SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Preliminary Draft Staff Report for:

Proposed Amended Rule 1111 – Reduction of NOx Emissions From Natural Gas-Fired Furnaces
Proposed Amended Rule 1121 – Reduction of NOx Emissions From Small Natural Gas-Fired Water Heaters

September 2024

Deputy Executive Officer
Planning, Rule Development and Implementation
Sarah L. Rees, Ph.D.

Assistant Deputy Executive Officer
Planning, Rule Development and Implementation
Michael Krause

Planning and Rules Manager
Planning, Rule Development and Implementation
Heather Farr

Authors:	Peter Campbell – Air Quality Specialist Jennifer Vinh – Air Quality Specialist
Contributors:	Emily Yen – Air Quality Specialist Jivar Afshar – Air Quality Specialist Xian-Liang (Tony) Tian, Ph.D. – Program Supervisor Daniel Penoyer – Air Quality Specialist
Reviewed by:	Yanrong Zhu – Program Supervisor Kevin Ni – Program Supervisor, CEQA Barbara Radlein – Planning and Rules Manager

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
GOVERNING BOARD

Chair: VANESSA DELGADO
Senator (Ret.)
Senate Rules Committee Appointee

Vice Chair: MICHAEL A. CACCIOTTI
Council Member, South Pasadena
Cities of Los Angeles County/Eastern Region

MEMBERS:

CURT HAGMAN
Supervisor, Fourth District
County of San Bernardino

GIDEON KRACOV
Governor's Appointee

PATRICIA LOCK DAWSON
Mayor, Riverside
Cities of Riverside County Representative

LARRY MCCALLON
Mayor, Highland
Cities of San Bernardino County

HOLLY J. MITCHELL
Supervisor, Second District
County of Los Angeles

VERONICA PADILLA-CAMPOS
Speaker of the Assembly Appointee

V. MANUEL PEREZ
Supervisor, Fourth District
County of Riverside

NITHYA RAMAN
Council Member, Fourth District
City of Los Angeles Representative

CARLOS RODRIGUEZ
Council Member, Yorba Linda
Cities of Orange County

JOSÉ LUIS SOLACHE
Council Member, Lynwood

DONALD P. WAGNER
Supervisor, Third District
County of Orange

EXECUTIVE OFFICER:

WAYNE NASTRI

Table of Contents

EXECUTIVE SUMMARY ES-1
CHAPTER 1: BACKGROUND 1-0
Introduction 1-1
Rule 1111 Regulatory History 1-1
NOx Emission Limit of 14 ng/J Established 1-1
Mitigation Fee to Delay Compliance of 14 ng/J Furnaces 1-1
Clean Air Furnace Rebate Program 1-2
2022 AQMP Control Measure 1-2
PAR 1111 Affected Industries 1-3
Rule 1121 Regulatory History 1-3
NOx Emission Limit of 10 ng/J Established 1-4
Request a Delay in the Compliance Date 1-4
Extension of Compliance Date and Mitigation Fee 1-4
2022 AQMP Control Measure 1-4
PAR 1121 Affected Industries 1-5
Public Process 1-5
CHAPTER 2: BARCT ASSESSMENT 2-0
Introduction of BARCT Assessment 2-1
PAR 1111 BARCT Assessment 2-1
Assessment of South Coast AQMD Regulatory Requirements 2-1
Emission Level of Existing Units 2-2
Other Regulatory Requirements 2-3
Assessment of Pollution Control Technologies 2-4
PAR 1121 BARCT Assessment 2-6
Assessment of South Coast AQMD Regulatory Requirements 2-6
Emission Level of Existing Units 2-8
Other Regulatory Requirements 2-8
Assessment of Pollution Control Technologies 2-10
Cost-Effectiveness and Incremental Cost-Effectiveness 2-13
Initial BARCT Emission Limit and Other Considerations 2-13
Method for Cost-Effectiveness and Incremental Cost-Effectiveness Analysis 2-13

Cost-Effectiveness Analysis 2-17
Summary of Cost-Effectiveness 2-20
Proposed BARCT Emissions Limit 2-22
Additional Information and Challenges 2-23
Grid Reliability 2-23
Mobile Homes 2-26
Refrigerants 2-27
CHAPTER 3: PROPOSED AMENDED RULE 1111 3-0
Introduction 3-1
Proposed Amended Rule 1111 3-1
PAR 1111 (a) - Purpose 3-1
PAR 1111 (b) – Applicability 3-1
PAR 1111 (c) – Definitions 3-2
PAR 1111 (d) – Requirements 3-3
PAR 1111 (e) – Certification 3-4
PAR 1111 (f) – Identification of Compliant Units 3-4
PAR 1111 (g) – Alternative Compliance Options 3-5
PAR 1111 (h) – Labeling, Recordkeeping, and Reporting 3-6
PAR 1111 (i) – Exemptions 3-8
CHAPTER 4: PROPOSED AMENDED RULE 1121 4-0
Introduction 4-1
Proposed Amended Rule 1121 4-1
PAR 1121 (a) – Purpose 4-1
PAR 1121 (b) – Applicability 4-1
PAR 1121 (c) – Definitions 4-2
PAR 1121 (d) – Requirements 4-2
PAR 1121 (e) – Certification 4-4
PAR 1121 (f) – Alternative Compliance Options 4-4
PAR 1121 (g) – Labeling and Reporting 4-5
PAR 1121 (h) – Exemptions 4-6
CHAPTER 5: IMPACT ASSESSMENT 5-0
Introduction 5-1
Emissions Inventory and Emission Reductions 5-1

Estimated Number of Units 5-1
Estimated Emissions Inventory 5-1
Cost-Effectiveness 5-2
Socioeconomic Impact Assessment 5-3
California Environmental Quality Act (CEQA) Analysis 5-4
Draft Findings Under Health And Safety Code Section 40727 5-4
Comparative Analysis 5-4

List of Tables

Table 1-1: Mitigation Fee Option End Dates 1-2
Table 1-2: PAR 1111 Affected Industries 1-3
Table 1-3: PAR 1121 Affected Industries 1-5
Table 1-4: Summary of Public Process 1-6
Table 1-5: Summary of Site Visits 1-7
Table 2-1: South Coast AQMD Regulatory Requirements Similar to PAR 1111 2-2
Table 2-2: Other Regulatory Requirements Similar to PAR 1111 2-4
Table 2-3: South Coast AQMD Regulatory Requirements Similar to PAR 1121 2-7
Table 2-4: Other Regulatory Requirements Similar to PAR 1121 2-9
Table 2-5. Weighted Average Cost-Effectiveness for PAR 1111 Categories with Heat Pump Replacement 2-21
Table 2-6: PAR 1111 BARCT NOx Emission Limits and Compliance Schedule 2-22
Table 2-7: PAR 1121 BARCT NOx Emission Limits and Compliance Schedule 2-23
Table 2-9: Common Refrigerants 2-27
Table 3-1: Rule 1111 and PAR 1111 Rule Structure 3-1
Table 3-2: PAR 1111 Table 1 Emission Limits and Compliance Schedule 3-3
Table 3-3: PAR 1111 Table 2 Zero-Emission Limits and Compliance Schedule 3-4
Table 3-4: PAR 1111 Table 3 Labeling Schedule 3-7
Table 4-1: Rule 1121 and PAR 1121 Rule Structure 4-1
Table 4-2: PAR 1121 Table 1 Emission Limits 4-3
Table 4-3: PAR 1121 Table 2 Zero-Emission Limits and Compliance Schedule 4-3
Table 4-4: PAR 1121 Table 3 Labeling Schedule 4-5
Table 5-1: PAR 1111 and PAR 1121 Baseline Emissions Estimate 5-2
Table 5-2. Cost-Effectiveness for PAR 1111 Categories 5-3
Table 5-3: Cost-Effectiveness for PAR 1121 Categories 5-3

List of Figures

Figure 2-1. BARCT Assessment Approach 2-1
Figure 2-2: In-State Electric Generation – Select Fuel Types, Sourced from CEC Quarterly Fuels and Energy Reporting Regulations 2-25

EXECUTIVE SUMMARY

South Coast AQMD Rule 1111 – Reduction of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces (Rule 1111), regulates oxides of nitrogen (NOx) emissions from natural gas-fired fan-type central furnaces with rated heat input capacity of less than 175,000 British thermal units per hour (Btu/hr), or for units with combined heating and cooling (package units), a cooling rate of less than 65,000 Btu/hour. Rule 1111 was adopted by the South Coast Air Quality Management District (South Coast AQMD) Governing Board in December 1978. The rule was amended in 2009 to lower the NOx emissions limit from 40 to 14 nanograms per Joule (ng/J). The rule was later amended several times to provide an alternative compliance option and extend the option that allows the manufacturer to pay a per-unit mitigation fee, in lieu of meeting the lower NOx emission limit. All furnace types have transitioned to 14 ng/J, except for mobile home furnaces for which the mitigation fee alternative compliance option will end by September 30, 2025.

South Coast AQMD Rule 1121 – Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters (Rule 1121) regulates NOx emissions from natural gas-fired water heaters with a rated heat input capacity of less than 75,000 Btu/hr. Rule 1121 was adopted by the South Coast AQMD Governing Board in December 1978. This rule was amended in 1999 to reduce the NOx emission limit from 40 ng/J stepwise to 10 ng/J and amended again in 2004 to extend the compliance dates of 10 ng/J limit for some categories. Currently, all Rule 1121 water heaters are meeting the NOx emissions limit of 10 ng/J, except for mobile home water heaters that are subject to an emissions limit of 40 ng/J.

Proposed Amended Rule 1111 – Reduction of NOx Emissions from Natural-Gas-Fired Furnaces (PAR 1111), seeks further NOx emission reductions and implements the 2022 Air Quality Management Plan (AQMP) Control Measure R-CMB-02 – Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Residential Space Heating (Control Measure R-CMB-02) and C-CMB-02 – Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Commercial Space Heating (C-CMB-02). Proposed Amended Rule 1121 – Reduction of NOx Emissions from Residential Type, Natural Gas-Fired Water Heaters (PAR 1121), seeks further NOx emission reductions and implements the 2022 AQMP Control Measure R-CMB-01 – Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Residential Water Heating (R-CMB-01). Staff conducted a comprehensive BARCT assessment, which includes an analysis of the technical feasibility and cost-effectiveness of zero-emission NOx technologies for PAR 1111 and PAR 1121.

PAR 1111 proposes to expand the applicability to all furnaces with a rated heat input capacity of less than or equal to 2,000,000 Btu/hr, which will include units from 175,000 Btu/hr to 2,000,000 Btu/hr that are currently unregulated, and divide the applicable units into four categories for zero-emission limits for new installations based on future effective dates, with a later implementation date for mobile home furnaces. The zero-emission compliance dates are further differentiated for units installed in new or existing buildings. The mitigation fee alternative compliance option will continue to be allowed for mobile home furnaces until the applicable zero-emission compliance date. Alternative compliance options are provided for emergency replacement and installations requiring construction to expand the space to house or relocate a furnace and associated equipment, perform a service upgrade for necessary power, or replace a furnace that does not require the simultaneous replacement of space cooling equipment.

PAR 1121 proposes zero-emission limits for new installations based on future effective dates, with a later implementation date for mobile home water heaters. The zero-emission compliance dates are further differentiated for units installed in new or existing buildings. Alternative compliance options are provided for emergency replacement and installations requiring construction to expand the space to house or relocate a water heater and associated equipment, or construction to perform a service upgrade for necessary power.

Both PAR 1111 and PAR 1121 provide an exemption from zero-emission requirements for mobile home water heater installations in master-metered mobile home parks where there are typically restrictions on the amount of electricity a mobile home can receive. In addition, PAR 1111 and PAR 1121 have clarified and updated rule language, restructured the rule, removed obsolete language, and streamlined the labeling, recordkeeping, and reporting requirements.

PAR 1111 and PAR 1121 will each affect the manufacturers, distributors, retailers, resellers, and installers of space and water heating systems that are used in over five million buildings, mostly residential homes. Staff estimates that upon full implementation, PAR 1111 will reduce NOx emissions by 7.7 tons per day (tpd), and PAR 1121 will reduce NOx emissions by 2.3 tpd. The public process for PAR 1111 and PAR 1121 consisted of six working group meetings, a public workshop, and many meetings with industry stakeholders and technology vendors to obtain feedback.

CHAPTER 1:BACKGROUND

INTRODUCTION

RULE 1111 REGULATORY HISTORY

PAR 1111 AFFECTED INDUSTRIES

RULE 1121 REGULATORY HISTORY

PAR 1121 AFFECTED INDUSTRIES

PUBLIC PROCESS

INTRODUCTION

Rule 1111 – Reduction of NOx Emissions from Natural Gas-Fired Furnaces reduces nitrogen oxide emissions from gas-fired fan-type space heating furnaces with a rated heat input capacity of less than 175,000 Btu/hr or, for combination heating and cooling units, with a cooling rate of less than 65,000 Btu per hour. The rule applies to manufacturers, distributors, and installers of such furnaces. Most single-family homes, many multifamily residences, and some light commercial buildings in the South Coast AQMD use this type of space heating equipment.

Rule 1121 – Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters aims to reduce NOx emissions from natural gas-fired residential water heaters with a rated heat input capacity less than 75,000 Btu/hr. This rule applies to manufacturers, distributors, retailers, and installers of natural gas-fired units and requires water heaters to meet a 10 ng/J emission limit and mobile home water heaters to meet a 40 ng/J emission limit. This rule does not apply to water heaters used in recreational vehicles or large water heaters subject to Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters (Rule 1146.2).

Rule 1111 and Rule 1121 require manufacturers to certify that each natural gas unit model offered for sale in the South Coast AQMD complies with the emission limit using the test methods approved by the South Coast AQMD and U.S. EPA.

RULE 1111 REGULATORY HISTORY

Rule 1111 was adopted by the South Coast AQMD Governing Board in December 1978. The original rule required the applicable space heating furnaces to meet a NOx emission limit of 40 ng/J of heat output, which equivalent to a concentration of 61 parts per million by volume (ppmv) at a reference level of 3 percent oxygen and 80 percent Annual Fuel Utilization Efficiency (AFUE), beginning January 1, 1984.

NOx Emission Limit of 14 ng/J Established

Rule 1111 was amended in November 2009 to implement the 2007 AQMP Control Measure CMB-03. The 2009 amendment established a new lower NOx emission limit of 14 ng/J (equivalent to 22 ppmv at a reference level of 3 percent oxygen and 80 percent AFUE) and required the three major categories of residential furnaces, condensing (high efficiency), non-condensing (standard), and weatherized furnaces to meet the new limit by October 1, 2014, October 1, 2015, and October 1, 2016, respectively. Furthermore, new mobile home heating units, which were unregulated prior to the 2009 amendment, were required to meet a NOx limit of 40 ng/J by October 1, 2012, and 14 ng/J by October 1, 2018. To facilitate the depletion of existing inventories and to ensure a smooth transition to the new limits, Rule 1111 also provided a temporary 10-month exemption (e.g., a sell-through period) for units manufactured and delivered into the South Coast AQMD prior to the compliance date.

Mitigation Fee to Delay Compliance of 14 ng/J Furnaces

Rule 1111 was amended in September 2014 to provide an alternative compliance option. The alternative compliance option allowed original equipment manufacturers (OEM) to pay a per-unit mitigation fee for each furnace with NOx emissions certificated at 40 ng/J distributed or sold in South Coast AQMD, in lieu of meeting the 14 ng/J NOx emission limit.

Rule 1111 was amended six times from 2018 to 2023 to extend the mitigation fee end dates, increase mitigation fees, and allow limited exemptions for furnaces at high altitude.

The mitigation fee end date for each type of furnaces is listed in the following table. All furnace types have transitioned to 14 ng/J, except for mobile home furnaces, which constitute about four percent residential furnace market share of the region. The mitigation fee alternative compliance option for mobile home furnaces will end by September 30, 2025, according to the current rule language.

Table 1-1: Mitigation Fee Option End Dates

Furnace Category	Mitigation Fee Option End Date
Condensing	September 30, 2019
Non-condensing	September 30, 2019
Weatherized	September 30, 2021
Mobile Home	September 30, 2025

Clean Air Furnace Rebate Program

In March 2018, the South Coast AQMD developed a rebate program for consumers who purchased and installed future compliant 14 ng/J furnaces in the South Coast AQMD. The purpose of the rebate program was to help commercialize future compliant furnaces and incentivize consumers to purchase and install them. On May 4, 2018, the South Coast AQMD executed the contract with Electric & Gas Industries Association (EGIA) to administer the Clean Air Furnace Rebate Program. On June 28, 2018, the rebate website was launched. The South Coast AQMD Governing Board initially approved funding of $3 million for the furnace rebate program, specifying a $500 rebate for each compliant furnace. In September 2020, the Governing Board approved additional funding of $3.5 million, modifying the program to specify a $500 rebate for up to 600 compliant weatherized furnaces, a $500 rebate for up to 200 high-altitude compliant condensing or non-condensing furnace installations, and a $1,500 rebate for each all-electric heat pump for central ducted space heating. Rebates for weatherized and high-altitude condensing and non-condensing furnaces ended on September 30, 2021, when remaining funds for those categories were reallocated for all-electric heat pump systems. Rebates for all-electric heat pump systems concluded in April of 2023 when funds were exhausted. The Clean Air Furnace Rebate Program incentivized the installation of over 5,300 ultra-low NOx furnaces for early implementation of 14 ng/J limit and over 2,400 all-electric heat pump installations after the implementation of 14 ng/J limit, with 25 percent of all-electric heat pump funds allocated to disadvantaged communities.

2022 AQMP Control Measure

In the 2022 AQMP, the Governing Board adopted control measures R-CMB-02: Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Residential Space Heating and C-CMB-02: Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Commercial Space Heating. R-CMB-02 proposed the development of zero-

emission NOx limits for residential space heating when feasible, and C-CMB-02 proposed the development of zero-emission NOx limits for commercial space heating when feasible. PAR 1111 will implement control measures R-CMB-02 and C-CMB-02. The 2022 AQMP Policy Brief for Residential and Commercial Building Appliances[(1)] cited heat pumps as an energy-efficient zero-emission alternative to natural gas furnaces.

PAR 1111 AFFECTED INDUSTRIES

PAR 1111 affects manufacturers, distributors, retailers, resellers, and installers of natural gas-fired furnaces with a rated heat input capacity less than or equal to 2,000,000 Btu/hr used for interior space heating. There are no OEMs of gas-fired furnaces located in the South Coast AQMD; however, these companies maintain regional sales offices and distribution centers in the South Coast AQMD with supply chains to support their products. The units affected by the proposed rule are mostly used in residential and commercial buildings for space heating.

The following table shows the North American Industry Classification System (NAICS) for the industries affected by PAR 1111. Staff estimated a total of 5,300,000 units in the South Coast AQMD are regulated by PAR 1111.

Table 1-2: PAR 1111 Affected Industries

Affected Industry	NAICS
Heating Equipment (except Warm Air Furnaces) Manufacturing	333414
Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	333415
Motor and Generator Manufacturing	335312
Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers	423610
Heating, Ventilation, and Air Conditioning (HVAC) Equipment Merchant Wholesalers	423730
Household Appliances, Electric Housewares, and Consumer Electronics Merchant Wholesalers	423620
Installers	238

RULE 1121 REGULATORY HISTORY

Rule 1121 was adopted by the South Coast AQMD's Governing Board on December 1, 1978. The objective of the rule is to reduce NOx emissions from natural gas-fired residential water heaters.

[(1)] http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/buildings_final.pdf

Rule 1121 applies to manufacturers, distributors, retailers, and installers of residential natural gas-fired water heaters less than 75,000 Btu per hour.

Starting in 1982, Rule 1121 required that gas-fired water heaters meet a NOx emission limit of 40 ng/J of heat output, except gas-fired mobile home water heaters, which were required to meet a NOx emission limit of 50 ng/J of heat output.

NOx Emission Limit of 10 ng/J Established

In December 1999, Rule 1121 was amended to reduce the NOx emission limit. The amendment reduced the NOx limit in two steps from 40 ng/J to 20 ng/J on July 1, 2002, and 10 ng/J on January 1, 2005. The mobile home water heater emission limit was reduced from 50 ng/J to 40 ng/J, effective on and after January 1, 2000. Alternate equivalent emission limits expressed in part per million were also added. The rule also required manufacturers to provide a report by July 1, 2003, on their progress toward meeting the final emission limit in the rule.

Rule 1121 was included in the Settlement Agreement for the 1999 AQMP amendment. The Settlement Agreement included a commitment to begin the lower emissions limits implementation by 2005, allowing up to a 1-year extension to the implementation, or additional extensions if the Governing Board makes a finding of infeasibility.

Request a Delay in the Compliance Date

Manufacturers reported their progress towards meeting the emission limits by July 2003 and requested a delay in the compliance date and exemptions for power vented and direct vented water heaters. In addition, manufacturers requested to delay residential water heaters less than 50 gallons for one year and residential water heaters greater than 50 gallons for an additional two years.

Staff submitted a report to the Governing Board in January 2004, where the January 2005 compliance date was found to be infeasible, and the Governing Board directed staff to proceed with the rule development.

Extension of Compliance Date and Mitigation Fee

The most recent amendment to Rule 1121 in September 2004 extended the emission limit of 10 ng/J by one year for conventional water heaters less than or equal to 50 gallons, two years for conventional water heaters greater than 50 gallons, and three years for direct-vent, power-vent, and power direct-vent water heaters. The mitigation fee program for the interim rule limit was extended for three years and changed from $1.80 per water heater to $3.00 per water heater. The rule also required manufacturers to provide a report on progress towards meeting the interim and final rule limits for direct-vent, power-vent, and power direct-vent water heaters. The mitigation fee period ended when the 10 ng/J emissions limit was implemented from 2006-2008, depending on water heater type.

2022 AQMP Control Measure

In the 2022 AQMP, the Governing Board adopted control measure R-CMB-01: Emission Reductions from Replacement with Zero Emission or Low NOx Appliances – Residential Water Heating. The control measure proposed the development of a rule to require zero-emission water heating in new and existing buildings when feasible. All-electric heat pumps were mentioned as an option for zero-emission water heating.

PAR 1121 AFFECTED INDUSTRIES

PAR 1121 affects manufacturers, distributors, retailers, resellers, and installers of natural gas-fired water heaters with a rated heat input capacity less than 75,000 Btu/hr. There are no OEMs of gas-fired water heaters located in the South Coast AQMD; however, these companies do maintain regional sales offices and distribution centers in the region, and the supply chains to support their products. The units affected by the proposed rule are mostly used in residential buildings for domestic hot water needs.

The following table shows the NAICS for the industries affected by PAR 1121. Staff estimated a total of 5,100,000 units in the South Coast AQMD are regulated by PAR 1121.

Table 1-3: PAR 1121 Affected Industries

Affected Industry	NAICS
Hot Water Heating System Installation	238220
Water Heater Controls Manufacturing	334512
Water Heaters, Gas and Electric, Merchant Wholesaler	423720
Major Household Appliance Manufacturing	335220
Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers	423610
Household Appliances, Electric Housewares, and Consumer Electronics Merchant Wholesalers	423620
Installers	238

PUBLIC PROCESS

PAR 1111 and PAR 1121 were developed through a public process that began in the last quarter of 2023 and included a series of working group meetings, individual stakeholder meetings, and site visits to affected facilities. South Coast AQMD staff held six working group meetings on October 5, 2023, November 28, 2023, January 31, 2024, April 4, 2024, June 20, 2024, and August 15, 2024. The working group is comprised of representatives from manufacturers, trade organizations, permit stakeholders, businesses, environmental groups, public agencies, consultants, and other interested parties. The purpose of the working group meetings was to present and discuss staff's BARCT assessment and the development of the proposed amendments and NOx limits for PAR 1111 and PAR 1121. Staff presented initial preliminary draft rule language at the working group meeting on June 20, 2024. A public workshop is scheduled for October 3, 2024. The following table summarizes the working group meetings held throughout the development of PAR 1111 and PAR 1121 and provides a summary of the key topics discussed at each of the working group meetings.

Table 1-4: Summary of Public Process

Date	Meeting Title	Highlights
October 5, 2023	Working Group Meeting #1	• Rule Development Process • Control Measures for Space and Water Heating • BARCT Assessment • Technologies • Manufacturer Survey • Incentives
November 28, 2023	Working Group Meeting #2	• Follow-up to stakeholder comments from Working Group Meeting #1 • Presented cost-effectiveness methods, assumptions, and initial results
January 31, 2024	Working Group Meeting #3	• Follow-up to stakeholder comments from Working Group Meeting #2 • Analysis of requirements in mobile homes • Updates to cost-effectiveness calculations • Presented affordability analysis method, assumptions, and initial results • South Coast AQMD rebate program for zero-emission units
April 4, 2024	Working Group Meeting #4	• Follow-up to stakeholder comments from Working Group Meeting #3 • Summary of site visits to mobile homes • Discussion of wall and floor furnaces • Discussion of commercial space heating • Cost-effectiveness for wall and floor furnaces, and commercial furnaces • Proposed rule concepts
June 20, 2024	Working Group Meeting #5	• Follow-up to stakeholder comments from Working Group Meeting #4 • Summary of site visits to multifamily buildings • Rule language proposals
August 15, 2024	Working Group Meeting #6	• Follow up to stakeholder comments from Working Group Meeting #5 • Summary of site visit to single-family home and multifamily homes • Feasibility of 120V heat pump water heaters • Tenant protections • Updates to rule language

Staff held several meetings with stakeholders who are potentially impacted by this rulemaking. In addition, staff conducted several site visits with stakeholders as listed in the following table.

Table 1-5: Summary of Site Visits

Date	Location
March 15, 2023	SCE Energy Education Center
June 8, 2024	SCE Energy Education Center
August 29, 2023	Rheem Manufacturing Company, Raypak
December 8, 2023	Oakridge Mobile Home Park
January 11, 2024	Lake Los Serranos Mobile Home Park
January 17, 2024	Corona Del Rey Apartments
March 14, 2024	The Fountains Mobile Home Park
May 2, 2024	Jia (Multifamily)
May 2, 2024	Pearl MDR (Multifamily)
May 22, 2024	Ava Burbank (Multifamily)
May 22, 2024	Ava Toluca (Multifamily)
July 18, 2024	A Single-Family House in Mission Viejo (120V HPWH)
August 7, 2024	Newport Ridge Apartment Homes (Multifamily)
August 7, 2024	San Paulo Apartment Homes (Multifamily)
August 7, 2024	New Construction Single-Family Home in Irvine
September 5, 2024	Palmeras Apartments in Irvine
September 5, 2024	Baywood Apartments in Newport Beach

CHAPTER 2: BARCT ASSESSMENT

INTRODUCTION OF BARCT ASSESSMENT

PAR 1111 BARCT ASSESSMENT

PAR 1121 BARCT ASSESMENT

COST-EFFECTIVENESS AND INCREMENTAL COST-EFFECTIVENESS

ADDITIONAL INFORMATION AND CHALLENGES

INTRODUCTION OF BARCT ASSESSMENT

The purpose of a BARCT assessment is to assess available pollution controls to establish emission limits for specific equipment categories consistent with state law. Under Health and Safety Code Section 40406, BARCT is defined as:

> "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."

The BARCT assessment follows a framework through the rule development process and includes public participation. The following figure illustrates the overall BARCT assessment approach.

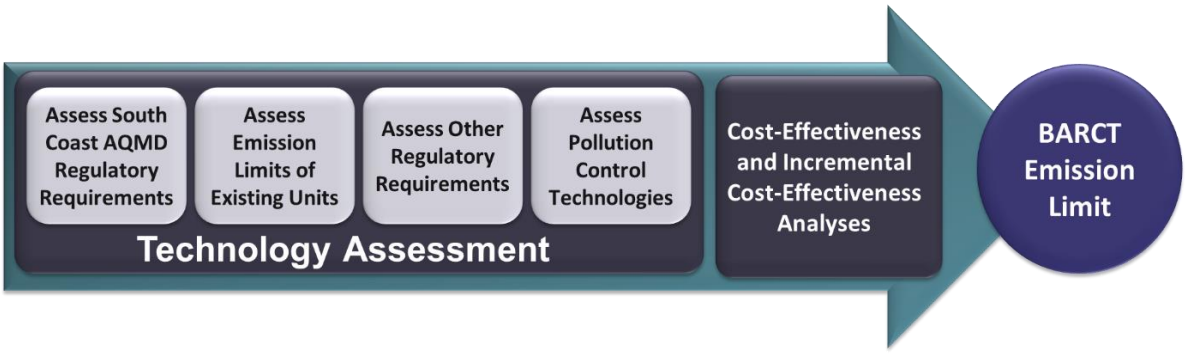

Figure 2-1. BARCT Assessment Approach

PAR 1111 BARCT ASSESSMENT

Assess South Coast AQMD Regulatory Requirements

Assessment of South Coast AQMD Regulatory Requirements

Staff reviewed existing South Coast AQMD NOx regulations for residential heating and small commercial heating. The following table summarizes the South Coast AQMD rules that staff evaluated as part of the BARCT technology assessment.

Table 2-1: South Coast AQMD Regulatory Requirements Similar to PAR 1111

Regulation/Rule Title	Relevant Unit/Equipment Size	Current or Future Effective NOx Emission Limits in ng/J or ppmv at 3 percent O_2, dry
Rule 1146.2 – Emissions of Oxides of Nitrogen (NOx) from Large Water Heaters, Small Boilers and Process Heaters	Large Water Heaters, Small Boilers and Process Heaters (less than or equal to 2,000,000 Btu/hr rated heat input capacity, excluding tank type water heaters subject to Rule 1121)	0 ppmv with compliance dates between 2026-2033: • Type 1 Units • Instantaneous Water Heaters ≤200,000 Btu/hr • Instantaneous Water Heaters >200,000 Btu/hr • Type 1 Pool Heaters • Type 2 Units • Type 1 High Temperature Units, and • Type 2 High Temperature Units
Rule 1147 – NOx Reductions From Miscellaneous Sources	Combustion equipment which require an AQMD permit but are not applicable to other Rules	• 60 ppmv for afterburners, burn-off furnaces, dryers over 1,200°F, kilns, and other units • 30 ppmv for ovens, dryers, kilns and furnaces under 1,200°F, and make-up air heaters, carpet dryers and other units
Rule 1121 – Control of Nitrogen Oxides from Residential-Type, Natural Gas-Fired Water Heaters	Residential-Type, Natural Gas-Fired Water Heaters (less than 75,000 Btu/hr rated heat input capacity)	• 10 ng/J or15 ppmv • 40 ng/J or 55 ppmv for mobile home water heaters

Emission Level of Existing Units

The next step of the BARCT assessment is to evaluate the emission of existing units operating within the South Coast AQMD. Condensing, non-condensing, and weatherized furnaces subject to Rule 1111 are certified to meet the 14 ng/J NOx emission limit; the applicable mobile home furnaces are meeting the 40 ng/J NOx emission limit. As mentioned previously, PAR 1111 will expand the applicability to include furnaces with a rated heat input capacity of up to 2,000,000 Btu/hr, including wall furnaces, floor furnaces, and small commercial furnaces, which are currently not subject to an emission limit. Staff conducted a review of currently available wall furnace and floor furnace product sheets and found several units with ultra-low NOx burners (14 ng/J) and units that do not state the NOx emission levels. Staff, therefore, assumed a NOx emission of 40 ng/J for wall and floor furnaces to account for units that do not have a stated emission level. For commercial

furnaces, staff used the Commercial Building Energy Consumption Survey (CBECS)[(2)] microdata for the Pacific Census Division to determine the building size and furnaces used in each respective building size category. Building sizes in the dataset range from 1,000 ft^2 to over 1,000,000 ft^2. For buildings greater than 5,000 ft^2, an emission of 40 ng/J was assumed since larger buildings are less likely to currently be subject to Rule 1111. For buildings smaller than 5,000 ft^2, an emission of 14 ng/J was assumed, as they may already be subject to the Rule 1111.

Other Regulatory Requirements

Staff reviewed regulatory requirements from other agencies for identical or similar equipment. The purpose of this step is to determine if there are more stringent regulations in other jurisdictions that should be considered, as NOx reduction rules enforced by the South Coast AQMD cannot be less stringent.

[(2)] https://www.eia.gov/consumption/commercial/

Table 2-2: Other Regulatory Requirements Similar to PAR 1111

Regulatory Entity	Regulation/Rule	Relevant Emission Limits
San Joaquin Valley Air Pollution Control District (Valley Air District)[3]	Rule 4905 – Natural Gas-Fired, Fan-Type Central Furnaces (units with a rated heat input capacity less than 175,000 Btu/hr, and for combination heating and cooling units with a rated cooling capacity of less than 65,000 Btu/hr) – Exempts furnaces that are to be installed with a propane conversion kit	14 ng/J (allows mobile home furnaces to meet 40 ng/J if a per unit emission fee is paid)
Bay Area Air Quality Management District (BAAQMD)[4]	Rule 9-4 – Nitrogen Oxides Emissions from Natural Gas-Fired Furnaces (units with total rated heat input capacity of less than 175,000 Btu/hr) adopted in March 2023	• Zero-emission limits with implementation in 2029 • Emission standards not applicable to furnaces used in mobile homes
California Air Resources Board (CARB)[5]	2022 State Strategy for the State Implementation Plan (adopted September 22, 2022) proposed measures for residential and commercial buildings; Anticipating Board consideration for rule adoption in 2025	Proposed zero-emission limits (GHG, NOx) for new equipment and appliances sold for use in both residential and commercial buildings, with implementation in 2030

Assessment of Pollution Control Technologies

The next step is to research the commercially available emission control technologies and seek information on any emerging emission control technologies. As part of this assessment, staff met with multiple manufacturers. Rule 1111 is technology and fuel neutral and is focused on achieving the maximum NOx emission reductions possible.

[3] San Joaquin Valley Air Pollution Control District, Rule 4905, https://ww2.valleyair.org/media/haahtjed/rule-4905.pdf

[4] Bay Area Air Quality Management District, Rule 9-4, https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230315_rg0906-pdf.pdf?rev=436fcdb037324b0b8f0c981d869e684d&sc_lang=en

[5] California Air Resources Board, 2022 State SIP Strategy, p. 30, https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

Staff assessed different pollution control technologies as part of the BARCT assessment. Staff presented and discussed the pollution control technology assessment in working group meetings. The objective is to identify and evaluate control technologies, approaches, and potential emission reductions.

Zero-Emission Technology and Emerging Technology

Zero-emission technologies such as heat pumps, electric resistance, and fuel cell technologies were explored as part of the BARCT assessment, all of which are proven technologies that have been in operation for decades. Staff conducted internet searches and met with stakeholders to gather more information on zero-emission technologies and emerging technology.

Heat Pump Technology for Heating, Ventilation, and Air Conditioning

Common zero-emission heating technology includes heat pumps. This technology can be over three times more efficient than conventional appliances and can be used for water heating, space heating, and cooling.

Unlike natural gas fired furnaces that generate heat directly, heat pumps use the principle of energy transfer to transport energy from an outside medium (such as the ground or outside air) to the interior, using a refrigerant cycle. Heat pumps typically consist of an indoor unit and an outdoor unit. Compared to traditional furnaces, heat pumps have the additional benefit of cooling. Different types of heat pumps cater to various HVAC needs, each offering unique advantages. The indoor unit of ducted heat pumps are integrated into a ductwork system, distributing heated or cooled air throughout a building. They are ideal for houses with pre-existing central heating and cooling but require installation of a ducting system for houses that do not. On the other hand, ductless mini-split heat pumps operate without ducts, using individual air handing units mounted inside individual rooms for zonal heating and cooling. These units offer more flexibility in temperature control and installation, making them suitable for spaces lacking ductwork or requiring independent temperature control. Window heat pumps are compact units designed to fit into windows, offering localized heating and cooling for single rooms or small areas. They are easy to install and provide immediate temperature control but are less efficient compared to their ducted or ductless system counterparts.

All air-source heat pumps draw heat from the outside air, which means they will gradually lose performance as the outside temperature drops. Ground-source heat pumps, on the other hand, have refrigerant lines underground to take advantage of the ground's relatively constant temperature. This provides consistent high performance but requires significantly higher installation costs.

Electric Resistance Technology for Space Heating

Electric resistance furnaces use resistance elements, such as heating coils or strips to warm the air, which can then be used in conjunction with air handlers, ductworks, and thermostats to deliver controlled heat through a residential or commercial space. This technology converts nearly all incoming electricity and converts it to heat directly. Some heat pumps have an electric resistance element used for backup heating since a heat pump's efficiency may decrease due to extreme cold conditions or inadequate spacing.

Electric resistance heaters have fewer requirements for installations compared to natural gas fired heaters, as they do not require a flue or venting system. This allows electric resistance to be

installed in a wide range of indoor spaces and is suitable for spaces where natural gas availability is limited or undesirable.

Electric resistance wall heaters are mounted directly onto walls and use electric resistance coils to warm the surrounding air. This warm air then rises naturally, creating convection currents that circulate through the room, gradually raising the ambient temperature. Similarly, electric resistance floor heaters use the same principle, but are generally installed along the baseboards of walls. Both wall and floor heaters are often used in residential and commercial spaces where localized space heating is needed and oftentimes, where a central heating system is not sufficient or not practical.

However, electric resistance furnaces are not as efficient as heat pumps since they convert electricity to heat in a nearly one-to-one ratio.

Solar Technology for Heating, Ventilation, and Air Conditioning

Solar heating technology collects thermal energy from the sun to heat space or water. Active and passive solar heating are the two most common types of solar heating. Active solar air heating systems use solar collectors to heat air, which is then circulated through the home using fans or ducts. This method is often used in conjunction with a traditional heating system to provide supplemental heat. Solar technology is commonly used to generate electricity for storage or to power an existing HVAC system. Due to the reliance on available sunlight, solar HVAC systems may need to have a back-up system when sunlight is not available. Solar HVAC systems are commonly coupled with mini split heat pumps, leveraging the use of a renewable energy source to power the HVAC system. Passive solar heating systems rely on building design elements, such as windows, walls, and floors, to collect, store, and distribute the solar energy naturally.

Mobile Homes

Mobile home furnaces have specific design and size requirements that are different from those of a traditional home furnace. There are various zero emission technologies for mobile home space heating, including solar, electric resistance, and heat pumps. Heat pump technologies include ductless mini-split, package, central air, and geothermal systems that have high energy efficiency and are gaining more popularity. Package heat pump systems do not have the concern of physical design for space and air flow as they do not require a separate indoor unit. Packaged heat pump systems combine the heating and cooling components into one outdoor unit and connect to the home's ductwork to distribute warm or cool air throughout the living space.

PAR 1121 BARCT ASSESSMENT

Assessment of South Coast AQMD Regulatory Requirements

Staff reviewed existing South Coast AQMD NOx regulations for residential water heating. The following table summarizes the South Coast AQMD rules that staff evaluated as part of the BARCT technology assessment.

Table 2-3: South Coast AQMD Regulatory Requirements Similar to PAR 1121

Regulation/Rule Title	Relevant Unit/Equipment Size	Current and Future Effective NOx Emission Limits in ng/J or ppmv at 3 percent O_2, dry
Rule 1146 – Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters	Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (greater than or equal to 5,000,000 Btu/hr rated heat input capacity)	• 7-9 ppm for units burning gaseous fuels 5,000,000 to less than 20,000,000 Btu/hr; • 5-9 ppmv for units burning gaseous fuels greater than 20,000,000 Btu/hr and less than 75,000,000 Btu/hr; • 5 ppmv for units burning natural gas greater than or equal to 75,000,000 Btu/hr; • 12 ppmv for thermal fluid heaters burning gaseous fuels; • 40 ppmv for nongaseous fuels; • 12 ppmv for atmospheric units; • 15 ppmv for units burning digester gas; • 25 ppmv for units burning landfill gas
Rule 1146.1 – Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters	Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (greater than 2,000,000 Btu/hr and less than 5,000,000 Btu/hr rated heat input capacity)	• 7-9 ppmv for units greater than 2 MMBtu/hr and less than 5,000,000 Btu/hr burning natural gas; • 12 ppmv for atmospheric units; • 12 ppmv for thermal fluid heaters; • 15 ppmv for units burning digester gas; • 25 ppmv for units burning landfill gas
Rule 1146.2 – Emissions of Oxides of Nitrogen (NOx) from Large Water Heaters, Small Boilers and Process Heaters	Large Water Heaters, Small Boilers and Process Heaters (less than or equal to 2,000,000 Btu/hr rated heat input capacity, excluding tank type water heaters subject to Rule 1121)	0 ppmv with compliance dates between 2026-2033: • Type 1 Units • Instantaneous Water Heaters ≤200,000 Btu/hr • Instantaneous Water Heaters >200,000 Btu/hr • Type 1 Pool Heaters • Type 2 Units • Type 1 High Temperature Units, and • Type 2 High Temperature Units

Regulation/Rule Title	Relevant Unit/Equipment Size	Current and Future Effective NOx Emission Limits in ng/J or ppmv at 3 percent O_2, dry
Rule 1111 – Reduction of NOx Emissions from Natural-Gas-Fired Furnaces	Gas-fired fan-type space heating furnaces with a rated heat input capacity of less than 175,000 Btu/hr or, for combination heating and cooling units, with a cooling rate of less than 65,000 Btu per hour	• 14 ng/J • 40 ng/J before October 1, 2025 with mitigation fee alternative compliance option, and 14 ng/J on and after October 1, 2025, for mobile home furnaces

Emission Level of Existing Units

Currently, Rule 1121 water heaters are required to be certified at the NOx emissions limit of 10 ng/J, whereas mobile home water heaters are required to be certified at an emissions limit of 40 ng/J. The list of units certified for use in the South Coast AQMD can be found on the South Coast AQMD website[(6)].

Other Regulatory Requirements

Staff reviewed regulatory requirements from other agencies for identical or similar equipment. The purpose of this step is to determine if there are more stringent regulations in other jurisdictions that should be considered, as rules enforced by the South Coast AQMD cannot be less stringent than another air district rule unless compliance is not achievable.

[(6)] https://www.aqmd.gov/home/programs/business/business-detail?title=certified-equipment&parent=certified-products

Table 2-4: Other Regulatory Requirements Similar to PAR 1121

Regulatory Entity	Regulation/Rule	Relevant Emission Limits
San Joaquin Valley Air Pollution Control District (Valley Air District)[7]	Rule 4308 – Boilers, Steam Generators, and Process Heaters (units with a total rated heat input capacity of greater than or equal to 75,000 Btu/hr and less than 2,000,000 Btu/hr) – Exempts units installed in manufactured homes, units installed in recreational vehicles, and hot water pressure washers	20 ppmv (except for pool heaters greater than or equal to 75,000 Btu/hr and less than or equal to 400,000 Btu/hr, which are at 55 ppmv)
Bay Area Air Quality Management District (BAAQMD)[8]	Rule 9-6 – Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters (units with total rated heat input capacity of 75,000 Btu/hr – 2,000,000 Btu/hr) adopted in March 2023	Zero-emission limits with implementation in 2027 for small water heaters with rated heat input capacity greater than or equal to 75,000 Btu/hr and in 2031 for others – Exempts units installed in manufactured homes (40 ng/J limit), units installed in recreational vehicles, and pool/spa heaters with less than 400,000 Btu/hr rated heat input capacity used exclusively to heat swimming pools, hot tubs, or spas
California Air Resources Board (CARB)[9]	2022 State Strategy for the State Implementation Plan (adopted September 22, 2022) proposed measures for residential and commercial buildings; Anticipating Board consideration for rule adoption in 2025	Proposed zero-emission limits (GHG, NOx) for new equipment and appliances sold for use in both residential and commercial buildings, with implementation in 2030

[7] San Joaquin Valley Air Pollution Control District, Rule 4308, https://ww2.valleyair.org/media/o5pdu0oe/rule-4308.pdf

[8] Bay Area Air Quality Management District, Rule 9-6, https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230315_rg0906-pdf.pdf?rev=436fcdb037324b0b8f0c981d869e684d&sc_lang=en

[9] California Air Resources Board, 2022 State SIP Strategy, p. 30, https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

Assessment of Pollution Control Technologies

The next step is to research the commercially available emission control technologies and seek information on any emerging emission control technologies. As part of this assessment, staff met with multiple manufacturers. South Coast AQMD Rule 1121 is technology and fuel neutral and is focused on achieving the maximum NOx emission reductions possible.

Staff assessed different pollution control technologies as part of the BARCT assessment. Staff presented and discussed the pollution control technology assessment in working group meetings. The objective is to identify and evaluate control technologies, approaches, and potential emission reductions.

Zero-Emission Technology and Emerging Technology

Zero-emission technologies such as heat pumps, electric resistance, and fuel cell technologies were explored as part of the BARCT assessment, all of which are proven technologies that have been in operation for decades. Staff conducted internet searches and met with stakeholders to gather more information on zero-emission technologies and emerging technology.

Heat Pump Technology for Water Heating

Common zero-emission heating technology includes heat pumps. This technology can be over three times more efficient than conventional appliances and can be used for water heating, space heating, and cooling.

Unlike natural gas-fired water heaters that generate heat directly, heat pump water heaters use the principle of energy transfer to transport energy from the surrounding air to the water, using a refrigerant cycle. The most common type of heat pump water heaters (HPWH) are integrated HPWHs, where the heat pump and storage tank are in a single unit. These are ideal for smaller spaces where installation flexibility is limited, as these offer the convenience of a "drop-in" replacement. Additionally, there are split system HPWHs, where the heat pump unit is separated from the water storage tank. This allows the heat pump unit to be installed in a less-obtrusive area, such as outdoors or a basement, whereas the storage tank can be installed in a different location indoors. In split systems, the heat pump takes heat from where the heat pump unit is installed. The split system, however, is not a "drop-in" replacement for a conventional tank-type water heater and may necessitate higher upfront costs for installation.

Two of the most common types of integrated HPWHs, 240-volt (240V) and 120-volt (120V), are differentiated by the power supply required to operate. 240V HPWHs generally are hybrid electric water heaters, where the heat pump water heater can use a back-up heating element to accommodate for high water usage to increase the recovery rate. Compared to 120V HPWHs, 240V HPWHs have a higher efficiency, but require a power supply that may not be available for all installations. 120V HPWHs offer a solution for a wider range of installations, but they do not have a back-up heating element which results in a slower recovery rate.

120V HPWHs can reduce costs and installation complexity that customers may face when retrofitting a HPWH, compared to 240V HPWHs. New Buildings Institute (NBI) worked closely with 120V HPWH manufacturers and utilities in California on a statewide 120-volt HPWH field validation program from 2021 to 2023. NBI installed 120-V HPWHs for 32 customers in most

climate zones across California.[10] Based on the study findings, they saved between $800 and $15,000 per household compared to 240V HPWH installation, primarily due to the minimal electrical interventions. These are very low amperage draw water heaters, they were pulling 4-6 amps of current during the monitoring period, despite being rated for 15 amps. From the installer feedback, 120V HPWHs were also faster to install, making them ideal for emergency replacements. 120V HPWHs were introduced to the market in 2022. Currently, there are two manufacturers (i.e., Rheem & A. O. Smith) with 120V HPWHs commercially available with sizes ranging from 40 to 80 gallons. More manufacturers are expected to commercialize 120V HPWHs. This type of HPWH can plug into a standard wall outlet (shared circuit ≥ 15 amps) and can be installed like a standard gas water heater. Due to its slower heat recovery rate and lower first hour ratings compared to its gas-fired counterpart, manufacturers recommend upsizing for similar hot water availability, which means a larger footprint is required. For example, for A. O. Smith products, the HPWH replacement typically is 4-6" larger in diameter and 3-8" taller. Another installation consideration is about ventilation. For a small space not meeting the air flow criteria, louvered door and inlet/outlet ducting may be considered.

The split system HPWH offers a solution for small spaces. This technology is widely used in industrial and residential water heating applications in countries like Japan and Australia and are now gaining more adoption in the California market. The SANCO$_2$ Heat Pump Water Heater system has been observed in use for multifacility retrofit projects including the South Coast AQMD Multifamily Affordable Housing Electrification Project. [11] [12] Manufacturers are also developing 120V split system HPWHs that minimize the need for electrical upgrades. EmberH2O Heat Pumps also have a 120V split system heat pump water heater [13]. The Hot Water Innovation Prize intends to reward manufacturers that develop innovative split system HPWHs and bring the technology to market.[14]

Multi-function heap pumps (MFHP) are another emergency technology that uses one efficient compressor and outdoor heat exchanger coil to provide space cooling, space heating, and domestic hot water heating. For retrofits in buildings with existing air conditioning, this means that full size capacity air-to-air MFHP can utilize existing air conditioning electrical circuits without modification. For buildings that do not have air conditioning, the air-to-air MFHP is less likely to trigger the need for a service breaker panel or service wire upgrade compared to the typical separate heat pump HVAC and standalone HPWH products. Harvest Thermal[15] and Villara Aqua ThermAire[16] are market available MFHP products and more developments are underway[17].

Some stakeholders have expressed concerns over how well heat pumps will operate in colder climates, such as the high-altitude locations within the South Coast AQMD. There are heat pump products available in the market that can operate at low temperatures, and the Northwest Energy

[10] https://newbuildings.org/wp-content/uploads/2023/07/PlugInHeatPumpWaterHeaterFieldStudyFindingsAndMarketCommercializationRecommendations_NBI202308.pdf
[11] https://eco2waterheater.com/product-info/
[12] https://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2019/2019-jan4-002.pdf?sfvrsn=8
[13] https://embertec.com/heat-pump(-water-heaters/
[14] https://partners.hotwatersolutionsnw.org/hot-water-innovation-prize
[15] https://www.harvest-thermal.com/
[16] https://villara.com/wp-content/uploads/2024/03/1.22-AquathermAire-One-Sheet.pdf
[17] https://calnext.com/wp-content/uploads/2023/02/ET22SWE0021_Residential-Multi-Function-Heat-Pumps-Product-Search_Final-Report.pdf

Efficiency Alliance's Qualified Products List includes HPWH products that are energy efficient in cold climates and products that can produce hot water via heat pump at negative 25 degrees Fahrenheit. Cold climate heat pumps can pull heat from the air even at sub-zero temperatures and are utilized in colder climates in the U.S. and abroad. Maine has one of highest per capita heat-pump adoption rates, outpacing Scandinavian countries, with rebates incentivizing installation of approximately 116,000 heat pumps in a state that has fewer than 600,000 occupied housing units. Heat pump technology is also being adopted in states such as Vermont and Alaska, and according to the International Energy Agency, 60 percent of Norway's buildings are fitted with a heat pump.

Electric Resistance Technology for Water Heating

Electric resistance water heating relies on electric heating elements immersed in a storage water tank to generate heat. These heating elements are submerged in water in the storage water tank and heat the water by converting the incoming electricity to heat. This technology converts nearly all incoming electricity and converts it to heat directly.

Thermostats monitor the water temperature inside the tank and cycle the heating elements on and off, as needed, to maintain a set temperature. Electric resistance water heaters are generally less efficient than heat pump water heaters, as it can only convert electricity to heat at a one-to-one ratio. Some heat pumps have an electric resistance element used for backup heating since a heat pump's efficiency may decrease due to extreme cold conditions or inadequate spacing.

Solar Technology for Water Heating

Solar thermal hot water systems include conventional-sized systems and consist of flat plate collectors, a controller, pump, and storage. The solar thermal collectors absorb sunlight and transfer the heat to the water or heat transfer fluid. Solar water heating can be active, by using pumps to circulate water, or passive, by relying on natural convection. Solar water heating is advantageous in warmer climates, as it depends on the availability of sunlight to function. Because of this, the use of a back-up water heater, be it a gas-fired, electric resistance, or a HPWH, may be required.

Mobile Homes

Mobile home natural gas water heaters generally have lower capacity and are compatible for natural gas and propane use. Similar to mobile home space heating systems, mobile home water heaters need to be approved by HUD for safety standards. Considering the limited space of manufactured homes, HUD requirements limit the options of water heater replacement in a mobile home. Some common zero-emission mobile home water heaters include electric tankless water heaters and electric storage water heaters. Manufactures are also providing HPWHs that are HUD approved for mobile home installation. For example, Clayton Homes eBuilt shows a Rheem ProTerra heat pump water heater[(18)]. Some manufacturers have stated that they will continue their heat pump development to further address space constraints for some existing mobile homes as the market grows.

[(18)] Clayton Homes eBuilt, https://www.claytonbuilt.com/ebuilt

Fuel Cell Technology for Water Heating

Residential fuel cells that provide combined heat and power (referred to as micro-CHPs) are commercially available in Japan and Europe. Most available micro-CHPs use natural gas, which is reformed into hydrogen gas and carbon dioxide (CO_2). The hydrogen is then sent to the fuel cell, which produces electricity and heat as a byproduct, producing zero NOx. This heat can be used to fulfill heating needs, including hot water and space heating. The same unit can use piped or bottled hydrogen gas, which also makes it an option to decarbonize home heating. However, most units also have a natural gas-fueled "top-up boiler" which provides additional needed heat at peak load.

In Japan, micro-CHPs have been heavily subsidized by the government under the Ene-Farm project, which is part of the larger "Hydrogen Society" policy to move Japan's infrastructure to hydrogen as a renewable fuel source. Japan has by far the largest market penetration of micro-CHPs, with 465,000 systems installed by 2022, though this amount was substantially fewer than the Japanese government's target of 1.4 million systems by 2020.

In Europe, adoption has been much lower. Two pilot projects, Ene-field and its successor PACE, have only installed 3,500 micro-CHPs, with the majority installed in Germany.

According to representatives of So Cal Gas, many of the Japanese and European manufacturers of micro-CHPs are reluctant to bring them to the US market since they would need to make modifications to the units to meet UL certification requirements. Staff was unable to locate any micro-CHPs available for sale in the United States.

Fuel cells have a broad range of applications from multi-megawatt systems to small units and continue to expand with emerging technologies[(19)]. Cost and durability are still critical challenges, and studies have indicated price ranges between $4,000 to $20,000 per kilowatt (kW). Natural gas fuel cells produce some NOx emissions. Fuel cell adoption in California currently is limited; however, fuel cell technology has the potential to replace existing units to meet the zero-emission limits.

COST-EFFECTIVENESS AND INCREMENTAL COST-EFFECTIVENESS

Initial BARCT Emission Limit and Other Considerations

After completing the technology assessment, staff recommends an initial BARCT NOx emission limit established using information gathered from the technology assessment. All provided emission concentration values (i.e., initial and final) in this report refer to concentration in terms of parts per million by volume (ppmv) based on a dry basis. Additionally, staff evaluates other considerations that could affect the emission limits that represent BARCT, including limits for those units operating close to the BARCT NOx limits. Heat pump technologies are still the main technologies that can achieve in the nearer term the NOx concentration limits proposed in PAR 1111 and PAR 1121. The summary of the BARCT assessment and staff's recommendations based on feasibility is discussed in the next section.

Method for Cost-Effectiveness and Incremental Cost-Effectiveness Analysis

The South Coast AQMD routinely conducts cost-effectiveness analyses for proposed rules and proposed amended rules and regulations that result in the reduction of criteria pollutants (NOx,

[(19)] U.S. Department of Energy, Multi-Year Research, Development, and Demonstration Plan, https://www.energy.gov/sites/default/files/2017/05/f34/fcto_myrdd_fuel_cells.pdf

sulfur oxides, volatile organic compounds, particulate matter, and carbon monoxide). The analysis is used as a measure of the relative effectiveness of a proposal. It is generally used to compare and rank rules, control measures, or alternative means of emissions control relating to the cost of purchasing, installing, and operating control equipment to achieve the projected emission reductions. The major components of the cost-effectiveness analysis are capital costs, emission reductions, discount rate, and equipment useful life. The cost-effectiveness for PAR 1111 and PAR 1121 was completed using the discounted cash flow method, which is explained as follows:

Discounted Cash Flow (DCF)

The DCF method converts all costs, including initial capital investments and costs expected in the present and all future years of equipment useful life, to present value. Conceptually, it is as if calculating the number of funds that would be needed at the beginning of the initial year to finance the initial capital investments and to set aside to pay off the annual costs as they occur in the future. The fund that is set aside is assumed to be invested and generates a rate of return at the discount rate chosen. The final cost-effective measure is derived by dividing the present value of total costs by the total emissions reduced over the equipment useful life. The following equation is used for calculating cost-effectiveness with DCF. The equation was presented in the 2022 AQMP Socioeconomic Report Appendix 2-B (p. 2-B-3):

$$Cost - effectiveness = \frac{Initial\ Capital\ Investments\ +\ (Annual\ O\&M\ Costs\ \times\ PVF)}{Annual\ Emission\ Reductions\ \times\ Years\ of\ Equipment\ Life}$$

Where O&M = Operation and Maintenance; and

PVF = Present Value Factor.

Equation 2-1. Discounted Cash Flow Cost-Effectiveness Equation

The PVF is calculated as follows:

$$PVF = \frac{(1+r)^N - 1}{r * (1+r)}$$

Where r = real interest rate (discount rate); and
N = years of equipment life.

Equation 2-2. PVF Equation

Finally, Health and Safety Code Section 40920.6 (a)(3) states that an incremental cost-effectiveness assessment should be performed on identified potential control options that meet air quality objectives. To determine the incremental cost-effectiveness under this paragraph, South Coast AQMD calculates the difference in the dollar costs divided by the difference in the emission reduction potentials between each progressively more stringent potential control option as compared to the next less expensive control option. Once the BARCT assessment is complete and NOx limits are established, staff considers incrementally more stringent options to demonstrate that the NOx limit represents the "maximum degree of reduction achievable by each class or category." The equation for incremental cost-effectiveness is provided as follows:

$$I\text{-}CE\left(\$/_{tons\ NOx\ reduced}\right) = \frac{Incremental\ Difference\ in\ Cost\ (Present\ Worth\ Value)}{Incremental\ Difference\ in\ Emission\ Reductions\ (Lifetime\ Reductions)}$$

Where I-CE = Incremental Cost-Effectiveness

Equation 2-3. Incremental Cost-Effectiveness Equation

The 2022 AQMP's objective is to meet the 2015 federal ozone standard through further emission reductions by transitioning to zero-emission technologies wherever feasible. For PAR 1111 and PAR 1121, staff identified technically feasible, commercially available, zero-emission control technologies for each category of equipment subject to PAR 1111 and PAR 1121. Staff did not identify less stringent control options that would meet the 2022 AQMP's air quality objective.

For the incremental analysis, staff considered a NOx technology that is incrementally more stringent than the current NOx limits. South Coast AQMD funded a project (Request For Proposal #P2018-06) in 2019 – 2023 for Lantec Products to develop prototype residential furnaces with NOx emissions lower than the current PAR 1111 Table 1 NOx limits. However, considering those prototype furnaces currently are not commercially available, and a number of zero-emission technologies are widely commercially available, staff did not consider the prototype low-NOx furnaces to be a feasible option that would achieve the 2022 AQMP's objectives. In conclusion, staff did not identify multiple control technologies for PAR 1111 and PAR 1121 that can achieve the 2022 AQMP's NOx reduction objective other than to transition to zero-emission technologies; therefore, an incremental cost-effectiveness assessment was not conducted.

Although the BARCT assessment only identified zero-emission technologies, there are a variety of control options that one can choose to meet the zero-emission limit. As discussed in earlier sections, heat pump, electric resistance, solar, and fuel cell are the viable zero-emission technologies that are relying on various fuel sources in alignment with the South Coast AQMD fuel neutral policy. In addition, each type of those technologies has multiple features and options for various applications. For example, heat pump water heaters have product lines for 240V and 120V applications to suit different electric and space setting, split systems that separate the tanks and compressor to save indoor space, multi-function systems that combine and streamline the HVAC and water heating to minimize the need of service upgrade. Cost-effectiveness varies depending on the control option selected to meet the zero-emission limit. For example, a heat pump HVAC replacing both space heating and cooling systems is much more cost effective than replacing just a space heating system, with cost saving estimated.

Equipment Costs

In order to determine equipment and installation costs for heat pumps for PAR 1111 and PAR 1121, staff utilized the data published TECH Clean California. TECH requires contractors who receive the rebates to report a wide variety of information on the project, including cost. Staff used the public data set for November 2023, choosing the median costs for installations in the four-county area. For the costs of the natural gas units, staff took capital costs from the 2019 E3 "Residential Building Electrification in California"[(20)] and calculated weighted average costs based on climate zone and building stock. For homes with air conditioning (AC), combined costs of the heating and cooling systems were considered, as the proposed heat pump replacement provides

[(20)] https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/

both heating and cooling. To estimate the percentage of homes with AC and without AC, staff relied on the US Census American Housing Survey[21] which for the Los Angeles-Orange-San Bernardino-Riverside area estimates that 87 percent of homes have AC. Because all replacements occur at the end of useful life, no costs of stranded assets were considered.

For commercial furnaces, staff considered packaged units, which have similar installation requirements for natural gas and heat pumps. Staff collected cost information for this equipment from online storefronts.

Estimating Fuel Switching Cost

The analysis considered the cost impacts of transitions from conventional combustion heating that uses natural gas to zero-emission technologies that use electricity as part of the cost-effectiveness assessment. For this assessment, the analysis relied upon the fuel price estimates which are based on a combination of the California Energy Commission's (CEC's) 2023 Integrated Energy Policy Report[22] and Energy Information Administration (EIA) national level forecasts. The current CEC forecast extends to 2050. Electricity forecasts are based on the Los Angeles Department of Water and Power (LADWP) and Southern California Edison (SCE) planning areas. Natural gas forecasts are only based on Southern California Gas Company (SoCalGas) forecasts, as SoCalGas is the primary gas utility in the region. Forecasted prices will not match observed electric and natural gas prices in any given year and may differ materially. Current prices are affected by demand and supply shocks, geopolitical factors, and other considerations which are all unforecastable. However, the CEC forecasts are created through a rigorous modeling process and reflect the best available expectation for future prices in the region. CEC forecasts are released every two years.

The analysis utilizes the residential utility rate forecast. Since the forecasted prices for LADWP and SCE differ, staff calculated a weighted average price based on the population served by each utility as follows:

LADWP: 4 million ÷ 17.2 million (Population served by LADWP ÷ regional population) = 0.23
SCE: 13.2 million ÷ 17.2 million = 0.77

Using the annual fuel usage for both electricity and gas and the projected utility rates, the fuel switching cost was calculated on a per-year basis using Equation 2-4.

$$Fuel\ switching\ cost\ (\$) = annual\ gas\ cost\ (\$) - annual\ electricity\ cost\ for\ replacement(\$)$$

Where annual gas cost ($) = annual gas use (therm) * projected gas rate ($/therm)

annual electricity cost for replacement ($) = annual electricity use for replacement (kWh) * projected electricity rate ($/kWh)

Equation 2-4: Fuel Switching Cost Equation

[21] https://www.census.gov/programs-surveys/ahs.html
[22] https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report

The fuel switching costs were calculated over the span of the useful life of the equipment and averaged.

Electrical Panel Upgrade Cost

In some instances, the transition to zero-emission units will require the electrical panel to be upgraded, which will add costs for the owner or operator of the units. For the cost-effectiveness analysis, the analysis relied on a panel upgrade cost estimate of $3,000, taken from the 2022 NV5 Service Upgrades for Electrification Retrofit[23], which found costs to consumer averaged $2,780. The analysis also considered a useful life of 30 years for the panel; however, the cost of an electrical panel upgrade was adjusted to account for this longer useful life of the electrical panel versus the unit, as well as sharing the cost of the panel between both space and water heating. The final cost for panel upgrades was therefore $750 for both space and water heating. This panel upgrade cost was applied as a weighted cost based on the percentage of homes likely to require a panel upgrade. Based on the TECH dataset, this was 4 percent of homes for space heating and 9 percent of homes for water heating.

Cost-Effectiveness Screening Threshold

The 2022 AQMP established a cost-effectiveness screening threshold of $325,000 per ton of NOx reduced based on 2021 dollars. The 2022 AQMP stated that this screening threshold will be adjusted based on the annual California Consumer Price Index (CPI). PAR 1111 and 1121 currently considers a $349,000 per ton of NOx reduced cost-effectiveness screening threshold using 2022 dollars. The 2022 AQMP threshold is neither considered a starting point for control costs, nor an absolute cap.

Cost-Effectiveness Analysis

To determine cost-effectiveness for the proposed BARCT limits, cost information and estimates for the control equipment were obtained. Staff utilized the public database of the TECH Clean California heat pump rebate program[24] to collect information on the installation cost for heat pumps. After cost information was obtained, a bottom-up approach evaluated each unit category subject to PAR 1111 and PAR 1121 and cost-effectiveness analysis was conducted on a per equipment basis. Baseline emissions for each equipment were calculated using the assumption methodology outlined in Chapter 4.

Cost-Effectiveness Analysis for Rule 1111

Using Equation 2-1-Equation 2-4, the cost-effectiveness of Rule 1111 was calculated.

Operating Costs for Rule 1111

To determine the operating cost changes inherent in moving from natural gas combustion to heat pumps, staff used the 2019 Residential Appliance Saturation Study (RASS)[25] released by the CEC. The RASS includes information on the energy use of both electrical and natural gas appliances in Californian homes. Staff selected the tabulations for the SCE and SoCalGas as the

[23] https://pda.energydataweb.com/api/view/2635/Service%20Upgrades%20for%20Electrification%20Retrofits%20Study%20FINAL.pdf
[24] https://techcleanca.com/public-data/
[25] https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass

most representative of the South Coast AQMD region. When estimating operating costs for furnaces in multifamily, staff instead used the California Apartment tabulation.

For commercial furnaces, staff used the CBECS microdata for the Pacific Census Division to determine the electrical and gas usage for average commercial buildings utilizing gas and electric heating.

Residential Central Furnaces and Commercial Furnaces: Present Value Factor

According to the Air Conditioning, Heating, and Refrigeration Institute (AHRI), air conditioners have an expected lifetime of 12-15 years.[26] In the Department of Energy's 2023 Energy Conservation Standards for Consumer Furnaces[27], it was assumed consumer furnaces not in the north of the country had an expected lifetime of 20.2 years, but noted replacement was likely to be linked to the replacement of a central air conditioner. The California Public Utilities Commission (CPUC) proposed a 36-year expected useful lifetime for central and wall furnaces[28]. The latest amendment to Rule 1111 also assumed a 25-year equipment lifetime. Given the equipment lifetime ranges from 12 – 36 years, staff, assumed a lifetime of 25 years for residential furnaces and a four percent discount rate and thus a PVF of 15.62 as calculated per Equation 2-2. PVF Equation

Single-Family Residential Furnaces: Cost-Effectiveness

The analysis considered the potential replacement of a residential central furnace, typically 40,000 to 90,000 Btu/hr. Staff estimated cost-effectiveness for using heat pumps replacing furnaces in homes with AC and without AC, assessed cost-effectiveness for using electric resistance furnaces replacing furnaces in home without AC, and calculated a weighted average.

The initial capital cost of a natural gas-fired unit is estimated to be $10,000, while the initial capital cost of the furnace and air conditioning system (AC) combined is estimated to be $18,800. The heat pump replacement has a median initial capital cost at $18,500 based on the TECH dataset. The average cost to install an electric resistance furnace is estimated to be $9,300. The cost of installing an electric resistance furnace was taken from the Angi website for Los Angeles County[29].

For a heat pump replacement to a gas furnace with or without AC, the annual fuel switching costs are estimated to be a cost savings of $1,950. As a result, the cost-effectiveness for a heat pump replacement to the furnace without AC is $827,000 per ton or $921,000 per ton with panel upgrade, and the cost-effectiveness for a heat pump replacement to a furnace with AC is negative $277,000 per ton or negative $183,000 per ton with panel upgrade. Although heat pump replacement for furnace without AC has a high cost-effectiveness, the replacement would have an additional benefit of space cooling, which is becoming more of a necessity due to climate change.

For an electric resistance furnace replacing a gas furnace in a home without AC, the fuel switching costs are estimated to be a cost savings of $1,600. The annual fuel use for electric resistance furnaces and residential central furnaces are based on the 2019 RASS. As a result, the cost-

[26] https://www.ahrinet.org/certification/cee-directory/air-conditioning-and-heat-pump-efficiency-101
[27] https://www.federalregister.gov/documents/2023/12/18/2023-25514/energy-conservation-program-energy-conservation-standards-for-consumer-furnaces
[28] Residential HVAC and DHW Measure Effective Useful Life Study Final Report, page 6, https://www.calmac.org/publications/CPUC_Group_A_2023_Res_HVAC_and_DHW_EUL_Study_Final_Report.pdf
[29] https://www.angi.com/articles/how-much-does-it-cost-install-electric-furnace.htm

effectiveness for an electric resistance furnace replacing a furnace in a home that does not have an AC is negative $295,000 per ton or negative $201,000 per ton with a panel upgrade. Staff used RASS data as a source of annual fuel use estimates in California; however, the energy use for the electric resistance heater is much lower than one would expect, considering they are significantly less efficient than heat pumps. The reason could be that electrical resistance heaters are generally installed in areas where heating is not in high demand and, therefore, skewing the demand estimates. In areas that do not have high heat demand, an electrical resistance furnace is a cost-effective solution.

In order to provide an upper bound for fuel switching costs, staff converted the annual fuel use for a gas furnace from the RASS data to electricity usage for an electric resistance furnace and adjusted for efficiency, resulting in a fuel switching cost of $9,307. Using this method, the cost-effectiveness for an electric resistance furnace replacing a furnace in a home without AC is $1,077,000 per ton or $1,172,000 per ton with a panel upgrade. Although electric resistance furnace is included in the analysis, this type of replacement is not as preferred as a heap pump replacement, considering its lower energy efficiency and high demand on the grid.

Given 87 percent of homes in the South Coast AQMD region have AC and 4 percent of homes may require a panel upgrade, the weighted average is estimated to be negative $129,000 for replacing furnaces in homes with and without AC with a heat pump. To address the high cost of furnace only replacements, PAR 1111 includes an alternative compliance option that allows a natural gas fired furnace to be rented for up to 24 months before a zero-emission furnace is required.

Multifamily Residential Furnaces: Cost-Effectiveness

The analysis considered the potential replacement of individual natural gas-fired units by heat pumps in a multifamily setting. The capital cost of a natural gas-fired unit is estimated to be $6,600, while the capital cost of the furnace and AC combined is estimated to be $12,400. The heat pump replacement cost from the TECH multifamily dataset is estimated to be $5,300. Fuel switching cost is estimated at $240. Cost-effectiveness for the furnace-only case is a cost savings of $459,000 per ton or a cost savings of $135,000 per ton with panel upgrade. In the case with combined furnace and AC the cost-effectiveness is negative $2,957,000 per ton or negative $2,633,000 per ton with panel upgrade. The weighted average cost-effectiveness (based on 87 percent of homes in the AQMD region having AC and 4 percent of homes requiring a panel upgrade) is negative $2,618,000 per ton.

Commercial Furnaces: Cost-Effectiveness

The analysis considered the potential replacement of package natural gas-fired furnace and air conditioning by heat pumps ranging in size from 5 to 10 tons. The capital cost of a natural gas-fired package unit is estimated to be between $5,400 to $12,200 depending on size, while the capital cost of the heat pump is estimated to be between $5,600 and $12,200. The cost difference between the gas package unit and heat pump unit of similar size is small, typically less than $1,000. Fuel switching cost is estimated at a cost savings of $33,500. Cost-effectiveness ranges from negative $74,500 to negative $79,000. Staff did not calculate weighted averages for the commercial cost-effectiveness since the need for a panel upgrade is highly variable for commercial buildings.

Cost-Effectiveness Analysis for Rule 1121

Using Equation 2-1-Equation 2-4, the cost-effectiveness of Rule 1121 was calculated.

Operating Costs for Rule 1121

While the RASS included information on energy use for natural gas water heaters, no information was provided on electricity use of heat pump water heaters. Therefore, staff turned to the annual electricity use estimates provided by EnergyStar[30] for certified products. Using an average of five different heat pump water heaters ranging from 55 gallons to 65 gallons, an average annual electricity usage was calculated to be 1036 kWh. An annual use of 188 therms/year and 192 therms/year were found from EnergyStar for 45- and 55-gallon water heaters respectively; therefore, staff used the average equating to 190 therms/year annual gas usage.

Residential Water Heaters: Present Value Factor

For storage water heaters, U.S. DOE estimates a useful life of 10 to 15 years.[31] For the 2024 amendment of Rule 1146.2, Type 1 storage water heaters were also assumed to have a 15-year useful life. For this reason, analysis assumes residential water heaters have a 15-year useful life and four percent discount rate and thus a PVF of 11.118 as calculated per Equation 2-2. PVF Equation

Single-Family Water Heaters: Cost-Effectiveness

The analysis considered the potential replacement of a natural gas-fired residential water heater less than 75,000 Btu/hr, with a heat pump. The capital cost of a natural gas-fired unit is estimated to be $3,000, while the capital cost of the heat pump is estimated to be $5,200. Finally, fuel switching costs are estimated as cost savings of $1,400, using Equation 2-4. Cost-effectiveness for the base case is $299,000 per ton or $601,000 per ton with panel upgrade. The weighted average cost-effectiveness (based on 9 percent of homes requiring a panel upgrade) is $327,000 per ton.

Multifamily Water Heaters: Cost-Effectiveness

The analysis considered the potential replacement of individual natural gas-fired water heaters by heat pumps in a multifamily setting. The capital cost of a natural gas-fired unit is estimated to be $2,700, while the capital cost of the heat pump replacement cost is estimated to be $4,300. Estimates for both natural gas units and heat pumps are assuming replacement of multiple water heaters in different multifamily units, which lowers the per unit cost. Fuel switching cost is estimated at a cost savings of $1,400. Cost-effectiveness in the base case is $33,000 per ton or $335,000 per ton with panel upgrade. The weighted average cost-effectiveness (based on 9 percent of homes requiring a panel upgrade) is $61,000 per ton.

Summary of Cost-Effectiveness

The following tables summarize the cost-effectiveness estimates for PAR 1111 and PAR 1121 categories.

[30] https://www.energystar.gov/productfinder/product/certified-heat-pump-water-heaters/results
[31] U.S. Department of Energy, Tankless or Demand-Type Water Heaters, https://www.energy.gov/energysaver/tankless-or-demand-type-water-heaters

Table 2-5. Weighted Average Cost-Effectiveness for PAR 1111 Categories with Heat Pump Replacement

Category	Cost-Effectiveness ($/Ton), No Panel Upgrade	Cost-Effectiveness ($/Ton), With Panel Upgrade	Cost- Effectiveness ($/Ton), Weighted Average
Single-Family Residential Furnace	(134,000)	(39,000)	(129,000)
Multifamily Residential Furnace	(2,632,000)	(2,309,000)	(2,618,000)
Commercial Furnace	(76,200)	N/A	N/A

* Fuel switching costs calculated by converting RASS annual fuel use for gas furnace to electricity with adjustment for efficiency

All categories for PAR 1111 are cost-effective. However, in the case of single-family homes that only have a furnace and no existing AC system, the cost-effectiveness can exceed the $349,000 cost-effectiveness threshold. The weighted average takes into account that 87 percent of homes have an existing AC system, and that four percent of homes would require an electrical panel upgrade. Given these weights, the weighted average for the cost-effectiveness for single-family homes with solely heat pump replacements is negative $129,000, which is less than the $349,000 cost-effectiveness threshold. Both multifamily and commercial furnaces are cost-effective for all categories.

Table 2-6. Cost-Effectiveness for PAR 1121 Categories with Heat Pump Replacement

Category	Cost-Effectiveness ($/Ton), No Panel Upgrade	Cost-Effectiveness ($/Ton), With Panel Upgrade	Cost-Effectiveness ($/Ton), Weighted Average
Single-Family Residential Water Heater	299,000	601,000	327,000
Multifamily Residential Water Heater	33,000	335,000	61,000

All categories for PAR 1121 are cost-effective, except for single-family homes requiring a panel upgrade. The weighted average, which takes into account that 9 percent of heat pump water heater

installations need a panel upgrade, equates to a cost-effectiveness value of $327,000, which is less than the $349,000 threshold.

PROPOSED BARCT EMISSIONS LIMIT

Health and Safety Code Section Sections 40920.6(a)(1) and 40920.6(a)(2) require that prior to adopting rules to meet the requirement of BARCT, one or more potential control options which achieve the emission reduction objectives of the rule must be identified, and the cost-effectiveness assessment of the potential control option(s) must be conducted. The final proposed BARCT emission limit for each class and category is the emission limit that achieves the maximum degree of emission reductions and is determined to be cost-effective. The following tables summarize the proposed NOx emission limits that represent BARCT for each equipment category.

Table 2-6: PAR 1111 BARCT NOx Emission Limits and Compliance Schedule

Equipment Category	NOx Emission Limit (ng/J)	Building Type	Compliance Date
Residential Fan-Type Central Furnace*	0.0	New	January 1, 2026
		Existing	January 1, 2028
Commercial Fan-Type Central Furnace	0.0	New	January 1, 2026
		Existing	January 1, 2028
Mobile Home Furnace	0.0	New	January 1, 2026
		Existing	January 1, 2030
Wall Furnaces and Floor Furnaces	0.0	New	January 1, 2026
		Existing	January 1, 2028

* Includes Condensing, Non-Condensing, and Weatherized Furnaces.

Table 2-7: PAR 1121 BARCT NOx Emission Limits and Compliance Schedule

Equipment Category	NOx limit (ng/J)	Building Type	Compliance Date
Water Heater*	0.0	New	January 1, 2026
	0.0	Existing	January 1, 2027
Mobile Home Water Heater	0.0	New	January 1, 2026
	0.0	Existing	January 1, 2030

* Excluding Mobile Home Water Heater

Future implementation dates will allow for an increase in the supply of zero-emission technology in the market. Manufacturers are currently producing heat pumps for both HVAC and water heating and might modify their business strategies in response to policy changes and market dynamics. It is anticipated that the supply chain will adapt to evolving market conditions.

Staff proposes to conduct a technology check-in, which will be included as part of the Governing Board Resolution. The technology check-in would include updates on market supply of zero-emission technology for all equipment categories, market adoption of new technologies, reevaluation of fuel switching costs, and evaluation of building readiness addressing issues on small spaces, limited power supply, mobile home application, and any equity issues. The results of the technology check-in will be presented to the Stationary Source Committee before June 2027.

ADDITIONAL INFORMATION AND CHALLENGES

Grid Reliability

2023 Integrated Energy Policy Report (IEPR) projects a peak demand increase of 18,000 MW by 2040 due to transport electrification and building electrification. Meanwhile, the Tracking Energy Development (TED) Taskforce, which is comprised of CEC, CPUC, CAISO, and Governor's Office, is tracking[32] 18,000 MW of new energy procurements which will be available by 2028.

In 2021, renewable generation accounted for 33.6 percent of the total California Power Mix, not including solar photovoltaic systems installed on residential and commercial buildings that are less than one megawatt (MW) as they are typically considered distributed generation and not required to report to CEC.[33] The California Power Mix is the percentage of specified fuel types derived from the California Energy Mix, and the California Energy Mix is the total in-state electric generation plus energy imports. There is expected to be more renewables adoption by states in the future, and California Senate Bill 100 called for a Renewables Portfolio Standard of 60 percent by 2030. Electricity imports account for approximately 30 percent of total system electric generation, with other states pursuing Renewable Portfolio Standards and state energy goals.

The CEC, CPUC, and CARB 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

[32] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/summer-2021-reliability/tracking-energy-development

[33] CEC, 2021 Total System Electric Generation, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation

climate targets. Related initiatives include the CPUC'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.[34] In February 2023, the CPUC ordered load serving entities to procure an additional 4,000 MW of Net Qualifying Capacity for 2026 and 2027, in addition to the mid-term reliability procurement requirements ordered in 2021 (11,500 MW, enough to power approximately 2.5 million homes). The CPUC also approved four energy storage contracts totaling 372 MW for SCE and recommended an electric resource portfolio for use in the California Independent System Operator's (CAISO) 2023-24 Transmission Planning Process. The recommended portfolio includes over 85 gigawatts (GW) of new resources by 2045, including 54,000 MW of renewable resources; over 28,000 MW of batteries; 2,000 MW of long-duration storage; and 1,100 MW of demand response.

The CEC adopts IEPR every two years and an update every other year. The 2022 IEPR has recognized the proposed zero-emission requirements for residential and commercial buildings in California and included recommendations and updates to the energy demand forecast.[35] The IEPR update released on January 1, 2024, provided forecasts for future natural gas and electricity rates, which staff utilized in the cost-effectiveness analysis. Staff used the cost averages for the period of 2024 – 2050, which are $1.71 per therm or 5.84 cents/kWh for natural gas and 24.81 cents/kWh for electricity commercial rates. For residential rates, staff used the cost averages for the period of 2024 – 2050, which are $2.31 per therm or 7.88 cents/kWh for natural gas and 29.85 cents/kWh for electricity.

Under Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018), the CEC must assess the feasibility of reducing greenhouse gas emissions in residential and commercial buildings to 40 percent below 1990 levels by January 1, 2030. Statewide electricity consumption was over 280,000 GWh in 2021 and is forecasted to be 358,738 GWh in 2035. The 2022 Planning Scenario peak forecast for CAISO, which manages roughly 80 percent of California's load, reaches 55,117 MW by 2035. CAISO is planning $11 billion in transmission capacity projects over the next 20 years, which covers 80 percent 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. The plan describes $11 billion in upgrades to the existing CAISO transmission footprint.[36] In addition, solar photovoltaic generation continues to increase as shown in the following figure .[37] Between 2022 and 2035, behind-the-meter photovoltaic generation is expected to grow on average by about six percent, reaching annual photovoltaic generation of 55,740 GWh by 2035.

[34] CPUC, Press Release, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M496/K979/496979465.PDF
[35] CEC, 2022 Integrated Energy Policy Report Update, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update
[36] California ISO, 20-Year Transmission Outlook, http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf
[37] CEC, 2022 Electric Generation and Capacity, https://www.energy.ca.gov/media/3757

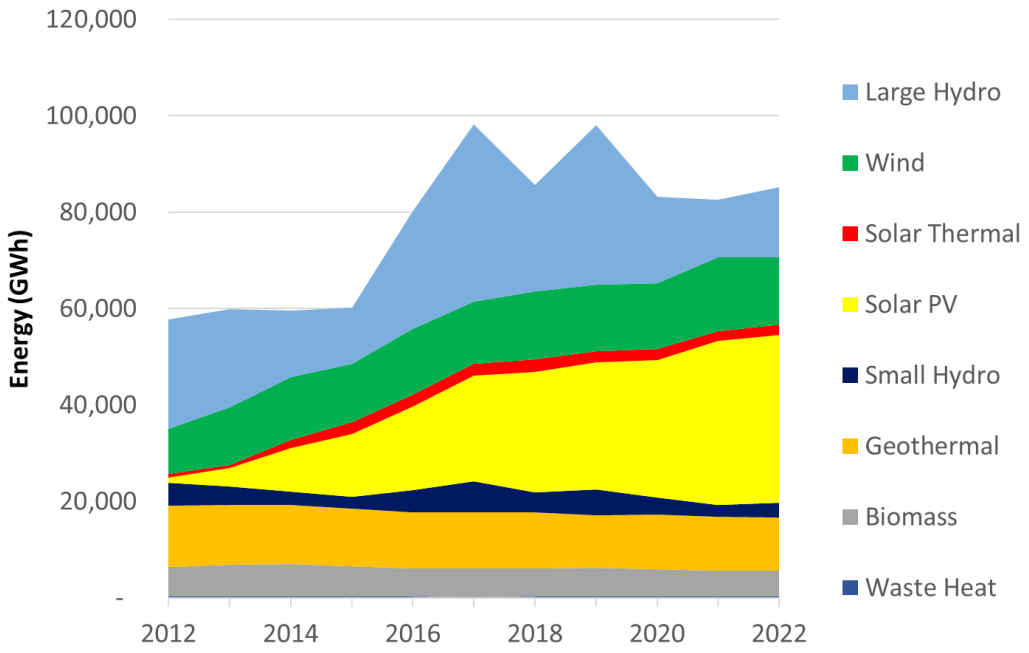

Figure 2-2: In-State Electric Generation – Select Fuel Types, Sourced from CEC Quarterly Fuels and Energy Reporting Regulations

According to SCE's 2021 Sustainability Report, SCE is expected to invest over $5 billion annually in the electric grid, with approximately 3,400 MW of energy storage installed or contracted. In 2021, SCE procured 530 MW of energy storage through three new contracts from third parties and in the same year, entered an engineering, procurement, and construction agreement to construct approximately 535 MW of utility-owned storage. SCE also expected increases in Distributed Energy Resources such as residential solar.[38] In the Pathway to 2045 document, SCE expected a 60 percent increase in electricity load and 40 percent increase in peak load by 2045, with building electrification responsible for 15 percent of load by 2045. SCE noted that the grid will still be summer peaking due to air conditioning.[39]

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 CPUC created new programs and modified existing programs to reduce energy demand and increase energy supply during critical hours of the day.[40] Per Senate Bill 350 (De León, 2015), the CPUC 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.[41] Staff recognizes that there are externalities for both electric and natural gas production and distribution. Staff also recognizes the need for regulation of emissions from electricity generation. South Coast AQMD

[38] SCE, Sustainability Report, https://www.edison.com/sustainability/sustainability-report
[39] SCE, Pathway 2045, https://www.edison.com/our-perspective/pathway-2045
[40] California Public Utilities Commission, CPUC Ensures Electricity Reliability During Extreme Weather for Summers 2022 and 2023, https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-ensures-electricity-reliability-during-extreme-weather-for-summers-2022-and-2023
[41] California Public Utilities Commission, CPUC Approves Long Term Plans To Meet Electricity Reliability and Climate Goals, https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-approves-long-term-plans-to-meet-electricity-reliability-and-climate-goals

Rule 1135 – Emissions of Oxides of Nitrogen from Electricity Generating Facilities, is a rule that aims to lower emissions from electricity generation.[42] Regarding the natural gas system, 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 approximately 33 percent of U.S. methane emissions and approximately four percent of U.S. greenhouse gas emissions. In the South Coast AQMD region, there have been examples of large leaks such as Aliso Canyon, where 109,000 metric tons of methane emissions were released between October 2015 and February 2016.

For this rulemaking, staff did not conduct lifecycle analyses related to the BARCT assessment for either the electricity or natural gas systems as a lifecycle analysis is not required by Health and Safety Code Section 40406 for a BARCT assessment. However, other organizations have conducted lifecycle analyses which show overall NOx reductions when moving to zero-emissions. A 2021 Northeast States for Coordinated Air Use Management (NESCAUM) study estimating NOx reductions for residential scenarios where fossil fuel-burning furnaces are replaced with heat pumps found significant reductions in NOx along with sulfur dioxide and carbon dioxide.[43] A 2023 NESCAUM study also found emission reductions for different scenarios.[44] A 2022 Energy Innovation Policy & Technology study found that switching to heat pumps for industrial processes reduces NOx emissions.[45]

Mobile Homes

Mobile homes, also known as manufactured homes, must comply with federal construction and safety standards, which are different from those for traditional homes. These standards are enforced by the U.S. Department of Housing and Urban Development (HUD). California Department of Housing and Community Development (HCD) also protects families and individuals who live in mobile homes by inspecting mobile home parks for health and safety violations in areas where the local government has not assumed enforcement. HCD further protects consumers by enforcing regulations for those who build and sell manufactured homes. Mobile home manufacturers also need to meet the energy efficiency standards by the Department of Energy. A manufactured home may be installed under the provisions of Health and Safety Code Section 18551 or the California Code of Regulations, Title 25.

On April 24, 2020, the CPUC approved the Mobile Home Park Utility Conversion Program[46]. This program allows mobile home park and manufactured housing communities the opportunity to replace privately owned, master-metered/sub-metered or non-sub metered electric and gas distribution systems with direct service for mobile home residents. Applications for the new program began January 1, 2021, and will continue through 2030 with a goal to convert total of 50

---

[42] South Coast AQMD, Rule 1135, http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1135.pdf

[43] NESCAUM, Estimating the Emissions Benefits of Switching to Heat Pumps for Residential Heating, https://otcair.org/upload/Documents/Reports/nescaum-otc-emission-reduction-analysis-for-residential-heating-202106.pdf

[44] NESCAUM and OTC, Residential Building Electrification in the Northeast and Mid-Atlantic, https://otcair.org/upload/Documents/Reports/Residential%20Building%20Electrification%20Final%20Report%20August%202023.pdf

[45] Energy Innovation Policy & Technology LLC, https://energyinnovation.org/wp-content/uploads/2022/10/Decarbonizing-Low-Temperature-Industrial-Heat-In-The-U.S.-Report-2.pdf

[46] CPUC Mobile Home Park Utility Conversion Program, https://www.cpuc.ca.gov/regulatory-services/safety/mhp/mobilehome-park-utility-upgrade-program

percent of mobile home park spaces in each utility territory to direct gas and/or electric utility service. SCE is targeting 3,300 mobile home conversions per year from list of 72,000 mobile homes. This program will benefit many mobile home residents by providing safer and more reliable utility services.

Refrigerants

Another concern highlighted by stakeholders is increasing the number of heat pumps will necessarily increase the amount of refrigerant escaping into the atmosphere. Many refrigerants currently in use, such as R-410A and R-134A, have a global warming potential (GWP) thousands of times higher than CO_2. While the refrigerant circuit in a heat pump is sealed, leaks in the system can result in the refrigerant escaping. When evaluating greenhouse gas emissions from these leaks, it is important to recognize that natural gas fired equipment emit greenhouse gases as a result of normal operations. The E3 Building Electrification in California Study analyzed potential emissions from heat pumps and concluded overall greenhouse gas emissions would be lower for heat pumps than combustion equipment. Furthermore, in 2020 the American Innovation and Manufacturing Act granted the EPA the authority to phasedown production of high GWP refrigerants, encouraging the adoption of lower GWP refrigerants. Several of these low GWP refrigerants also have the co-benefit of increased performance, with R-290 (propane) and R-744 (CO_2) able to operate at much lower temperatures than other refrigerants currently in use.

Table 2-8: Common Refrigerants

Refrigerant	GWP	Notes
R-134a	1,430	Part of EPA phasedown
R-410a	2,087	Part of EPA phasedown
R-32	675	Part of EPA phasedown
R-1234ze	<10	
R-744	1	CO_2, low temperature applications
R-290	3	Propane, low temperature applications

CHAPTER 3: PROPOSED AMENDED RULE 1111

INTRODUCTION

PROPOSED AMENDED RULE 1111

INTRODUCTION

The main objective of PAR 1111 is to propose NOx limits that represent BARCT for the applicable equipment. PAR 1111 also removes obsolete language, reorganizes the rule structure to reflect recently amended and adopted rules, and includes an alternative compliance subdivision.

PROPOSED AMENDED RULE 1111

PAR 1111 reorganizes the rule structure to reflect recently amended and adopted rules and includes new subdivisions. Table 3-1 summarizes the changes to the subdivisions to PAR 1111 from Rule 1111.

Table 3-1: Rule 1111 and PAR 1111 Rule Structure

Subdivision	Rule 1111	PAR 1111
(a)	Purpose and Applicability	Purpose
(b)	Definitions	Applicability
(c)	Requirements	Definitions
(d)	Certification	Requirements
(e)	Identification of Compliant Units	Certification
(f)	Enforcement	Identification of Compliant Units
(g)	Exemptions	Alternative Compliance Options
(h)	(N/A)	Labeling, Recordkeeping, and Reporting
(i)	(N/A)	Exemptions

PAR 1111 (a) - Purpose

The purpose of PAR 1111 is to reduce NOx emission from natural gas-fired furnaces used for interior space heating.

PAR 1111 (b) – Applicability

Subdivision (b) is separated into its own subdivision to align with recently amended and adopted rules. PAR 1111 applies to manufacturers, distributors, retailers, resellers, and installers of natural gas-fired furnaces with a rated heat input capacity up to 2,000,000 Btu/hr.

The applicability is expanded from fan-type central furnaces with rated heat input capacity up to 175,000 Btu/hr used for comfort heating or 65,000 Btu/hr for combination heating and cooling units to all natural gas-fired furnaces with a rated heat input capacity of less than or equal to 2,000,000 Btu/hr.

The provisions of the rule are primarily enforced through the supply chain (i.e. manufacturers, distributors, retailers, etc.). Resellers and retailers are also added to applicability. Sellers were subject to Rule 1111 but have been removed to avoid redundancy.

PAR 1111 (c) – Definitions

Subdivision (c) was previously subdivision (b) in Rule 1111. Subdivision (c) lists the definitions used in PAR 1111. For all definitions, refer to PAR 1111 released with the staff report.

The following definitions have been added to PAR 1111:

- Commercial Fan-Type Central Furnace
- Compliance Portal
- Existing Building
- Floor Furnace
- Furnace
- Install
- Installer
- New Building
- Non-Condensing Furnace
- Reseller
- Residential Fan-Type Central Furnace
- Wall Furnace

Install, installer, and reseller are defined to clarify who is subject to the rule. Furnace is defined to include commercial fan-type central furnace, floor furnace, non-condensing furnace, residential fan-type central furnace, and wall furnace. Wall and floor furnaces have not been regulated by Rule 1111 or other rules at the South Coast AQMD. Existing building and new building are defined to differentiate between compliance dates.

The following definitions have been revised in PAR 1111:

- Condensing Furnace
- Downflow Furnace
- Mobile Home Furnace
- NOx Emissions
- Rated Heat Input Capacity
- Weatherized

Condensing furnace, downflow furnace, mobile home furnace, and weatherized are revised to align with the newly added definitions and to clarify which furnaces fall under the different equipment categories. NOx emissions and rated heat input capacity are revised to align with amended Rule 1146.2 (Adopted June 7, 2024).

The following definitions have been removed from Rule 1111, as they are obsolete definitions:

- Btu
- Dual Fuel System
- Fan Type Central Furnace
- Heat Pump
- Single Firing Rate

- Variable Firing Rate

PAR 1111 (d) – Requirements

Subdivision (d) was previously subdivision (c) in Rule 1111. Paragraph (c)(5) in Rule 1111 regarding mitigation fees was removed from this section and relevant paragraphs were moved to subdivision (g) under Alternative Compliance Options for a streamlined rule structure. Subdivision (d) outlines the compliance dates for each equipment category.

Paragraph (d)(1) – Current Rule 1111 Emission Limits

Paragraphs (c)(1) to (c)(3) from Rule 1111 were removed and (c)(4) was revised for PAR 1111 paragraph (d)(1) to consolidate the existing requirements. Paragraph (d)(1) specifies the current NOx emission limits and compliance dates for residential fan-type furnaces for each equipment category in PAR 1111 Table 1 (presented in this Staff Report as Table 3-2).

Paragraph (d)(1) states that no person shall manufacture, supply, sell, resell, offer for sale, import, or install for use within the South Coast AQMD, any residential fan-type central furnace unless the furnace is certified pursuant to subdivision (e) not to exceed the applicable NOx emission limits in Table 1 that are expressed as nanograms of NOx per joule of useful heat delivered to the heated space (ng/J). Paragraph (d)(1) includes that no person shall resell or import within the South Coast AQMD in addition to the previous requirements (i.e. manufacture, supply, sell, offer for sale, or install).

Table 3-2: PAR 1111 Table 1 Emission Limits and Compliance Schedule

Equipment Category	NOx Emission Limit (ng/J)	Compliance Date
Condensing Furnace	14	October 1, 2019
Non-Condensing Furnace	14	October 1, 2019
Weatherized Furnace	14	October 1, 2021
Mobile Home Furnace	14	October 1, 2018

Paragraph (d)(2) – PAR 1111 BARCT Emission Limit for New and Existing Buildings

Paragraph (d)(2) sets the updated BARCT emission limits for the applicable equipment categories in PAR 1111 Table 2 (presented in this Staff Report as Table 3-3). This paragraph states that no person shall manufacture, supply, sell, resell, offer for sale, import, or install, for use in the South Coast AQMD, any furnace that exceeds the Table 2 NOx emission limits by the Table 2 compliance dates.

Table 3-3: PAR 1111 Table 2 Zero-Emission Limits and Compliance Schedule

Equipment Category	NOx Emission Limit (ng/J*)	Building Type	Compliance Date
Residential Fan-Type Central Furnace*	0.0	New	January 1, 2026
		Existing	January 1, 2028
Commercial Fan-Type Central Furnace	0.0	New	January 1, 2026
		Existing	January 1, 2028
Mobile Home Furnace	0.0	New	January 1, 2026
		Existing	January 1, 2030
Wall Furnaces and Floor Furnaces	0.0	New	January 1, 2026
		Existing	January 1, 2028

* Includes Condensing, Non-Condensing, and Weatherized Furnaces.

PAR 1111 (e) – Certification

Subdivision (e) provides guidance to manufacturers to certify furnaces. Certification was originally subdivision (d) in Rule 1111.

Paragraph (e)(1) – Testing Requirements

- Subdivision (e)(1) was edited for clarity, including the addition of the South Coast AQMD Rule 1111 Nitrogen Oxides Emissions Compliance Testing for Natural Gas-Fired, Fan-Type Central Furnaces certification protocol to the valid operation procedures[47].

Paragraph (e)(3) – Applying for Furnace Certification

Reworded source test requirement to better align with the same section in PAR 1121.

Paragraph (e)(4) – Timeline

Added a requirement for the manufacturer to submit the items identified in paragraph (e)(4) no more than 180 days after the date of source test identified in subparagraph (e)(4)(D). This was added to align with the certification requirements of Rule 1121.

PAR 1111 (f) – Identification of Compliant Units

Subdivision (f) outlines the procedure and requirements for identification and verification of compliant units. Subdivision (f) was originally subdivision (e) in Rule 1111. PAR 1111 does not propose any requirement change for this subdivision, except for updating the language and streamlining the structure.

[47] https://www.aqmd.gov/docs/default-source/laboratory-procedures/methods-procedures/r1111_protocol.pdf

Paragraph (f)(3) – Consumer Notification Requirement

If a manufacturer of any mobile home furnace that is distributed or offered for sale into or within the South Coast AQMD elects to comply using the alternative compliance plan pursuant to paragraph (g)(1) in lieu of meeting the 14 ng/J certification limit, the manufacturer shall only distribute or publish informative materials that clearly display "If installed in the South Coast AQMD, this furnace is only allowed to be installed and used in mobile homes and does not meet the South Coast AQMD Rule 1111 NOx emission limit (14 ng/J), and, thus, is subject to a mitigation fee of up to $150." The aforementioned informative materials in subparagraph (f)(3)(A) mean the following: consumer brochures for the furnace; technical specification sheets for the furnace; and the manufacturer's website that promotes, discusses, or lists the furnace. Alternative language can be used in lieu of subparagraph (f)(3)(A), provided that the language similar to the language in subparagraph (f)(3)(A); submitted to the Executive Officer by August 1, 2018; and approved by the Executive Officer no later than August 31, 2018. If the alternative language is not approved, the manufacturer shall use the language in subparagraph (f)(3)(A).

PAR 1111 (g) – Alternative Compliance Options

Subdivision (g) is a new subdivision for rule structure streamlining purpose that includes existing requirements regarding mitigation fees in Rule 1111 paragraph (c)(5). Subdivision (g) addresses alternative compliance options, including mitigation fees and emergency replacements.

Paragraph (g)(1) – Mitigation Fee Alternative Compliance Option

Prior to the applicable Table 2 compliance date, a manufacturer of mobile home furnaces may elect to pay a per unit mitigation fee for selling or enabling distributors, retailers, resellers, or installers to sell mobile home furnaces certified to meet the 40 ng/J NOx emission limit in lieu of the 14 ng/J NOx emission limit. This mitigation fee option ends on September 30, 2025. The manufacturer must comply with the following requirements:

- Pay a per unit mitigation fee of $150 for each mobile home furnace distributed or solid into or within the South Coast AQMD;
- Submit an alternative compliance plan, no later than 60 days prior to the applicable compliance date, for each 12-month time period after the applicable Table 1 compliance date, during which the manufacturer elects to pay the mitigation fee in lieu of meeting the NOX emission limit;
    - Clauses (g)(1)(b)(i) to (g)(1)(b)(iv) detail what should be included with the alternative compliance plan; and
- Submit to the Executive Officer a report signed by the responsible official for the manufacturer, identifying by model number, the quantity of mobile home furnaces distributed or sold into or within the South Coast AQMD and a payment of mitigation fees for the applicable 12-month alternative compliance period for the quantity of applicable mobile home furnaces distributed or sold into or within the South Coast AQMD during the alternative compliance period.

Paragraph (g)(2) – Alternative Compliance Option for Emergency Replacements

Paragraph (g)(2) provides a new alternative compliance option for emergency replacements when zero-emission requirements become effective for residential fan-type central furnaces; and commercial fan-type central furnaces, floor furnaces, and wall furnaces. After the

applicable Table 2 compliance date, if a furnace requires a short-term replacement due to a sudden unit failure and an electrical upgrade is required to increase the power supply capacity to operate a furnace that complies with Table 2 emission limits, a manufacturer, distributor, retailer, reseller, or installer may do one of the options stated in subparagraph (g)(2)(A) and (g)(2)(B).

For residential fan-type central furnaces, a manufacturer, distributor, retailer, reseller, or installer may elect to offer a furnace for rent that complies with Table 1 emission limits for up to six months prior to installing a furnace that complies with Table 2 emission limits provided the manufacturer, distributor, retailer, reseller, or installer report the date the temporary furnace was rented through the compliance portal no later than 72 hours after the date the temporary unit was rented.

For commercial fan-type central furnaces, floor furnaces, and wall furnaces, a manufacturer, distributor, retailer, reseller, or installer may elect to offer a furnace for rent for up to six months prior to installing a furnace that complies with table 2 emission limits provided the manufacturer, distributor, retailer, reseller, or installer report the date the temporary furnace was rented through the compliance portal no later than 72 hours after the date the temporary unit was rented. Different from residential fan-type central furnaces, commercial fan-type central furnaces, floor furnaces, and wall furnaces for rent would not be subject to Table 1 emission limits, as they were not previously regulated to meet those limits.

Paragraph (g)(3) – Alternative Compliance Option for Construction

Paragraph (g)(3) provides a new alternative compliance option for construction in existing buildings. After the applicable Table 2 compliance date, if an existing building requires construction to expand the space designed to house or relocate the compliance equipment, perform a utility upgrade, or replace a furnace that does not require the simultaneous replacement of space cooling equipment as specified in clause (g)(3)(A), a manufacturer, distributor, retailer, reseller or installer may elect to offer a natural gas-fired furnace for rent for up to 24 months prior to complying with Table 2 emission limits, provided all the conditions in clause (g)(3)(B) are met. Clause (g)(3)(B) specifies that the manufacturer, distributor, retailer, reseller or installer who elects to use this alternative compliance option shall report the date the temporary furnace was rented through the compliance portal no later than 72 hours after the date the temporary unit was rented, comply with the labeling specified requirements, and comply with Table 1 emission limits if the furnace for rent is a residential fan-type central furnace.

PAR 1111 (h) – Labeling, Recordkeeping, and Reporting

Subdivision (h) is a new subdivision that details the labeling, recordkeeping, and annual reporting requirements. Labeling requirements are important tools for enforcement, especially when some units distributed to the market can only be installed under certain conditions. While manufacturers ship units into many markets, to ensure the labels are only included on units sold into or within the South Coast AQMD, they may elect to send a sticker or label to their distributors so they can be applied at the point of sale.

Paragraph (h)(1) – Propane Conversion Kit Furnace Labeling and Reporting

The manufacturer, distributor, or installer of any furnace that elects to use the exemption in paragraph (i)(1) must clearly display on the shipping carton or the name plate of the furnace

"This furnace is to be installed for propane firing only. Operating in natural gas mode is in violation of the South Coast AQMD Rule 1111.". They must also submit a report by March 1st of the following calendar year to the Executive Officer, which consists of, but is not limited to, the quantity of propane conversion kits for furnaces distributed or sold for use into the South Coast AQMD for the applicable compliance plan period, and the quantity of propane conversion kits for furnaces distributed or sold for use into the South Coast AQMD during the 12-month period of July 1 to June 30, prior to the applicable compliance date.

Paragraph (h)(2) – Recordkeeping and Labeling for Limited High-Altitude Furnace Exemption

The manufacturer, distributor, or installer of any furnace that elects to use the exemption in paragraph (i)(2), which exempts downflow furnaces with a rated heat input capacity of less than 175,000 Btu/hr or condensing or non-condensing furnaces with a rated heat input capacity greater than or equal to 100,000 Btu/hr that are installed in elevations at or above 4,200 feet above sea level, must record the information stated in subparagraphs (h)(2)(A). Labeling requirements are also specified in subparagraph (h)(2)(B) for those units.

Paragraph (h)(3) – Labeling Requirements

PAR 1111 is proposing a labeling requirement for the period between the new building compliance date and existing building compliance date for each equipment category.

Any furnace that complies with the Table 1 emission limits, but does not comply with the Table 2 emission limits, pursuant to the Table 3 (presented in this Staff Report as Table 3-4) labeling schedule and is supplied or offered for sale for use within the South Coast AQMD, shall prominently displace the statement "If Installed in South Coast AQMD: 1) After January 1, 2026, shall not be sold for installation in new buildings 2) After January 1, 2028, only for installation in mobile homes; and 3) After January 1, 2030, not compliant for use and installation in South Coast AQMD." The dates for the labeling requirement start date and end date align with the compliance dates in Table 2 for new and existing buildings respectively.

Table 3-4: PAR 1111 Table 3 Labeling Schedule

Furnace's Compliance Schedule	Labeling Requirements	
	Start Date	End Date
Mobile Home Furnaces	January 1, 2026	January 1, 2030
All Other Furnaces	January 1, 2026	January 1, 2028

Paragraph (h)(4) – Furnaces for Rent Only

Furnaces available for rent according to the alternative compliance options (g)(2) and (g)(3) must display the statement "If Installed or used in South Coast AQMD: This unit is for rent only." This paragraph provides a means of enforcing the temporary use of natural gas furnaces.

Paragraph (h)(5) – Annual Reporting Requirement

On or after the Table 2 compliance dates for existing buildings, manufacturers of natural gas-fired furnaces distributed or solid for use into the South Coast AQMD shall submit a report by

March 1st of the following calendar year to the Executive Officer, which includes: name of the product manufacturer, list of the product models, the applicable equipment category in Table 2, the provisions of this rule that each model complies, and number of units and rated heat input capacity of each model that was sold into or within the South Coast AQMD.

PAR 1111 (i) – Exemptions

Subdivision (i) was previously subdivision (g) in Rule 1111. Subdivision (i) specifies the exemptions to PAR 1111. Exemptions (g)(1), (g)(2), (g)(3), and (g)(5) were removed, while portions of (g)(4) and sections (g)(7) through (g)(10) were moved to alternative compliance options.

Paragraph (i)(1) – Propane-Fired Furnaces

the manufacturer of any natural gas-fired furnace that is not certified to meet the 14 ng/J of NOx emission limit and is to be installed with a propane conversion kit for propane firing only in the South Coast AQMD, is exempt from subdivisions (d) and (e), provided that the labeling and recordkeeping requirements in (h)(1) are met. This is an existing exemption in Rule 1111 paragraph (g)(4). Its labeling and reporting requirements under the same paragraph have been moved to PAR 1111 paragraph (h)(1) for a streamlined rule structure.

Paragraph (i)(2) – Downflow and Large Residential Furnaces

Until January 1, 2028, downflow furnaces with a rated heat input capacity less than 175,000 Btu/hr, and condensing and non-condensing furnaces with a rated heat input capacity of greater than or equal to 100,000 Btu/hr, either of which are installed at elevations at or above 4,200 feet above sea level as a replacement for an existing furnace are exempt from paragraph (d)(1), given that the recordkeeping and labeling requirements in (h)(2) are followed. After January 1, 2028, this exemption will be phased out, those furnaces for installation at high-altitude shall also meet the zero-emission standard pursuant to (d)(2).

Paragraph (i)(3) – Master-Metered Mobile Home Exemption

With the consideration that master-metered mobile homes may currently not have sufficient electrical service to install-emission appliances, this provision provides them an exemption from zero-emission requirements. The CPUC Mobile Home Park Utility Conversion Program plans to convert 50 percent of mobile home park spaces to a direct utility service by 2030.[(48)]When mobile homes are converted, they are no longer be exempt by this provision.

[(48)] https://www.cpuc.ca.gov/regulatory-services/safety/mhp/mobilehome-park-utility-upgrade-program

CHAPTER 4: PROPOSED AMENDED RULE 1121

INTRODUCTION

PROPOSED AMENDED RULE 1121

INTRODUCTION

The main objective of PAR 1121 is to propose NOx limits that represent BARCT for the applicable equipment. PAR 1121 also removes obsolete language, reorganizes the rule structure to reflect recently amended and adopted rules, and includes an alternative compliance subdivision.

PROPOSED AMENDED RULE 1121

PAR 1121 reorganizes the rule structure to reflect recently amended and adopted rules and includes new subdivisions. Table 4-1 summarizes the changes to the subdivisions in PAR 1121 from Rule 1121.

Table 4-1: Rule 1121 and PAR 1121 Rule Structure

Subdivision	Rule 1121	PAR 1121
(a)	Applicability	Purpose
(b)	Definitions	Applicability
(c)	Requirements	Definitions
(d)	Certification	Requirements
(e)	Mitigation Fee	Certification
(f)	Enforcement	Alternative Compliance Options
(g)	Exemptions	Labeling and Reporting
(h)	Final Progress Report	Exemptions
(i)	Program Administration	(N/A)

PAR 1121 (a) – Purpose

The purpose of PAR 1121 is to reduce NOx emission from natural gas-fired water heaters. Subdivision (a) is a new subdivision added to align with recently amended and adopted rules to standardize the rule structure.

PAR 1121 (b) – Applicability

Subdivision (b) was previously subdivision (a) in Rule 1121. PAR 1121 applies to manufacturers, distributors, retailers, resellers, and installers of natural gas-fired water heaters with a rated heat input capacity less than 75,000 Btu/hr.

The provisions of the rule are primarily enforced through the supply chain (i.e. manufacturers, distributors, retailers, installers, etc.). Resellers are also added to applicability since they are part of the supply chain.

PAR 1121 (c) – Definitions

Subdivision (c) was previously subdivision (b) in Rule 1121. Subdivision (c) lists the definitions used in PAR 1121. For all definitions, refer to PAR 1121 released with the staff report.

The following definitions have been added to PAR 1121:

- Compliance Portal
- Existing Building
- Install
- Installer
- Mobile Home
- New Building
- Parts Per Million by Volume
- Reseller
- Standard Conditions

Install, installer, and reseller are defined to clarify who is subject to the rule. Existing building, mobile home, and new building are defined to differentiate between compliance dates.

The following definitions have been revised in PAR 1121:

- Heat Input
- Heat Output
- Independent Testing Laboratory
- Mobile Home Water Heater
- NOx Emissions
- Protocol
- Rated Heat Input Capacity
- Recreational Vehicle
- Water Heater

Heat input, heat output, rated heat input capacity, and recreational vehicle are revised to align with their definitions in Rule 1146.2, which was amended on June 7, 2024. Independent testing laboratory, NOx emissions, protocol, and rated heat input capacity are revised for clarity. Water heater is revised to ensure this term includes mobile home water heaters.

The following definitions are considered obsolete and have been removed from Rule 1121:

- Btu
- Direct Vent Water Heater
- Mitigation Fee
- Power Vent Water Heater
- Power Direct Vent Water Heater

PAR 1121 (d) – Requirements

Subdivision (d) was previously subdivision (c) in Rule 1121. Paragraphs (c)(1) to (c)(8) in Rule 1121 were removed and the relevant equipment and NOx emission limits are summarized in paragraph (d)(1).

Paragraph (d)(1) – Current Rule 1121 Emission Limits

Paragraph (d)(1) specifies the current NOx emission limits for water heaters and mobile home water heaters in PAR 1121 Table 1 (presented in this Staff Report as Table 4-2)

Paragraph (d)(1) states that no person shall manufacture, supply, sell, resell, offer for sale, import, or install, for use in the South Coast AQMD, any water heater unless the water heater is certified pursuant to subdivision (e) and does not exceed the Table 1 NOx limit, expressed by ng/J or ppmv. Paragraph (d)(1) includes that no person shall supply, resell, or import within the South Coast AQMD in addition to the previous requirements (i.e. manufacture, sell, offer for sale, or install).

Table 4-2: PAR 1121 Table 1 Emission Limits

Equipment	NOx Emission Limits	
	ng/J	ppmv
Water Heater*	10	15
Mobile Home Water Heater	40	55

* Excluding Mobile Home Water Heater

Paragraph (d)(2) – PAR 1121 BARCT Emission Limit for New and Existing Buildings

Paragraph (d)(2) sets the updated BARCT emission limits for water heaters and mobile home water heaters as shown in PAR 1121 Table 2 (presented in this Staff Report as Table 4-3). This paragraph specifies that no person shall manufacture, supply, sell, resell, offer for sale, import, or install a water heater for use in the South Coast AQMD that exceeds the Table 2 NOx emission limits. The applicable PAR 1121 Table 2 compliance dates for New Building types shall be determined based on the construction or alteration completion date.

Table 4-3: PAR 1121 Table 2 Zero-Emission Limits and Compliance Schedule

Equipment Category	NOx limit (ng/J)	Building Type	Compliance Date
Water Heater*	0.0	New	January 1, 2026
	0.0	Existing	January 1, 2027
Mobile Home Water Heater	0.0	New	January 1, 2026
	0.0	Existing	January 1, 2030

* Excluding Mobile Home Water Heater

PAR 1121 (e) – Certification

Subdivision (e) provides guidance to manufacturers to certify water heaters. Subdivision (e) was originally subdivision (d) in Rule 1121. Obsolete language, which are paragraphs (d)(4), (d)(5), and (d)(6) in Rule 1121, were removed from this subdivision.

Paragraph (e)(1) – Tests by Independent Testing Laboratory

Contains revisions to defined terms and clarification that natural gas-fired water heaters and water heaters designed to be fired with natural gas are subject to certification. Certification is based on emissions tests conducted by independent testing laboratories in accordance to the protocol.

The manufacturer shall obtain confirmation that each model of water heater complies with the applicable requirements of paragraph (d)(1) from an independent testing laboratory, prior to applying for certification for a natural gas-fired water heater or a water heater designed to be fired with natural gas. This confirmation shall be based on emission tests conducted pursuant to the protocol of a randomly selected unit of each model.

Paragraph (e)(2) – Applying for Water Heater Certification

Paragraph (e)(2) remains mostly unchanged with an update to the reference in subparagraph (e)(2)(A).

When applying for certification of water heaters, the manufacturer shall submit to the Executive Officer the following: a statement that the model is in compliance with paragraph (d)(1) signed and dated by the manufacturer, attesting to the accuracy of all statements; general information, including name and address of manufacturer, brand name, trade name, and model number as it appears on the water heater rating plate; a description of each model being certified, and a source test report verifying compliance with paragraph (d)(1) for each model to be certified. The source test report shall be prepared by the confirming independent testing laboratory and contain all elements identified in the protocol for each unit tested.

Paragraph (e)(3) – Timeline

When applying for certification of water heaters, the manufacturer shall submit the items identified in paragraph (e)(2) no more than 180 days after the date of the source test identified in subparagraph (e)(2)(D).

PAR 1121 (f) – Alternative Compliance Options

Subdivision (f) is a new subdivision that details the alternative compliance options.

Paragraph (f)(1) –Alternative Compliance Option for Emergency Replacements

If a water heater requires a short-term replacement due to a sudden water heater failure after the applicable Table 2 compliance dates for zero-emission limits and an electrical upgrade is required to increase the power supply capacity to operate a water heater that complies with the zero-emission limits, a manufacturer, distributor, retailer, or installer may elect to offer a water heater for rent that complies with the PAR 1121 Table 1 emission limits for up to six months prior to installing a water heater that complies with the zero-emission limits. The manufacturer, distributor, retailer, reseller, or installer must report the date the temporary water heater was rented through the compliance portal no later than 72 hours after the date the temporary mobile home water heater was rented and comply with the labeling requirement in paragraph (g)(2).

Paragraph (f)(2) – Alternative Compliance Option for Construction

This provision is to address the space constraints and other limitations for replacing a gas water heater with a zero-emission unit when construction is required in an existing building. This may include expanding the space to accommodate a zero-emission unit with a larger footprint, relocating the zero-emission replacement and associated equipment necessary for operation, or performing a utility upgrade necessary to operate the zero-emission unit. The manufacturer, distributor, retailer, reseller, or installer may elect to offer a gas water heater for rent that complies with Table 1 emission limits for up to 24 months during the construction, provided the specified reporting and labeling requirements are met. The manufacturer, distributor, retailer, reseller, or installer is required to report the date the temporary water heater was rented through the compliance portal no later than 72 hours after the date the water heater was rented and comply with the labeling requirements in paragraph (g)(2).

PAR 1121 (g) – Labeling and Reporting

Subdivision (g) is a new subdivision that takes some requirements regarding labeling from subdivision (c) of Rule 1121. Labeling requirements are important tools for enforcement, especially when some units distributed to the market can only be installed under certain conditions. While manufacturers ship units into many markets, to ensure the labels are only included on units sold into or within the South Coast AQMD, they may elect to send a sticker or label to their distributors so they can be applied at the point of sale.

Paragraph (g)(1) – Labeling Water Heaters for Installation and Use in Existing Buildings

PAR 1121 is proposing a labeling requirement for the period between the new building compliance date and existing building compliance date for each equipment category. Pursuant to the labeling schedule in PAR 1121 Table 3 (presented in this Staff Report as Table 4-4), any water heater that is supplied or offered for sale for use in the South Coast AQMD prior to the applicable zero-emission compliances dates that complies with the PAR 1121 Table 1 emissions limits, but not the zero-emission limits, shall prominently display the statement: "If Installed in South Coast AQMD: 1) After January 1, 2026, shall not be sold for installation in new buildings 2) After January 1, 2027, only for installation in mobile homes; and 3) After January 1, 2030, not compliant for use and installation in South Coast AQMD."

Table 4-4: PAR 1121 Table 3 Labeling Schedule

Equipment	Labeling Requirement	
	Start Date	End Date
Water Heater*	January 1, 2026	January 1, 2027
Mobile Home Water Heater	January 1, 2026	January 1, 2030

* Excluding Mobile Home Water Heater

Paragraph (g)(2) – Labeling Rental Units for Alternative Compliance

This paragraph specifies the labeling requirement for any water heater supplied or offered for rent for use in accordance with an alternative compliance option in subdivision (f). Those water heaters shall prominently display the statement "If Installed or used in South Coast AQMD: This unit is for rent only."

Paragraph (g)(3) – Shipping Carton and Name Plate Labeling

The manufacturer of any water heater manufactured for sale in the South Coast AQMD shall clearly display the following on the shipping carton and name plate of the water heater: model number, date of manufacture, and certification status.

Paragraph (g)(4) – Annual Reporting Requirement

On and after the Table 2 compliance dates for existing buildings, manufacturers of natural gas-fired water heaters or water heaters designed to be fired with natural gas shall submit a report by March 1st of the following calendar year to the Executive Officer. The report shall include the following: name of the product manufacturer; list of the product model(s); the applicable equipment category in Table 2; the provision of this rule that each model complies; and number of units and rated heat input capacity of each model that was sold for use in the South Coast AQMD.

PAR 1121 (h) – Exemptions

Subdivision (h) details the exemptions to the rule. This subdivision was previously subdivision (g) in Rule 1121. While paragraphs (h)(1) and (h)(2) are existing provisions, PAR 1121 proposes new exemptions in paragraph (h)(3).

Paragraph (h)(1) – Recreational Vehicle Exemption

PAR 1121 shall not apply to water heaters used in recreational vehicles.

Paragraph (h)(2) – Rule 1146.2 Exemption

PAR 1121 shall not apply to water heaters subject to Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters.

Paragraph (h)(3) – Master-Metered Mobile Home Park Exemption

The requirements specified in paragraph (d)(2) shall not apply to mobile home water heaters for installation in a master-metered mobile home park. Master-metered mobile home parks may not have sufficient power delivered to the entire mobile home park; therefore, the mobile homes located on that property may not have sufficient power to install equipment that complies with the zero-emission limits. The CPUC plans to convert 50 percent of master-metered mobile home parks to a direct utility service[(49)] by 2030, wherein the mobile home would no longer be subject to the exemption in paragraph (h)(4). Over time, staff anticipates all master-metered mobile home parks will be converted to direct utility service, at which time, they will be able to install zero-emission water heaters.

[(49)] https://www.cpuc.ca.gov/regulatory-services/safety/mhp/mobilehome-park-utility-upgrade-program

CHAPTER 5: IMPACT ASSESSMENT

INTRODUCTION

EMISSIONS INVENTORY AND EMISSION REDUCTIONS

COST-EFFECTIVENESS AND INCREMENTAL COST-EFFECTIVENESS

SOCIOECONOMIC IMPACT ASSESSMENT

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ANALYSIS

DRAFT FINDINGS UNDER HEALTH AND SAFETY CODE

COMPARATIVE ANALYSIS

INTRODUCTION

Both PAR 1111 and PAR 1121 are each expected to impact over 5 million units located in the South Coast AQMD region, for a total of 10 million units.

EMISSIONS INVENTORY AND EMISSION REDUCTIONS

PAR 1111 total NOx emissions inventory is estimated to be 7.7 tpd and the PAR 1121 NOx emissions inventory is estimated to be 2.3 tpd. The 2022 AQMP indicated a total of 351 tpd of NOx emitted from all sources in the region in 2018, the base-year of the emissions inventory and modeling analysis in the plan. Appliances used in residential and commercial buildings, which primarily include space and water heaters, cooking devices, and some other appliances combusting natural gas, emit about 26.8 tpd of NOx[(50)]. Given these data, PAR 1111 and PAR 1121 account for 37.3 percent of NOx emissions from appliances used in residential and commercial buildings.

Estimated Number of Units

PAR 1111 will impact 5,350,000 units, the applicable residential fan-type central furnace, commercial fan-type central furnace, mobile home furnaces, wall furnaces and floor furnaces. PAR 1121 will impact 5,128,000 units, the applicable small tank type water heaters. To estimate the baseline emissions for both PAR 1111 and PAR 1121, staff evaluated the following information:

- Baseline emissions factor in pounds per million Btu (lbs/MMBtu) from current rule emission limit
- Estimated annual fuel use
- Estimated universe by category
- Useful life (years)

Estimated Emissions Inventory

For all categories, the following equation was used to calculate the emission inventory in tpd:

$$\begin{aligned} &Emission\ Inventory\ (tpd) \\ &\quad = Baseline\ Emissions\ Factor\ \left({}^{lbs}/_{MMBtu}\right) \\ &\quad * Annual\ fuel\ use\ \left({}^{MMBtu}/_{(year * unit)}\right) * Esitmated\ Universe\ (units) \\ &\quad * \frac{1\ ton}{2000\ lbs} * \frac{1\ year}{365\ days} \end{aligned}$$

Equation 5-1: Baseline Emissions Calculation

The baseline emissions factor was calculated, using the current NOx emission limits. For PAR 1111, an emission limit of 40 ng/J for commercial, wall, and floor furnaces was used and 14 ng/J for residential fan-type central furnaces was used. Similarly, the baseline emissions factor for 1121 was calculated, using the current emission limit of 10 ng/J. An efficiency factor of 75 percent was used, as the efficiency of gas-fired furnaces and water heaters range from 60-95 percent.

[(50)] https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/appendix-iii.pdf

The CEC's RASS in 2019[51] was used for the average annual gas unit energy consumption for primary heat for homes with SoCalGas as a provider, which include resident fan-type central furnaces, wall furnaces, and floor furnaces. For commercial furnaces, the staff used the CBECS microdata for the Pacific Census Division to determine the annual gas usage for average commercial buildings utilizing gas. Annual fuel use for residential water heating was taken from EnergyStar.

The total estimated universe for PAR 1111 residential fan-type central furnaces, wall and floor furnaces was estimated using the American Housing Survey. PAR 1121 estimated universe was also extrapolated from the American Housing Survey. For the total number of commercial units, the CBECS microdata for the Pacific Census Division was used. The number of estimated units is detailed in **Error! Reference source not found.**.

The analysis assumed 100 percent emission reduction for zero-emission units. The estimated emission reduction is 7.7 tpd for PAR 1111 and 2.3 tpd for PAR 1121 at full implementation.

Table 5-1: PAR 1111 and PAR 1121 Baseline Emissions Estimate

Rule	Equipment Category	Estimated Universe	Baseline Emissions (tpd)
PAR 1111	Residential Fan-Type Central Furnace	4,200,000	3.99
	Commercial Fan-Type Central Furnace	113,000	3.19
	Wall Furnaces and Floor Furnaces	1,037,000	0.52
PAR 1121	Water Heaters	5,128,000	2.32
Total		10,478,000	10.02

COST-EFFECTIVENESS

Health and Safety Code Section 40920.6 requires a cost-effectiveness analysis when establishing BARCT requirements. The cost-effectiveness of a control technology is measured in terms of the control cost in dollars per ton of air pollutant reduced for each class and category of equipment. The costs for the control technology include purchasing, installation, operating, and maintaining the control technology.

As detailed in chapter two, the South Coast AQMD typically relies on the DCF method which converts all costs, including initial capital investments and costs expected in the present and all future years of unit useful age, to a present value.

[51] https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass

The following table summarizes the cost-effectiveness estimates for each category of PAR 1111 and PAR 1121.

Table 5-2. Cost-Effectiveness for PAR 1111 Categories

Category	Cost-Effectiveness ($/Ton), No Panel Upgrade	Cost-Effectiveness ($/Ton), With Panel Upgrade	Cost- Effectiveness ($/Ton), Weighted Average
Single-Family Residential Furnace	(134,000)	(39,000)	(129,000)
Multifamily Residential Furnace	(2,632,000)	(2,309,000)	(2,618,000)
Commercial Furnace	(76,200)	N/A	N/A

Table 5-3: Cost-Effectiveness for PAR 1121 Categories

Category	Cost-Effectiveness ($/Ton), No Panel Upgrade	Cost-Effectiveness ($/Ton), With Panel Upgrade	Cost-Effectiveness ($/Ton), Weighted Average
Single-Family Residential Water Heater	299,000	601,000	327,000
Multifamily Residential Water Heater	33,000	335,000	61,000

The proposed BARCT emission limits will take effect in future years for installations in new buildings and at the end of the equipment life in existing buildings, and the full implementation will be achieved 25 years for PAR 1111 and 15 years for PAR 1121 after their latest compliance date. Currently, the market adoption is limited and some of the zero-emission units staff evaluated require pre-planning and adjustment prior to installation, which will involve a higher cost. The future effective compliance dates and implementation at equipment natural turnover will allow for market growth for emerging technologies that typically includes a price decrease.

SOCIOECONOMIC IMPACT ASSESSMENT

A socioeconomic impact assessment will be prepared and released for public review and comment at least 30 days prior to the South Coast AQMD Governing Board Hearing for PAR 1111 and PAR 1121, which is scheduled for December 6, 2024 (subject to change).

California Environmental Quality Act (CEQA) Analysis

Pursuant to the California Environmental Quality Act (CEQA) and South Coast AQMD's certified regulatory program (Public Resources Code Section 21080.5 and CEQA Guidelines Section 15251(l); codified in South Coast AQMD Rule 110), the South Coast AQMD, as lead agency, is reviewing the proposed project (PAR 1111 and PAR 1121) to determine if it will result in any potential adverse environmental impacts. Appropriate CEQA documentation will be prepared based on the analysis.

Draft Findings Under Health And Safety Code Section 40727

Requirements to Make Findings

Health and Safety Code Section 40727 requires that prior to adopting, amending, or repealing a rule or regulation, the South Coast AQMD Governing Board shall make findings of necessity, authority, clarity, consistency, non-duplication, and reference based on relevant information presented at the public hearing, and in the staff report.

Necessity

PAR 1111 and PAR 1121 are needed to establish BARCT requirements and achieve emission reductions proposed by 2022 AQMP Control Measure R-CMB-02, C-CMB-02, and R-CMB-01 in order to meet the National Ambient Air Quality Standards for ozone.

Authority

The South Coast AQMD Governing Board has authority to adopt amendments to Rule 1111 and Rule 1121 pursuant to the Health and Safety Code Sections 39002, 40000, 40001, 40440, 40702, 40725 through 40728, and 41508.

Clarity

PAR 1111 and PAR 1121 are written or displayed so that their meanings can be easily understood by the persons directly affected by them.

Consistency

PAR 1111 and PAR 1121 are in harmony with and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations.

Non-Duplication

PAR 1111 and PAR 1121 will not impose the same requirements as any existing state or federal regulations. The proposed amended rules are necessary and proper to execute the powers and duties granted to, and imposed upon, the South Coast AQMD.

Reference

In amending Rule 1111 and Rule 1121, the following statutes which the South Coast AQMD hereby implements, interprets or makes specific are referenced: Health and Safety Code Sections 39002, 40000, 40001, 40440, 40702, 40725 through 40728, and 41508.

Comparative Analysis

Under Health and Safety Code Section 40727.2, the South Coast AQMD is required to perform a comparative analysis when adopting, amending, or repealing a rule or regulation. The comparative analysis is relative to existing federal requirements, existing or proposed South Coast AQMD rules

and air pollution control requirements and guidelines which are applicable to combustion equipment subject to PAR 1111 and PAR 1121. A comparative analysis will be prepared and released in the Draft Staff Report at least 30 days prior to the South Coast AQMD Governing Board Hearing on PAR 1111 and PAR 1121, which are anticipated to be considered for approval on December 6, 2024 (subject to change).