Impact of Electrification Reach Codes on Residential New Construction Projects

Melissa Kosla, ADM Associates
Heather Polonsky, ADM Associates

Abstract

Local building energy codes enable decarbonization through electrification of new construction buildings. Effective in 2020, California updated its statewide residential building codes to allow local Reach Codes, which assist with promotion of electrification in the new construction building landscape.

As part of an evaluation of a Northern California Community Choice Aggregator's decarbonization efforts, evaluators examined Reach Codes adopted in nine jurisdictions in 2020 and 2021. The study analyzed feedback from interviews with local building department representatives and residential new-construction market-actors, including architects, designers, developers, and construction personnel. The evaluators also supplemented this study with an analysis of household energy consumption data pre- and post-code enactment. These methods evaluated the impact of Reach Codes on energy consumption, greenhouse gas emissions, and compliance while simultaneously collecting feedback from key stakeholders to assess barriers to meeting Reach Code goals. This paper summarizes the research goals, methodology, qualitative interview findings, and quantitative regression results from this evaluation, and discusses the importance of electrification promotion in residential new construction moving toward a more efficient and sustainable residential building practices.

Stakeholder interviews revealed a disconnect between building department staff and developers regarding the utility and feasibility of Reach Codes, with a strong undercurrent of skepticism from developers. Although quantitative data availability was limited for homes completed to Reach Code requirements in these jurisdictions, data available demonstrated energy usage in the "Require Mostly" and "Require All" jurisdictions observed a decrease in kWh, therms, and annual energy costs; these findings are statistically significant.

Based on the evaluation study findings, evaluators recommend: 1) encouraging market-actor involvement in code development; 2) continue promotion of efficient electrical equipment; and 3) consider designing a regional reach code to limit confusion among new construction market actors across different jurisdiction.

Introduction

California has a state-wide goal of becoming carbon neutral by 2045; however, the market for all-electric new construction in California remains low, with an estimated 0.5% to 1.5% of single-family homes being all-electric (Opinion Dynamics, 2023). Building electrification can prove to be pivotal in reaching California's greenhouse gas (GHG) emissions reductions target, with one study estimating that electrifying the water and space heating of 30% of California's buildings by 2030 would eliminate 7 million metric tons of GHG emissions – the equivalent of 1.5 million cars annual emissions (Hopkins et al, 2018).

In California, the California Energy Commission created the Title 24 Building Energy Efficiency Standards (Title 24) to regulate energy efficiency regulations for residential and nonresidential buildings constructed in the state. Title 24 is a section in the California Codes of Regulations that detail energy standards for buildings in California.

In an effort to encourage electrification, California allows local jurisdictions to implement stricter energy efficiency ordinances that surpass the Title 24 requirements. These more stringent requirements are called Reach Codes. Every three years, California cities and

counties can adopt Reach Codes to provide a unique opportunity for officials to compel constituents towards decarbonization through beneficial electrification, provided they are both cost-effective and compliant with the energy consumption limits set by Title 24 (Mayors Innovation Project, 2023). In response to this opportunity, jurisdictions across California drafted codes that encouraged all-electric or all-electric readiness in residential new construction.

A Northern California Community Choice Aggregator utility (CCA) partnered with another CCA in the region to develop model electrification Reach Codes designed to encourage all-electric and all-electric readiness construction in Santa Clara County. The model reach code developed by the Utility included requirements related to mandatory features and devices and performance and prescriptive compliance approaches. Thirteen Santa Clara County jurisdictions used the Utility's model reach codes as a starting point to develop their own, jurisdiction-specific reach codes. The implemented code effective dates ranging across 2020 and early 2021. The Utility offered its member jurisdictions technical support and assistance to amend their local building codes to "reach" further than state codes by encouraging or requiring electrification or electric readiness of all new single-family new construction projects. The Utility then spearheaded these efforts to gain multiple benefits of electrification, including: reducing costs (lower buildings costs and energy costs), improving health and safety (reduced gas leaks), and utilizing the grid's clean energy (Frontier Energy et al, 2019; Harvard T. H. Chan School of Public Health, 2022; Lin et al, 2013; Verzoni, 2020).

Evaluators partnered with the Utility to document the utility's goals, involvement, and impacts of the Reach Codes implemented in the jurisdictions. The evaluators sought to understand the current residential new construction market from several market actor perspectives and identify opportunities that prove successful for encouraging electrification in the residential sector during the most critical and impactful stage of implementation: the initial construction of the building. The building phase of the home is a unique, one-time opportunity that can prove to be powerful at encouraging the installation of high efficiency equipment and encouraging decarbonization by building electric readiness into the home during construction, such as dedicated 240V branch circuits for cooking equipment, space and water heating equipment, and clothes dryer equipment.

The following table summarizes the nine jurisdictions reach code stipulations implemented Reach Codes in the Santa Clara County

Table 1: Single Family New Construction Reach Code Stipulations

Member Agency	Reach Code Approved	Code Effective Date	Encourage Electric	Require Mostly Electric	Require All Electric	EV Reach
Mountain View	Yes	1/1/2020			Yes	Yes
Morgan Hill	Yes	3/1/2020			Yes	
Milpitas	Yes	1/6/2020	Yes			Yes
Monte Serano	Yes	1/1/2020	Yes			Yes
Saratoga	Yes	1/1/2020		Yes		Yes
Los Gatos	Yes	2/21/2020			Yes	Yes
Cupertino	Yes	1/1/2020			Yes	Yes
Los Altos Hills	Yes	1/1/2021		Yes		
Campbell	Yes	3/6/2020		Yes		

This analysis included an in-depth analysis of interview feedback from government building department representatives and with residential new-construction market actors. This analysis is also supported by statistically significant findings from billing analyses across new construction homes prior to and following the Reach Code effective dates. This paper describes the research goals and methodology of the efforts conducted to evaluate the efficacy of these jurisdiction-level electrification Reach Codes, summarizes the qualitative market actor and building department official interview findings, assesses the quantitative billing and cost impacts to the households in each jurisdiction, and finally, discusses the importance of electrification promotion in residential new construction moving toward a more efficient and sustainable residential building practices.

In the following sections, the evaluators summarize the methodology employed when conducting the interviews with buildings officials and market actors in relation to the Reach Codes in the Santa Clara County. Following this, the evaluators summarize the billing analysis methodology and results, as well as a discussion and highlight of key findings and recommendations resulting from both the interview and billing analysis findings.

In-depth Interview Methodology

As part of an evaluation of the Santa Clara County Utility Reach Code effort, evaluators ADM Associates assessed nine of the 13 jurisdictions in which Reach Codes were adopted. The in-depth interviews task relied on building department staff and market actors focused on the 2020/2021 electrification Reach Codes in Santa Clara County. These interviews gathered feedback about how the codes were developed, how they are enforced, and what impact the new codes have had relevant to stakeholders' work. The building department staff interviews included building officials and the market actor group, which included architects, designers, developers, and construction personnel. The evaluators aimed to interview market actors with a variety of motivations to gather shared feedback as well as differing perspectives of barriers.

Research Questions

The following table summarizes the research objectives and research questions that the evaluators aimed to answer through these building official and market actor interviews.

Table 2: Research Objectives

Research Objectives	**Questions**
Motivation for Reach Codes	• Why were the codes developed? • Who was responsible for code development? • Who was involved in the development of the codes? • What do the codes stipulate?
Perceptions of Reach Code effectiveness	• What are building officials' opinions of the codes? • What are market actors' opinions of the codes?
Response by constituents or other stakeholders	• How were codes communicated to market actors? • How were the codes communicated to residents? • What were the responses to codes? • What were building officials' biggest concerns? • What were market actors' biggest concerns?
Customer perception of gas-restricted housing	• Did constituents support the codes? • What were constituents' biggest concerns?

Impact of natural gas restrictions on construction costs	• Did construction costs increase? • What specific cost impacts were most impacted?
Operational impacts of the new code	• How did the permit application process change? • How did permit review process change?
Unanticipated challenges or benefits	• How have opinions of codes changed now that have been implemented? • What impact have the code changes had on construction? • What loopholes were identified? How were they addressed? • Where do respondents see Reach Codes going next?

In-depth Interviews

The Utility provided contact information for participating cities' building officials. The evaluators identified market actors through a combination of internet searches (predominantly www.houzz.com searches), referrals, and use of Dodge Data & Analytics database, which includes new construction projects by stage (predesign, design, bidding, etc.), along with contact information for the market actors involved, based on state, county, or zip code.

The evaluators interviewed 11 building department representatives and 8 market actors involved in residential construction projects across Santa Clara County. Thirteen Santa Clara County cities implemented the Reach Codes designed by the Utility – the evaluators reached out to all 13 city building officials and were able to complete interviews for 11 of the 13 building officials. The remaining two building officials did not respond to interview opportunities.

Building department representatives' tenures in their current positions varied considerably from a few months to multiple decades, however all respondents had worked at building departments or as general contractors for five to thirty years. The market actors had long tenures in the new construction industry, and their specific roles ranged from developers and project managers to architects and general contractors; some developers focused solely on residential development (n=5), while others engaged in both residential and commercial development (n=3).

In-depth Interview Results

The following section describes the results of the interviews, divided into four primary themes with various subcategories.

Theme 1: Motivation for Code Development

Building Department Officials

According to responding building officials, none of the municipalities had enacted an electrification Reach Code prior to the development of the current Reach Code. In eight of the eleven municipalities represented, the city councils were the catalyst for developing the Reach Codes; the remaining three municipalities' efforts were spearheaded by the city's sustainability or environmental services divisions. The primary motivations for developing the Reach Codes identified by interview respondents were the influence of neighboring municipalities' efforts and environmental concerns (Table 3).

Table 3: Motivation for Code Development

Concern	n	Quote
Political	7	*"Mayor did not want to be the only city in Santa Clara County that did not pass a Reach Code."* (Building Official)
Environmental	4	*"Primary driver is decarbonization. [The council has] a strict decarbonization goal for [the city] …they're looking kind of at everything to get to that level of decarbonization by a set date."* (Building Official)

Market Actor

Although they were not directly involved in development of the Reach Codes, market actor respondents identified similar motivations for the adoption of building codes; market actors most frequently cited environmental (n=5) and political (n=4) reasons as county officials' primary motivators for the Reach Codes. Respondents noted these motivating factors were frequently intertwined, as exemplified in the following comment:

"They see themselves as sustainable justice warriors, the city councils. I think the reason why they're adjusting [the codes] is because there are politically salient things to get behind. The impact that [the codes] creates downstream for costs of construction aren't very measurable at first and they don't have political backlash attached to them. So, it's a win-win for [council members]." (Architect)

Theme 2: Involvement in Code Development

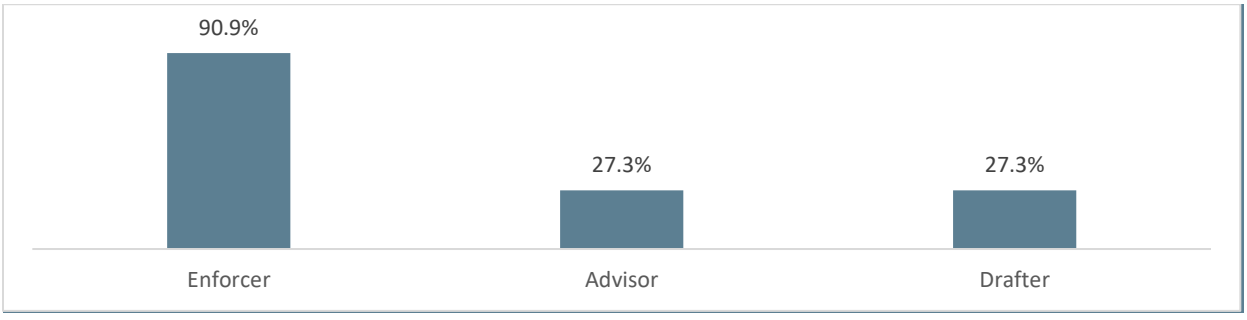
Building Department Officials

Role in Code Development

Three of the interviewed building officials noted they advised their city council or sustainability directors on Reach Code development and three indicated they helped draft the Reach Codes for their cities. Additionally, all but one building official indicated they are responsible for enforcing the Reach Codes. The one building official who did not note enforcement duties explained that they were the interim planning director at the time of code development and were specifically tasked with developing the codes and that they have since retired from the department.

Four of the six building officials who were involved in the development of the reach codes – either as advisors or drafters – reported using the Utility's model code as a starting point for development of the reach code in their cities. They indicated the Utility code was easy to understand and helped frame the code development conversation with city council, sustainability staff, and the other stakeholders involved in Reach Code development (Figure 1). The remaining two building officials who were involved in the development of their jurisdictions reach codes acted as advisors and were not able to speak to the utilization of the model code template.

Figure 1: Reach Code Role (n = 11)



Communicating Proposed Codes to Stakeholders

Nine of the eleven building officials commented on how codes were communicated to stakeholders. All nine of these respondents indicated the codes were open to public comment at city council meetings. The ways in which the building officials announced public comment varied. Four respondents noted larger outreach efforts including multiple public meetings and general communication campaigns, while five respondents indicated proposed changes and feedback opportunities were communicated through newsletters and emails, or conversations with other stakeholders. All nine respondents indicated that few stakeholders provided feedback on the proposed codes, regardless of whether or not there was a robust communication campaign.

"People were not interested. It was not a big deal… advocates responded a lot, so that skewed results, but the normal homeowner did not respond. Developers did not provide feedback; we sent out emails to all the developers; telling them what was going on and crickets, nothing." (Building Official)

Table 4: Communication of Proposed Codes

Opinion	**n (n = 9)**
Codes were open to public comment at the city council meetings	9
Codes were communicated during larger outreach efforts	4
Proposed changes and feedback opportunities were communicated	5

Opinion of Code

In general, respondents emphasized that their job is to enforce building codes, regardless of their opinions towards the code, and underscored that their top priority as the city building official is to ensure building safety and integrity. With that being said, ten of the eleven responding building officials personally supported the Reach Codes.

"We're participating with a lot of other folks to reduce emissions and that's all good...As a building codes administrator our focus isn't on those issues, it's more about fire and life safety. But just as a person, you know, we're California and folks in the Bay Area are kind of leaders in that work." (Building Official)

Among the ten respondents who expressed support for building electrification, the primary reasons for their support were reducing GHG emissions (n=8) and improving in-house air quality (n=7). One respondent also referenced safety concerns associated with gas lines, noting a preference for electrification towards building safety. The one respondent who expressed disagreement with the Reach Codes cited infrastructure concerns, as well as the general sentiment that these regulations distract from the safety goals of building codes.

Table 5: Opinion Toward Code

Concern	n	Quote
Support	10	*"I support them. I think that you know, us being the subject matter experts, we need to encourage people to do the right thing right and to be environment focused. So, I'm more on the progressive side, and I support progress, because again, unless an option is taken away, people will go with the easier option and not always think long term and big picture. So that's why I think we need to keep pushing for it and you know remove the gas."* (Building Official)
		"Once I started paying attention, I became concerned about gas cooktops. We had a public resident come and talk about the dangers of gas stoves and kids becoming asthmatic. It doesn't sit well for me." (Building Official)
Opposed	1	*"I just feel that as somebody who enforces building codes, my main concern is making sure a building is safe, and people can get out of a building if they need to. Whether or not they have gas in the building doesn't benefit that the situation…I just feel like with this and the EV chargers, it's something else [that] gets thrown at me and my team to try to enforce. We get no additional resources. It's just another burden…I have concerns. If you have a building with 100 AMP electrical service and you're telling them they have to take gas appliances out, are they going to have electrical capability to go all electric without new electrical service. I know load management is getting better, but where is it going to end?"* (Building Official)

Market Actor

All but one market actor indicated they were not involved in the development of the Reach Codes across the various municipalities in Santa Clara County. The one market actor who did indicate involvement in code development noted that their involvement was minimal, explaining they were able to provide feedback about the drafted code via email.

Among the seven market actors who did not provide feedback about the codes before their enactment, there was a sense of disappointment; respondents desired more of an opportunity to respond to the proposed code changes before they went into effect.

Moreover, the market actors indicated that once developed, the code changes were not well-advertised to them. They explained that while city officials typically make some effort to inform the design and construction communities of code changes, it is ultimately "*incumbent on the builder to figure it out*" (Developer).

Theme 3: Response to Reach Codes

Building Department Officials

Building officials indicated the Reach Codes have not faced significant resistance from local developers, builders, or homeowners. Some respondents (n=3) noted that much of their new single-family home construction is higher-end custom homes, so builders can implement the Reach Codes with a relatively small impact on project cost and profit. One official noted they could see more complaints arising from larger, mass-produced home developers, as electrification could substantially impact profit margins. Other building officials (n=3) noted that builders recognize that they must comply with code and therefore do not feel compelled to argue.

"They're kind of just used to it. The builders and designers know it and expect it. They're not surprised by it and they're building it into their preliminary conversations, so people are not blindsided that way." (Building Official)

Although building officials did not report major code pushback, all respondents reported they fielded some questions and concerns from builders and constitutions. The most common questions and concerns presented to them were those related to grid capacity (n=9), gas cooktops (n=7), and cost (n=4) (Table 6).

Table 6: Response Towards Code

Concern	n	Quote
Grid Capacity	9	*"The biggest concern is the dependency on this private company agency (the utility that generates energy) to provide the power that we're pushing these people to use…if we are pushing people to do the right thing and to be all electric to help with decarbonization and then they can't get power…we're pushing people to do this, yet they can't get the service. And if something were to happen to the service grid overall."* (Building Official)
Gas Cooktops	7	*"The number one complaint we received is people do not want to give up their gas range. They'll have an electric dryer. They'll have an electric furnace, but people are really attached to their range."* (Building Official)
Cost	4	*"Again, cost was the number one concern, although there was a lot less than you know constituency than there was certainly from the developer builders"* (Building Official)

Market Actor

Half of the market actor respondents (n=4) expressed support for the Reach Codes; they agreed with the overarching intent of the Reach Codes, namely, to push the county towards a more sustainable and environmentally conscious construction.

While half of the market actor respondents expressed support of the Reach Codes, all eight respondents – including the supporters – expressed concerns with how the codes were drafted. Market actor respondents expressed a general sentiment that the codes did not fully consider the potential impacts these code changes might have on the new construction industry.

"These reach codes are made without full knowledge of implications on larger system. Often, they're politically driven, I'm not anti-political but those decisions are being made without background or construction." (Building Developer)

"I do fundamentally agree with many of them, but they're just covering people in the red tape without recognizing what the conditions are on the ground. It's just still simply infuriating." (Architect)

More specifically, respondents had infrastructure-related concerns, expressing a wariness of the grid's ability to handle the demand generated from full electrification (n=8). These infrastructure related concerns were rooted in frustrations with the utility that generates energy in the region, both in terms of the utility's ability to upgrade transformers and the time it takes to upgrade those transformers.

Some of the respondents also worry about the potential safety hazard of complete electrification, indicating that the lack of a natural gas backup system could result in dangerous situations during storms and power outages. Additionally, one respondent spoke to how infrastructure issues are further compounded by new solar regulations, explaining that the current electrical equipment in the area cannot accommodate solar net metering, nor a two-way electricity exchange.

In addition to infrastructure concerns, respondents expressed concerns about the added costs (n=6), cooking equipment (n=4), and housing availability (n=1) (Table 7). Cost-related concerns included those related to the cost of equipment, additional project management hours,

and upgrading the generation utility's infrastructure. Although four respondents mentioned concerns related to eliminating gas cooktops, three of these respondents felt optimistic that with time and education, homeowners would understand the benefits of induction cooktops and electric cooking and would no longer desire gas cookware as strongly.

Table 7: Market Experts Code Concerns

Concern	n	Quote
Added Costs	6	*"I support the codes if there is the infrastructure and the cost implications are dealt with. Like you're a city [lets] forgive some permit cost or [give us] a credit on your bills for energy or whatever to do these things like somewhat. Like there should be incentive that, like reduces some red tape costs or something. If you're stretching a client budget."* (Architect)
Cooking Equipment	4	*"Most people are hesitant about cooking without gas. The new induction ranges are really good, but people haven't had experience cooking on them'."* (Architect)
Housing Availability	1	*"My primary concern is we are in a housing crisis, and I can't be profitable as a builder under a 2-million dollar home, which is crazy. Cost of materials, cost of labor, and how intricate new homes are. If we add more and more code then we inevitably create a more complex and more costly home, slowing down the ability to produce homes. It's tough, because I do want to see high efficiency, but we have a housing crisis to deal with. I think we need to do more multifamily."* (Architect)

Theme 4: Influence of Reach Codes

Building Department Officials

All but one of the responding building officials reported that the Reach Codes did not alter their permit application review processes or costs: *"same process different code"* (Building Official). The one building official who noted a change in the review process emphasized that it is more time consuming because it requires additional review of permits under the Reach Codes as well as the additional time devoted to answering builders' and residents' questions.

"I'm going to be honest with you, it's time consuming. It's just very time consuming. It definitely takes more time at the pre application stage." (Building Official)

Market Actor

Similar to the building official respondents, market actors did not cite any major changes to the permit application process. Market actors noted that regardless of whether a building code is a Reach Code or the California state code, architects and builders are responsible for meeting all code requirements and "*checking all the boxes*" (Developer).

Theme 4: Moving Forward

Building Department Officials

When thinking about Reach Codes moving forward, three building officials expressed concerns about where the Reach Codes will go next. Specifically, these respondents were nervous about potential repercussions if Reach Codes were to be applied to remodels. They explained that residents do not always obtain the necessary permits for renovations and remodels, and if electrification codes were to apply to remodels and renovations, they worry about increased non-compliance and permit avoidance.

One building official speculated that rather than Reach Codes expanding to renovations, that future codes will target manufacturers. This respondent explained that Reach Codes may become more palatable if manufacturers focused their efforts on affordable, efficient equipment.

This respondent believed that if there were bans on certain gas appliances, then electrification would result naturally.

Eight of the responding building officials thought electrification would be more consistent and easier to understand and implement if it were mandated statewide, rather than via municipality-based Reach Codes. They stress the desire for local jurisdictions to make more consistent requirements with their neighbors. However, four of these respondents believed that political factors would prevent such a mandate from occurring.

"When you have statewide mandate the architects, designers, property owners, they already know what they're going to be up against. But if you have individual local ordinances, it may be different in each jurisdiction. There's no consistency, its problematic for designers…years back a lot of jurisdictions had different amendment, and the argument contractors had was, well how come I can go to [this city] and I can install something and in [this other city] I can't…so over the years there's been more of a stress to make local jurisdictions more consistent with their neighbors." (Building Official)

The two respondents who indicated they prefer the local approach to electrification recognized the benefits of a single, statewide mandate, but ultimately preferred the local approach as it acknowledges the specific needs and concerns of each municipality.

"From a design perspective its simpler. But generally, you have local issues that sometimes need to be addressed and have a bigger concern than statewide. That probably applies for a lot of things…having peoples input and local perspective should make those decisions." (Building Official)

Market Actor

Most of the market actor respondents' suggestions for improvement highlighted earlier comments. Respondents hope future code adaptations more carefully consider the current state of the construction industry and the capacity of existing grid infrastructure (n=8). Two respondents explained that Reach Code implementation would benefit from a more holistic conversation between all relevant stakeholders:

"[We need a] more holistic approach about what we want to do and how are we going to do it. They took the approach 'we want to go to the moon next week, but we don't have a rocket'." (Construction Personnel)

Additionally, some respondents desired more uniformity across the various Reach Codes, indicating it can be confusing for builders, and customers alike, when codes vary dramatically from municipality to municipality (n=3). This sentiment echoes the opinions of the building officials who noted they would prefer if advancements in building codes focused on electrification were enacted by the state, rather than by local municipalities, as this top-down approach would prevent intra-county differences.

Billing Analysis Methodology

In addition to the interview findings presented above, the evaluators conducted a billing analysis to identify observed impacts of the reach codes within the new construction homes in the jurisdictions analyzed in this report. The billing analysis task relied on monthly billing data from homes in each jurisdiction that were newly constructed following the Reach Code enactment as well as monthly billing data from new construction homes one year prior to when the Reach Codes were enacted. This allows the evaluators to compare the post-Reach Code homes to a reliable baseline of energy usage without the additional energy efficiency requirements set by the Reach Codes.

Billing Analysis

The evaluators employed a billing analysis approach to determine the energy impacts, GHG reductions, and cost impacts of residential electrification efforts across nine of the 13 jurisdictions in which Reach Codes were enacted. This was accomplished by comparing the energy use intensity differences between households constructed within one year prior to the Reach Code implementation (pre-code homes) and households constructed following Reach Code implementation (post-code homes). The difference in normalized energy consumption between the pre-code and post-code households provides an estimate of the average electric and gas energy reductions accomplished by introducing the Reach Codes.

The Utility categorizes each Reach Code into one of three code specification categories: "Encourage Electric", "Require Mostly Electric", and "Require All Electric" (Table 1).

Data Required

The evaluators employed the following datasets to identify relevant pre-code and post-code households:

- **Housing data**: The evaluators utilized housing data from the California Department of Housing and Community Development's Annual Building Activity dataset, which included variables such as APN, address, county, reporting year, and permit date.
- **Utility customer data**: The utility shared customer data with the evaluators, which tracked account IDs associated with each service address.
- **Gas and electric billing data**: The Utility shared monthly billing data tracking households' gas and electricity usage from 2019-2022.
- **Customer move-in/move-out dates**: The Utility shared the move-in and move-out dates for accounts associated with the households of interest.
- **Weather data**: Data in the form of heating degree day (HDD) and cooling degree day (CDD) data from the National Oceanic and Atmospheric Administration (NOAA, 2023).
- **Typical meteorological year (TMY) data**: The evaluators sourced TMY HDD and CDD data from the National Renewable Energy Laboratory (NREL, 2023)
- **Square footage data**: The Utility shared total household square footage data for a subset of households. The evaluators sourced square footage for the remaining households from Redfin using an API based on household address. Online searches were used to fill remaining data gaps in Redfin square footage data.
- **Solar photovoltaic (PV) data**: The Utility shared utility data on solar PV prevalence for households installing solar.
- **EV charger data**: The Utility shared data on households with EV charger rates.

The evaluators filtered the housing data to only include single-family homes within the nine jurisdictions in **Error! Reference source not found.**. The pre-code households were limited to households that were permitted within one year prior to jurisdiction-specific code effective dates.

Data cleaning steps, as well as the corresponding household and bill counts, are outlined in Table 8. All bills that occurred prior to the household construction or renovation permitting date were removed. After cleaning, 413 unique pre-code and post-code homes remained for potential inclusion in the analysis.

Table 8: Data Preprocessing Steps

Cleaning Step	Household Count
Raw data from client	428
Remove households with problematic APNs	426
Remove bills outside of move-in/move-out dates	425
Remove bills prior to permit date	413

As part of this evaluation, the evaluators included a billing analysis of 96 pre-code households and 104 post-code households. The limitations of this sample size is noted in the subsection below. This number decreased from the total population of 413 households in the data preprocessing step due to the requirement that homes must display at least 9 months of valid billing data in the post-period. Once households were grouped by code specification or jurisdiction, imbalances in household counts per cohort were revealed. As outlined in Table 9, the "Encourage Electric" pre-code cohort and the "Require Mostly Electric" pre- and post-code cohorts display lower than ideal household counts for billing analyses. It is ideal for the pre-code and post-code household groups to each contain equal or similar number of households and reach 75 households in each group to achieve confident results.

Table 9: Household Counts by Code Specification

Code Specification	Pre-Code Households	Post-Code Households
Encourage Electric	8	53
Require Mostly Electric	15	18
Require All Electric	73	33
Total	96	104

Limitations

The evaluators note several limitations in the data utilized in this billing analysis including low or imbalanced sample sizes, lack of data to explain bill variance, inability to track occupancy of homes, and lack of solar submeter data.

Additionally, the evaluators identified several households that seem to have lacked occupancy for a portion of the analysis period, indicated by negligible or no consumption during several months of the year. Billing data indicated that post-code homes may have lower occupancy rates, contributing to reduced electricity usage.

Finally, an additional limitation to this analysis was the inability to confirm variance in observed monthly energy consumption. Data on solar submeters would improve our ability to assess solar production's effect on net household energy consumption and therefore gauge occupancy of the home by backing out solar production on energy bills.

Regression

Regressions were conducted to assess kWh and therms used by each building, and cost impacts for each code specification. The evaluators calculated the difference between pre-code and post-code weather-normalized electricity and gas consumption as well as energy costs. The general regression equation is outlined below.

Equation 1: Regression Model Specification

$$ADC = \alpha_0 + \beta_1 Post + \beta_2 Solar + \beta_3 EV_{Charger} + \beta_4 HDD + \beta_5 CDD$$

Where,

ADC = Weather-normalized average daily consumption (kWh, therms, or cost) per square foot

$Post$ = Dummy variable indicating whether household was permitted pre- or post-code

$Solar$ = Dummy variable indicating whether household has solar PV (per PG&E data)

$EV\_Charger$ = Dummy variable indicating whether household has an EV Charger rate
HDD = Daily heating degree days
CDD = Daily cooling degree days
α_0= The model intercept
β_{1-5} = Coefficients determined via regression

Emission and Cost Analysis

After determining the impact of Reach Codes on energy usage, the evaluators applied the Utility's natural gas emissions factor to daily gas usage to assess changes in GHG emissions. The costs were calculated using the Utility's rate structure appropriate for each household, based on usage.

Billing Analysis Results

Descriptive Statistics

The evaluators summarize simple descriptive statistics of the difference in energy usage between pre- and post-electrification households in the tables below.

Table 10: Average Electric Usage Pre-Code vs. Post-Code

Code Specification	Average Post Sqft	Pre Annual kWh/Sqft	Post Annual kWh/Sqft	Avg Household kWh Impact
Encourage Electric	2,133	0.6994	0.5110	402
Require Mostly Electric	4,565	0.7863	0.5336	1,154
Require All Electric	2,299	1.7679	1.0635	1,619
Total	2,607	1.5255	0.6902	2,177

Table 11: Average Gas Usage Pre-Code vs. Post-Code

Code Specification	Average Post Sqft	Pre Annual Therms/Sqft	Post Annual Therms/Sqft	Avg Household Therms Impact
Encourage Electric	2,133	0.0530	0.0765	-50
Require Mostly Electric	4,565	0.0222	0.0049	79
Require All Electric	2,299	0.1040	0.0550	113
Total	2,607	0.0870	0.0573	77

As displayed in Table 10, electricity usage per square foot is substantially higher in the "Require All Electric" pre-code cohort than the other two code specification categories. The post-code annual kWh/Sqft for this cohort decreases substantially, likely due to increased efficiency of electric appliances in the post-code households. Additionally, for the "Require All Electric" households in the post-code cohort, we would expect to see no gas usage, as there are no gas appliances in the household at the time of construction.

This indicates that the "Require All Electric" group may have installed and continued to use gas appliances despite having all-electric end use equipment when constructed. This is possible because after occupants move into the post-code households, homeowners may elect to install natural gas appliances, such as gas stoves, especially in high income households. Homeowners may build their homes to electrification standards to meet new construction electrification code and convert fuel types to natural gas at a later date.

Regression Results

For the purposes of this report, the evaluators summarize the billing analysis results for that were found to be statistically significant, and therefore removed results for the "Encourage Electric" jurisdictions. In summary, the evaluators found that the "Require Mostly Electric" and "Require All Electric" displayed statistically significant reductions in electric usage, gas usage, and energy costs due to implementation of the reach codes.

Table 12: Statistically Significant Electric Regression Results

Code Specification	Daily kWh per Sqft Post-Elec	P-Value	Adjusted R-Squared	Avg Post Sqft	Avg Home kWh Impact	lb. of CO_2e per Home
Require Mostly Electric	-1.01E-03	0.01	0.17	4,565	-1,677	-121
Require All Electric	-1.12E-03	0.00	0.15	2,299	-943	-68

Table 13: Statistically Significant Natural Gas Regression Results

Code Specification	Daily Therms per Sqft Post-Elec	P-Value	Adjusted R-Squared	Avg Post Sqft	Avg Home Therms Impact	lb. of CO_2 per Home
Require Mostly Electric	-5.03E-05	0.00	0.05	4,565	-84	-981
Require All Electric	-1.84E-04	0.00	0.25	2,299	-155	-1,805

Table 14: Statistically Significant Cost Regression Results

Code Specification	Daily Cost per Sqft Post-Elec Estimate	P-Value	Adjusted R-Squared	Avg Post Sqft	Avg Home Cost Impact ($)
Require Mostly Electric	-5.42E-04	0.00*	0.14	4,565	-904
Require All Electric	-8.05E-04	0.00*	0.15	2,299	-677

The regression results are as follows:

- The "Require All Electric" group displayed a statistically significant savings of 943 (23%) kWh and 154 (65%) therms between pre- and post-code homes, equating to a reduction of 68 lb. of CO_2e per home from electric reductions and 1,805 lb. CO_2e due to gas reductions. In terms of cost, this group displays $677 lower energy costs due to reach codes.
- The "Require Mostly Electric" group displayed a statistically significant savings of 1,677 (47%) kWh and 84 therms between pre- and post-code homes, equating to a reduction of 121 (83%) lb. of CO_2e per home from electric reductions and 981 lb. CO_2e due to gas reductions. In terms of cost, this group displays $904 lower energy costs due to reach codes.

The reduction in both electric and natural gas usage across the groups is likely driven by the electrification code itself. It was expected that the overall electric usage of the post-code homes would increase due to conversion of potential gas equipment toward electric equipment. However, the increased efficiency requirements seem to more than offset the increased electric usage due to the additional equipment, and instead lead to a reduction in total electric usage in the reach code homes. In addition, the combination of encouraging a shift to electricity and increasing the efficiency of mixed fuel buildings seems to have reduced natural gas consumption in all households.

Discussion/Conclusion

The following section summarizes the primary findings and recommendations ascertained from the building official and market actor interviews and billing analysis.

Some of the key challenges for regional clean energy adoption are the presence of policies and standards that align with regional goals, ability to tailor programs to the needs of the region, facilitating regional coordination and collaboration, and quantification of the effectiveness of these programs (Silicon Valley Institute, 2014). The Utility's success in Reach Code effort requires these same critical needs. Because Reach Code initiatives impact a wide

range of stakeholder audiences with differing needs, perspectives, and objectives, a comprehensive approach to engagement is important for compliance and success.

Encourage Market-Actor Involvement in Code Development

Currently, stakeholders most directly involved in enforcement and compliance with the Reach Codes often had minimal say in the development of Reach Codes. Market actors seem to desire more of an opportunity to respond to the proposed code changes before they are approved. Additionally, market actors indicated that once developed, the code changes were not well-advertised to them. All market actors interviewed expressed concerns with how the codes were drafted and expressed a general sentiment that the codes did not fully consider the potential impacts these code changes might have on the new construction industry, such as infrastructure-related concerns, and potential safety hazards of complete electrification.

This indicates a need for city officials typically to inform the design and construction communities of code changes. Additionally, although city codes are typically spearheaded by city councils, councils should consider increasing the involvement of building officials and relevant market actors in code development through enhanced communication campaigns and amplified promotion of public comment opportunities. This supports the notion that it is imperative to engage with stakeholders early and often. Such engagement may increase stakeholder buy-in and allow for smoother roll out of new codes.

Continue Promotion of Efficient Electrical Equipment

The most common concerns regarding the feasibility and acceptability of the Reach Codes were related to gas cooktops and grid infrastructure. The evaluators therefore recommend increasing education and promotion of induction electric cooktops as a viable and preferred alternative to gas cooktops. Many interviewees indicated residents had a preference towards gas cooktops, noting that electric cooktops, particularly induction technology, is not well understood by the public. One interviewee remarked that the county needs educational and promotional campaigns about induction cooking that mirror those of electric vehicle adoption.

While gas cooktop concerns were ubiquitous across building officials, market actors, and residents (as reported by building officials and market actors), infrastructure concerns were more prominent among the market actors. Specifically, interviewees worried about the grid's capacity to handle the extra electric load that would result from these codes and the ability of the state's aging electrical equipment to handle such an increase. This is further supported by models that show current substation transformers are ill-prepared for California's electric vehicle electrification goals alone (Xie et al, 2021, Elmallah et al, 2022). The evaluators therefore find that instead of prohibiting natural gas in future code developments, the Reach Codes are recommended to focus on requiring electric equipment in new construction homes and considering allowing for later addition of natural gas lines when developing code requirements.

Consider Designing a Regional Reach Code

Respondents from both groups would prefer a statewide electrification mandate, rather than locally driven mandates, but recognize the political challenge involved in such a mandate. Respondents seemed to desire more uniformity across the various Reach Codes, as differences in building requirements between jurisdictions can be confusing for builders, and customers alike. This sentiment echoes the opinions of the building officials who noted they would prefer if advancements in building codes focused on electrification were enacted by the state, rather than by local municipalities, as this top-down approach would prevent intra-county differences.

This finding touches on the need for regional programs to link codes to transregional efforts, which could allow each jurisdiction to learn from each other to improve deployment,

collaboration, and impact of the Reach Codes (Building Energy Codes Working Group, 2021). Connecting code regulations between jurisdictions toward larger efforts can encourage collaboration of market actors, streamline marketing, and ease market actors' and residents' confusion.

Reach Codes Offer Observable Energy and Cost Savings

Although interviews revealed a disconnect between building department staff and developers, the billing analysis concluded that there are statistically significant decreases in electricity usage, gas usage, and household energy costs across the "Require All Electric" and "Require Mostly Electric" jurisdictions. This indicates that Reach Codes, if implemented properly, have the potential play a large role in reducing California's reliance on natural gas, and therefore reducing GHG emissions, while also benefitting customers by reducing both their electric and gas energy bills, improving air quality, and reducing risk of gas leaks within the home.

Conclusion

In conclusion, this evaluation study revealed that the Reach Codes in the Santa Clara County are well on the their way to a streamlined design process, with many jurisdictions using the Utility's model Reach Codes as a jumping off point to create their own local requirements. However, more open communication and collaboration is needed between building department officials and market actors for the Reach Codes to be successful, including intra-jurisdictional collaboration. Additionally, it is recommended to incorporate additional marketing and education towards energy efficient electric equipment for the residents, specifically for induction cooktops, to encourage safe electrification in the residential sector. Despite the areas for improvement discussed above, the Reach Codes provide quantifiable impacts in energy, GHG reductions, and energy bill costs that have the potential to make a large impact in the acceleration of electrification in California and considerable impact in California's GHG emissions goals that can occur simultaneously with capacity expansion and grid improvements.

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