



THE COSTS OF BUILDING DECARBONIZATION POLICY PROPOSALS FOR CALIFORNIA NATURAL GAS RATEPAYERS: IDENTIFYING COST-EFFECTIVE PATHS TO A ZERO CARBON BUILDING FLEET

Alison Ong, Michael Mastrandrea, and Michael Wara | June 2021





Acknowledgements

The authors wish to thank Energy and Environmental Economics, Inc. (E3) for providing us with their Natural Gas Revenue Requirement model. We also gratefully acknowledge discussions with Amber Mahone, Dan Aas, and Ari Gold-Parker at E3, Denise Grab at the Rocky Mountain Institute, Carmelita Miller and Mad Stano at the Greenlining Institute, Jan Berman at Pacific Gas & Electric, Jean Spencer and Christina Ly at the California Public Utilities Commission, and Panama Bartholomy of the Building Decarbonization Coalition. We are grateful to the Heising-Simons Foundation for support to MW for work on this project. The material presented in this whitepaper reflects the analysis and opinions of the authors only.

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Recommended Citation

Alison Ong, Michael Mastrandrea, and Michael Wara, *The Costs of Building Decarbonization Policy Proposals for California Natural Gas Ratepayers: Identifying Cost-effective Paths to a Zero Carbon Building Fleet*, Stanford Woods Institute Climate and Energy Policy Program White Paper, 2021.

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EXECUTIVE SUMMARY

This study quantifies the potential increases in residential natural gas rates associated with building decarbonization approaches under consideration by policy makers in California. We conclude that planned system safety investments and some but not all potential decarbonization policies may pose serious affordability challenges to California consumers over time, exacerbating affordability challenges that already exist for lower income communities and customers. Policy alternatives that affect existing buildings, as opposed to only targeting new construction, result in greater rate increases while also achieving greater emission reductions. Our analysis also suggests that strategically shrinking the size of the natural gas distribution system could be a promising cost- and emissions-mitigation measure that leads to greater emission reductions while moderating rate increases. However, we note that system retirement will require intensive planning and regulatory change in order to execute successfully. Our results highlight the need for a gas transition strategy that involves actively protecting customers from rate increases.

In order to achieve its ambitious climate goals of a 40% reduction in greenhouse gas (GHG) emissions below 1990 levels by 2030 and carbon neutrality by 2045, California will have to drastically decrease its use of fossil natural gas. Any large-scale action to make progress towards this goal will affect millions of California households: currently, around 80% of homes are connected to and rely on the natural gas system for energy services (*Aas et al. 2020*). A transition away from natural gas use in residential and commercial buildings is particularly challenging for several reasons: natural gas system components have long lifetimes and hence planned depreciation schedules; the natural gas system has high fixed costs but is paid for by volumetric rates in California; the system is aging and so requires expensive yet essential safety investments. Safety investments are expected to increase in the next few years in the wake of the San Bruno and Aliso Canyon disasters. At the same time, the need to decarbonize is driving increased support for replacing natural gas consumption with alternatives—either renewable natural gas (RNG) or electricity. Escalating safety investments combined with accelerating declines in demand both imply that rates will rise for natural gas customers without modifications to current approaches. A successful gas transition must be prudently managed so as to avoid unsustainably large cost burdens for ratepayers—particularly those unable to electrify. As state policymakers seek out feasible and cost-effective pathways for achieving emissions reductions from the natural gas sector, the impacts to customer bills must be carefully considered and actively managed.

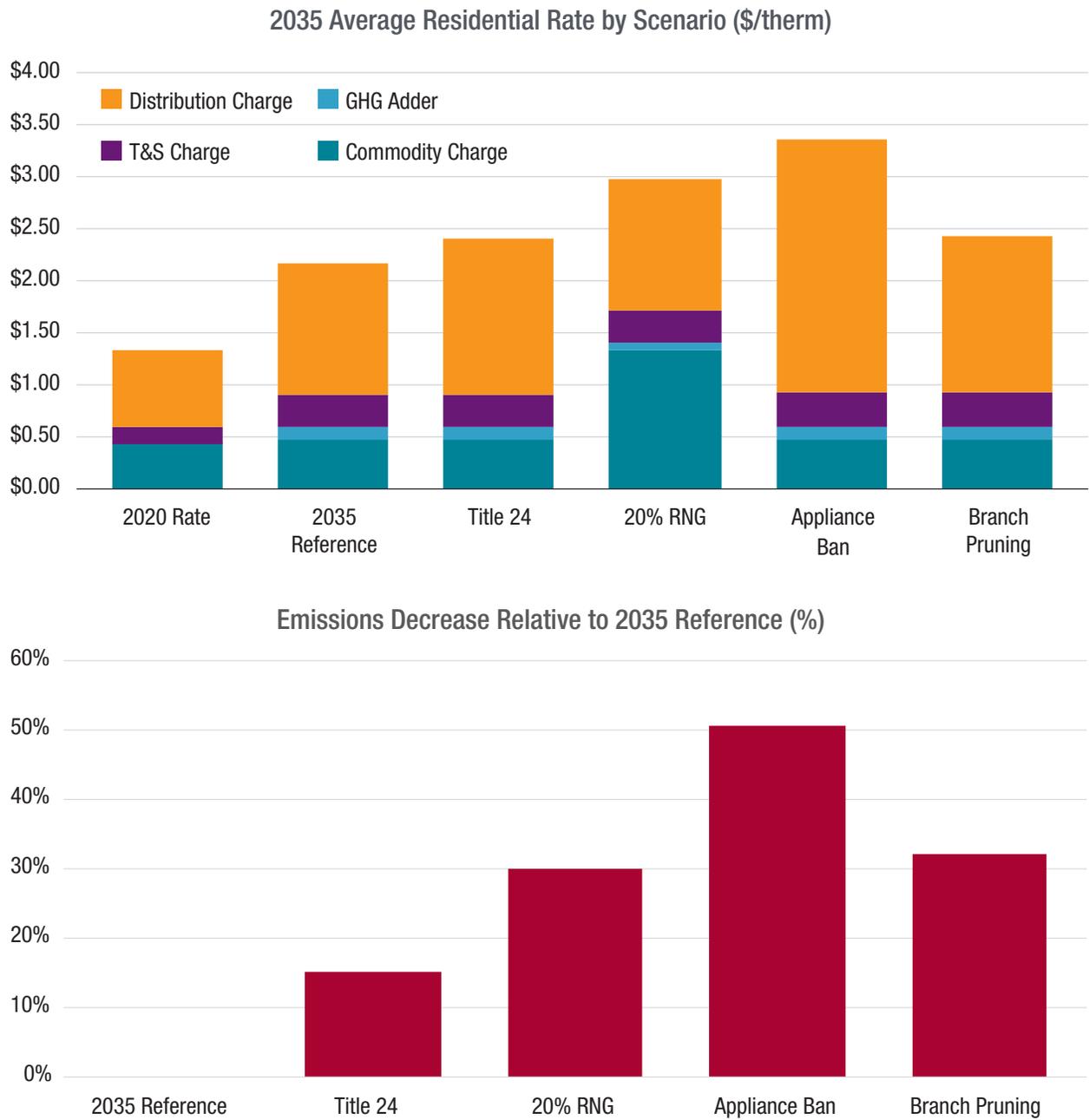
We developed four illustrative policy scenarios to capture a range of transition strategies currently under discussion by stakeholders. We then comparatively assess the effects of each policy alternative on natural gas retail rates and on GHG emissions. Analyses were conducted to estimate the cost and emissions impacts associated with (1) a moratorium on natural gas in all new construction (Title 24), (2) the introduction of increasing percentages of RNG into the pipeline to reduce emissions intensity (RNG), (3) a moratorium on purchases of new natural gas-fired household appliances, requiring replacement with electric equivalents (Appliance Ban), and (4) strategic retirements of distribution system assets in conjunction with targeted electrification to avoid or lower gas system investments (Branch Pruning). We compare each stylized scenario to both a current policy reference case and to today's rates in real dollars per therm.

We find that, due to planned safety investments, significant rate increases will already occur under the reference scenario, with 2035 average statewide residential rates projected to be about \$2.16/therm, or 64% higher in real 2018 dollars compared to today's average rate of \$1.32/therm. The impact of the Title 24 scenario is an incremental +\$0.24/therm increase (+11%) compared to the reference 2035 rate. This is non-negligible but far less than the incremental price of either the RNG scenario (+\$0.81/therm, 37% higher than reference) or the Appliance Ban scenario (+\$1.20/therm, 56% higher than reference). For these scenarios, larger emission reductions come at the cost of larger rate increases. In contrast, the Branch Pruning scenario has the potential to achieve larger cuts in both natural gas use and emissions with a smaller increase in rates of \$0.25/therm, or 12% higher than reference. Our findings are summarized in Table 1 and Figure 1.

Table 1. A description of each scenario, the percentage increase in average residential rate relative to the Reference Case in 2035, and the percentage decrease in annual emissions relative to the Reference Case in 2035.

Scenario Name	Policy Description	Rate Increase (%)	Emissions Decrease (%)
Reference	No specific additional policy is undertaken to reduce natural gas usage or emissions.		
Title 24	Electrification incentives curb consumption from 2023-2026, a statewide moratorium on natural gas hookups in all new construction takes effect from 2026 onwards.	11%	15%
RNG	The concentration of Renewable Natural Gas is increased by 2% per year beginning in 2021, reaching 20% RNG by 2030.	37%	30%
Appliance Ban	Beginning in 2026, the sale of new gas-fueled appliances is prohibited, resulting in phase-in of electric equivalents.	56%	51%
Branch Pruning	From 2023 onwards, strategic retirements of distribution infrastructure assets begin alongside targeted electrification.	12%	32%

Figure 1. Average residential rate in 2035 by scenario (expressed in real dollars per therm), and the percentage decrease in 2035 emissions relative to the Reference Case for each scenario.



BACKGROUND AND CONTEXT

There is emerging consensus among energy and economic modelers, policymakers and advocates that achieving California's economy-wide emission reduction goals will require large reductions in fossil natural gas consumption for most building energy uses. These reductions can be achieved by replacing natural gas as an energy source in many California residential and commercial buildings either with electricity or with RNG. California's clean electricity and economy-wide decarbonization goals will also, in the longer term, lead to a shift away from natural gas use in other sectors. Transitioning away from natural gas poses many unique challenges because it is supplied by an integrated network, because of the long-lived nature of natural gas infrastructure, and because of the safety issues associated with its transport, storage, and use. In response, California policymakers are pursuing and considering a number of actions to ensure a just and managed transition.

Local governments hold a variety of views on the role that natural gas should play for their communities. A growing number of California municipalities and some counties have established local ordinances mandating or encouraging building electrification. For example, the City of San Jose prohibits natural gas in all new buildings (with limited and temporary exceptions) while the City of San Francisco requires that all new construction must be all-electric (*Gough 2021*). At the same time, several municipalities have voiced support for "balanced energy resolutions." According to the Southern California Gas Company's (SoCal Gas's) website, over 100 local jurisdictions are in favor of maintaining the freedom to choose between natural gas and electricity in their homes (*SoCal Gas Company n.d.*). Meanwhile, northern and southern California investor-owned gas and electric utilities are charting different strategic directions with respect to decarbonization of residential and commercial buildings.

The future of natural gas in California is also a priority issue at the statewide level. The California Public Utilities Commission (CPUC) has initiated a long-term gas planning process to develop a strategy for managing the state's transition away from natural gas-fueled technologies (*CPUC 2020*). Assembly Bill (AB) 3232, enacted in 2018, requires the California Energy Commission (CEC) to assess the potential for the state to reduce GHG emissions associated with the state's residential and commercial building stock by at least 40% below 1990 levels by 2030 (*Friedman 2018*). A draft staff report from May 2021 details strategies to achieve the mandates set forth in AB 3232 (*Kenney et al. 2021*). In addition, the California Air Resources Board (CARB) is embarking on the next Scoping Plan update to be completed in 2022, which will lay out a policy portfolio for achieving California's legally binding goal of reducing GHG emissions at least 40% below 1990 levels by 2030, as well as charting a path to carbon neutrality by 2045 (*CARB 2021*).

The CEC is also considering updates to California's Building Energy Efficiency Standards for new construction, additions, and alterations of residential and nonresidential buildings (Title 24), which it must update every three years. The 2022 Title 24 update may encourage greater use of electric heat pump technologies in low-rise residential buildings, high-rise residential buildings and selected nonresidential building categories statewide (*CEC Staff 2021*). A future iteration may also include a statewide ban on natural gas in new construction. Some environmental advocates, highlighting the impact of fossil methane on indoor and outdoor air quality, have begun to advocate for strict NO_x limits on the sale of new household appliances that would make electrification the only feasible option for replacing existing home hot water heaters, furnaces, and stoves. Meanwhile, investment in RNG has improved the feasibility of decarbonizing the natural

gas system from the supply side. SoCal Gas has an active interest in RNG technologies and has pledged to achieve 20% RNG in its system by 2030.

As part of its Natural Gas Research and Development Program, the CEC provided a grant to Energy and Environmental Economics, Inc. (E3) and UC Irvine to create a report on “The Challenge of Retail Gas in California’s Low-Carbon Future.” The study assessed a variety of decarbonization strategies and concluded that building electrification is likely to be a lower-cost, lower-risk long-term strategy compared to RNG (*Aas et al. 2020*). The report also highlighted that, “without a gas transition strategy, unsustainable increases in gas rates and customer energy bills could be seen after 2030, negatively affecting customers who are least able to switch away from gas, including renters and low-income residents.” Motivated by these concerns, Gridworks published a 2019 report on “California’s Gas System in Transition: Equitable, Affordable, Decarbonized and Smaller” (*Gridworks 2019*) and in January 2021 followed with a report proposing a new Gas Resource and Infrastructure Planning framework (*Gridworks 2021*).

Two incidents have also focused regulatory attention on the continuing need for safety-related investments in aging natural gas infrastructure, even with declining demand. A Pacific Gas & Electric (PG&E) natural gas transmission pipeline rupture in San Bruno, California on September 9, 2010 caused eight fatalities and catastrophic damage to a residential neighborhood. Subsequent investigation revealed systematic problems with PG&E natural gas safety procedures. In 2015, a well blowout released an estimated 120,000 tonnes of methane, in addition to other associated hazardous air pollutants at SoCal Gas’s Aliso Canyon natural gas storage facility in Los Angeles, California, forcing evacuation of nearby neighborhoods for months. Evaluation by outside experts concluded that practices at natural gas storage facilities in California did not meet national industry standards for maintaining well integrity (*Long et al. 2018*) and resulted in changes to the design of and operational practices at natural gas storage facilities throughout California.

This safety imperative creates both a challenge and an opportunity in navigating building decarbonization. Prudent investments must continue to be made to ensure safe operation of existing gas infrastructure, but any investments in gas infrastructure carry increasing stranded asset risk given typical asset lifetimes of 40 or more years and the need to drastically reduce the use of natural gas in the coming 20 years. And even in modeled low-carbon scenarios in which non-fossil gas alternatives play a significant role, gas demand in buildings is expected to decline significantly because of the anticipated growing cost-effectiveness of building electrification compared to these alternatives.

Despite reduced consumption, natural gas transmission and distribution infrastructure continues to be utilized for several decades even in the high-electrification scenarios produced for the CEC (*Aas et al. 2020*). As customers switch from gas to electric appliances, current approaches to allocating the costs of maintaining gas infrastructure will concentrate those costs on a shrinking population of gas customers. A shrinking customer base must support the same level of infrastructure, unless strategies for targeted decommissioning of natural gas infrastructure are pursued. Gas rates and customer costs could rise unsustainably, particularly for low-income residents and renters who may face barriers to electrification. Recognizing the need to address these infrastructure costs, the CEC has recently awarded a total of about \$2 million to two projects that will analyze “Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure” and will involve PG&E and SoCal Gas for Northern and Southern California, respectively (*California Energy Commission 2021*). The CPUC long-term planning process mentioned above will also consider the issue of targeted infrastructure decommissioning.

The complexities around charting a future for the natural gas system have raised additional stakeholder concerns. Multiple studies from nonprofit groups such as the Rocky Mountain Institute have called for more immediate action to decarbonize the natural gas sector from an emissions and planning standpoint (*Billimoria and Henchen 2020; Billimoria et al. 2018*). Other work has emphasized the adverse health and air quality impacts from household natural gas usage (*Zhu et al. 2020; Rocky Mountain Institute and Sierra Club, n.d.*). Still others have highlighted important issues around affordability for natural gas customers. A 2019 report from the Greenlining Institute, centered around equitable building electrification, notes the issue of increasing cost burden for those who remain natural gas customers (*Miller et al. 2019*). And in July 2020, a letter from three Democratic California Assembly members to the CPUC voiced misgivings about blue-collar families' ability to afford electrification (*O'Donnell, Cooper, and Rubio 2020*). Mitigating rising energy costs is already a significant issue for state regulators, as evidenced by the February 2021 En Banc to discuss trends in electricity and gas rates over the coming decade (*Sieren-Smith et al. 2021*). To date, it has been difficult to understand how the various gas transition policy alternatives may further impact ratepayer burden. This whitepaper provides high-level quantitative comparisons of retail rate and GHG emissions impacts resulting from the range of natural gas strategy proposals currently under discussion as they may play out over the 2030 to 2035 timeframe.

STUDY APPROACH

Many of the natural gas system's costs are fixed rather than variable: maintenance of the distribution system, investments in safety-related infrastructure enhancements, new customer connection costs, and other common costs that contribute toward a gas utility's total revenue requirement are all relatively insensitive to changes in throughput and are increasing over time. A major driver of these increased gas costs is the need for safety upgrades in the aftermath of the San Bruno and Aliso Canyon disasters. The most recent General Rate Case applications request an increase of \$134 million (6.8%) for PG&E gas distribution revenue between 2019 and 2020 (*PG&E et al. 2018*), and an increase of \$480 million (19.1%) for SoCal Gas's revenue requirement between 2018 and 2019 (*SoCal Gas Company et al. 2017*). As investments in safety will already increase the revenue requirement over the next several years, near-term gas rates are likely to rise regardless of any policy actions that could decrease natural gas consumption. However, any decline in throughput will also have an impact on rates. The rate structure in California is volumetric, meaning that customers pay a set rate per unit of gas consumed (expressed in this paper in terms of \$/therm). Lower total gas consumption must still support the same amount of infrastructure, so a shrinking customer base indirectly increases the \$/therm rate charged to all remaining customers.

Various policy alternatives may have significant impacts on either the gas utility's revenue requirement or on overall consumer demand for natural gas over time, necessitating a comparative rate analysis to understand the relative impacts of each policy proposal. The rate analysis is important from an energy equity perspective as well. Electrifying a home requires buying new appliances and often upgrading electrical panels and wiring, which may be cost-prohibitive for many Californians. Renters may not have control over the decisions to electrify their homes or remain customers of the natural gas system. Understanding the costs that consumers will face and the barriers to electrification will be necessary to avoid a future where an ever-shrinking natural gas customer base forces disproportionate cost burden onto those least able to afford electrification.

Our analysis uses the E3 Natural Gas Revenue Requirement tool, which was developed in consultation with PG&E and SoCal Gas for their 2020 CEC report (using all publicly available data). Utility data on commodity, distribution infrastructure, and transmission and storage costs were obtained from PG&E and SoCal Gas's 2018 General Rate Cases and projected out through 2050. Information about customer usage and number of accounts was also obtained from the utilities. The total revenue requirement is divided based on the utility's cost allocation percentage by customer class, projected throughput, and projected number of customers. Rates are output as \$/therm. The model also includes a series of toggles to examine the effects of different financial strategies such as accelerated amortization schedules and reduced reinvestment. Our study generally follows the assumptions and model logic used in this Revenue Requirement tool, with specific modifications as documented in the SI.

We present rates in four components: commodity cost, transmission and storage (T&S) charge, distribution system charge, and a GHG adder. Commodity cost refers to the cost of procuring the fuel itself and is based on EIA projections of the price of natural gas. In the United States, the price of fossil natural gas has remained low (<\$0.40/therm) for the past several years and is projected to stay fairly constant in real terms. In 2020, the commodity cost comprises 32% of the total residential rate. This rate component would be sensitive to increases in the price of natural gas, for example if a natural gas shortage occurs or if more natural gas is exported as LNG. The commodity cost could also rise significantly if the natural gas pipeline mixture begins incorporating an increased amount of renewable natural gas, as all types of RNG are more expensive than fossil natural gas.

The T&S charge, 12% of the 2020 residential rate, refers to the cost of the natural gas transmission pipelines and gas storage fields. All natural gas customers, whether residential or industrial, benefit from the T&S system and thus, evenly share the cost burden. As a statewide transition plan considers halting and even shrinking the size of the natural gas system, the T&S component would be affected last; it constitutes the "backbone" of the existing infrastructure.

The distribution system charge, 56% of the 2020 residential rate, refers to the cost of infrastructure that delivers natural gas from the T&S level to end-use consumers. Not all natural gas customers use the distribution system. In the case of shortages, there is a designated priority order for customers whose service can be interrupted first. In response to such shortages in the 1980's severely affecting residential customers, California created the "core" designation to signal their non-interruptible status, with the tradeoff that residential customers must pay a higher share of the distribution system costs. Today, the residential sector comprises about 50% of distribution system throughput in the state but shoulders around 75% of the distribution system charges. As a result, the distribution rate component is highly sensitive to changes in the number of residential accounts and total throughput in the residential sector.

The GHG adder, <1% of the 2020 rate, is based on projections about the \$/tonne CO₂e cost associated with GHG emissions in California covered by the cap and trade system. The emissions rate is assumed to be 0.0053 MtCO₂/therm for fossil natural gas (*US EPA 2015*) and zero for RNG. Since the inception of California’s cap and trade program, the price of carbon has been at or near the auction reserve (“floor”) price, which was \$16.05/tonne CO₂ in 2020. We assume that the price of carbon in the future stays at the auction reserve price, and therefore remains a small component of total rates. If the price of carbon becomes more expensive than this forecast suggests, it would result in a larger GHG adder to total natural gas rates (but a more moderate increase if the pipeline share of RNG is large).

While there is momentum to enact building decarbonization measures as early as 2022, many statewide changes may instead come into effect in 2025–2026, such as the next round of Title 24 updates. By 2030, ratepayers would only be starting to feel the effects of policies implemented four years earlier; we therefore focus our analysis on rate impacts in 2035, as compared to current rates and intermediate impacts in 2030.

We also calculate associated emissions reduction from implementation of each policy option. Based on EPA estimates of the emissions rate of natural gas, avoided throughput can be converted to an avoided emissions value. The estimates presented here reflect the reduction in emissions from decreased natural gas usage, and do not incorporate the increase in emissions associated with fuel switching from gas to electricity or decrease in emissions due to lower fugitive emissions.

SCENARIOS

Several different policy approaches to shape the future of the natural gas system are emerging. As noted above, many cities have passed local ordinances discouraging or outright banning natural gas in new construction, and this could become the statewide standard in the future. Air quality management districts may consider changes to emissions standards that would effectively mandate electric appliances. And some utilities have proposed still other directions: SoCal Gas has pledged to invest in use of RNG, while PG&E has expressed an interest in targeted electrification that would allow for strategic retirements of gas distribution system assets. We developed four illustrative scenarios to capture the range of transition strategies being discussed in order to comparatively assess the effects of each policy alternative on natural gas retail rates and GHG emissions.

Title 24

The first of our scenarios estimates the effects of a statewide moratorium on natural gas hookups in all new construction (both new buildings and substantial reconstruction) for the residential sector via revisions to the Title 24 building code. Based on our reading of current proposals around the revised Title 24 standards that will be finalized in the coming months, we model a 50% reduction in the Reference case growth rate for residential gas consumption taking effect this cycle (2023–2026) then a full ban taking effect the next cycle (2026 onwards), which caps future growth. From 2026, we expect some rate of decline in consumption over time as existing residences are replaced and customers choose economic electrification. This is estimated as a 1% drop in throughput per year after the ban is implemented. We also

consider a scenario where customer numbers remain flat post-2026 to represent a low bookend case for the Title 24 scenario (see SI).

RNG

Overall building emissions may be reduced by decreasing natural gas use or by making the supply itself less emission-intensive. The second scenario is based on an announcement from SoCal Gas that the company intends to reach 20% RNG by 2030 and achieve net-zero GHG emissions by 2045 (*SoCal Gas Company 2021*). This plan is not explicit about RNG targets beyond 2030. We approximate a statewide version of this strategy by increasing the pipeline share of RNG by 2% per year starting in 2021 to reach 20% by 2030; continuing this trend results in 30% RNG in 2035. To model the rate impact conservatively, in this scenario no widespread electrification is presumed to have occurred: projected infrastructure revenue requirement, customer numbers, and throughput all follow the Reference scenario trajectory, and the only change is in the pipeline gas mixture. The three types of RNG considered—biogas, synthetic natural gas (SNG), and hydrogen—vary in terms of price and maximum feasible percentage of the pipeline mixture. E3's PATHWAYS model produces prices under standard assumptions as well as a low-cost sensitivity for SNG/hydrogen. For our illustrative analysis we average the two values (price sensitivities can be found in the SI), yielding 2035 prices of \$0.43 for fossil natural gas, \$1.73 for biogas, \$6.13 for SNG, and \$2.91 for hydrogen. In the case of biogas supply, we assume a maximum pipeline share of 15%, following CEC's draft AB 3232 report (*Kenney et al. 2021*). For hydrogen, we follow Melaina et al. and set the maximum pipeline share to 8% (*Melaina, Antonia, and Penev 2013*). Taken together, this equates to a 2035 pipeline mixture of 70% fossil natural gas, 15% biogas, 8% hydrogen, and 7% SNG.

Appliance Ban

A potential statewide moratorium on natural gas in new construction would only affect new buildings; one way to target natural gas use in existing buildings would be a mandate to phase out natural gas-powered appliances and replace them with electric equivalents. One approach that has been proposed to accomplish such a goal is introduction of strict air quality standards that would make purchase of new natural gas-fueled home appliances infeasible. A key difference between this scenario and the Title 24 scenario is that an appliance ban affects a far greater proportion of California households: the lifetime of an appliance is on the order of 10–20 years, whereas the lifetime of a house tends to be around 75 years in California. For a high-level estimate of an appliance ban's impacts on natural gas rates, we assumed gas-fired water heaters and space heaters would be replaced with electric equivalents when reaching end of life, which means about 80% of home gas usage would be displaced. We further assume an average lifetime of 15 years. The model then linearly decreases by $(1/15) * (80\%)$ each year after implementation of the ban, leaving throughput at effectively 20% of its original level after 15 years have passed. The effects of implementing the appliance ban in 2026 are modeled; a sensitivity modeling the effects of implementing this ban in 2023 can be found in the SI. We note that this scenario only considers appliance electrification for the residential sector, and not, for example, appliances such as gas stoves in commercial establishments.

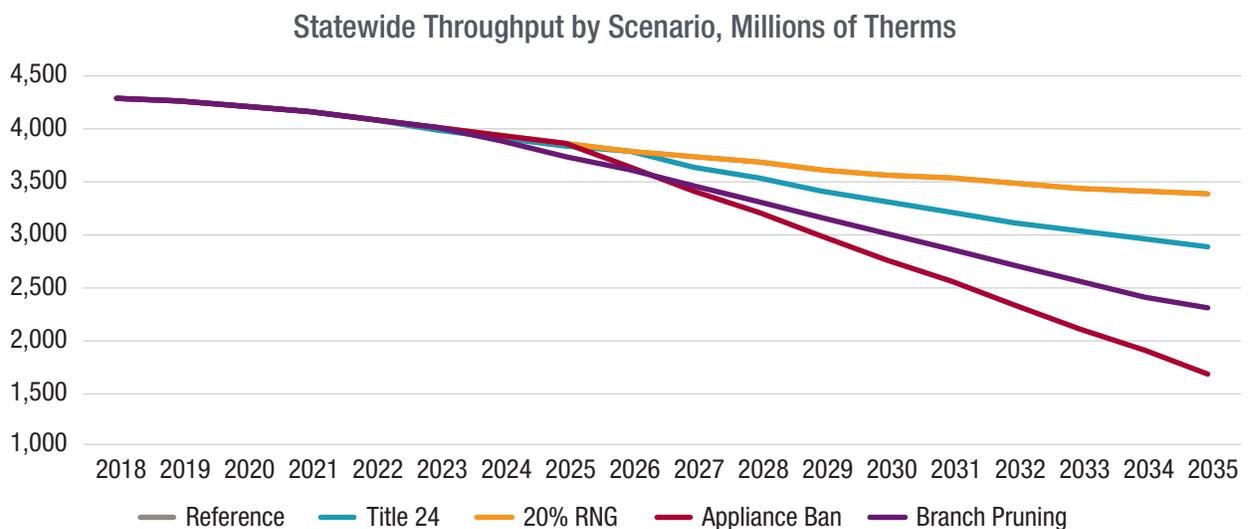
Branch Pruning

Our final scenario estimates the impacts of deliberately reducing the size of the distribution system. Conceptually, this means targeted electrification efforts that allow capping and abandonment of portions of the natural gas distribution infrastructure but leave the T&S backbone unchanged. We model this stylistically by linearly decreasing distribution (throughput and customer) infrastructure reinvestment from 100% to 20% over a ten-year period starting in 2023. The decline in reinvestment translates to an effective shrinkage rate of the distribution system. We also assume that, while no customers could immediately be pruned today, planning will be sufficient to enable all customers to be pruned by 2045. The fraction of the system that is eligible to be pruned is modeled as a linearly increasing factor from 0% to 100% over the period 2023 through 2045. The “shrinkage rate” defined above is divided by this factor to yield an estimate of customer/throughput decline in a given year, and the resulting trajectory is input into the Revenue Requirement model. The scenario results in large decreases in customer numbers and throughput, but it also decreases the revenue requirement. This results in more moderate rate increases overall, with greater declines in emissions.

We also model a Reference case. Here, no specific policy action is taken to accelerate rates of building electrification, impose limitations on residential natural gas use, or intentionally change the pipeline supply mixture to include high levels of RNG.

The scenarios in terms of throughput change over time are shown in Figure 2.

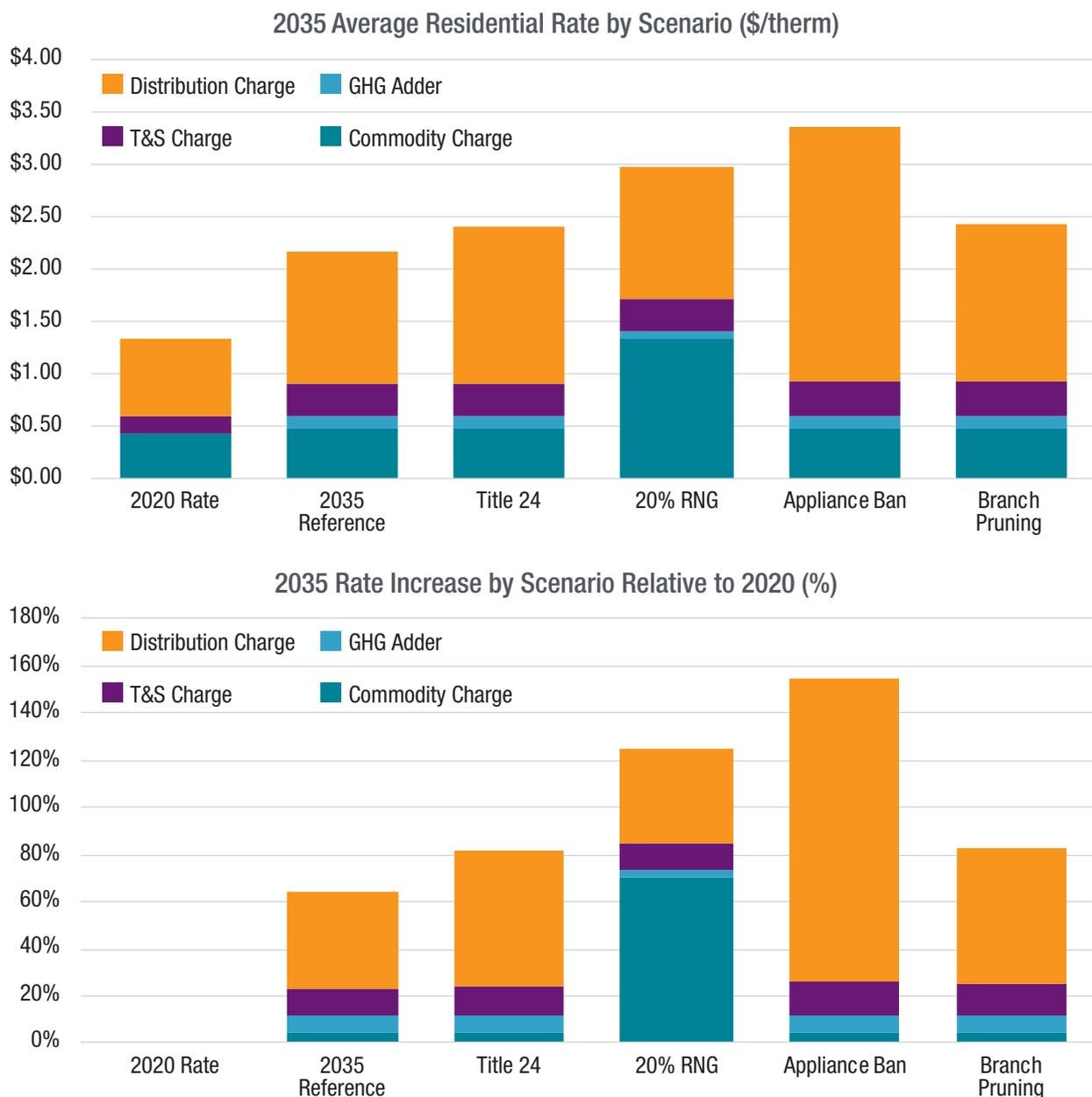
Figure 2. Throughput trajectories over time by scenario. Because the 20% RNG scenario only modifies pipeline composition, it follows the same throughput trajectory as the Reference scenario.



RESULTS AND DISCUSSION

The results of our analysis are summarized in Figure 3. The left-hand chart shows the average residential retail rate in real \$/therm for 2020, as well as in 2035 for the Reference scenario and for various mitigation policy scenarios. On the right is the same set of results expressed as percentage increases relative to the 2020 rate.

Figure 3. Comparison of 2035 average residential gas rates by scenario, expressed in terms of real 2018 dollars per therm and as percentage increases relative to the 2020 average residential rate.



Based on current projections, under the Reference case the average residential rate will rise by \$0.84/therm, or 64%, in real terms between 2020 and 2035. This rate increase is attributable to changes in both capital investment and consumption. Planned investments in new infrastructure and safety-related maintenance will raise the revenue requirement. Simultaneously, although the absolute number of natural gas customers increases under the Reference scenario, overall throughput shrinks as some rate of economic electrification and energy efficiency improvement are assumed to occur over time. Even before factoring in further rate increases due to building decarbonization policy, California natural gas ratepayers may face exacerbating affordability challenges over this period.

As shown in Figure 2, the Title 24 scenario is likely to have a small impact on overall rates. Based on our sensitivity analysis, neither initiating a full gas ban in 2023 (versus in 2026) nor holding the number of remaining customers flat (versus a 1% decline per year) has a significant effect on the overall magnitudes at play. In particular, when evaluated in comparison with the rate increases already predicted under the Reference scenario, a statewide natural gas ban in new construction is unlikely to be the driving force behind drastic or unsustainable rate increases for households. The impact of a sweeping statewide mandate for all-electric new homes has been a significant focus for both advocates of accelerating building decarbonization and those concerned about affordability and equity. However, the impact to residential natural gas ratepayers of this approach may be far overshadowed by that of other policy alternatives currently under consideration.

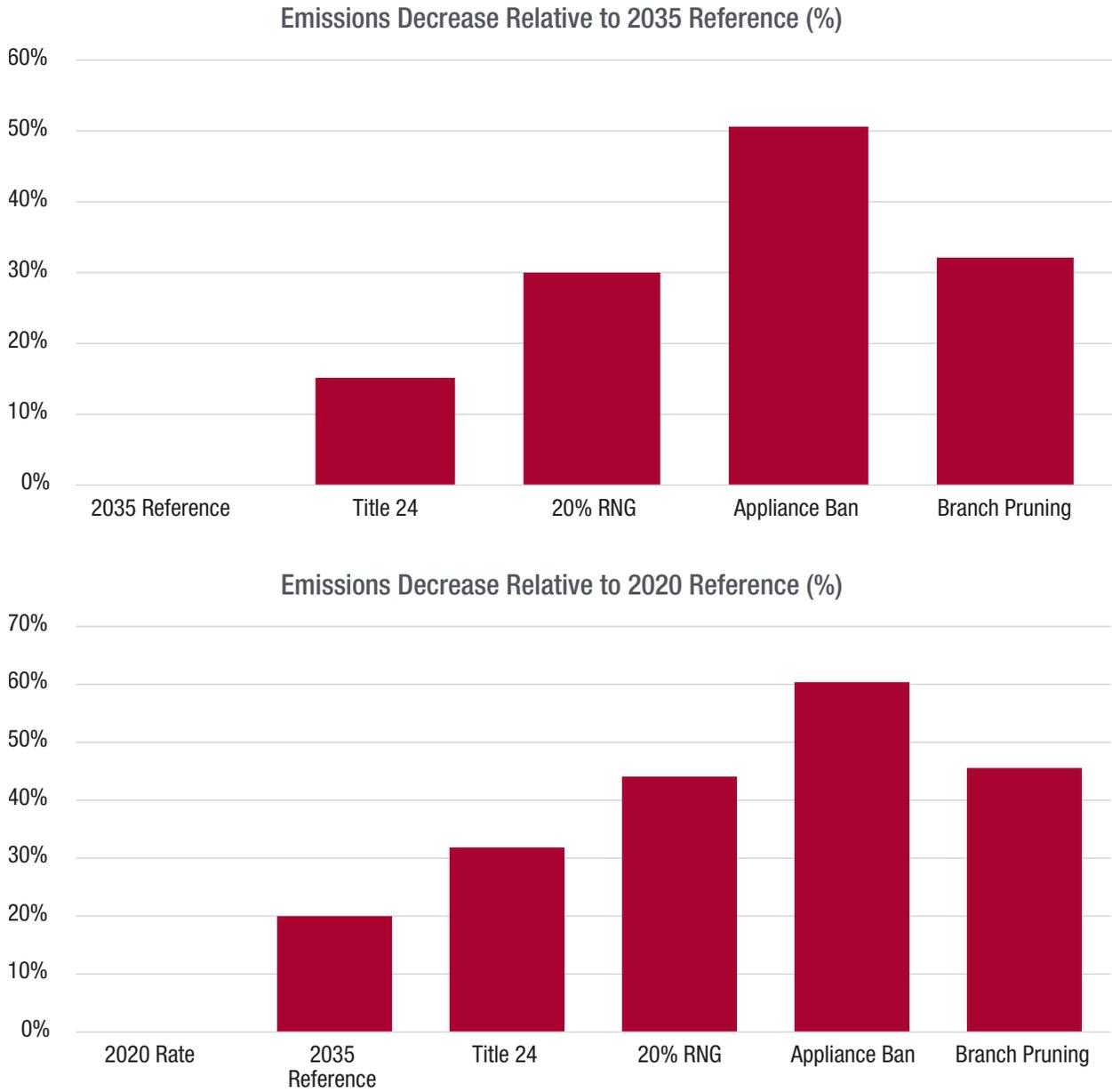
The RNG scenario has significant impacts on the 2035 residential rate—the modeled scenario shows a nearly 40% incremental increase over the Reference scenario retail rate, which uses 100% fossil natural gas. While the exact costs of procuring biogas, hydrogen, and synthetic natural gas in 2035 are uncertain, under current assumptions customers may be paying nearly \$3/therm for natural gas. In addition, this scenario considers only supply-side changes and does not incorporate measures that reduce natural gas consumption. A hypothetical combination of RNG in the pipeline and some level of building electrification could result in even more expensive rates, which may have particularly unfavorable equity implications: a shrinking customer base comprised of those unable to afford electrification would be forced to pay for an increased share of fixed costs and more expensive fuel at the same time. We note that this scenario might occur if SoCal Gas pursues its RNG focused strategy while Title 24 requirements or other measures that encourage electrification drive decreases in throughputs.

The Appliance Ban scenario has an even greater effect on rates, which will become more apparent over time. Because the appliance ban reduces natural gas consumption in a large number of homes and would directly affect the majority of Californians instead of only those occupying new construction, it results in the sharpest declines in customer numbers and throughput. Implementing the ban in 2026 results in an increase of 56% on top of the 2035 reference, or 154% greater than the 2020 rate in real dollars per therm. Earlier implementation of the appliance ban in 2023 produces even more drastic results—a 129% increase incremental to the 2035 Reference case, or 275% greater than the 2020 rate. Out of all the scenarios modeled, near-term action regarding an appliance ban has the greatest potential for significant and harmful ripple effects in the mid- to longer-term time horizon without additional action.

Finally, the Branch Pruning scenario illustrates that more moderate rate increases are achievable if electrification is conducted in a well-targeted manner that allows for strategic retirement of assets. Instead of decreasing throughput while imposing the same level of infrastructure costs, branch pruning attempts to keep the size of the system appropriately scaled to customer need. Therefore, while the throughput trajectory is fairly steep, the cost increase is similar in magnitude to the Title 24 scenario.

The ultimate goal of all these measures is decarbonization, and any policy alternative should be evaluated on the basis of its emissions impacts as well as its economic effects. Figure 3 illustrates the avoided emissions from natural gas consumption in each scenario. The left-hand chart compares emissions for each mitigation scenario to the 2035 Reference scenario, while the right-hand chart shows percentage savings compared to natural gas emissions from the residential sector in 2020. Despite a variety of mechanisms at play, the relative expense of the policy measure tends to scale with relative reduction in emissions. The notable exception is our stylized Branch Pruning scenario. Branch pruning and a Title 24 “gas ban” resulted in comparable 2035 rates, but branch pruning may yield over 15% greater reductions in statewide residential natural gas emissions, or over 500 million fewer therms of natural gas used each year statewide. Our results indicate the value of investing time and resources into understanding barriers and creative cost mitigation strategies for branch pruning more thoroughly. Branch pruning raises important legal considerations, such as substitution of service and obligation to serve, as well as important procedural justice questions (*Wallace et al. 2020*). In addition, branch pruning strategies raise their own significant equity concerns because property owners and residents must invest in electric appliances and associated electric upgrades as neighborhoods are converted on a planned time frame. These equity issues could be addressed via yet to be developed, targeted subsidies for electrification. Our results illustrate how timely and prudent management has the potential to improve policy outcomes in terms of GHG emissions reductions, cost mitigation, and increased electrification.

Figure 4. Comparison of annual emissions reductions across scenarios, expressed as a percentage decrease relative to the 2035 Reference Case and to the 2020 level of emissions.



CONCLUSION

Our analysis shows that rate impacts of different building decarbonization strategies in 2035 are wide-ranging, depending on the policy decisions made in the next few years. We further show that modest emissions reductions are possible for modest mitigation policies, while large emissions cuts may incur large costs to ratepayers in the absence of active planning and cost management measures. We identify four major takeaways from this exercise.

1. By 2035 some policy approaches and mitigation measures could result in significant cost burdens, with the gaps becoming more extreme as the customer base shrinks. While there are many sources of uncertainty inherent in modeling a future California natural gas system, decisions made in the short term can be expected to have large ripple effects into the future.
2. In the short term (pre-2030), the main driver behind higher rates results from known and needed safety investments and not from new mitigation policy. Large cost increases of over 50% in real terms are already predicted for ratepayers. Even before considering mitigation measures that would escalate rates further, there is an urgent need to address affordability.
3. Actions that focus only on restrictions for new construction, including a Title 24 “gas ban,” are unlikely to be major drivers of rate increases, especially when considered in comparison with anticipated rate increases due to needed safety investments. In contrast, both supply-side actions (introduction of RNG) and large-scale changes in consumption (an appliance ban) have much more significant effects. Despite both the 20% RNG and Appliance Ban scenarios showing substantial rate increases, they may have differing implications for equity. The 20% RNG measure, taken in isolation, indicates that a large number of customers will be paying more for gas, while the Appliance Ban implies that a much smaller (and rapidly shrinking) customer base—which may be on average less affluent—will have to bear a higher cost burden.
4. Our analysis indicates that strategically electrifying entire geographic areas to enable “branch pruning” of the distribution system may enable favorable policy outcomes both in terms of rates and emission reductions. This study’s results demonstrate that careful planning has the potential to achieve greater levels of electrification and emission reductions relative to a policy alternative of similar cost. There are currently multiple unknowns concerning execution of such a complex, long-term policy. These challenges include planning process, equity, procedural justice, and the legal obligations of regulated investor owned utilities (Wallace et al., 2020). Communities and utilities need new and better planning processes to proactively identify and prepare neighborhoods for electrification. Communities, especially those that have been historically disadvantaged with respect to energy services should be entitled to a choice in whether and when they electrify (Miller et al., 2019). And electric utilities need legal certainty that if they electrify a neighborhood, they won’t later be compelled to serve natural gas to residences because of their statutory obligation to serve (Wallace et al., 2020). Accomplishing all of these goals successfully is a large challenge. But a branch pruning approach to building decarbonization is one that this work shows deserves much greater study and is likely worth tackling given the combination of ratepayer and emissions benefits it would create.

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