr, or with a cooling rate of < 65,000 Btu/hr	Rule 1111	14 ng/J
Water Heaters < 75,000 Btu/hr	Rule 1121	10 ng/J

Emission Levels of Existing Units



- BARCT assessment requires staff to assess the emission of existing units
  - Demonstrates the achievable emissions levels of existing, commercially available

Emission Levels of Existing Units

- Emissions of available units for space and water heating in tables below
  - Zero-emission technologies discussed in further slides

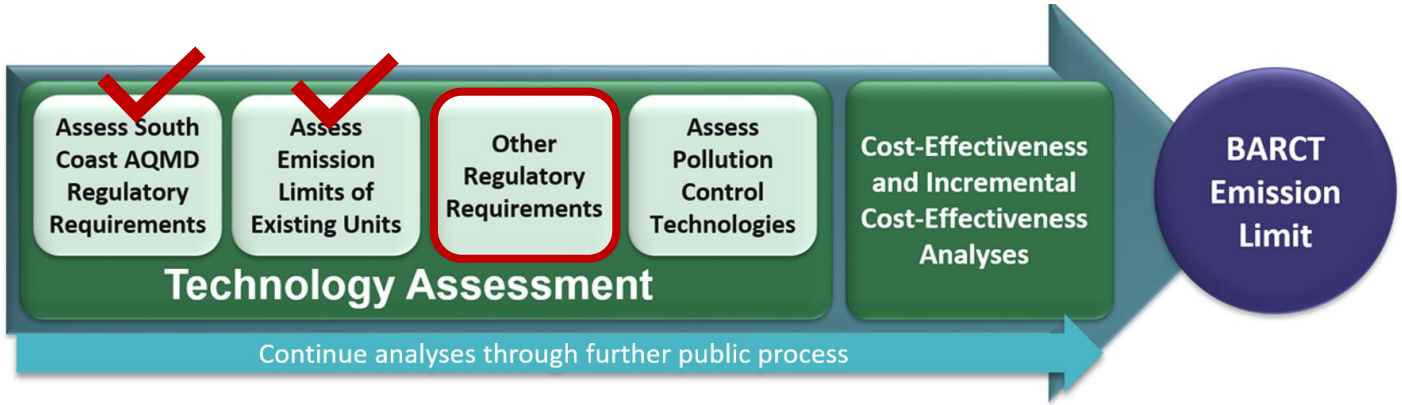
Space Heating:

Equipment type	NOx Emissions (ng/J)
Gas-fired furnace	14
Wall heater	Unknown, likely >40
HVAC Heat pump	0
Solar Heater	0
Gas mobile home furnace	40
Electric resistance heater	0

Water Heating:

Equipment type	NOx Emissions (ng/J)
Tank-type gas water heater	10
Electric resistance water heater	0
Heat pump water heater	0
Solar Heater	0

Other Regulatory Requirements



California Energy Commission Building Code

- In August 2021, California Energy Commission (CEC) adopted 2022 Title 24 Building Energy Efficiency Standards (2022 Building Code) for newly constructed buildings and additions and alterations to existing buildings
  - Requires new construction of homes be electric ready, with additional dedicated circuits
  - Encourages heat pump heating, ventilation, and air conditioning (HVAC) and heat pump water heaters
- Draft 2025 Building Code includes voluntary replacement of air conditioning with heat pumps

2022 Single Family Residential Compliance Manual

2021 Building Energy Efficiency Standards Summary (ca.gov)

California Energy Commission : Docket Log

California Air Resources Board (CARB) – Zero Emissions

- CARB adopted State Implementation Plan (SIP) Strategy in 2022 to demonstrate how California will meet the U.S. EPA 8-hour ozone standard
- SIP included a plan to develop a zero-emission standards for space and water heating with implementation date of 2030
- Rulemaking process underway for zero-emission appliances
  - Seeking to reduce greenhouse gas emissions from new space and water heaters
  - Primary goal to reduce emissions from new residential and commercial space and water heaters sold in California
  - Plan to bring to board by 2025
  - Further information on CARB rulemaking process: https://ww2.arb.ca.gov/our-work/programs/zero-emission-appliance-standards

Local Ordinances

- Over 70 cities and counties in California have passed building electrification ordinances for new residential and commercial buildings
  - Mostly in Northern California
  - At least five cities in the South Coast AQMD

City	Effective Date	Exemptions
Santa Monica	October 2022	Historical buildings
Riverside	January 2023	Commercial kitchens and hospital emergency equipment
Agoura Hills	February 2023	None
Los Angeles	April 2023	Commercial kitchens, emergency equipment
Glendale	January 2024	Where technically infeasible

Bay Area AQMD : Rules 9-4 and 9-6

Rule 9-4

- Rule regulating furnaces less than 175,000 Btu, amended December 2022

Emission Limits

- Current NOx limit: 40 ng/J
- Interim NOx limit by 2024: 14 ng/J
- Zero emission standard by 2029
  - Mobile homes exempt from zero emission standard

Rule 9-6

- Rule regulating water heaters and boilers less than 2 million Btu, amended December 2022

Emission Limits

- Current NOx limit: 10-14 ng/J depending on capacity
- Zero emission standard by:
  - 2027 for 75,000 Btu or less
  - 2031 for 75,000 to 2 million
- Water heaters in recreational vehicles and pool heaters under 400,000 Btu are exempt from zero emission standard

Implementation Monitoring for zero emission standards

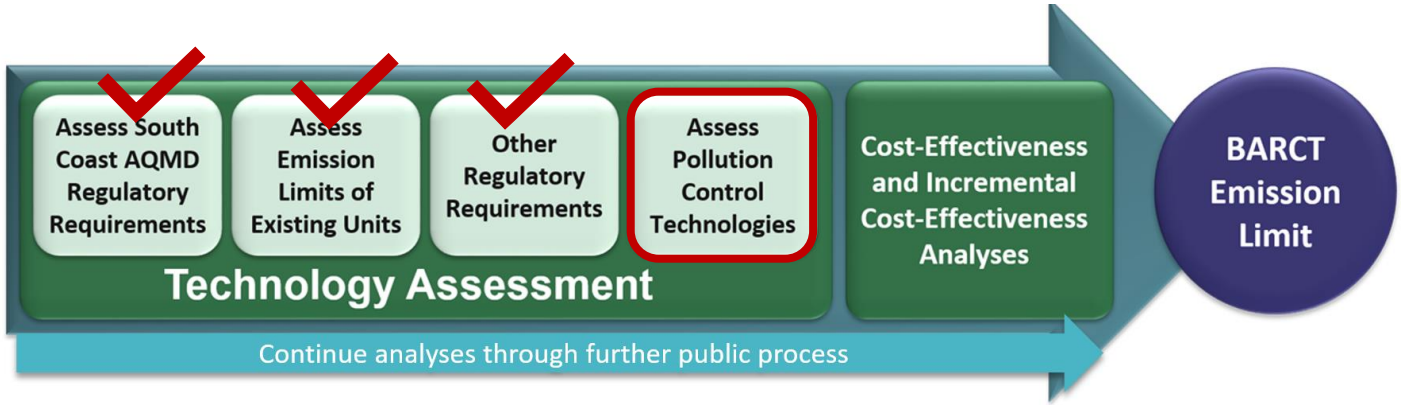
- Interim report two years before compliance date
- Implementation Working Group commenced this year

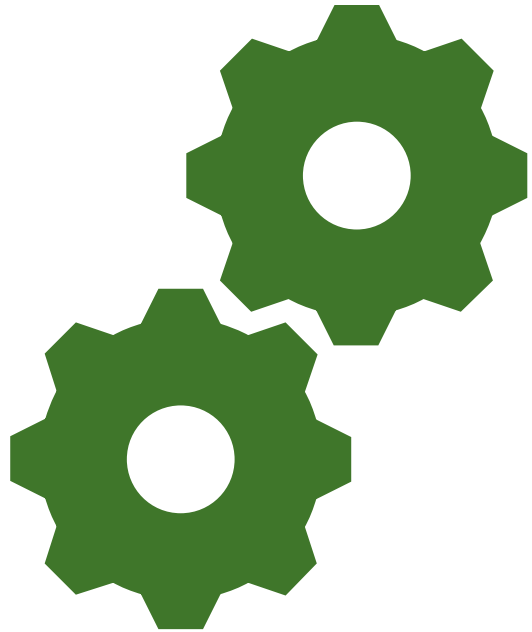
Summary of Alignment with Rules and Strategies of Other Agencies

- 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 2022 SIP Strategy	Bay Area AQMD Rules 9-4 and 9-6	California Energy Commission 2025 Energy Code
Board Consideration	Anticipated 2025	Adopted March 2023	Anticipated 2024
Implementation Date	**Anticipated 2030** - New equipment and appliances sold for use in residential buildings	**2027, 2029** - Natural gas-fired units	**2023, 2026** - Heat pumps required for new buildings - Heat pumps encouraged on replacement
Emission Limit	Anticipated zero-emission (GHG, NOx)	Zero-NOx standard	None
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	https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Technologies



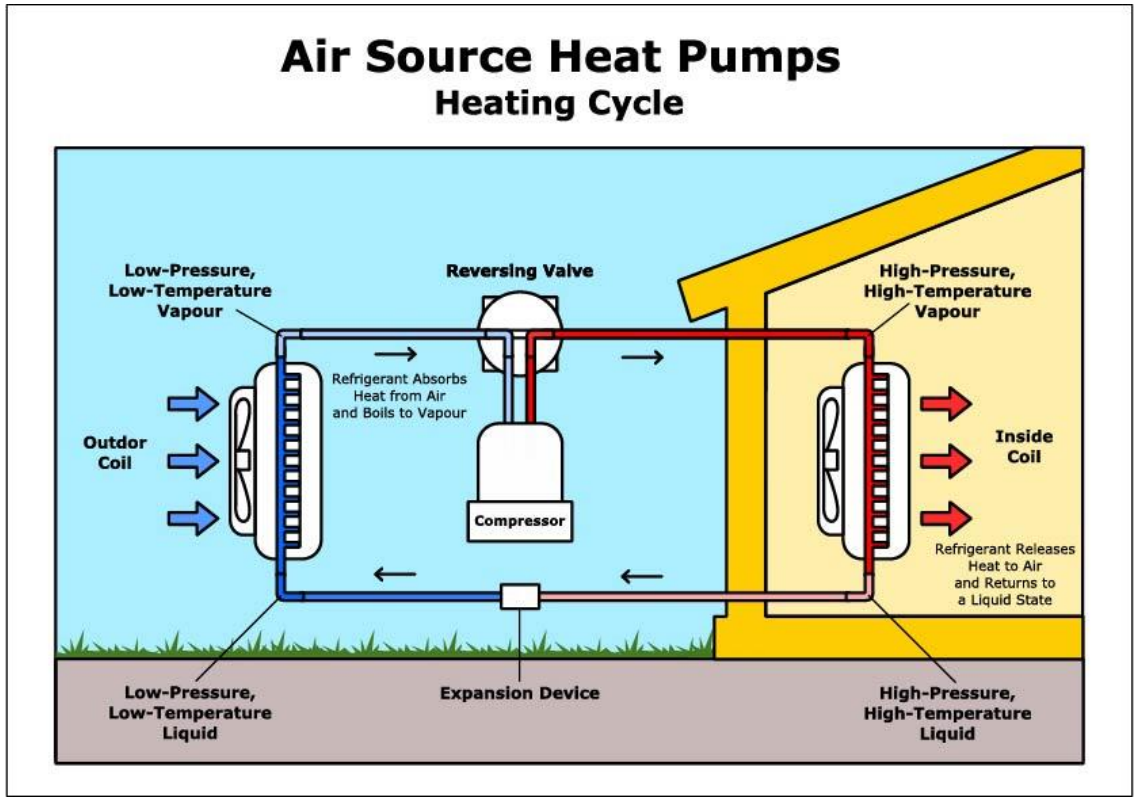


Technologies

- Zero-emissions will be achieved by replacing existing units with new zero NOx units rather than through add-on pollution control equipment
  - Implementation at point of sale (e.g., non-zero units can continue operating, but are replaced by zero-NOx units at end of useful life)
- Several technologies are available, heat pumps have the highest market penetration
  - Residential heat pumps typically three to four times more efficient than equivalent electric resistance unit

Rule 1111 Technologies – Heat Pumps

- HVAC Heat pumps work like an air conditioner or refrigerator in reverse: moving heat from the outside to the interior of the home
- Can draw heat from several different sources:
  - Air Source
  - Water source
  - Geothermal
- Heat pump systems can also provide:
  - Air conditioning (AC)
  - Central air or serve individual rooms
- Ductless systems can be installed more easily for homes without air ducts

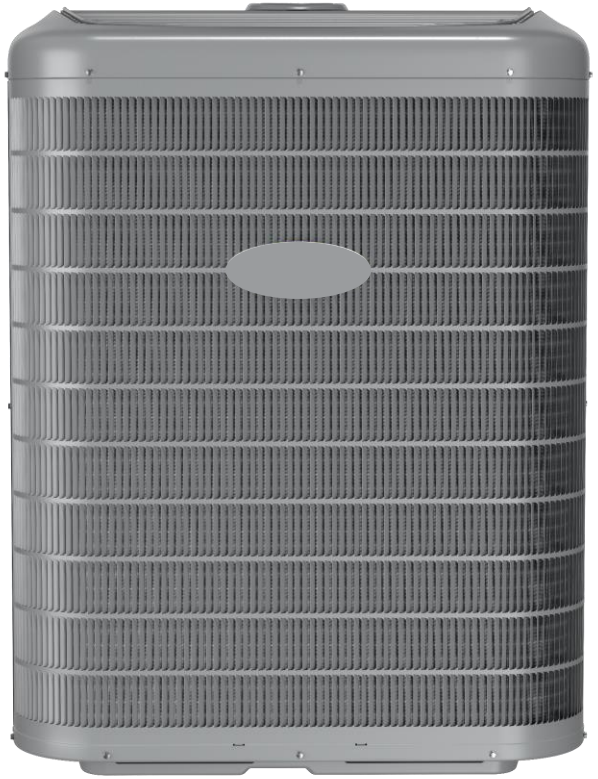


Energy Efficiency Ratings

UEF	• Uniform Energy Factor, efficiency rating for water heaters
COP	• Co-efficient of Performance, ratio of energy produced to energy used for heat pumps
HSPF2	• Heating Seasonal Performance Factor, heating efficiency for heat pumps
SEER2	• Seasonal Energy Efficiency Rating, cooling efficiency for air conditioners and heat pumps

Rule 1111 Technologies - Ducted Heat Pumps

- Produces hot or cold air which is distributed through the home via ducts
  - Can replace AC and furnace
  - Some efficiency loss from ducting
- For homes with existing central AC and furnace:
  - Easy “drop-in” installation
  - Usually will not require panel upgrades
  - Lower cost than installing separate furnace and AC per E3 study*

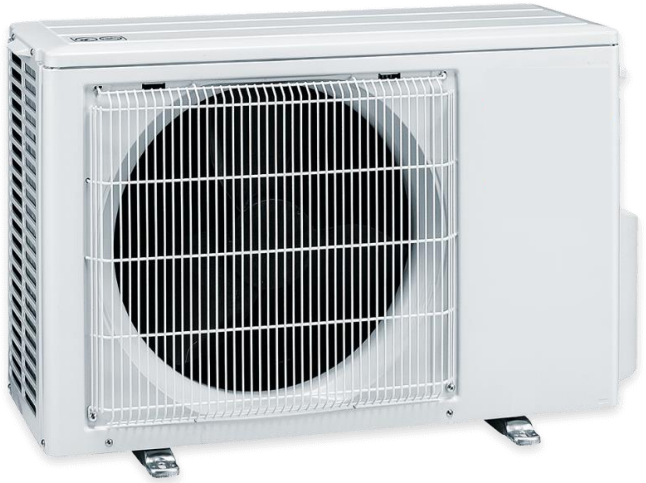


*E3 - Residential Building Electrification in California

Rule 1111 Technologies - Ductless Mini Split

Assess Pollution Control Technologies

- Refrigerant lines run from outdoor unit to indoor unit, no ducts required
- Single outside unit can serve multiple indoor units
- Lower cost than ducted heat pump in homes without central AC



Rule 1111 Technologies - Window Heat Pump

Assess Pollution Control Technologies

- Emerging technology
- 120-volt units, no panel upgrade required
- Rests on windowsill, simple installation
- Cheaper for room heating and cooling than mini-split
- Lower efficiency

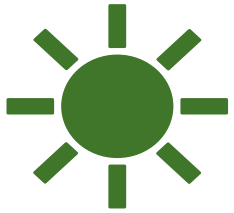
Other Rule 1111 Technologies

Electric Resistive Heater

Uses electric resistor to produce heat, in general lower installation cost but less efficient than heat pump systems

Radiant Heating

Heating elements under the floor to heat the home, elements can use hot air, water or electric heaters



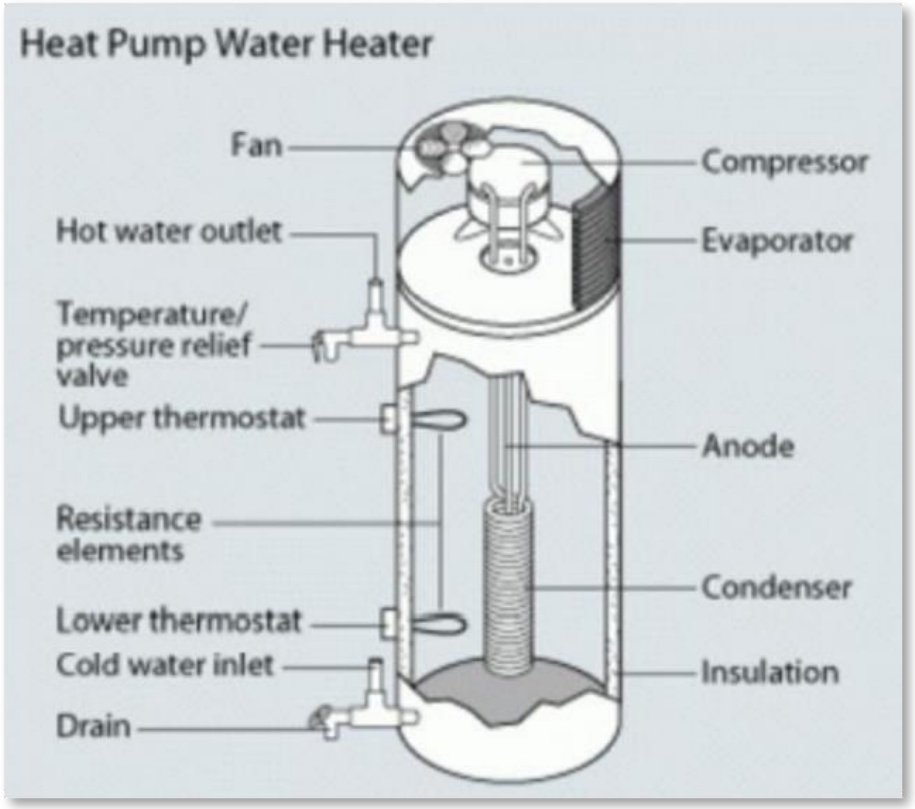
Solar Heating

Heat air using solar energy, can store the heat for later use

Rule 1121 Technologies – Heat Pumps

Heat Pump Water Heaters (HPWH) work similarly to HVAC heat pumps, but use heat pump to heat water in a holding tank

- Three to four times more efficient than electric resistive heater
- Often have back-up electric resistive element
- Can be a packaged unit with similar footprint as gas heater, or split system with outside condenser
- May require panel upgrades for homes without an electric water heater



Heat Pump Water Heaters - Plugins

120-Volt Plugin Water Heaters

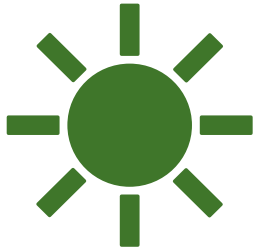
- Requires minimal electrical work
- Several manufacturers have models already available
- Similar size and shape of gas tank water heater, though slightly larger than comparable gas heater
- Similar performance to 240-volt units but with lower energy efficiency and without electric resistance back-up
- Suitable for:
  - Warmer climates
  - Smaller homes with lower hot water demand
  - Emergency replacements without panel upgrade

Other Rule 1121 Technologies

Electric Resistive Heaters

Less efficient than heat pump but is not reliant on outside heat source.

Can have tank or tankless electric resistive heaters.



Solar Water Heaters

Directly heats water or transfer fluid with solar energy.

Needs storage system for when sun goes down.

Solar Heating

- Water pumped through rooftop panels then sent to storage tank for later use
- Technology also applicable for space heating
  - Radiant heat provided by radiators mounted on walls or under the floor
- High installation costs but no operational costs
  - May require more maintenance than other options

Challenges

Challenges

Grid Infrastructure:

- Adopting zero-emission technologies will increase overall load on electric grid
  - California's grid is a summer peaking system, space heating will mostly occur in winter
  - Water heating has a smaller impact on load
  - State and local utilities are considering this impact in their future plans

Challenges

Cost:

- Most zero-emission units are more expensive and may require electric upgrades to operate
  - Heat pump system for heating and air conditioning is cheaper than an AC and furnace combined
  - Incentives from South Coast AQMD and other sources can mitigate cost and drive demand
  - Electric panel upgrades can be prevented in some cases using plug-in units or splitter switches, which allow two appliances to use the same 240-volt outlet

Challenges - Refrigerants

Refrigerant leakage:

- Heat pumps use refrigerants, most of which are greenhouse gases with over 1000x the Global Warming Potential (GWP) of CO_2
  - Heat pumps are sealed systems using small amount of refrigerant
  - E3 study shows overall greenhouse gas emissions from heat pumps are lower than natural gas heaters
  - Table shows new low GWP refrigerants are becoming available, while EPA is "phasing down*" production of higher GWP refrigerants

Refrigerant	GWP	Notes
R134a	1,430	Part of EPA phasedown
R410a	2,087	Part of EPA phasedown
R32	675	Part of EPA phasedown
R513a	629	Blend of R134a and lower GWP refrigerants
R1234ze	<10	Limited availability
R744 (CO_2)	1	Effective at low temperatures, requires high pressure
R290 (Propane)	3	Explosive hazard
R717 (ammonia)	0	Hazardous

*https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation

Challenges

Multi-family:

- Costs are magnified for multi-family residences and building owners may pass the cost to renters
  - Different incentives for multi-family may be necessary
  - TECH has multi-family incentives; rebates are passed on to building owners through contractors

Challenges – Cold Climate

Performance:

- Heat pumps that use outside air may have compromised performance in cold weather
  - Places with cold climate have already adopted heat pumps (Northern Europe, Japan, Maine), specialized cold climate heat pumps can provide hot air/water at outside temperatures as low as -25 °F
  - Many heat pumps have electric resistive elements that can provide heat when outside air gets too cold
- The Northeast Energy Efficiency Partnership operates a cold climate heat pump database: https://ashp.neep.org/#!/product_list/
- The Northwest Energy Efficiency Alliance has a cold climate heat pump water heater database: https://neea.org/resources/residential-hpwh-qualified-products-list

Challenges - Mobile Homes

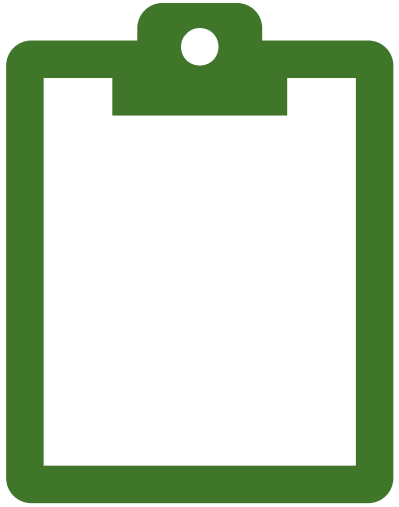
Space Heating

- Mini-split and ducted heat pumps can be installed in mobile homes in the same way as other buildings
- Panel size and mobile home community load may be barrier to adoption

Water Heating

- Water heaters in mobile homes are often smaller than heat pump water heaters offered
  - Typical height under 50 inches, heat pump water heaters often over 60 inches
- Department of Housing and Urban Development regulates water heaters installed in mobile homes, may have additional requirements for heat pumps

Manufacturer Survey



Manufacturer Survey

- Staff sent a survey to space and water heating manufacturers on May 10, 2023:
  - Part of rulemaking process for Proposed Amended Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters
  - Survey questions on both residential and commercial building applications, regarding:
    - Challenges, incremental costs, and new technologies
  - Eight manufacturers responded
- The next slides summarize the responses staff received for residential space and water heating

OEM Survey – HVAC Summary

Manufacturer reported availability of air source heat pump HVAC:

- Integrated, package and ductless systems from one to five tons, covering most housing sizes
- Ductless heat pumps showed highest efficiency (up to 18.1 HSPF2 and 27.4 SEER2)
- More models in development

Heat pumps are available for most residential space heating applications

OEM Survey – Water Heating Summary

Manufacturer reported availability of air source heat pump water heaters:

- 50-, 66-, and 80-gallon sizes
  - Common residential sizes, although smallest sizes aren't represented
- UEF up to 4.02
- Both unitary (single unit, similar to gas tank-type water heaters) and split systems (consist of indoor and outdoor units)
- Plug-in 120-volt units available or being developed by multiple manufacturers
- More models in development

Heat pumps are available for most residential water heating applications

Incentives

Incentives

TECH Clean California

- Covers both single and multi-family residences
- Up to $1,000 for Heat Pump HVAC
- Up to $3,100 Heat Pump Water Heater

Inflation Reduction Act Tax Credits

- Available through 2032
- Credits on federal taxes for various energy efficient home upgrades, including heat pumps
- 30% of project costs up to $2,000, yearly cap

Inflation Reduction Act Rebates

- Anticipated to start in 2024
- Administered by California Energy Commission

Clean Air Appliances Rebate Program (CAARP)

New South Coast AQMD incentive program under development

- Expands on the existing Clean Air Furnace Rebate Program
- Seeking to develop a multi-million-dollar incentive program funded from mitigation fees collected in Rules 1111 and 1121
- Rebates for heat pump water heaters and heat pump HVAC systems
- Focus large portion on lower-income and multi-family units
- Could be implemented in phases, for both funding and applicable appliance types

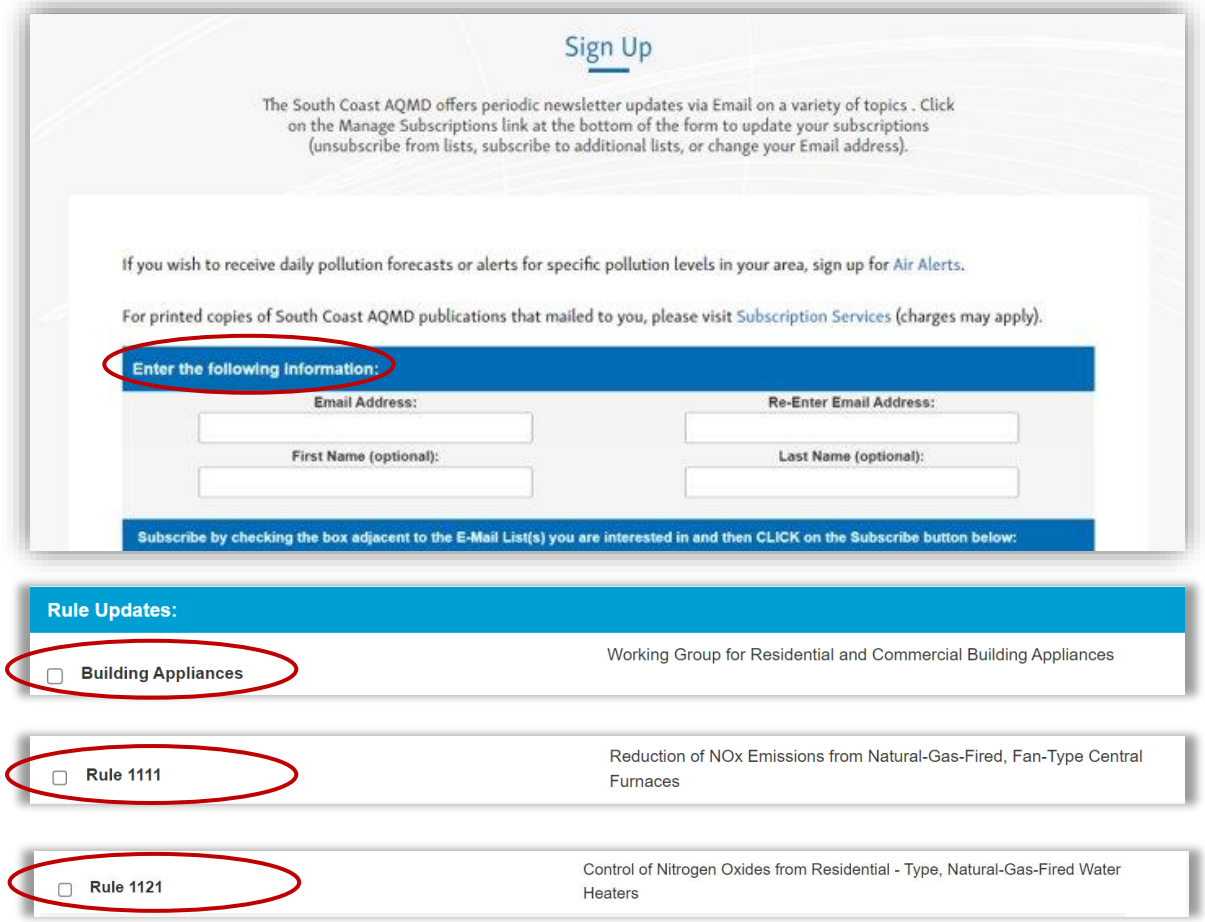
Summary

- Zero-emission technologies exist for nearly all categories
- Staff considering including previously unregulated categories into Rule 1111 (built-in heaters, commercial furnaces)
- Staff will continue to collect information on challenges and potential solutions
- Available incentives, including South Coast AQMD incentive program under development, can mitigate costs

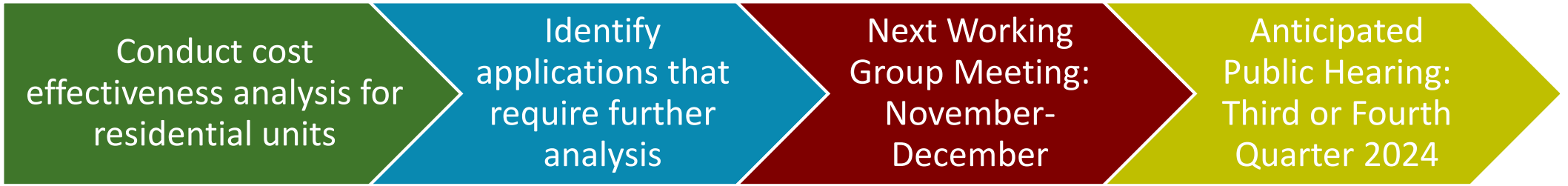
Sign Up for Notifications

- To receive newsletter updates via email for notifications regarding the 1111 and 1121 rule development and other forthcoming building appliances rules, please subscribe by checking the **Rule 1111, Rule 1121** and **Building Appliances** check boxes located under Rule Updates: http://www.aqmd.gov/sign-up

- To receive printed copies of South Coast AQMD publications via mail, please visit: http://www.aqmd.gov/nav/contact/subscription-services



Next Steps


Conduct cost effectiveness analysis for residential units
Identify applications that require further analysis
Next Working Group Meeting: November-December
Anticipated Public Hearing: Third or Fourth Quarter 2024

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