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Joint Agency Staff
Gas Transition White Paper

2024 Joint Agency Staff Paper: Progress Towards a Gas Transition

A White Paper Supporting the CPUC's Long-Term Gas Planning Rulemaking R.20-01-007

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1. Preface: Joint Agency Roles in Gas Transition Planning

Three State agencies—the California Public Utilities Commission (CPUC), California Energy Commission (CEC), and California Air Resources Board (CARB) (referred to as the "joint agencies")—are closely coordinating to develop strategic plans for reducing fossil gas demand and planning for the future of the pipeline system that delivers fossil gas to end-use customers today. This document provides background, describes current agency and interagency activity in these areas, and sets the stage for further coordination and action.

CARB's 2022 AB 32 Scoping Plan Update (Scoping Plan) identifies a statewide path towards California's 2045 carbon-neutrality target per AB 1279. The CEC, via the Integrated Energy Policy Report, forecasts energy needs, which can then be used in assessing gas infrastructure needs and as an input to other statewide energy analysis. In the Long-Term Gas Planning Rulemaking (R.20-01-007), the CPUC is reconsidering how gas utility investments are made (or not made) and paid for by ratepayers in order to advance the State's climate goals while also ensuring safety, reliability, affordability, and equity. This joint agency white paper reflects staff analysis and supports long-term gas planning, drawing from numerous adopted plans, proceedings, and rulemakings, including the Scoping Plan, the CEC's Gas Decarbonization and Integrated Energy Policy Report proceedings and analysis per AB 3232, and the 2022 State Strategy for the State Implementation Plan.

CPUC
The CPUC regulates investor-owned utility services, expenditures, and rates, with the goal of protecting consumers, safeguarding the environment, and assuring Californians' access to safe, reliable, and affordable energy. Relevant authorities include approving utility rate structures and cost allocations, establishing safety and reliability standards, and overseeing utility programs and pilots to incentivize and enable a gas transition. This work is spread across various proceedings, including general rate cases, the Long-Term Gas Planning Rulemaking, and the Building Decarbonization Rulemaking.
CEC
As the lead agency on statewide energy planning and policy, the CEC's role includes overarching forecasting and analysis related to gas planning topics. The primary venues for this work are the Integrated Energy Policy Report, which provides an assessment of major energy trends and issues facing California's electricity, gas, and transportation fuel sectors, and the CEC's Proceeding on Gas Decarbonization. The CEC administers incentive programs that support the gas transition, including nearly $1 billion for electric heat pumps for low-income and disadvantaged communities, through the Equitable Building Decarbonization Program. The CEC also administers relevant clean energy research and development programs and develops energy efficiency standards for buildings and appliances.

CARB
CARB is the lead agency for climate change programs and oversees all air pollution control efforts in California to attain and maintain health-based air quality standards. CARB leads the Scoping Plan process, which outlines pathways and actions to achieve the State's climate targets such as economy-wide carbon neutrality and reducing emissions 85 percent below 1990 levels by 2045 per AB 1279. The Scoping Plan is updated at least once every five years, and the 2022 Scoping Plan Update provides a planning framework for aligning the gas system with the State's overall climate targets and air pollution mandates.

2. Executive Summary

Fossil gas (also known as "natural gas" or "gas") heats our homes and buildings, powers our industrial and agricultural sectors, and produces electricity—but at a cost to climate and public health. Achieving California's ambitious climate targets requires a monumental shift away from this fossil fuel. State agencies must align the gas system with State priorities and support a smooth transition to a decarbonized energy system. The challenge lies in balancing many priorities to create a path to a clean, affordable, safe, reliable, and equitable gas system.

Because gas infrastructure and gas-consuming equipment have decades-long lifespans, a comprehensive transition off fossil gas requires a combination of near-term actions and long-term strategies. This White Paper is a foundational step to reducing reliance on fossil gas while mitigating potential negative impacts to California's residents, businesses, and workforce.

California's gas system is an interconnected network that supplies more than 11 million customers with fossil gas each day.[1] The primary uses of fossil gas in California are in buildings, electricity generation, and industrial operations, each representing roughly one-third of total demand.

Thoughtful planning of the transition away from fossil gas will help achieve California's climate goals while helping the State identify and evaluate actions that can reduce rate and bill impacts while also ensuring safe and reliable operation of the gas system, supporting public health, prioritizing disadvantaged communities, and advancing opportunities to engage the affected gas workforce.

In order to provide both reliability and reasonable rates and bills, it will be critical that utilities maintain the right balance of investment in gas infrastructure. If too much infrastructure is maintained at too high a cost, and those costs must be spread across a declining customer base, gas transportation rates could increase to unsustainable levels. On the other hand, too little investment in gas infrastructure could contribute to gas commodity price spikes that are passed through directly to gas ratepayers and could also impact electric rates and bills. An underinvested system could also lead to negative safety impacts. Long- term planning, along with State regulation and appropriate incentives, will be needed to guide utilities toward the correct balance.

Technology advancements and the declining costs of alternatives to fossil gas have sped up decarbonization efforts and opportunities. However, challenges remain to shifting the State's economy off fossil gas. Different approaches may be appropriate for different sectors as the State moves to reduce demand from buildings, industry, and electric generation. Some of the approaches that may be considered include building electrification; networked geothermal; low-carbon fuels, including hydrogen; and carbon capture, utilization, and storage (CCUS).

This joint agency white paper frames the key issues in California's gas transition, setting forth guiding principles for equity and transparency. It outlines activities for ongoing coordinated planning across agencies, informs the CPUC's Long-Term Gas Planning Rulemaking, and puts forward key

[1] CPUC. Natural Gas and California. https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california.

considerations that must be balanced in furtherance of an equitable transition to a secure and sustainable energy future.

3. Introduction

Fossil gas heats our homes and buildings, powers our industrial and agricultural sectors, and produces electricity—but at a cost to climate and public health. Today, fossil gas is a key pillar of the State's energy system. In fact, the State consumes about 2,131 trillion British thermal units (BTU) of fossil gas per year, more than twice the 904 trillion BTU it consumes in electricity.[2] However, achieving California's ambitious climate targets, including economy-wide carbon neutrality by 2045,[3] requires a monumental shift away from this fossil fuel.

The reasons to support and manage a transition away from fossil gas include:

- **Transitioning away from fossil gas is necessary to achieve the State's climate goals:** In 2020, fossil gas was responsible for 31 percent of California's greenhouse gas (GHG) emissions. Significantly reducing fossil gas use is a crucial step in achieving the State's climate goals.
- **Fossil gas pollution has equity and public health impacts:** Fossil gas combustion in power plants, industrial processes, and home appliances is responsible for significant air pollution impacts,[4] particularly for some of California's most vulnerable communities.
- **The transition off fossil gas poses risks to affordability, safety, reliability, and the gas workforce:** The transition away from fossil gas must balance these risks and protect vulnerable residents.
- **Transitioning from fossil gas will affect the workforce:** the transition must consider the existing skilled workforce and provide opportunities to transition to high-quality jobs.

State agencies must align the gas system with California's decarbonization goals and support a transition to a decarbonized energy system. The challenge lies in balancing many priorities. The joint agencies must simultaneously:

- Achieve the State's climate, air quality, and clean energy targets by reducing gas demand;
- Ensure all Californians have access to clean and affordable energy; and
- Consider the needs of the State's critical industrial and agricultural sectors.

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[2] CPUC calculations based on EIA data for 2022. BTU values given are equivalent to approximately 2,056 Bcf of gas (one third of which is used to produce electricity) and 265,000 GWh of purchased or directly received electricity. EIA, California Natural Gas Consumption Estimates, 2022, https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_ng.html&sid=US&sid=CA, and EIA, State Electricity Profiles, 2022, California Electricity Profile 2022 - U.S. Energy Information Administration (EIA).

[3] Assembly Bill 1279 (Muratsuchi, 2022) also calls for a reduction in anthropogenic emissions by 85 percent from 1990 levels by 2045.

[4] Health impacts of fossil gas combustion include exacerbation of asthma by exposures to NO2, which has also been associated with premature death, cardiopulmonary effects, decreased lung function growth in children, and respiratory symptoms. Fossil gas combustion is also associated with health-damaging ultrafine and fine particulate matter emissions.

- Ensure utilities and energy providers maintain gas and electric system safety and reliability in a world of increasing uncertainty; and
- Support new career opportunities for the current workforce while maintaining a well-trained, expert, and thriving gas workforce throughout the duration of the gas transition.

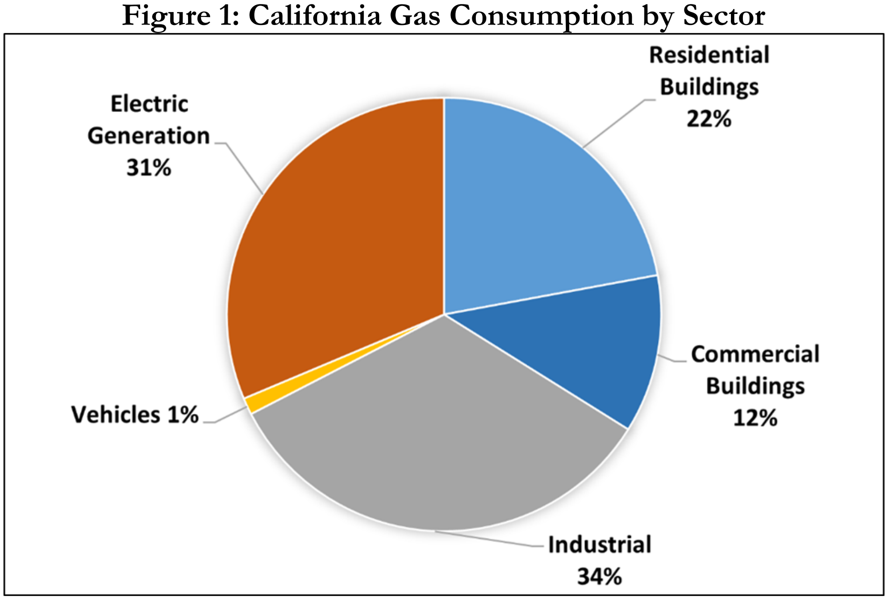
Threading this needle is a considerable undertaking with attendant risks and opportunities, which are discussed throughout this document.

Since gas infrastructure and gas-consuming equipment have decades-long lifespans, a comprehensive transition off fossil gas requires a combination of near-term actions and long-term strategy. This White Paper is a foundational step to charting a course that will move the State away from fossil gas while mitigating potential negative impacts to California's residents, businesses, and workforce.

4. Background

California's gas system is an interconnected network that supplies more than 11 million customers with fossil gas each day.[5] The primary uses of fossil gas in California are in residential and commercial buildings, electricity generation, and industrial operations. Each of these sectors is responsible for roughly one-third of total fossil gas demand (Figure 1). California's fossil gas demand peaks in winter to meet space heating needs for buildings. Summer typically has the second highest demand, when air conditioning loads drive higher gas demand for electricity generation.

Figure 1: California Gas Consumption by Sector



Source: CEC Staff.

[5] CPUC. Natural Gas and California. https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california.

Primary Gas Users

Homes and Small Commercial Buildings

About 91 percent of California homes are connected to the gas system, as compared to 65 percent of homes nationally.[6] The primary fossil gas uses in buildings are water and space heating, which make up more than 90 percent of gas demand in California homes.[7] The remaining home gas appliances, including gas stoves, clothes dryers, fireplaces, and pool or spa heaters, account for around 10 percent of residential gas use. Figure 2 shows the breakdown of average residential gas usage for PG&E customers in 2019 (SoCalGas residences have a similar breakdown). Space and water heating are also the major gas uses in commercial buildings, along with cooking. California residential gas demand has slightly declined over the past decade and is currently forecasted to continue to decline at about 0.6 percent per year through 2040, due primarily to energy efficiency and fuel substitution.[8,9] Adoption of CARB's concept for a zero-emissions appliance standard, which potentially will be implemented in 2030, could increase the decline to 8.5 percent per year through 2040.[10, 11]

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[6] Based on 2021 census data for habitable homes. U.S. Census Bureau, 2021 American Housing Survey. https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html.
https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html.

[7] Palmgren, Claire, Miriam Goldberg, Ph.D., Bob Ramirez, Craig Williamson, and DNV GL Energy Insights USA, Inc. 2019. 2019 California Residential Appliance Saturation Study. California Energy Commission. Publication Number: CEC-200-2021-005. https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass.

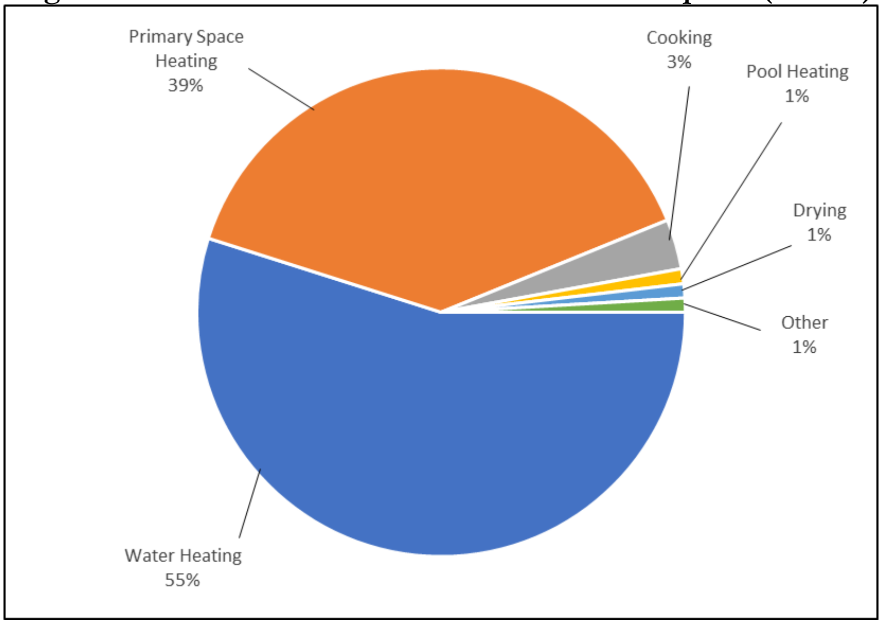
[8] CEC. *2023 Integrated Energy Policy Report*. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.

[9] For decline in *peak* demand between 2010-2011 and 2020-2021 in Southern California, including residential and non-residential demand, see also CPUC. Winter 2020-2021 Conditions and Operations Report. 2022. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/natural-gas/aliso-canyon/conditions-and-operations-reports/winter-2020-21-gas-report.pdf. See also SoCalGas, PG&E, SDG&E, Southwest Gas Corporation, City of Long Beach Energy Resources Department, and SCE, 2023 California Gas Report. https://www.socalgas.com/regulatory/cgr.

[10] CEC. *2023 Integrated Energy Policy Report*. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.

[11] In consultation with CARB staff, CEC staff assumes that by 2030 all space and water heaters sold in California for either new or existing residential and commercial buildings must comply with a statewide zero-emission GHG standard (i.e., 100 percent adoption in 2030). However, the adoption rate is assumed to grow in the interim years to reach this 100 percent adoption level, which begins in 2026. Thus, the impacts from CARB's standard begin in 2026, and these large impacts remain for the entire forecast time horizon.

Figure 2: 2019 California Residential Gas Consumption (PG&E)

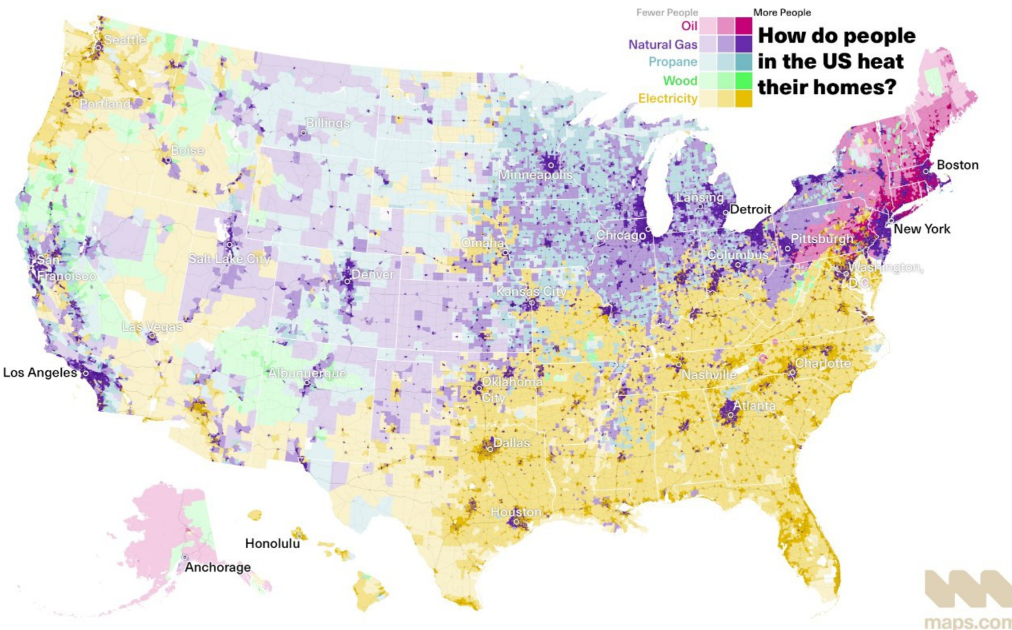


Source: CEC 2019 Residential Appliance Saturation Survey.

For safety and comfort reasons, home heating is a key service. While in California and the upper Midwestern states, this service is typically provided by gas, electricity is a more common heat source in the South and Pacific Northwest.[12]

[12] EIA. Residential Energy Consumption Survey. https://www.eia.gov/consumption/residential/data/2009/#sh.

Figure 3: The Geography of Heating U.S. Homes



Source: Joshua Stevens, Maps.com, reflecting U.S. Census 2021 American Community Survey data

Electricity Generators

In 2022, fossil gas made up about 36 percent of the State's total power mix (see Figure 5 below). Roughly half of that fossil gas generation was produced in-state, while the other half was imported.[13] Gas-fired electricity generation currently plays an important role in maintaining electric grid reliability because of its flexibility. For example, gas-fired power plants can operate at reduced output during the day while solar generation is high, then ramp up in the evening as solar comes offline and electricity demand is high. California's gas-fired generators are scattered around the State's gas system but are mostly located along high-pressure gas transmission pipelines.

Industrial Processes

About 85 percent of fossil gas used for industrial purposes fuels heating and chemical processes such as high-pressure steam generation, drying, heat treating, curing, forming, distillation, calcining, smelting, and driving chemical reactions. The largest industrial consumers are petroleum refining and oil and gas extraction, which together account for roughly 53 percent of the sector's demand. Food and beverage industries follow with 15 percent of industrial fossil gas demand (see Figure 6 below).[14]

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

[14] CARB, 2023: California Greenhouse Gas Emissions from 2000 to 2021: Trends of Emissions and Other Indicators: https://ww2.arb.ca.gov/sites/default/files/2023-12/2000_2021_ghg_inventory_trends.pdf.

California's Gas System

Most customers are served by the large investor-owned utilities (IOUs): Southern California Gas Company (SoCalGas) (5.9 million customers), Pacific Gas & Electric (PG&E) (4.5 million customers), San Diego Gas and Electric (SDG&E) (900,000 customers), and Southwest Gas (200,000 customers). Nearly 90 percent of California's gas supplies are imported from out-of-state production facilities located in Canada, Wyoming, New Mexico, and Texas. California's in-state gas production—much of which comes from geologic basins in the Central Valley and Southern California—has been slowly declining since the late 1980s. Imported gas is transported through interstate pipelines until it is delivered to the utilities' high-pressure transmission system and then onto the lower-pressure distribution system. Most customers receive gas through "service" lines that connect buildings to the distribution system. However, some electric generators and large industrial customers' service lines are often connected directly to the transmission system.

In addition to gas pipelines, in-state gas storage is an important asset for managing gas operations and assuring reliability.[15] Gas utilities and their customers use storage injections and withdrawals to help physically balance daily variations in system pressures and flow, to ensure sufficient gas is available for winter delivery, and to hedge against price fluctuations. The combination of storage and pipeline flows is particularly critical to meet current customer demand on peak winter days, as interstate pipeline supplies alone are insufficient to meet peak demand.[16] Without storage, utilities would need much more pipeline capacity to meet peak demand and would be more vulnerable to equipment failures and supply disruptions outside California. (See Appendix A for map of the State's storage facilities).

Gas Rates

Gas rates are determined by a utility's costs—known as the revenue requirement—divided by the units of gas sold by that utility. For core customers,[17] gas rates have three main components:

- **Core procurement (gas commodity) costs**, which are largely driven by supply and demand in the market and are passed through directly to customers without any mark-up by the utility. Gas commodity costs are unregulated and determined in gas markets that are impacted by national and international events. However, the CPUC has established an incentive mechanism to encourage utilities to procure gas at below-market prices. These mechanisms set a benchmark based on average market prices at specified locations. If a utility's procurement costs are above the benchmark, the losses are shared by ratepayers and

[15] Depleted fossil gas or oil fields function as gas storage reservoirs in California. For more information, please see: California Department of Conservation, https://www.conservation.ca.gov/calgem/Pages/UndergroundGasStorage.aspx

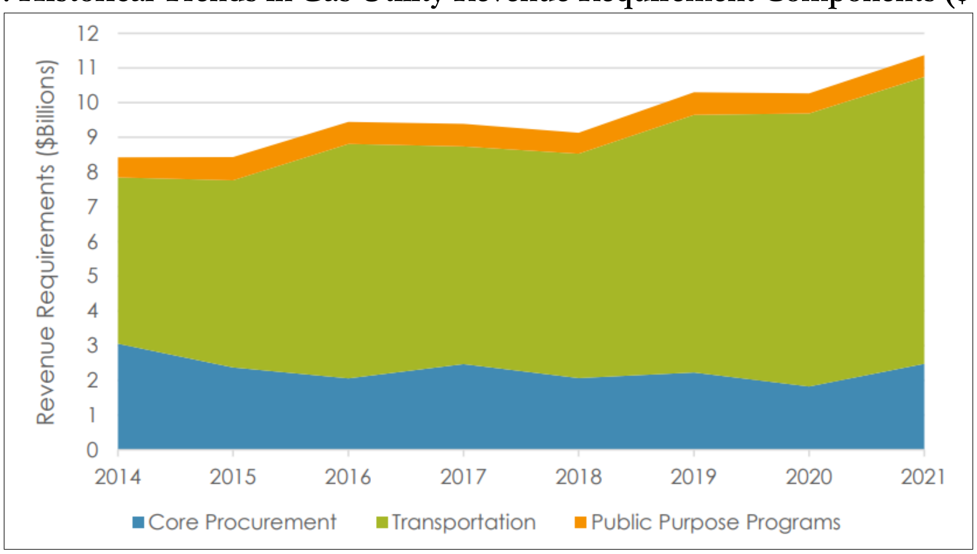
[16] SoCalGas. Pp. 99 and 181, *2022 California Gas Report*. https://www.socalgas.com/regulatory/cgr.

[17] Gas customers are categorized as either core or noncore customers. Core customers include residential, small commercial, and small industrial customers, while noncore customers consist of electric generators and large commercial and industrial customers. Since noncore customers buy their own gas from third parties instead of from utilities, their utility rates primarily cover the cost to transport that gas on the utilities' pipelines. Noncore commercial and industrial customers also contribute to Public Purpose Programs.

shareholders. Similarly, if the costs are below the benchmark, the gains are also shared, although there is a cap on total shareholder awards of 1.5 percent of total gas procurement costs.[18]

- **Gas transportation costs**, which are approved by the CPUC, cover the costs to maintain infrastructure, comply with safety regulations, and deliver gas to the customer. Capital-related transportation costs are included in the "rate base," and each utility receives a rate of return on this amount.[19] Based on recent rate case decisions, annual gas rate base can be estimated at $17 billion for PG&E, $9 billion for SoCalGas and $1 billion for SDG&E. Gas transportation infrastructure makes up a significant fraction of the revenue requirement (73 percent in 2021), as shown in Figure 4. Gas transportation rates can increase if the revenue requirement goes up, but they can also increase if the utility's costs stay the same but the units of gas delivered go down. Therefore, as gas customers reduce their gas use and electrify their homes, gas transportation rates may rise.
- **Public Purpose Programs**, such as the California Alternate Rates for Energy (CARE) program, a program that subsidizes costs for low-income residential customers. While regulators oversee the design, operation, and goals of Public Purpose Programs, and the CPUC sets budgets for these programs based on those factors, the Public Purpose Program surcharge is imposed pursuant to Public Utilities Code Section 890(a).

Figure 4: Historical Trends in Gas Utility Revenue Requirement Components ($ billions)



Source: CPUC.

[18] Cal Advocates audits the utilities' results and issues a report of its findings. The following example is the report on SoCalGas' Year 27 (4/1/2020-3/31/2021) Gas Cost Incentive Mechanism application: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M417/K418/417418088.PDF.

[19] Although it does not earn a rate of return, transportation costs also include the cost of compliance with California's Cap-and-Trade program for those customers who do not pay those costs directly as "covered entities."

Decarbonization Pathways

Because fossil gas is used across sectors in a diverse set of applications, there is no single alternative. The joint agencies are evaluating and deploying existing and emerging alternatives, including:

Building Electrification

Building Electrification involves swapping-out fossil gas applications for high-efficiency electric alternatives. Electrification is the best fit for decarbonizing homes and commercial buildings, where gas infrastructure can be fully electrified with technologies such as heat pumps for space and water heating and clothes drying and induction stoves.

Converting 11.6 million gas-using homes in the state to all-electric is costly and logistically difficult.[20] Industrial facilities are technically harder to electrify, and many industrial electric technologies are still in the developmental stage. Barriers to large-scale electrification across sectors include infrastructure and equipment costs, contractor training, installation speed, and potential increases in building operational costs.

Networked Geothermal

Geothermal heating (and cooling) for buildings is an old technology which utilizes temperature differences between the ground and air to operate ground-source heat pumps. This approach is analogous to the air-source heat pumps used by heat pump air and water heaters and by conventional air conditioning. Expensive to install and cheap to operate, geothermal heating uses a small amount of electricity to operate once installed and is therefore also energy efficient. Using geothermal to heat and cool multiple buildings, known as networked geothermal, can produce greater efficiencies. Some states are experimenting with gas utility ownership of networked geothermal, following the logic that networked geothermal constitutes a replacement for the building heating services previously provided using gas.

Low-Carbon Fuels

Low-carbon fuels can be a complementary pathway to electrification and may be particularly useful for electric generation or for "hard-to-electrify" applications where direct electrification is technically challenging or cost-prohibitive, such as in the industrial sector. These fuels include biomethane and certain forms of hydrogen, which can be produced through numerous pathways with differing environmental and public health impacts. Challenges to deployment of alternative fuels include high production and transportation costs, although in some cases deployment of these fuels may be less expensive than direct electrification or avoid other barriers. Other potential considerations include finite supplies and potential concerns about air pollution and other environmental impacts, especially in communities already experiencing disproportionate pollution burdens.

[20] In 2020, 11.6 million of California's 13.18 million homes, or 88 percent, used gas. EIA, 2023: Highlights for fuels used in U.S. homes by state, 2020: https://www.eia.gov/consumption/residential/data/2020/state/pdf/State%20Fuels%20Used.pdf.

Carbon Capture, Utilization, and Storage (CCUS)

Carbon capture, utilization, and storage (CCUS) strategies are complementary activities that will assist in the fossil gas transition by sequestering carbon dioxide emissions from industrial or energy-related facilities that are unable to electrify or fully utilize alternative zero-carbon fuels. The 2022 Scoping Plan recognizes the role of CCUS in achieving the State's climate goals, identifies likely emission sources that will rely on CCUS to mitigate remaining emissions, and provides a path forward to achieve the targets established in AB 1279 (Muratsuchi, 2022)— carbon neutrality and an 85 percent reduction below 1990 levels by 2045. SB 905 (Caballero, 2022) was passed alongside AB1279, and requires CARB to create the Carbon Capture, Removal, Utilization, and Storage Program under which CARB and other State agencies will establish a framework for the development and deployment of CCUS technologies. SB 905 also requires various technical evaluations for safety, water, and air quality impacts and a permitting portal to streamline the permitting process. Federal incentives have supported, and will continue to support, the development and deployment of CCUS technologies.

5. Equity During the Transition

Affordability, access, and employment considerations must be incorporated to achieve a gas transition that is equitable for all Californians. There are two major cost risks in moving off fossil gas:

- The first risk is that too much gas infrastructure will be maintained requiring an unsustainable level of investment in a sector where demand is shrinking. This could lead to rising gas transportation rates that create a feedback loop. As customers switch from gas to electricity, gas system costs will be spread over a smaller base, leading to transportation rate increases for the remaining customers. As rates rise, those who can afford to electrify may continue to depart the system, further contributing to higher transportation rates for the remaining gas customers.
- The second, and opposite, risk is that the gas infrastructure needed for reliability and commodity price management will be retired too soon. When there is insufficient gas transmission and storage infrastructure to meet demand, the price of the gas commodity can rise dramatically. High gas commodity prices impact gas customers directly because they are passed through into procurement rates. High gas prices also impact electric customers indirectly because gas-fired electric generators typically set the price that all electricity providers receive in the market run by the California Independent System Operator (CAISO).

Low-income customers could end up bearing a disproportionate share of the cost burden of both risks.[21] Addressing these risks equitably is a primary goal of a managed transition. It requires getting the balance right by maintaining neither too much nor too little infrastructure. To attempt this

[21] Rental buildings create even greater challenges, since the landlord owns many of the major appliances and must agree to any building modifications, while the tenant pays the utility bills.

balance, the joint agencies will need to transparently assess future demand and provide regulation and incentives to right-size the gas system over time.

In addition, an equitable transition must facilitate access to the benefits of high-efficiency electric appliances for all Californians. This will require engaging with customers and understanding customer preferences as well as overcoming affordability challenges such as high upfront costs and other constraints discussed in a later section.

Electrification may also lead to higher overall energy bills in the near term, although over time, increased electrification will put downward pressure on rates as costs are spread across a greater volume of electricity usage. This longer-term affordability benefit will only be realized to the extent that overall electricity consumption increases and system costs**,** which will increase with electrification, are shared.

As discussed in a later section, gas appliances can create unhealthy air inside homes, which is a particular challenge for those in disadvantaged communities who are already disproportionately burdened by other sources of air pollution. Conversely, agencies must also consider potential gentrification and displacement impacts associated with electric building upgrades and retrofits. Further, a transition away from fossil gas is only possible with participation from, and coordination with, residents, businesses, and workers across the state, as discussed in a later section.

Finally, transitioning away from fossil gas will impact the industry's skilled workforce and that demands attention, both for the safety of the gas system and the well-being of working families across California. As discussed in a later section, the transition is also anticipated to expand local employment in clean energy sectors, creating opportunities to benefit communities economically as well as environmentally.

6. Reducing Fossil Gas Demand

As described in CARB's 2022 Scoping Plan, meeting the State's GHG reduction goals while improving health outcomes for Californians will require "an ambitious and aggressive approach to decarbonize every sector of the economy."[22] Managing costs, safety, and reliability while transitioning away from fossil gas requires an evaluation of opportunities to reduce carbon in the gas-consuming sectors and a planned and synchronized approach to implementation. The timing and composition of decarbonization policies for gas will affect the infrastructure needs and economics of the gas system throughout the transition. An analysis of affordability, safety, reliability, and other risks of the gas transition should include the potential range and timing of carbon reduction measures in each sector.

[22] California Air Resources Board, "2022 Scoping Plan for Achieving Carbon Neutrality," page 1, https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf.

Technology advancements and the declining costs of alternatives to fossil gas have sped up decarbonization efforts and opportunities. However, each gas-consuming sector still faces challenges to migrating away from fossil gas.

Buildings

Research indicates that electrification is generally the most economical approach to reducing fossil gas demand for homes and small commercial buildings[23] given that supplies of alternative gaseous fuels such as biomethane or hydrogen are likely insufficient to meet current demand and may necessitate more costly infrastructure upgrades.[24] The long lifetime of home appliances makes timely action imperative, as each new building and appliance replacement presents an opportunity to achieve long-term energy efficiency and GHG savings and provide important co-benefits for occupants.

Electric appliances also improve indoor air quality by eliminating indoor fuel combustion, which is a major source of indoor nitrogen oxides (NOx) and particulate matter emissions. Fossil gas stoves can also release carbon monoxide and formaldehyde, which can be toxic. Indoor air is largely unregulated in the United States and is often more polluted than outdoor air.[25] In fact, gas stove combustion in California homes routinely exposes occupants to pollutant concentrations that are considered harmful outdoors.[26] A recent study found that more than 20 percent of current childhood asthma in California is attributable to gas stove use.[27] Lower-income communities and communities of color are likely the most burdened by indoor air pollution from gas stoves because of factors such as inadequate ventilation above cookstoves and smaller living space in multi-family buildings.[28]

Approaches to reducing fossil gas use in buildings include:

- **Reducing or eliminating gas use in new buildings:** This is an important strategy to reduce the costs of the gas transition since building all-electric new construction is significantly less expensive than retrofitting an existing home and avoids potentially stranded gas infrastructure. The State is pursuing opportunities to reduce gas demand in new

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[23] CEC. Energy Research and Development Division. Final Project Report: *The Challenge of Retail Gas in California's Low Carbon Future*. https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-055-F.pdf. (Note: Geothermal may also be an option for some space heating applications).
[24] Ibid.
[25] U.S. Environmental Protection Agency. 2020. *The Inside Story: A Guide to Indoor Air Quality*. Accessed December 8, 2020. https://www.epa.gov/indoor-air-quality-iaq/inside-story-guide-indoor-air-quality.
[26] Mullen, Nasim, Jina Li, and Brett Singer. 2012. *Impact of Natural Gas Appliances on Pollutant Levels in California Homes*. Berkeley: Lawrence Berkeley National Laboratory. https://eta.lbl.gov/publications/impact-natural-gas-appliances
[27] Gruenwald T, Seals BA, Knibbs LD, Hosgood HD III. Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. *International Journal of Environmental Research and Public Health*. 2023; 20(1):75. https://doi.org/10.3390/ijerph20010075.
[28] Seals, Brady, and Andee Krasner. 2020. *Health Effects from Gas Stove Pollution*. RMI, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club. https://rmi.org/insight/gas-stoves-pollution-health.

buildings through the California Building Standards Code (Title 24).[29] The CPUC phased out ratepayer funded subsidies for most gas line extensions, which were typically directed to new buildings, effective July 1, 2023. On July 1, 2024, ratepayer funded subsidies for electric line extensions in mixed-fuel new construction (i.e., new buildings that use gas and/or propane in addition to electricity) will also be phased out. Additionally, in 2024 the CPUC phased out ratepayer-funded energy efficiency incentives for non-cost-effective gas appliances in new construction.

- **Retrofitting existing buildings to be all-electric:** California has an estimated 11.6 million existing homes that use gas[30] and 7.4 billion square feet of existing commercial space.[31] While existing building retrofits offer greater potential for emissions reductions than new construction, they also face more barriers. These barriers include affordability constraints from upfront costs and potential negative bill impacts, space constraints and structural issues, electric panel and/or grid infrastructure upgrades sometimes needed to facilitate the installation of electric appliances, potential needs for distribution system upgrades which further raise electric bills, and consumer preferences (e.g., preference for cooking with gas). Networked geothermal is also an option to provide heating and cooling when electrifying buildings. Reducing fossil gas use in existing buildings will be necessary to achieve California's climate goals. Geographically concentrating retrofits would help to manage costs, as discussed under "Managing the Gas Transition."
- **Phasing out fossil gas appliance sales:** In September 2022, CARB committed to explore developing and proposing zero-emission GHG standards for new space and water heaters sold in California, a strategy that would impact both new and existing buildings. For this measure, CARB has begun the public process to develop zero-emission standards using its regulatory authority for GHGs. CARB's 2022 Scoping Plan also identifies actions for California to achieve carbon neutrality by 2045, including that 100 percent of appliance sales for existing residential buildings are electric by 2035.
- **Acceleration of deployment of high efficiency appliances using low- and ultra-low global warming potential (GWP) refrigerants.**[32] Hydrofluorocarbons (HFCs), commonly used today in refrigeration and air-conditioning equipment, are GHGs with a high GWP that can be thousands of times more potent than CO_2 in contributing to climate change. While the quantity of HFCs leaked from equipment units may be relatively small, their high- GWP

[29] The most recent 2022 Energy Code became effective January 1, 2023, and encourages building decarbonization. Notable updates include heat pump technology requirements and performance standards for space conditioning and water heating in single-family homes, multi-family buildings, and select commercial buildings; solar PV and battery storage requirements for high-rise, multi-family buildings and some commercial building types; and mandatory "electric-ready" and "energy storage-ready" requirements that will ease the future retrofitting of heat pump space conditioning and water heaters, electric cooktops, and electric clothes dryers in single-family homes and multi-family buildings.
[30] EIA, 2023: Highlights for fuels used in U.S. homes by state, 2020: https://www.eia.gov/consumption/residential/data/2020/state/pdf/State%20Fuels%20Used.pdf.
[31] CEC staff analysis of data provided by Dodge Data and Analytics.
[32] California Health and Safety Code Section 39736 defines "Low GWP" to mean GWP of less than 150 and defines "Ultra-low GWP" to mean GWP of less than 10. See also SB 1206 (Skinner, 2022).

makes them important sources of GHG that must be addressed. Without such efforts, the GHG benefits of building decarbonization will be partially offset, even with a transition to all-electric appliances.[33]

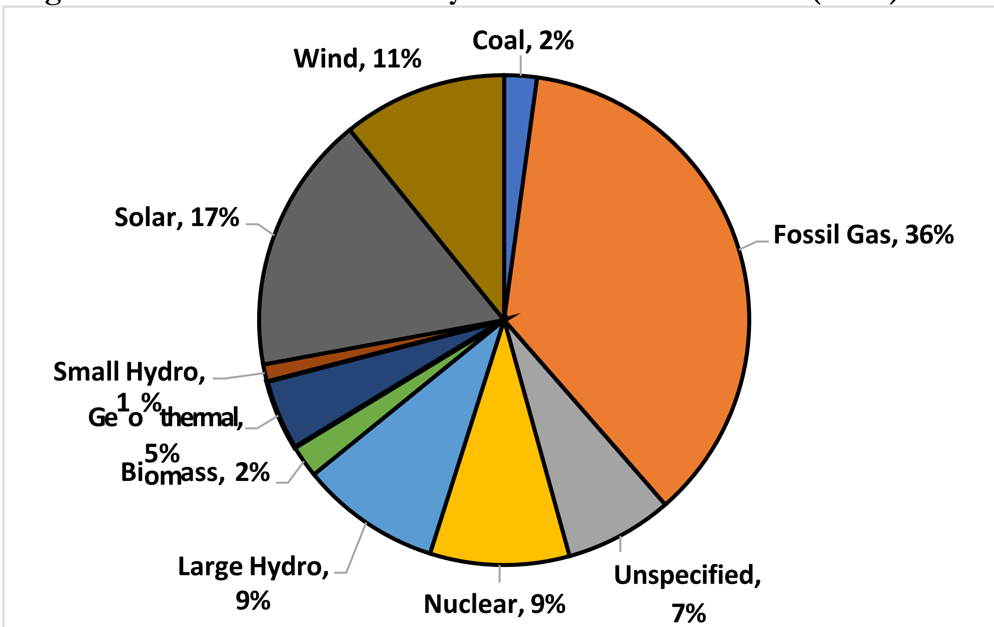
- **Prioritizing energy efficiency and load flexibility:** Energy efficiency continues to be critical as consumers shift to electric equipment in buildings. Using less fuel to perform the same task, whether electricity or gas, provides a reduced utility bill and fewer GHG emissions. A key action for attaining these goals, as outlined in the 2022 Scoping Plan, is the deployment of 6 million heat pumps in California homes by 2030. Load flexibility, or shifting demand to different parts of the day, maximizes renewable energy resources, reduces reliance on gas-fired peaker plants, aligns energy demand with real-time energy prices, and provides other beneficial grid services, ideally without disrupting customers.

Electricity Sector

In 2021, fossil gas made up about 40 percent of the State's total power mix (Figure 5). Fossil gas-fired generation currently plays an important role in maintaining electric grid reliability because of its ability to be dispatched on command. As the State implements climate policies for the energy sector, fossil-fueled gas plants will be used less and less, steadily reducing the percentage of GHG emissions from the electric sector over time. State analyses, including CARB's 2022 Scoping Plan, project that California will continue to rely on some gas-fired generation for electric grid reliability and flexibility to balance supply and demand.

[33] Numerous incentive programs overseen by the CPUC provide "kicker" incentives for low-GWP appliances, and high-GWP appliances will be ineligible for some incentives effective January 1, 2025 unless otherwise directed by the Assigned Commissioner in R.19-01-011. Additionally, CARB is exploring this issue through the Refrigerant Management Program. https://ww2.arb.ca.gov/our-work/programs/refrigerant-management-program.

Figure 5: California 2022 Total System Electric Generation (GWh)



Source: CEC Staff.[34]

Approaches to reduce fossil gas use in the electricity sector include:

- **Increasing deployment of zero-carbon resources:** This includes existing and emerging technologies that may provide clean and affordable electricity, such as offshore wind energy, linear generators, fuel cells, and long-duration energy storage, which are especially helpful during "net peak," the time of greatest stress for the grid. Taken together, these new zero-emission technologies must provide the services currently supplied by gas resources supporting grid reliability.
- **Supporting targeted transitions to cleaner fuels:** Particularly in areas where transmission is constrained and local land availability is limited, the best alternative may be switching power plants to renewable gas, such as biomethane or hydrogen made from renewable resources. In these cases, great care should be taken to ensure air impacts of any hydrogen combustion are below that of a fossil-gas powered plant. Pairing the transition to renewable gas with CCUS could further reduce emissions.
- **Prioritizing energy efficiency and load flexibility**: Effective use of load flexibility could reduce the need for fossil gas electricity generation by reducing demand on the grid during times when the grid is stressed. Both gas generation and demand response programs helped

[34] CEC. Energy Almanac. 2022 Total System Electric Generation. https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2022-total-system-electric-generation

meet historic electricity demand in summer 2022.[35] Increasing energy efficiency in industrial, commercial, and residential buildings can further reduce peak demand.

- **Reducing barriers to deployment:** These opportunities are diverse and some rely on nascent technologies. Research and development, incentives, and innovative financing programs would help develop these technologies. Improved project planning, greater diversification of equipment suppliers, increased production capacity, stable equipment supply chains, an expanded workforce, and a streamlined ability to permit new infrastructure are also needed to bring these opportunities to fruition.

Industrial Sector

California's robust industrial sector plays a significant role in the State's economy, accounting for 12 percent of Gross State Product and 6 percent of the State's workforce.[36] California is the nation's second largest source of industrial products, exceeded only by Texas.[37] The industrial sector is a significant consumer of fossil gas. As Figure 6Figure 6shown in Figure 6 below, refining for petroleum products makes up the largest share of industrial consumption. Together with extraction, the oil and gas industries account for roughly 53 percent of the industrial sector's demand. Food and beverage industries follow with 15 percent of demand.

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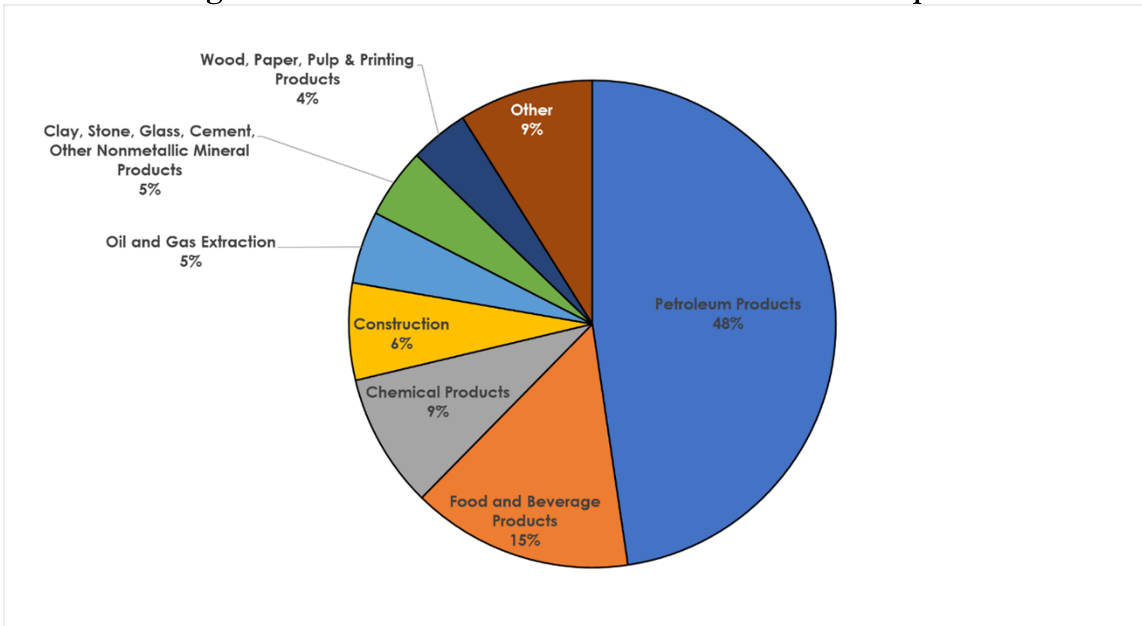
35 During the peak demand day of September 6, 2022, the California Office of Emergency Services sent a text alert requesting Californians to conserve electricity, which was followed by an estimated 1,510 MW drop in demand. During that time, as at peak times on subsequent days, gas supplied about half of electricity demand. CAISO. Summer Market Performance Report, Sept 2022. https://www.caiso.com/Documents/SummerMarketPerformanceReportforSeptember2022.pdf.

36 U.S. Bureau of Economic Analysis. Annual Gross Domestic Product: All Industry Total in California [SAGDP2N], retrieved from U.S. BEA; BEA Interactive Data Application. November 3, 2022.

37 U.S. Census Bureau. Manufacturing's Top States: 2021 Value of Shipments. 2023. https://www.census.gov/library/visualizations/2023/comm/manufacturing-top-states.html.

Figure 6: 2021 California Industrial Fossil Gas Consumption



Source: CEC, Quarterly Fuel and Energy Report (QFER) Database.

There is considerable innovation underway in clean industrial technologies. These include substituting cleaner products, such as lower-carbon cements, and using different forms of energy to drive industrial processes. Alternative energy sources include electricity (especially in electric boilers for low-to mid- temperature process heat and electric heat pumps), hydrogen applications, and CCUS. However, decarbonization of the industrial sector remains technically and economically difficult.

One of the primary barriers for this sector is high capital and operating costs. Many industrial plant managers want short payback projects and only replace existing equipment when it is approaching the end of its useful life. Alternative fuels and electricity are also more expensive than fossil gas for most industrial applications. Additionally, industrial subsectors manufacture a range of products using unique methods and equipment, often with high levels of system integration and sensitive energy input needs, such as a high level of power quality for electrical processing equipment. This variation does not lend itself to broadly applicable drop-in replacement technologies within and across subsectors. Lastly, electrification may require additional electricity generation and delivery infrastructure. Decarbonization involving hydrogen or CCUS may require construction of pipelines, storage, and other infrastructure.[38]

[38] Other barriers include production disruptions associated with retrofits, risk aversion, and lack of awareness around clean energy measures, and regulatory and permitting requirements.

Approaches to reduce fossil gas use in the industrial sector include:

- **Addressing cost and infrastructure barriers:** Additional engagement with industry stakeholders is needed to better assess the potential for achievable electrification and address existing barriers to deployment.
- **Investing in innovation to commercialize solutions:** Advancements in low-carbon and cost-effective technologies, such as for high-temperature heating applications, will be needed to scale decarbonization in this sector.
- **Assessing the need for financial incentives**: Incentives or other regulatory approaches may be needed to align the market with the State's policy objectives.
- **Exploring hydrogen and CCUS opportunities**: Hydrogen production clusters located near industrial customers may reduce costs via shared infrastructure. Carbon capture at point sources is a future option to reduce GHG emissions.

CARB's 2022 Scoping Plan identifies several actions to reduce fossil gas use in the industrial sector. Clear processes are needed to further develop and implement these actions, including support for new low-carbon technology development that may be needed for feasible and cost-effective deployments.

Low-Carbon Fuels

Fossil gas plays a very small role as a transportation fuel in California, mostly providing fuel for compressed natural gas (CNG) buses and trucks. CNG and liquified natural gas (LNG) can be cost-effective replacements for fossil diesel and produce comparatively lower criteria pollutant emissions. Even so, fossil gas as a transportation fuel produces GHG emissions which need to be transitioned out of transportation as soon as is feasible.

In 2020, Governor Newsom issued Executive Order N-79-20, which established zero-emission vehicle targets for the transportation sector to support the State's goal of carbon neutrality by 2045. CARB subsequently adopted Advanced Clean Trucks, Advanced Clean Cars, and Advanced Clean Fleets Regulations to support the phase-in of zero-emission vehicle (ZEV) technologies across vehicle fleets by 2045. CARB's 2022 Scoping Plan identifies a need for California to shift away from all fossil fuel vehicles by 2045. California will continue to invest in clean vehicle incentives and charging and fueling infrastructure to achieve this goal. More details on how to achieve California's zero emissions vehicle goals can be found in the California Clean Transportation Plan.[39]

While zero-emission vehicles may displace direct fossil gas use in vehicles, fossil gas is still utilized by these vehicles indirectly, as the State continues to rely on fossil gas for a portion of our electricity generation resource mix. Daytime charging enables electric vehicles to charge when more solar electricity is available and may be an important tool to reduce reliance on fossil gas-fired generation.

[39] CEC. Clean Transportation Program, 2023-2024 Investment Plan Update. https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-program-investment-8.

Transportation aside, low-carbon fuels can complement electrification where electrification is technically challenging or cost-prohibitive across a multitude of use cases.

Biomethane

Biomethane is a renewable gas produced from organic matter that has been processed to remove contaminants and meet standards for injection into the gas system. Major sources in California are landfills, dairies, organic waste, and wastewater treatment plants. Biomethane is chemically equivalent to fossil gas and can be used as a direct replacement in most fossil gas applications. Biomethane has a broad range of carbon intensities. In general, however, it possesses a carbon intensity less than fossil natural gas and presents the opportunity to capture methane for a beneficial use, rather than allowing it to escape to the atmosphere, where it acts as a GHG 27 to 30 times more potent than carbon dioxide.[40]

The market for biomethane is strongly driven by the federal Renewable Fuel Standard (RFS) and California's Low Carbon Fuel Standard (LCFS) program, which encourages the use and production of cleaner low-carbon transportation fuels in California. In California, most biomethane not otherwise used onsite is directed toward the transportation fuels market because of the credits available under the LCFS program. As of 2018, the CPUC allows PG&E, SoCalGas, and SDG&E to participate in the LCFS program by facilitating production and procurement of biomethane at volumes equivalent to fossil gas dispersals at dozens of IOU-operated CNG filling stations across California. A credit sharing agreement allows vehicles filling up at those stations to receive renewable CNG at cost parity with fossil CNG. However, the use of renewable CNG remains a combustion-based technology that entails harmful tailpipe emissions with negative environmental consequences. The role of biomethane as a primary fuel in the transportation sector is going to decline as the State transitions to ZEVs.

Pursuant to Senate Bill 1440 (Hueso, Chapter 739, Statutes of 2018), in 2022 the CPUC adopted biomethane procurement targets on gas investor-owned utilities and core transport agents that will encourage biomethane production and increase the amount of biomethane directed toward homes and small commercial gas users.[41] Program amendments or complementary programs for non-transportation sectors may be needed to ensure the incentive structure for biomethane aligns with the applications that will provide the most economic and climate benefits, such as in the industrial and electricity sectors.

Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016) also established targets to achieve a 50 percent reduction in the level of the statewide disposal of organic waste from the 2014 level by 2020 and a

[40] Estimated 100-year global warming potential. US EPA. "Understanding Global Warming Potentials." https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

[41] The February 2022 decision set a 2030 biomethane procurement target of 12.2 percent for each IOU's respective 2020 core customer fossil gas demand, excluding Compressed Natural Gas Vehicle demand, as noted in the California Gas Report (approximately 72.8 Bcf). The procurement mandate provides that all contracts signed by the utilities under the program must end in 2040, for the CPUC to have the opportunity to reevaluate the program at that point.

75 percent reduction by 2025. Required organic waste diversion from landfills has the potential to increase biomethane production from anaerobic digestion facilities and wastewater treatment plants.

Key considerations with scaling biomethane use in the gas system include:

- **Limited potential supply**: While in-state biomethane production is increasing, total in-state biomethane production potential is estimated to be only 5 to 10 percent of today's fossil gas demand.[42,43]
- **Higher prices**: Biomethane prices are generally significantly higher than the market price of fossil gas.[44,45]
- **Air quality and public health impacts:** Because biomethane is chemically identical to methane, its combustion has air pollution impacts that must be controlled.
- **Lack of Infrastructure:** Biomethane can be collected and transported in dedicated pipelines, but this is expensive. It can also be blended into common carrier gas pipelines, but the costs for cleaning and interconnecting to the pipeline system have created significant barriers to entry. Lastly, biomethane can be compressed and transported via truck or rail, but this creates additional air quality concerns.

The joint agencies have implemented strategies and initiatives to explore and advance the role of biomethane in supporting California's clean energy goals (see Appendix C for a description of biomethane programs). The CEC's 2021 Integrated Energy Policy Report (IEPR) sets policy guidance for moving forward in this area with the following interagency recommendations:

- The joint agencies continue to fund biomethane research to enable advancements and lower costs in production.
- Consider modifications to the incentives that apply to the use of alternative fuels to expand use to new sectors, such as the industrial sector.
- Evaluate other incentives for biomethane production including from feedstocks beyond the primary feedstocks currently used, such as crop residue or forest biomass.
- Identify opportunities where State or utility investments in infrastructure could create a pathway for biomethane to enter new markets at lower cost.

Hydrogen

In recent years, hydrogen has garnered attention and funding as a promising alternative to fossil gas, particularly for applications in the industrial and electricity generation sectors. However, different

[42] CARB. *Final Draft Report on The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute.* https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-307.pdf.

[43] The *2021 IEPR* cited a range of projection potentials - 52 to 310 Bcf per year - or 2.85 to 17 percent of current annual normal year gas demand. 2021 IEPR, Volume III, p.61.

[44] ICF. *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment.* American Gas Foundation. December 2019. See also, Barsun, Stephan, Ben Cheah, Jean Shelton. 2021. Renewable Natural Gas in California. Characteristics, Potential, and Incentives. California Energy Commission. Publication Number: CEC-800-2022-006.

[45] The ICF Report provided the following wide cost ranges: landfills \$7 to \$29/MMBtu; animal manure \$18.40 to \$32.60/MMBtu; wastewater recovery facilities \$7.4 to \$26.1/MMBtu; and food waste \$19.4 to \$28.3/MMBtu.

pathways for producing hydrogen have vastly different environmental impacts, depending on the fuel source and production process. Most hydrogen currently produced in California comes from steam methane reformation (SMR) of fossil gas. However, clean, renewable hydrogen can be made from water using renewable energy or from biomethane using methane pyrolysis or in existing SMR facilities. The 2022 Scoping Plan assumed that hydrogen is supplied by three methods: electrolysis using zero-carbon electricity, SMR of biomethane, and biomass gasification paired with CCUS. Using hydrogen to support California's clean energy future requires the use of these clean and renewable production processes, and the joint agencies prioritize the use of non-fossil-based hydrogen that can also receive federal incentives. Senate Bill 1075 requires CARB, in consultation with the State's energy agencies, to develop recommendations on the role that various sources of hydrogen can play in achieving the State's climate, clean energy, and clean air goals by June 1, 2024. The legislation also calls for the CEC to "study and model potential growth for hydrogen in decarbonizing the electricity and transportation sectors" and report on its findings in the 2023 and 2025 IEPRs.[46]

Emergent hydrogen applications include:

- **Power sector**: Hydrogen can serve as a "battery" that can store electricity and later generate it through a fuel cell via an electrochemical reaction or through hydrogen combustion turbines. The major gas turbine manufacturers now offer modifications that convert fossil gas turbines to burn a hydrogen and fossil gas blend, and manufacturers are working on designs to run turbines on 100 percent hydrogen fuel. In May 2023, the U.S. Environmental Protection Agency announced proposed new carbon pollution standards for coal- and gas-fired power plants to mitigate emissions while supporting the sector's ability to deliver reliable and affordable electricity.[47] Beginning in 2030, the proposal requires greater emissions controls and would phase in increasingly stringent requirements over time, including a low-GHG hydrogen compliance pathway in 2032 and 2038 for gas-fired turbines.[48]
- **Pipeline blending**: In limited amounts, hydrogen can be blended with fossil gas in existing gas pipelines. The CPUC recently required California's four large gas IOUs to conduct additional real-world testing of clean renewable hydrogen blended at both low (up to 5 percent) and high volume (up to 20 percent).

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[46] CEC. 2023 IEPR. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.

[47] Federal Register. May 23, 2023. "New Source Performance Standards for Greenhouse Gas Emissions From New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines for Greenhouse Gas Emissions From Existing Fossil Fuel-Fired Electric Generating Units; and Repeal of the Affordable Clean Energy Rule." https://www.federalregister.gov/documents/2023/05/23/2023-10141/new-source-performance-standards-for-greenhouse-gas-emissions-from-new-modified-and-reconstructed.

[48] U.S. EPA. *Fact Sheet Greenhouse Gas and Guidelines for Fossil Fuel-Fired Power Plants Proposed Rule.* https://www.epa.gov/system/files/documents/2023-05/FS-OVERVIEW-GHG-for%20Power%20Plants%20FINAL%20CLEAN.pdf.

- **Industrial use**: Hydrogen has the potential to displace some current fossil gas uses in California's industrial sectors, such as in refining, metals manufacturing and processing, fertilizer, and glass production.
- **Transportation:** Hydrogen can be used in nearly all transportation applications, especially those that are difficult to directly electrify such as long-haul trucking, locomotives, marine transport, heavy equipment, and aviation.

While hydrogen applications show promise, there are still key barriers to their large-scale deployment. Key considerations include:

- **Cost**: To date, the high costs of producing, storing, and transporting hydrogen have been some of the primary challenges. The decreasing costs of renewable electricity, increased investments in electrolyzer manufacturing, and federal and State funding may make hydrogen more economically competitive in coming years. Of particular importance will be the hydrogen production tax credits made available by the Inflation Reduction Act, typically referred to as the "45V" tax credits (in reference to the section of code in which the credits are enshrined).[49]
- **Air quality and public health impacts:** Hydrogen fuel cells can deliver electricity with no emissions. By contrast, hydrogen combustion may have air pollution impacts that must be understood in the context of achieving the State's air quality goals. Combustion of 100 percent hydrogen eliminates all criteria pollution but does generate some NOx (at levels that may not exceed state-of-the-art natural gas combustion).
- **Lower energy density:** Because hydrogen has one-third the energy of fossil gas by volume, blending hydrogen into the existing natural gas pipeline at higher mixtures would require significant investment in pipelines and compressor stations to address compression and pressure issues. The industry is largely focused on building 100 percent hydrogen dedicated pipelines—extending the network in California that has operated for decades.
- **Lack of Infrastructure:** Few clean renewable hydrogen production facilities exist today. Safe and cost-effective modes of storage and transportation exist and are in use, but more hydrogen trailers and pipelines are needed to connect clean renewable hydrogen production with end-uses. Existing fossil gas infrastructure offers a possible option. However, steel and iron pipelines and other pipeline components suffer from embrittlement and cracking with high hydrogen blends.[50] Hydrogen can be compressed and transported by truck or rail, but

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[49] For the purposes of determining the tax credit, "clean" is any hydrogen produced that results in lifecycle (i.e., well-to-gate) GHG emissions of no more than 4 kg of CO2e for every 1 kg of hydrogen produced. The 45V tax credits provide anywhere between $0.12 to $0.60 for each kilogram of clean hydrogen produced, which scales depending on the hydrogen's carbon intensity and is eligible for a 5x multiplier if a production facility meets prevailing wage and apprenticeship requirements. As such, the maximum potential tax credit is 5x $0.60, or $3.00, per kilogram of clean hydrogen produced.

[50] Petouhoff, Mike. 2021. "Presentation - Introduction of EPIC Initiative: The Role of Green Hydrogen in a Decarbonized CA - A Roadmap and Strategic Plan." Accessed September 27, 2022, at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=239050&DocumentContentId=72482.

compression results in further loss of energy, decreasing the efficiency of hydrogen as a form of energy storage.

- **Small Molecular Size:** As the lightest of all gases, hydrogen diffuses easily in air and may be more vulnerable to leaks. Given limited data on leaks associated with hydrogen supply chain, development of technologies and strategies to monitor and prevent hydrogen leaks is imperative from a safety, air emissions, and cost perspective.
- **Deploying end-use technologies:** Unlike biomethane, hydrogen is not a drop-in fuel. Though industrial and electrical facilities may be able to accept very small amounts of hydrogen without retrofitting their systems, any significant hydrogen use generally requires system and equipment upgrades. More work is needed to facilitate the widespread deployment of mature, clean, renewable hydrogen production technologies and end-use technologies.

The federal government has appropriated billions of dollars for programs to accelerate the deployment of hydrogen production, storage, transportation, and end-uses including $8 billion for hydrogen deployment hubs (H2Hubs). The State launched the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES), a non-profit public private partnership dedicated to accelerating the development and deployment of California's renewable hydrogen market, to lead the State's application. In October 2023, the U.S. Department of Energy awarded up to $1.2 billion to ARCHES to develop renewable, clean hydrogen projects in California. The Inflation Reduction Act of 2022 (IRA) includes a production tax credit that will award up to $3 per kilogram for clean hydrogen,[51] which is expected to accelerate its deployment.[52] State funding commitments include $65 million in hydrogen research and development funding to advance the use and production of renewable hydrogen, building on top of well over $500 million in direct investments in hydrogen deployment over the past decade.[53] Additionally, the State plans to match federal investment in buildout of the hydrogen hub over the next several fiscal years. Along with these federal and State programs, regional initiatives seek to advance hydrogen deployment. These include SoCalGas' Angeles Link project,[54] which would be the nation's largest clean renewable hydrogen pipeline system, PG&E's Hydrogen to Infinity (H2∞) project,[55] and the HyBuild Los Angeles initiative.[56] The CPUC recently authorized SoCalGas to conduct feasibility studies for the Angeles Link project. Plans for PG&E's H2∞ project and the HyBuild Los Angeles initiative are still being developed.

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[51] Rhodium Group. August 12, 2022. "A Turning Point for US Climate Progress: Assessing the Climate and Clean Energy Provisions in the Inflation Reduction Act." Accessed September 27, 2022, at: https://rhg.com/research/climate-clean-energy-inflation-reduction-act/.

[52] H.R.5376 - Inflation Reduction Act of 2022, Public Law 117-169 (August 16, 2022). Accessed September 27, 2022, at: https://www.congress.gov/bill/117th-congress/house-bill/5376.

[53] LAO Report, Feb. 14, 2024, The 2024-25 Budget: Crafting Climate, Resources, and Environmental Budget Solutions: https://www.lao.ca.gov/Publications/Report/4841#Energy.

[54] See: https://www.socalgas.com/sustainability/hydrogen/angeles-link.

[55] See: https://www.pge.com/en/about/pge-systems/hydrogen-to-infinity.html.

[56] See: https://www.ghcoalition.org/hybuild-la.

Carbon Capture, Utilization, and Storage (CCUS)

Coupling fossil gas or biomethane use with carbon capture technology is another approach to mitigate emissions from the gas system. CCUS encompasses methods and technologies that capture CO_2 emissions from the source or directly from the air. The captured CO_2 can either be injected and sequestered into geologic formations, such as depleted oil and gas reservoirs and saline formations (CCS), or incorporated into industrial materials, such as concrete (CCU).

CARB's 2022 Scoping Plan identifies CCUS as an important tool to reduce GHG emissions and mitigate climate change, particularly to minimize emissions where no technological alternatives may exist. The plan proposes CCUS to address emissions from key sectors, including electricity generation, cement and glass production facilities, and refineries to demonstrate how the State could achieve the two targets in AB 1279 (Muratsuchi, 2022) of carbon neutrality and an 85 percent reduction below 1990 levels by 2045. At this time, no CCUS projects have become fully operational in California, however several are in various stages of development.

Elsewhere, projects have been deployed largely on natural gas processing, fertilizer, ethanol, and coal-fired power plants, with 27 projects operational around the world.[57] More than 100 projects are under development and are expanding to include hydrogen.[58,59] Deploying these technologies to meaningfully reduce and sequester or use carbon emissions from fossil-fired generation or other industrial units using natural gas requires additional considerations to CCUS deployment include:

- **High costs and energy use:** Continued improvement of carbon capture solvents and CO_2 separation technologies may reduce the costs and energy use associated with carbon capture.
- **Development of a long-term safety and permanence framework:** Senate Bill 905 was passed in 2022 and directs CARB to establish a Carbon Capture Removal, Utilization, and Storage Program to require 100 years of storage of sequestered carbon. SB 905 also establishes a Geologic Carbon Sequestration Group to identify suitable injection well locations, appropriate monitoring standards, and potential hazards related to seismicity.
- **Protecting Public Health:** SB 905 directs CARB to include strategies in the framework to minimize, to the maximum extent technologically feasible, co-pollutant emissions from facilities where CCUS or Carbon Dioxide Removal (CDR)[60] technology is deployed to ensure that the use of carbon dioxide removal technologies and carbon capture and storage technologies do not have an adverse impact on local air quality and public health, particularly

[57] SB 1314 prohibits an operator from injecting a concentrated carbon dioxide fluid produced by a carbon dioxide capture project or a carbon dioxide capture and sequestration project into a Class II injection well for purposes of enhanced oil recovery, including the facilitation of enhanced oil recovery from another well.

[58] Global CCS Institute. Global Status of CCS 2021. https://www.globalccsinstitute.com/wp-content/uploads/2021/11/Global-Status-of-CCS-2021-Global-CCS-Institute-1121.pdf.

[59] On the other hand, the Enchant proposal to add CCUS to the San Juan coal-fired power plant in New Mexico would capture and sequester 95 percent of the CO_2 emissions, according to the U.S. DOE-funded Front-End Engineering and Design study just completed. See https://enchantenergy.com/san-juan-generation-station-carbon-capture-feed-study-completed-and-publicly-released/.

[60] Sometimes also referred to as "direct air capture."

> in low-income and disadvantaged communities. SB 905 further states, "Where avoidance of increased air pollution on site from such a project is not feasible, invest in mitigation in the community location adjacent to where the carbon dioxide capture, removal, or sequestration project is located which would be exposed to or impacted by any potential increased air pollution if mitigation measures are required pursuant to the California Environmental Quality Act (Division 13 (commencing with Section 21000)) for the project to address significant impacts in local air pollution."

Federal funding, including tax credits under the IRA and programs under Infrastructure Investment and Jobs Act (IIJA), will incentivize and expand the use of CCUS.[61] At the state level, California's 2022-23 State Budget Act directs $75 million for the carbon removal innovation program, which will support research, development, and pilot demonstration of atmospheric carbon removal projects.

Currently, there are a few demonstration CCUS projects underway in California (see Appendix C for more information). While these projects will capture a small percentage of overall facility emissions, they may help enable broader low-carbon CCUS applications.

7. Managing the Gas Transition

Managing the gas transition to reduce and balance risks to affordability, reliability, and safety is a critical goal. The gas transition, with its associated changes in supply and demand, presents two main risks to affordability that could come from maintaining too much or too little infrastructure. Because the gas and electric systems are interdependent, both systems face these risks.

The fact that gas infrastructure costs are already increasing exacerbates the challenge of the transition. These cost increases are primarily due to aging infrastructure that requires additional safety investments that are mandated by State and federal regulations.[62] Fossil gas demand has also declined by about 17 percent from its peak in 2000 and is forecast to continue declining, meaning costs to pay for updating an aging system are already spread across a smaller base.[63,64] This trend will be amplified as gas demand continues to decrease in the coming decades.

The CPUC has already issued two important decisions related to the gas transition in the Long-Term Gas Planning Rulemaking. First, it adopted a Gas Infrastructure General Order (GO-177) that requires large and environmentally impactful gas investment projects to receive a Certificate of Public Convenience and Necessity before construction begins. GO-177 serves as an important step towards development of a more comprehensive planning process for the gas transition in the Long-

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[61] In December 2023, the Sutter Decarbonization Project was selected by the Office of Clean Energy Demonstrations within the Department of Energy (DOE) to negotiate to enter into a cost-sharing agreement to build a commercial-scale carbon capture and storage project that will capture and store up to 1.75 million metric tons of carbon dioxide each year.
[62] The safety risks of this aging infrastructure have made themselves known in several high-profile events during the early part of this decade—including the gas pipeline explosion in San Bruno which killed eight people and the gas storage valve leak at Aliso Canyon which temporarily displaced nearly 10,000 families.
[63] SoCalGas and PG&E forecast total demand declines of 1.5 percent and 0.5 percent per year, respectively. *2022 California Gas Report.*
[64] U.S. EIA. [California Natural Gas Total Consumption (Million Cubic Feet) (eia.gov)](eia.gov).

Term Gas Planning proceeding.[65] Second, the CPUC issued a decision adopting review criteria for repair or replacement of gas transmission pipeline infrastructure. The decision also adopted criteria to determine when declining demand can enable transmission pipelines to be derated or decommissioned without negatively affecting reliability.[66]

One of the primary economic risks of the transition is that gas distribution infrastructure will become underutilized or even abandoned ("stranded") before the utility has recovered the entire investment cost from ratepayers. While such determinations are fact specific, utilities are generally allowed to recover investments made on behalf of customers, including a rate of return. An increase in stranded assets would lead to increasing rates for those customers who continue to use gas. As more of the system becomes underutilized or abandoned, those increases could eventually become exponential. Decommissioning costs and safe abandonment of gas assets should also be considered in evaluation of the economic risks of the transition.

To the extent that the gas transition results in allocating the costs of the gas system across a shrinking number of customers, a feedback loop could be created whereby rising costs lead more customers to depart the gas system, concentrating costs further on the remaining customers. A shortage in revenues relative to gas system needs could also result in infrastructure needed for fossil gas reliability and commodity price management being shut down too soon.

The second economic risk of the gas transition is retiring gas transmission and storage infrastructure before gas demand has dropped sufficiently. Imbalances between gas supply and demand can lead to gas commodity price spikes that impact gas customers directly as they are passed through into rates.[67] Electric customers are also impacted by gas prices spikes because the marginal electric producer sets the price paid to all producers in the CAISO market, and gas-fired electric generators are often the marginal producer.[68]

In the context of declining gas use, this raises the question: which gas infrastructure can reasonably be expected to remain in use over what period? The answer may vary for different types of infrastructure and at different locations. For example, since some gas-fired electric generation is expected to be needed through 2045 and beyond, it may be reasonable to continue to use long depreciation schedules for the gas infrastructure needed to serve that load. For other infrastructure, where customers are more likely to exit sooner, a shorter depreciation schedule or non-pipeline alternatives may be more appropriate.

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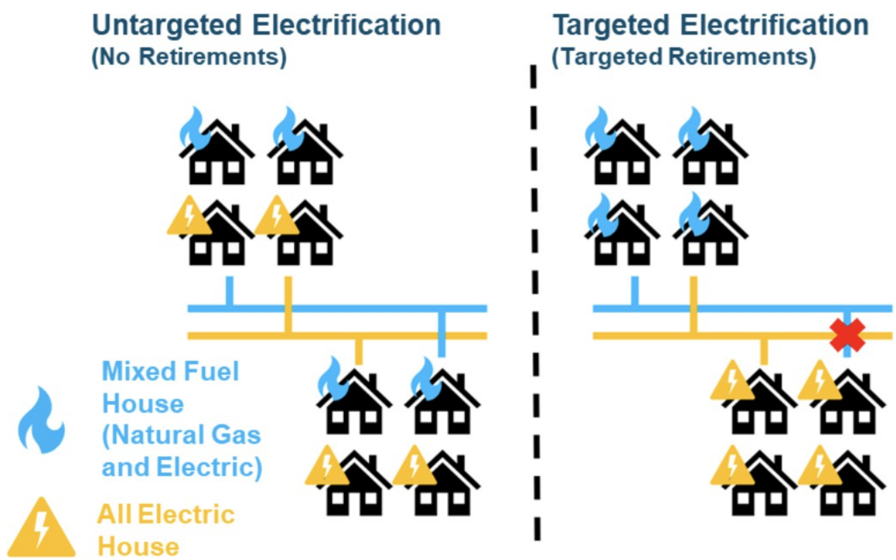
[65] Decision 22-12-021: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M499/K705/499705675.PDF
[66] Decision 23-12-003: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M521/K892/521892086.PDF
[67] For example, the CPUC's Energy Division found that the combined impact of restrictions on Aliso Canyon and loss of transmission pipeline capacity cost gas ratepayers approximately $2.25 per bill and electric ratepayers $599 million in total in 2018. "Aliso Canyon I.17-02-002 Phase 2: Results of Econometric Modeling" https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/natural-gas/aliso-canyon/november-2-2020-results-of-econometric-modeling.pdf.
[68] In 2023, CAISO released a "Gas Conditions and CAISO Markets" report that found that its energy market saw $3 billion in excess costs in December 2022 due to high gas prices: https://www.caiso.com/Documents/Gas-Conditions-and-CAISO-Markets-Report-for-Dec2022-Jan2023.pdf

These and related questions regarding the economic risk of existing or future assets being stranded will be considered in the CPUC's R.20-01-007 as well as by other agencies as appropriate. Strategies under consideration to moderate costs and smooth the transition include the following.

Coordinate Zonal Electrification and Fossil Gas Decommissioning

This approach prioritizes specific neighborhoods or regions for electrification efforts in parallel with fossil gas infrastructure disconnections and decommissioning, particularly in places where major new investment in the system would otherwise be needed. Without coordination, customers leaving the fossil gas system are likely to be geographically dispersed. In that scenario, all or most fossil gas distribution infrastructure must remain operational to continue to provide service. However, by coordinating all the residences on a distribution pipeline segment, for example, to electrify in a location with no downstream customers, it may be feasible to retire the entire gas distribution main underneath that street, as illustrated in Figure 77. As noted in a recent report, accessing the cost savings resulting from avoiding these gas replacements could constitute the difference between electrification producing cost savings or net costs for affected ratepayers.[69]

Figure 7: Two Gas System Scenarios with and without Targeted Electrification



Source: E3.

The gas utilities currently replace hundreds of miles of distribution pipe every year, some of which may be avoidable through targeted electrification. PG&E conducts some avoided-gas-infrastructure

[69] Energy and Environmental Economics, Inc. (E3), "Benefit-Cost Analysis of Targeted Electrification and Gas Decommissioning in California: Evaluation of 11 Candidate Sites in the San Francisco Bay Area," California Energy Commission grant: PIR-20-009, December 2023; https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California.pdf.

electrification projects through its Alternative Energy Program, which received increased funds reallocated from gas investments per the PG&E General Rate Case Decision adopted in November 2023.[70]

The CPUC issued a staff proposal in the Long-Term Gas Planning Rulemaking in December 2022 outlining a potential approach to determining which areas would be best electrified in what order, accounting for gas infrastructure cost savings potential, community health benefits, and potential demand reduction.[71] This staff proposal also recommended that the legislature consider targeting high priority areas as "Electrification Zones" for higher electrification appliance incentives. Finally, the proposal suggested creating an oversight process for potential gas distribution system investment projects, potentially allowing them to be replaced with electrification instead. Parties provided extensive input on this proposal.

Redefine the Utilities' Obligation to Serve

For CPUC-regulated utilities that provide gas service within a service territory, the obligation to serve is understood to be a requirement to provide and maintain gas service to any customer who requests and pays for such gas service. This requirement is grounded in statute and CPUC precedents that require utilities to provide safe, reliable, and affordable energy services without discrimination.

Some parties to the CPUC's Long-Term Gas Planning Rulemaking have suggested that the obligation to serve could be interpreted as a general requirement to provide energy services—not necessarily a requirement to provide a specific fuel, like gas. Under such an interpretation, a utility would be permitted to withhold gas service if electricity is available to serve the same application. However, other parties disagreed, arguing that this interpretation is at odds with specific statutory language, and that any utility that attempts to withhold gas service would be vulnerable to significant legal risk.[72]

Given this legal uncertainty, even in areas where the majority of customers are satisfied with electric-only service, an obligation to provide gas service may compel a utility to keep an uneconomical segment of fossil gas infrastructure operational to serve a small subset of customers who wish to maintain gas service, despite such service imposing significant costs on other ratepayers. Accordingly, absent a statutory modification to the obligation to provide gas service—such as, a change to make clear that electric-only service satisfies the obligation in certain circumstances—an orderly, affordable gas transition will be more challenging to achieve.

[70] CPUC, D.23-11-069, pp. 221-23, Ordering Paragraphs 6 and 16:https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M520/K896/520896345.pdf.
[71] CPUC Staff, "Staff Proposal on Gas Distribution Infrastructure Decommissioning Framework in Support of Climate Goals," December 2022. https://www.cpuc.ca.gov/industries-and-topics/natural-gas/long-term-gas-planning-rulemaking.
[72] CPUC. R.20-01-007. *Track 2 Gas Infrastructure Final Workshop Report*. pp. 48-53. final-track-2-january-workshop-report---20220707.pdf (ca.gov).

Minimize New System Investments

Minimizing new investments in infrastructure that could become stranded assets is important to reducing ratepayer costs during the gas transition. To minimize stranded assets without compromising safety, reliability and commodity price stability, the focus of minimizing new investments should include distribution infrastructure.

An important example is avoiding gas hookups in new construction. Historically, each year in California, tens of thousands of new homes and other facilities were connected to the gas system. Part of the initial cost to builders and developers of connecting new customers to gas was offset through allowances and other subsidies provided by the utility.[73] These subsidies have effectively provided an incentive for expansion of the gas system by reducing the costs of new hookups. In September 2022, the CPUC ended these gas line extension subsidies for all rate classes beginning July 1, 2023,[74] eliminating this incentive to build new fossil gas infrastructure and saving ratepayers approximately $164 million annually. In December 2023, the CPUC further ended electric line extension subsidies for mixed fuel new construction (i.e., new buildings using gas and/or propane use in addition to electricity) beginning July 1, 2024.[75] While gas is no longer incentivized, new gas connections are still allowed under State regulations. Some cities have gone a step further and banned fossil gas hookups in new construction within their jurisdictions. Depending on their approach and future court proceedings, these bans may be affected by the recent Ninth Circuit Court of Appeals' decision against Berkeley's ban on new gas connections.[76]

Similarly, current energy efficiency programs funded by gas ratepayers and overseen by the CPUC include subsidies for new gas equipment that is more efficient than the baseline options but installing such new gas equipment may "lock in" gas use for years to come.

Front-Load Recovery of System Costs

Another strategy to avoid future rate shocks, especially for those economically vulnerable customers who remain on the system the longest, may be to pay off more of the utility's fixed infrastructure investments earlier, while the costs can be spread across more customers. One approach is accelerated depreciation, where recovery of the initial asset investment and return on the investment occurs over a shorter lifetime than that in which the asset will be used. Once the fixed cost of the asset is paid off, only the cost to operate and maintain the system will be spread across the shrinking ratebase.

The CPUC has traditionally set gas utilities transportation rates, which include infrastructure costs, by dividing the cost of a given infrastructure investment equally across its useful life, plus a rate of return for the utility. If gas demand is consistent over the years, this "straight-line method" works

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[73] Based on equations reflecting rate category, demand and other factors, including additional amounts for each residential gas appliance type.
[74] CPUC. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M496/K987/496987290.PDF. With potential exceptions only if a project has demonstrated environmental benefit with no alternative to combustion.
[75] CPUC. D.23-12-037.
[76] https://cdn.ca9.uscourts.gov/datastore/opinions/2023/04/17/21-16278.pdf.

reasonably well. However, if demand is decreasing, the annual costs are spread across a lower demand each year—resulting in higher rates for gas delivery.[77] As discussed above, those with the least financial resources will likely be left to face these ever-increasing rates and thus be the most impacted. Therefore, front-loading the recovery of system costs, such as through accelerated depreciation, when more ratepayers are still connected to the gas system, could have positive equity outcomes. However, this approach will increase gas rates in the near term.

Similarly, some stakeholders have suggested changing rate calculation methods to use a consistent rate per-therm of gas across multiple years instead of depreciating the same amount every year. Because more therms of gas are used today than will be used in the future, this would result in higher near-term gas prices, offsetting some of the future increases. An analogous similar, "per-kilowatt" approach for electricity would result in lower electric rates in the near term,[78] also supporting a transition from gas to electricity. Using a "per-unit" approach for both gas and electricity could mitigate the impact of higher near-term gas rates by decreasing near-term electricity rates at a time when the overall increases in the cost of living is placing stress on many households and businesses.

Additional approaches to mitigating overall cost impacts of the gas transition will also be needed. These may include assessing the feasibility of a range of potential options to reduce or avoid costs and/or minimize new investments in the gas system and targeting incentive and financing programs there. It is also important to acknowledge that, while California has already launched and funded numerous market transformation programs to scale electrification and decarbonization technologies and retrofits for homes and businesses (see Appendix C for program descriptions), these programs are not sufficient to support a comprehensive transition. More work needs to be done to assess the effectiveness of existing incentive programs and to bring the lessons learned from this experience to inform planning for the gas transition.

Use Pilots to Assess Investment Needs

Pilot projects will also help the State assess the feasibility and cost of electrifying buildings on a large enough scale—and on a timely enough schedule—to avoid costs or significant new investments in the gas system. Pilot projects also present an important opportunity to assist low-income households that would not be able to otherwise afford electrification or areas where significant investments in the gas system can be avoided. The CEC has funded research in northern and southern California to identify and scope potential pilot projects in urban areas. In coordination with the CPUC's data requests for the Long-Term Gas Planning Rulemaking, the CEC also recently launched development of a data-driven tool for identifying promising decommissioning sites, enhancing the

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[77] For example, start with 50 customers buying 50 units of demand at a price of $300 across two years. Using the straight-line method, $150 will be paid off each year. If there are 50 customers both years, their price is $1.50 per unit each year. But if there are 25 customers in the second year, those customers each must pay $3/unit that year—their prices doubled.

[78] Because electric demand is increasing, a "per-kilowatt" approach would result in lower rates in the near term by shifting those costs to more numerous future customers.

capacity of State agencies to conduct planning and craft policy for the gas system in California's low-carbon future.

Ratepayer and Non-Ratepayer Funding Considerations

Increasing gas costs pose a risk to customers, particularly low-income customers, and create an equity challenge because utility bills are regressive—lower income residents pay a higher share of their income on utility bills. Increasing gas rates may also raise the cost of gas-fired electricity and negatively impact California's manufacturing industries. The affordability of electric rates is critical to enabling and encouraging wide-spread electrification across sectors.

Obtaining funding for decarbonization strategies is a significant challenge. In addition to exploring options to leverage additional funding sources such as the tax credits and incentives in the IRA and IIJA, other strategies for gas infrastructure costs, such as securitization,[79] have also been proposed. The Long-Term Gas Planning Rulemaking will continue to assess such alternative funding and financing mechanisms for both gas and electricity system costs.

In addition to the above strategies, the following are important areas under discussion.

Gas-Electric Interdependencies

California's gas system reliability and electric grid reliability are closely entwined; reliability and cost impacts on one system are tightly linked to the other system. Planning efforts must account for these interdependencies. For example, gas generation supports the grid during periods of low solar, wind, and hydroelectric generation, and electric grid reliability will only become more critical as large portions of the economy are electrified (see Figure 8). While the State is rapidly adding four-hour duration battery storage, gas generation is still projected to be needed through 2045. However, by about 2035 gas generation is expected to be used less than 10 percent of the time, primarily in the evening and during the winter.[80]

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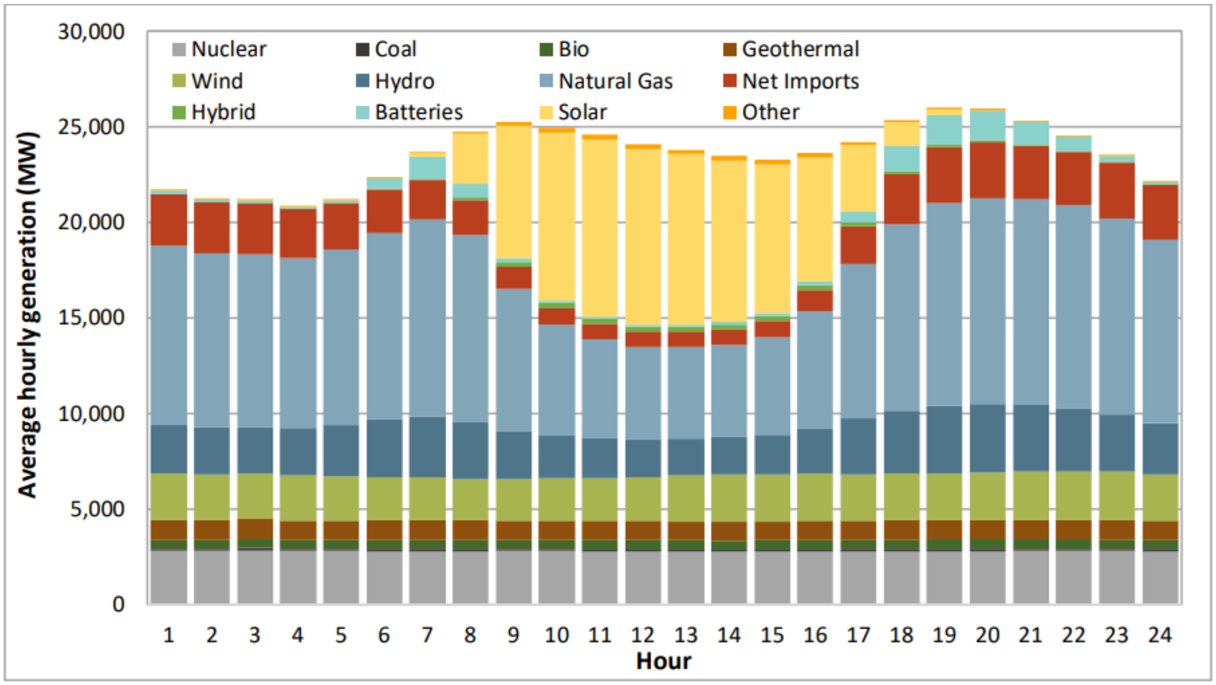
[79] Securitization is an alternative financing method, in which a portion of the rate base would be paid off with bond proceeds. The bonds would be paid overtime at a lower interest rate than the rate of return on the utility's rate base. There are challenges to this approach, however. For instance, over-reliance on securitization can increase borrowing costs. Further, if such bonds are to be paid off via gas rates, declining system throughput could undermine the security of the bond payments.

[80] "Integrated Resource Planning (IRP) Proposed 2023 Preferred System Plan (PSP) and 2024-2025 Transmission Planning Process Portfolios Analysis," October 20, 2023, Slide 49: 2023-10-20_psp_workshop_slides_ver3.pdf (ca.gov)

Figure 8: Average Hourly Generation by Fuel Type (Q1 2023)



Source: CAISO.[81]

Further, gas supply shortfalls can cause electricity price spikes and curtailment of electric generators that impair electric grid reliability. In California's electricity market, electricity spot prices are based on the cost to run the marginal unit, meaning the last electric generator needed to meet demand. Gas-fired electric generators are often the marginal unit, especially in the evenings and the winter. Thus, their costs to run often set the price for the electricity market. High gas prices can be amplified in the electric market because all generators—even those like solar that have no fuel costs—receive the same price as the marginal unit unless they are under long-term contract. Demand for gas by electric generators likewise affects fossil gas prices.[82]

Managing the interdependency of the two systems throughout the energy transition will require careful long-term planning and the alignment of incentives, with a special focus on extreme hot and cold weather events when reliability risks are most prominent. The 2021 IEPR recommends that the CEC work with the CPUC and stakeholders to expand planning for extreme events to ensure sufficient gas supplies are available to maintain gas and electric grid reliability and minimize price

[81] CAISO Q1 2023 Report on Market Issues and Performance, September 19, 2023, p. 8: 2023-First-Quarter-Report-on-Market-Issues-and-Performance-Sep-19-2023.pdf (caiso.com).

[82] Consumers experience neither the daily spot price of natural gas nor the daily electricity market price in real time but later, when they receive their monthly bill.

spikes. The State and utilities must also plan and coordinate so that that there is sufficient local electric capacity available to reliably serve customers who move off the gas system.

Public Health

Transitioning fossil gas end uses across sectors provides a substantial opportunity to reduce criteria air pollutants associated with gas combustion and provide public health benefits, especially through building electrification. However, some alternative fuels still produce air pollutants that should be thoroughly assessed to protect communities from negative health impacts.

Since biomethane is chemically equivalent to fossil gas, its combustion will generate the same level of criteria air pollutants. Processes fueled by hydrogen combustion instead of fossil gas may yield higher NOx emissions because hydrogen burns faster and hotter than fossil gas, though this potential for higher emissions may be controlled through appropriate engineering. In addition to hydrogen combustion, hydrogen production process may also contribute to criteria pollution. While electrolytic hydrogen generated from renewable electricity does not generate criteria pollutants, other production methods may. Equipment manufacturers and operators must mitigate air pollution impacts from both hydrogen production and combustion and maintain NOx emissions compliance with air quality permitting requirements.

Additional research is needed to better assess technical pathways to reduce NOx emissions from alternative fuel applications and minimize public health impacts. Further, facility retrofits to accommodate higher levels of biomethane or hydrogen could provide opportunities to also upgrade combustion turbines with best available control technology (or BACT) to better capture air pollution and improve local air quality. Federal, State, and local air district efforts to reduce air pollution will remain critical for hard-to-decarbonize sectors that may continue to utilize combustion.

Safety

Utilities must maintain gas system safety in accordance with State and federal regulations as they transition away from fossil gas. Additional coordination between agencies, including the California Geologic Energy Management Division (CalGEM), is needed to co-optimize for safety, cost management, and reliability.

New Standards Following Safety Incidents

California experienced two major incidents—the 2010 San Bruno pipeline explosion and the 2015 Aliso Canyon well leak—that elevated the vital importance of gas system safety and maintenance. Since then, the State and federal governments have implemented greater oversight and new safety measures for California gas utilities' infrastructure.

Following the San Bruno Pipeline Explosion, the CPUC ordered California' s investor-owned gas utilities to test or replace any transmission pipeline sections without a record of a pressure test to the modern standard.[83] The federal government also imposed stricter rules for pipeline assessments and inspections.

In response to the Aliso Canyon well leak and subsequent legislation, CalGEM adopted comprehensive regulations focused on the safety of underground gas storage facilities in California that are more stringent than federal regulations.[84] To better protect public health and safety, the regulations require additional layers of protection. Gas utilities and storage providers have increased the frequency of well testing to comply with the new regulations and constructed additional wells to maintain injection and withdrawal capacity, which has led to additional costs.[85]

Managing Safety Costs

Ensuring the safety of the gas system is paramount, but implementation of these recent State and federal safety requirements is proving to have significant costs. These costs have contributed to large increases in the gas utilities' revenue requirements and the resulting rates charged to customers.[86, 87] Because many of these costs are associated with the gas transmission system and storage, they will remain even with significant pruning of the gas distribution system.[88]

State energy agencies should coordinate to explore opportunities for streamlining compliance and reducing costs, while still ensuring safety. The agencies should also assess opportunities to align State and federal regulations for pipeline and storage inspections to avoid redundant efforts.

Workforce Considerations

The gas industry is a major employer in California, providing jobs in plumbing, pipefitting, metalworking, electrical, installation and repair, and material transportation work. Unionized jobs in the gas sector support families across California by providing good pay, job stability, and worker protections. Additionally, the State will continue to rely on this highly technical and specialized workforce for many more years as the transition away from fossil gas occurs. As the State seeks to

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[83] Decision 11-06-017: https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/137309.PDF.

[84] See Senate Bill 887 (Pavley, Statutes of 2016) and Public Resources Code section 3180, which required CalGEM to develop and implement its regulatory scheme. On a federal level, Congress enacted the PIPES Act of 2016, requiring PHMSA to issue, within two years of passage, "minimum safety standards for underground natural gas storage facilities." Operators have been working to comply with CalGEM risk management plan requirements and integrity management requirements under PHMSA.

[85] To reduce the likelihood of leaks, the 2018 rules also set a default integrity testing schedule of every 24 months until the operator establishes the corrosion rate and meets other safety requirements. These testing requirements allow CalGEM to reduce the testing interval once operators have demonstrated it is safe to do so. CalGEM developed the regulations in a public process in consultation with the National Labs. While CalGEM allows gas system operators to set their own well testing schedules, there could be instances when these inspections extend into the peak winter season, causing some wells to be offline when gas storage is most important for gas system reliability.

[86] CPUC, 2022 California Electric and Gas Utility Costs Report, pp 63-71: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2023/2022-ab-67-report.pdf.

[87] CPUC, 2023 Senate Bill 695 Report, pp. 79-90: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2023/2023-sb-695-report---final.pdf.

[88] Compliance with the state and federal post-Aliso well leak regulations necessitated significant up-front costs in risk management and integrity management planning but should be reduced over time.

decrease fossil gas use and downsize the gas system, agencies must consider the impacts to the industry and its workforce, to gas system safety, and to California families.

Meanwhile, the clean energy industry is one of the fastest-growing employers in the state. Electrification of gas-driven end uses will produce further clean energy jobs. The State must accelerate investments and high-quality unionized employment opportunities in clean energy sectors like offshore wind, geothermal energy, and long-duration energy storage as well as behind-the-meter electrification throughout the state. New sectors like networked geothermal, clean renewable hydrogen, and CCUS could also foster new career opportunities using existing skill sets. It is critical that the State partner with industry to create quality jobs in the clean energy sector and that these jobs prioritize providing good wages and benefits.

There will also be a need to retain skilled workers to safely decommission gas infrastructure and operate and maintain the remaining gas system for several decades. This may include work needed to retrofit portions of the system for alternative fuel use. State agencies will need to develop a plan to simultaneously support pathways to clean energy careers, while ensuring the gas workforce remains robust enough to aid in a safe transition to cleaner technologies.

State agencies must coordinate with unions, workforce training providers, employers, energy companies, appliance manufacturers and other stakeholders to develop a transition plan that minimizes adverse impacts on gas workers, retains a skilled workforce to manage the existing infrastructure, and advances opportunities for workers to seek alternative career paths.[89]

8. Research and Innovation Needs

Transitioning off fossil gas—while maintaining safety, affordability, and reliability—requires additional research, development, and deployment of new and emerging technologies. Supplementing privately and federally funded research, State agencies administer multiple research and development programs primarily overseen by the CEC, that support innovation needed to transition off fossil gas across sectors (see Appendix C for a list of relevant research programs). The State will continue building upon these efforts to continue to support a cost-effective and equitable transition away from fossil gas. Key research priorities include:

- **Efficient building electrification:** Innovative solutions for improving building envelope upgrades, high efficiency heat pump water heaters and HVAC heat pumps with low-global warming potential (GWP) refrigerants, combination heat pumps for domestic hot water and

[89] State agencies have already begun coordinating on clean energy workforce planning more broadly. In September 2020, Governor Newsom issued Executive Order N-79-20, which requires the California Labor and Workforce Development Agency and other state agencies to accelerate climate change mitigation efforts and build a more sustainable and inclusive economy. Additionally, the CPUC and the California Workforce Development Board signed a Memorandum of Understanding to collaborate on workforce development opportunities in key energy and transportation policy areas.

space conditioning, and technologies that address electrical service capacity such as Smart Energy Management Systems.[90]

- **Zonal electrification associated with gas decommissioning:** Program design approaches to support communities in electrifying enough homes to decommission the associated gas distribution mains and services connected to them and achieving associated cost savings and GHG reductions.[91]
- **Clean electricity storage and generation:** Cost-effective short- and long-duration energy storage to support electric grid reliability and performance and cost improvements for clean, dispatchable generation resources (such as biomethane, clean renewable hydrogen-fueled resources, and CCUS retrofits).[92]
- **Industrial decarbonization:** Low-carbon, high-temperature industrial heating[93] (process heat accounts for about 85 percent of industrial natural gas use in California), energy efficient separation processes, and the feasibility of industrial clusters for clean renewable hydrogen utilization.
- **Hydrogen:** Clean renewable hydrogen production, delivery, and storage technologies for a range of applications, electrolyzers that are lower-cost, more efficient, longer lasting, and with more-durable performance, optimizing combustion systems to use high-percentage hydrogen blends while minimizing criteria pollutant emissions, and hydrogen leakage detection and prevention.
- **CCUS:** Improved energy efficiency of the capture process, novel utilization pathways for captured CO_2 that could improve economics of CCU projects, pre-combustion capturing technologies for specific applications (e.g., cement manufacturing and hydrogen production), technology to also capture co- pollutants.[94]

Social scientific research supporting these technologies: The transition away from fossil fuels is also a social transition. The research areas itemized above must build on sufficient knowledge of the widely varied contexts, citizen perspectives, supply chains, and evolving outcomes involved in developing and deploying the relevant technologies.

[90] Such as smart electrical panels, home energy management systems, smart circuit splitters, battery systems, and programmable subpanels.
[91] Research in progress includes CEC contracts PIR-20-008 and PIR -20-009.
[92] All of which have yet to become available in sufficient quantity and at reasonable cost.
[93] This includes opportunities for 1) direct electrification of heating, 2) use of zero-carbon heat sources, and 3) fuel switching to zero-carbon fuels, including low-carbon hydrogen.
[94] Brown et al. 2023 evaluates the feasibility and emissions outcomes of hypothetical CCUS projects on cement plants and petroleum refineries in California and Texas. The study concludes that these projects would significantly reduce facility emissions of both CO_2 and harmful co-pollutants such as particulate matter (PM) and sulfur dioxide (SO_2), primarily because these pollutants must be removed from the flue gas stream for the carbon capture system to function effectively.

9. State Agency Coordination and Stakeholder Engagement

The complexity of the policy and technical considerations for transitioning away from fossil gas will require close coordination among agencies over a long-term planning horizon. The joint agencies must work closely with stakeholders and take steps to streamline engagement across proceedings (see Appendix D for a list of related joint agency proceedings), such as by holding joint agency workshops and meetings. The agencies should also continue collaborating with the Disadvantaged Communities Advisory Group (DACAG), the Environmental Justice Advisory Committee,[95] and other equity stakeholders to ensure the fossil gas transition benefits all Californians, particularly those in disadvantaged and low-income communities.

Expanding Analytical Efforts

The agencies are expanding analytical expertise and capabilities that will allow them to identify and quantify the challenges of the State's transition from fossil gas and help plan for changing demand patterns and gas system requirements more accurately. The CEC's Gas Decarbonization proceeding now provides an important avenue for analysis to inform long-term planning during the gas transition. As part of the proceeding, the CEC is expanding existing data and analytics, including forecasts and assessments of gas demand, supply, transportation, price, rates, reliability, and efficiency to provide input for gas system planning. Some of these improvements are underway, and others will be implemented over the next couple of years. Improvements include forecasting daily gas demand under peak cold day conditions, better assessing the impact of decarbonization efforts, and enhancing hydraulic modeling of the gas system. The CPUC is also enhancing its modeling capabilities and taking steps to make gas system data on topics such as costs and geographic variation more readily available.

Long-Term Infrastructure Planning

No process currently exists to coordinate gas planning across utilities, over time, or with other activities and State goals. The CPUC's general rate cases gather some relevant data but not at the level of detail needed. Utilities themselves do not have jurisdiction over their customers' energy decisions. A coordinated, iterative, and long-term planning process could help the agencies align initiatives related to gas system planning and analytics in order to achieve California's decarbonization goals and effectuate an equitable gas transition. Among other things, the agencies may seek to encourage reduced gas consumption and assess infrastructure needs.

[95] DACAG advises CEC and CPUC to ensure that disadvantaged communities, including tribal and rural communities, benefit from proposed clean energy and pollution reduction programs; the Environmental Justice Advisory Committee is CARB's advisory body on the Scoping Plan and other climate change efforts.

10. Key Considerations and Actions

The joint agencies recommend building from the following considerations and actions to better align the fossil gas system with the State's target of carbon neutrality, mitigate the anticipated impacts of the transition, and inform the CPUC's Long-Term Gas Planning proceeding.

Developing Guiding Principles for an Equitable and Transparent Gas Transition

The following principles will help facilitate an equitable and transparent gas transition:

A. Prioritize benefits and reduce impacts to low-income and disadvantaged communities through a balanced transition that considers equity in all aspects of the transition.

B. Low-income Californians should not bear a disproportionate share of the costs of the gas transition. Likewise, those who have been most burdened by air pollution from fossil fuels and are least able to access clean energy technologies should be prioritized to receive the benefits of strategic investments to transition off fossil gas and able to fully participate in the State's clean energy transition.

C. Expand coordination, involvement, and engagement with low-income and disadvantaged communities, including tribes, in gas transition work across the joint agencies.

D. Coordination and engagement with community-based organizations, tribal governments, local governments, and low-income advocates and equity advisory groups[96] is essential to raise awareness about gas transition opportunities and risks and to incorporate community needs and priorities into agency decisions.

E. Increase coordination with the Labor and Workforce Development Agency to develop and expand opportunities to mitigate impacts to the existing skilled workforce. Additionally, create career pathways in new clean energy sectors focused on training for existing fossil gas employees as well as individuals from disadvantaged communities.

Ongoing Coordinated Gas Transition Planning Across Agencies

The joint agencies are meeting regularly at the interagency staff and principal level to effectively analyze, understand, and coordinate efforts to decarbonize the gas system and manage gas transition impacts. Ongoing efforts among the agencies include:

A. Coordination at the joint agency staff and principal level, including consideration of a Gas Joint Agency Steering Committee (analogous to the electricity-focused JASC) or similar forum.

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[96] Including the Disadvantaged Communities Advisory Group, the advisory body to the CEC and CPUC on clean energy matters, and the Environmental Justice Advisory Group, CARB's advisory body on climate change efforts.

B. The CPUC's progress in the Long-Term Gas Planning Rulemaking (R.20-01-007) and other related proceedings.

C. The CEC's ongoing updates to the California Building Standards Code (Title 24).

D. Ongoing initiatives to promote electrification of homes and commercial buildings and State buildings, including through the California Green Building Standards Code.

E. CARB's development of zero-emission standards for space and water heaters sold in California beginning in 2030 and other actions identified in CARB's 2022 Scoping Plan to achieve carbon neutrality by 2045.

F. CEC and CPUC decarbonization incentive and financing programs, including pilot and incentive programs that explore strategic targeting of incentives to allow decommissioning or cost reductions in local gas infrastructure.

G. CEC and CARB assessments of pathways to decarbonize industrial end uses, including commercialized and emerging decarbonization technologies for the industrial sector and identification of priority areas for technology deployment, increased investment and innovation, and alternative fuel pathways.

H. Consideration of the optimal use of biomethane, hydrogen, and CCUS across sectors, including opportunities for shared production and distribution infrastructure for alternative fuels like biomethane and hydrogen for industrial uses.

I. Joint coordination, including with the Labor and Workforce Development Agency, on the needs and opportunities of the workforce related to electrification and the gas transition as well as opportunities in new clean energy sectors.

J. CEC and CPUC research, development, and demonstration that supports the fossil gas transition across programs including the CEC's EPIC and Natural Gas Research programs, as well as through utility-led research and development portfolios.

K. CEC initiatives to build upon forecasting capabilities for gas system planning and assessments, complementing and independently validating modeling conducted by the gas utilities and informing interagency gas planning.

L. CEC collaboration with the CPUC and utilities to develop daily gas forecast data and create a new forecast scenario with forecast results tailored for utilities' gas system planning.

M. Joint agency initiatives, in coordination with CAISO, to account for gas and electricity interdependencies in planning and expanding planning, monitoring, and assessments of gas and electric interdependencies to foster system affordability and reliability and to avoid spikes in commodity or electricity prices.

N. Efforts to maximize the benefits of related federal funding opportunities to support the gas transition.

Core Issues in the CPUC's Long-Term Gas Planning Rulemaking

The CPUC's Long-Term Gas Planning Rulemaking will take up core issues related to a balanced gas transition, in coordination with the joint agencies, including:

A. Developing and assessing scenarios for gas system revenue requirements and revenues over time.

   i. The Revenue Requirement (RRQ) to maintain and operate the gas system over time will be heavily influenced by the time frame of decarbonization in the gas sector and the combination of emission reduction measures employed. Similarly, gas transition planning must be informed by models or scenarios of system cost reduction opportunities.

B. Scoping potential new iterative planning requirements for gas IOUs addressing key elements of the transition.

   i. The CPUC is considering requiring gas IOUs to develop plans to address key elements of the gas transition, including decarbonization and reliability.

C. Coordinating electrification and related incentives with measures to reduce gas system costs over time.

   i. The CPUC will be considering opportunities to reduce gas system costs, including through coordinated electrification and gas infrastructure decommissioning.

D. Facilitating gas customers' access to electrification in association with gas decommissioning.

   i. Consistent with its emphasis on serving ratepayers, including disadvantaged communities, the CPUC will consider how to make the process more convenient and affordable for customers and communities interested in electrifying, up to and including ending their gas service.

E. Minimizing stranded asset risks while continuing to fund infrastructure that provides reliability, resiliency, and commodity cost mitigation benefits.

   i. The CPUC's will consider options for creating a structured and transparent long-term planning process to support prudent and transparent, data-driven decision-making regarding investments, such as system expansions, replacements, repairs, and maintenance.[97] This process may apply differently to investments at different scales (distribution, transmission, and storage).

[97] As discussed above, on December 1, 2022, by Decision 22-12-021, the CPUC adopted a Gas Infrastructure General Order (GO-177) that will ensure that large and environmentally impactful gas investment projects receive thorough review.

F. Assessing opportunities to recover gas system costs earlier, while costs can be spread across a larger customer base.

    i. The CPUC may explore options, such as accelerated depreciation or units of production depreciation, that would front-load recovery of system costs. Using a parallel proportional approach for electricity may help incentivize earlier electrification.

G. Exploring opportunities to ensure reliability but at reduced cost and without compromising safety.

    i. Energy Division and CalGEM staff meet regularly and will continue to discuss matters related to the cost and impacts of utility compliance regarding CalGEM's 2020 standards.

H. Considering providing guidance on ratemaking options to support the gas transition.

    i. The CPUC may continue to assess potential changes to ratemaking and provide guidance on ratemaking options to support the gas transition. The CPUC may structure guidance in such a way as to support affordability, safety, and reliability and to advance its Environmental and Social Justice Action Plan goals.

I. Assessing the need for non-ratepayer funding

    i. It may be necessary to recover some gas transition costs from sources beyond gas and electric utility customers to implement an equitable transition.

11. Appendix A: Gas System Background

California's Gas Demand

Fossil gas makes up about 31 percent of the State's total energy consumption. In 2021, a state-by-state comparison showed that California was the second largest consumer of fossil gas in the US (after Texas), representing approximately 8 percent of the total U.S. market.[98] The State consumes around 5.3 billion cubic feet per day (Bcfd) of gas on an average day and as much as 11 Bcfd on a very cold winter day.

Core and Noncore Customers

Gas customers are categorized as either core or noncore customers:

Core customers include residential, small commercial, and small industrial customers. These customers consume about 35 percent of California's annual fossil gas, mostly for space heating, water heating, and other appliance uses. Core customers are served by the utilities or by Core Transport Agents who purchase gas on behalf of their customers. These customers are served using low-pressure distribution pipelines.

Noncore customers consist of electric generators and large commercial and industrial customers. While noncore customers are smaller in number and require fewer pipeline miles, they consume a far larger volume of fossil gas each year (approximately 65 percent).[99] Noncore customers purchase their own gas supplies, from gas marketers or suppliers.[100, 101] Many are served directly from the high-pressure transmission system.

Gas Supplies and Infrastructure

Nearly 90 percent of California's gas supplies are imported from out-of-state production facilities located in Alberta, Canada; Southern Wyoming; Northwest New Mexico; West Texas; and Southeast New Mexico. This supply is imported by an interstate pipeline network that delivers gas supplies to California's gas utilities at or near the State's border (Figure 9). California's in-state gas production—much of which comes from geologic basins in the Central Valley and Southern California—has been slowly declining since the 1980s due to aging reservoirs and less favorable economics.

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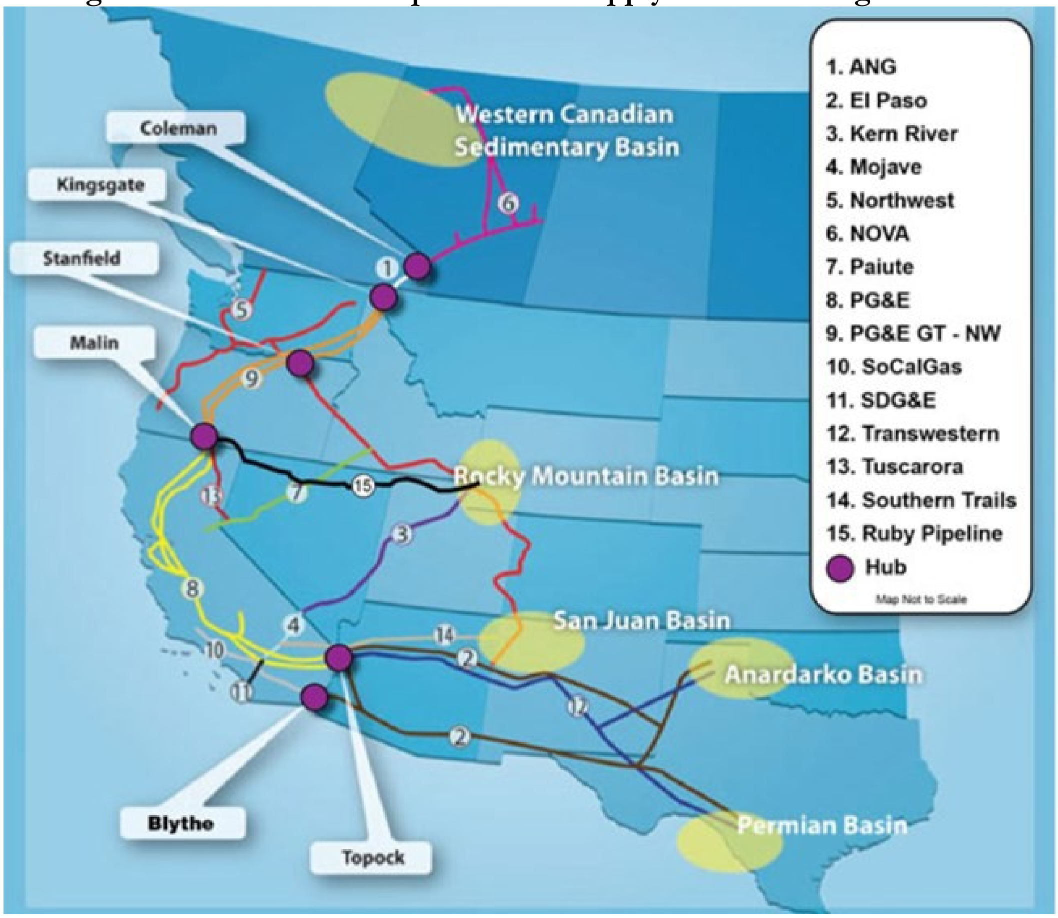
[98] Frequently Asked Questions (FAQs) - U.S. Energy Information Administration (EIA).

[99] In the winter, however, core customers account for roughly 65 percent of consumption due to heating loads, and industrial and other customers only 35 percent.

[100] The state's reliability standards are designed to ensure that gas service is maintained for core customers without interruption, even under the most extreme cold conditions. If the utilities are unable to deliver all the gas that is expected to be consumed, they may call for a curtailment of some gas deliveries to noncore customers. Curtailing core demand is a measure of last resort due to safety, reliability, and cost implications, as utilities must send out a crew to check and restore gas services to each customer, including relighting pilot lights, a process that can take weeks.

[101] Natural gas use for vehicles is core if purchased at core rates from the utility and noncore otherwise.

Figure 9: Interstate Gas Pipelines and Supply Basins Serving California



Source: CPUC.

The utilities transport gas from interstate pipelines through their high-pressure transmission, or "backbone," pipelines to the local transmission system, and finally to the lower-pressure distribution system where gas reaches homes and small commercial customers.[102] Other transmission system components include compressor stations that facilitate the transportation of gas over long distances and gas-storage facilities. California's gas distribution infrastructure includes smaller and more numerous components: regulator stations and valves that facilitate safe deliveries into lower pressure lines; odorizing stations; metering at various points; numerous valves to isolate parts of the system for maintenance; and service lines that deliver gas to individual customers. Distribution main and service pipelines are made of steel or plastic and typically run beneath streets. Much of this pipe is over 50 years old and some is made of a type of Aldyl-A plastic installed before 1984 and

[102] A small number of large customers take gas service directly from an interstate pipeline. Some customers, such as around Lake Tahoe, receive gas from a Nevada utility.

subsequently found to be brittle. Large gas utilities replace some of their distribution pipeline each year, based on leaks found, pipeline age, material, soil conditions and other factors that contribute to estimated risk.

California's Gas Utilities

California's gas utilities provide service to about 11 million households and other customers.[103] Most customers are served by the large investor-owned utilities: SoCalGas (5.9 million customers), PG&E (4.5 million customers), SDG&E (900,000 customers) and Southwest Gas (200,000 customers). Three municipally-owned gas utilities—the cities of Long Beach, Palo Alto, and Vernon—serve a smaller number of customers.

The CPUC regulates services provided by the investor-owned utilities, including the in-state transportation of gas over the utilities' transmission and distribution pipeline systems, gas storage, gas procurement for residential and small business customers, metering, and billing. The CPUC also oversees the safety of these utilities.

Table 1: California IOU Reported Gas Infrastructure

	Customers	Distribution Pipelines (mi)	Transmission Pipelines (mi)	Metering & Regulator Stations	Compressor Stations[104]
PG&E	4,500,000	78,356	6,427	2,298	9
SoCalGas	5,900,000	95,302	2,960	2,516	9
SDG&E	900,000	15,267	178	279	0
SW Gas	200,000	5,726	0.1	104	0
Total	11,500,000	194,651	9,565	5,197	18

Source: CPUC, using utility data.

Gas Storage

There are 12 gas storage facilities in California.[105]

103 U.S. Census Bureau QuickFacts: California.
104 Does not include compression at gas storage fields.
105 SoCalGas owns and operates the four storage facilities in its territory, which include Honor Rancho, La Goleta, Aliso Canyon, and Playa Del Rey. PG&E wholly owns three storage facilities (Los Medanos, McDonald Island, and Pleasant Creek), while Central Valley Gas Storage, Gill Ranch Gas Storage (25 percent owned by PG&E), Lodi Gas Storage (which consists of two integrated gas storage fields: Lodi and Kirby Hills), and Wild Goose Gas Storage, all located in PG&E territory, are independently owned.

Figure 10: California Gas Storage Facilities

Source: 2020 California Gas Report.

Gas Markets

Fossil gas commodity prices are not regulated. Utilities, large industrial customers, and electric generators purchase gas in a commodity market where prices are set by buyers and sellers negotiating according to the balance between supply and demand. However, the price charged to transport gas to consumers is regulated. Market participants, such as the State's gas utilities, can buy and sell fossil gas at more than 30 regional trading points in the United States.[106] Most utilities buy a

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[106] Henry Hub in Louisiana is a physical location where gas can move between nine different pipelines, with access to a large percentage of the U.S. population. It therefore sets the national benchmark price and is used to price both physical and financial contracts.

baseload quantity of gas they expect to need every day in the month-ahead market. They then buy "swing" supply in the day-ahead market or use stored gas to meet variations in demand.

Fossil gas is one of the most volatile traded commodities and is subject to daily and monthly price fluctuations. Fossil gas prices reached a low in 2011, when fracked gas availability had increased, and have increased since. While daily spot prices of $3-$5 per million British thermal units (MMBtu) have been typical in recent years, during Winter Storm Uri in 2021, spot prices reached historic highs in Southern California of over $144/MMBtu. More recently, daily average spot prices in Northern and Southern California (at the "citygate") ranged from $15 to $57 in December 2022. Prolonged cold weather throughout the West, starting in November, significant interstate pipeline outages, and low storage inventories in the Pacific region contributed to these prices, combined with longer term factors such as increasing international demand. Notably, the Russia-Ukraine war has led to record-high demand from European countries for U.S. liquefied natural gas (LNG).[107,108] Causes of high winter prices in winter 2022-23 and potential policy responses are the subject of CPUC Investigation (I.) 23-03-008. With warmer winter weather, prices in winter 2023-2024, through this writing in January, have been lower than last year.

Regional Demand Impacts on California

California gas supply and prices are affected by supply and demand outside the state. Northern California relies primarily on gas from Canada and the Rocky Mountain Basin, while Southern California relies on gas from the three southwestern gas basins. As seen this winter and in recent years, both winter storms and summer heat events across these regions can dramatically impact Californians' gas costs.[109]

Until winter 2022-23, Northern California gas markets had been relatively stable due in part to access to imports from winterized Canadian wells and sufficient storage capacity. Southern California has experienced more volatility due to several factors including major outages on both in-state and interstate pipelines, greater dependence on gas from non-winterized Texas wells, and insufficient storage capacity for noncore customers (Southern California storage capacity was greatly reduced in the aftermath of the Aliso Canyon leak).[110] Aliso Canyon storage availability was increased in late 2023.

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107 US EIA. Today in Energy. U.S. monthly average Henry Hub spot price nearly doubled in 12 months. July 14, 2022.

108 Production declines were mostly due to declining prices, decreased demand, and economic issues. Additionally, federal policies that limited new gas drilling activities had an effect.

109 For example, when Winter Storm Uri hit the southwestern US in February 2021, gas demand for heating rose, supply fell due to gas wells freezing, and spot market prices skyrocketed, causing dramatic increases in Southern California prices. As a result, California's gas demand dropped, some California gas wholesalers sold gas to other higher-priced areas, and the state began relying more on gas from its storage facilities.

110 The lack of noncore access to storage both increases spot market volatility in Southern California and makes noncore customers more vulnerable to that volatility.

12. Appendix B: Policies Driving the Fossil Gas Transition

Table 2 summarizes several key policies driving momentum in the transition away from fossil gas. This list is not comprehensive, rather it is intended to highlight primary policy drivers. In addition to these policies, State agencies are leading research efforts, programs, and public proceedings to support the transition away from fossil gas.

Table 2: Key State Policies

Year	Policy Driver	Impact
2022	AB 1279 (Muratsuchi)/SB 905 (Caballero)	AB 1279 Enacts the goal to achieve economy-wide carbon neutrality by 2045 and maintain net negative GHG emissions thereafter and to ensure that by 2045 statewide anthropogenic GHG emissions are reduced at least 85 percent below 1990 levels. SB 905 requires CARB to create the Carbon Capture, Removal, Utilization, and Storage Program to evaluate, demonstrate, and regulate CCUS and carbon dioxide removal (CDR) projects and technology.
2022	Governor Newsom's Clean and Healthy Buildings Goals	Calls for bold climate actions, including goals for 3 million climate-ready and climate-friendly homes by 2030 and 7 million by 2035 and 6 million heat pumps by 2030.
2022, 2023	CPUC Line-Extension Subsidies Decisions	Eliminates ratepayer subsidies for the extension of new gas lines beginning on July 1, 2023, and new electric lines for gas/propane-and-electric buildings beginning on July 1,

		2024, with possible non-residential exemptions.
2022	CARB's 2022 State SIP Strategy	Proposes a zero GHG emission standard concept for space and water heaters sold in California to go into effect in 2030 and calls for CARB staff to propose standards for these appliances by 2025.
2022	CEC's 2022 Building Energy Efficiency Standards	Encourages electric heat pump technology for space and water heating in newly constructed homes, establishes electric-ready requirements for homes, expands solar PV and battery storage standards for commercial buildings, and strengthens ventilation standards to improve indoor air quality. The new standards become effective January 1, 2023.
2022	CARB's 2022 Scoping Plan	Identifies actions to dramatically reduce fossil gas consumption to meet the State's GHG reduction targets in AB 1279. In the Scoping Plan Scenario, almost all building energy demand is met by electricity by 2045 and biofuel and low-carbon hydrogen meet approximately 15 percent of industrial demand.
2022	SB 905 (Caballero, Skinner, Limón)	Establishes a clear regulatory framework for CCUS and bans the injection of carbon dioxide (CO_2) produced by a CCUS project for enhanced oil recovery.

2018	SB 100 (de León)	Put into law the State's commitment to a 100 percent renewable and zero-carbon electricity system by 2045, which will significantly decrease the State's use of fossil gas in the electric sector. Senate Bill 1020 (Laird, 2022) added targets of 90 percent renewable energy by 2035 and 95 percent by 2040.
2018	SB 1477 (Stern)	Established new incentive programs for near-zero emission homes and jumpstarted the market for early-stage, low-carbon building technologies, focused on supporting low-income residents.
2018	SB 1440 (Hueso)	Directed the CPUC to consider a biomethane procurement program. The CPUC's subsequent decision[111] established a Renewable Gas Standard for the gas IOUs to procure 12.2 percent of 2020 annual core customer demand[112] as biomethane by 2030.
2016	SB 1383 (Lara)	Set a target of achieving a 40 percent reduction in statewide methane emissions below 2013 levels by 2030.

[111] CPUC. D.22-02-025.
[112] Excluding Compressed Natural Gas Vehicle demand, as noted in the California Gas Report (approximately 72.8 Bcf).

13. Appendix C: Joint Agency Fossil Gas Decarbonization Programs

Program	Lead	Description
Equitable Building Decarbonization Program	CEC	State and federal funds have been committed to a new statewide equitable building decarbonization program including direct-install building retrofits for low- and moderate-income households and general incentives to advance efficient electrification in existing buildings.
TECH and BUILD	CPUC/ CEC	These two programs were created by SB 1477. The Technology and Equipment for Clean Heating (TECH) Initiative encourages heat pump appliance installations, and the Building Initiative for Low-Emissions Development (BUILD) Program encourages all-electric new construction. Program funds under SB 1477 are derived from allowances allocated to natural gas utilities under the Cap-and-Trade Program.
Natural Gas Research Programs	CPUC/CEC	CPUC ratepayers fund this program via the public purpose program charge administered by the CEC. The program funds public interest research and development projects to advance efficient, safe, and health-protective roles for gas and related fuels. For fiscal year 2022-23, the program's key themes include targeted gas system decommissioning, decarbonization of gas end-uses, energy efficiency, and energy equity. These ratepayer funds should be coordinated holistically with IOU gas R&D program administrators (currently SoCalGas and PG&E), which also contribute funding to gas R&D to most efficiently undertake gas R&D research.
Electric Program Investment Charge (EPIC):	CPUC/CEC	The CPUC approves ratepayer public purpose program funds for the IOUs and the CEC to support EPIC program investments to support decarbonization of electricity generation and consumption. Relevant research areas include renewable and zero-carbon electricity generation, reliability and resilience, and electric technologies for homes, businesses, industries, and

		transportation based on CPUC established Strategic Goals and Objectives.
Cap-and-Trade Program	CARB	The program sets a sustained and steadily increasing carbon price signal to prompt action to reduce GHG emissions across electricity generators and importers, industrial facilities, and natural gas and transportation fuel suppliers. Because natural gas use by the residential, commercial, and industrial sectors is covered by the Cap-and-Trade Program, these sectors experience an economic incentive to invest in cleaner and more efficient technologies.
Carbon Capture, Removal, Utilization, and Storage Program	CARB	SB 905 requires CARB, in coordination with sister agencies, to establish a program to evaluate the efficacy, safety, and viability of CCUS and carbon dioxide removal (CDR) technologies and facilitate the capture and sequestration of carbon dioxide
Utility Energy Efficiency Programs	CPUC	These utility-administered programs, funded through gas and electric rates, have been expanded to include electrification.
San Joaquin Valley Affordable Energy Pilots	CPUC	These pilot projects provided electric heating appliances in 11 communities not served by fossil gas as an alternative to extending natural gas services to these areas. The pilots included funding for home remediation and bill credits in addition to appliance installations.
Industrial Grid Support and Decarbonization Program	CEC	This program will fund demonstration and deployment projects that will shift load from peak hours based on the signals from grid, decarbonize industrial processes.
Food Production Investment Program	CEC	This program will fund demonstration and deployment projects that will shift load from peak hours based on grid signals and decarbonize food production processes.

Carbon Removal Innovation Program	CEC	This program will fund research and development projects and establish pilot demonstration research center(s) to support deployment of engineered atmospheric carbon removal technologies.
Climate Innovation Program	CEC	This program provides financial incentives to California-headquartered companies to develop and commercialize technologies that provide technological advancements to help California meet its GHG reduction targets at an accelerated timeline and at lower cost or enable the State to be more resilient to the impacts of climate change.

14. Appendix D: Key State Proceedings Related to Gas Decarbonization

Program	Lead	Description
Gas Decarbonization Proceeding	CEC	In March 2022, the CEC launched an informational proceeding to engage State agencies and stakeholders in planning for a safe, reliable, and equitable transition away from fossil gas. The proceeding includes workshops on various gas transition topics.
California Building Energy Efficiency Standards (BEES)	CEC	California's Energy Code (also known as the Building Energy Efficiency Standards) is designed to reduce wasteful and unnecessary energy consumption in newly constructed and existing buildings. The CEC updates the Building Energy Efficiency Standards (Title 24, Parts 6 and 11) every three years by working with stakeholders in a public and transparent process. The CEC is now in the planning process for the 2025 Energy Code.
Long-Term Gas Planning Rulemaking[113]	CPUC	In January 2020, the CPUC opened this rulemaking to create a planning process for decarbonization of the gas system while maintaining gas system safety, reliability, and affordability. Many concepts raised in Chapters 2 and 3 are addressed in this proceeding.
Building Decarbonization Rulemaking[114]	CPUC	In January 2020, the CPUC opened this rulemaking to implement SB 1477 (Stern, 2018) and encourage building decarbonization more generally.
Renewable Gas Rulemaking[115]	CPUC	This proceeding was originally opened to implement AB 1900 (Gatto, 2012) and has since been used to explore the usage of renewable gas (i.e., biomethane, renewable hydrogen, etc.) more generally.

[113] CPUC. R.20-01-007.
[114] CPUC. R.19-01-011.
[115] CPUC. R.13-02-008.

AB 32 Scoping Plan	CARB	AB 32 requires CARB to develop a Scoping Plan for achieving California's GHG emissions reduction targets with updates at least every five years. It is designed to meet the State's long-term climate objectives and support a range of economic, environmental, energy security, environmental justice, and public health priorities. CARB approved the final 2022 Scoping Plan in December 2022.

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