



Rule 9-6: Flexibility and Affordability Amendments for Zero NOx Water Heaters

Board of Directors Meeting Continuation

May 13, 2026

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Deputy Executive Officer for Policy



Summary of Key Recommendations

Staff Recommendation	Previous Direction
Low-income exemption based on participation in income-qualified program or housing cost burden	Deferred to full Board
Project-specific exemptions requiring contractor participation	SSC recommended
One project-specific exemption per address	SSC recommended
Assess a moderate processing fee for project-specific exemptions to recover costs of the program	New recommendation
Provide for a 9-month delay to develop exemption process and conduct outreach	New recommendation

Low-Income Definitions

Household Size	250% Federal Poverty Guidelines	80% Area Median Income (Highest county- Santa Clara)	80% Area Median Income (Lowest county – Solano)
1	\$39,125	\$101,520	\$63,040
2	\$52,875	\$116,040	\$72,080
3	\$66,625	\$130,520	\$81,080
4	\$80,375	\$145,040	\$90,080

Data Source: American Community Survey (ACS) – all data is for 2023 calendar year

Low-Income Definitions and Ranges by Household

Table 1. 250% Federal Poverty Guidelines (FPG)ⁱ

Household size	Annual Income Maximum
1	\$ 39,125
2	\$52,875
3	\$ 66,625
4	\$80,375

Table 2. 50% Area Median Income (AMI) by Bay Area Countyⁱⁱ

Household size	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma
1	\$51,775	\$51,775	\$61,250	\$ 45,350	\$ 61,250	\$ 61,250	\$ 63,450	\$ 39,400	\$ 44,825
2	\$59,150	\$59,150	\$70,000	\$ 51,850	\$70,000	\$70,000	\$72,525	\$45,050	\$51,250
3	\$66,550	\$66,550	\$78,750	\$58,325	\$78,750	\$78,750	\$81,575	\$50,675	\$57,650
4	\$73,950	\$73,950	\$87,500	\$64,800	\$87,500	\$87,500	\$90,650	\$56,300	\$64,050

Table 3. 80% Area Median Income (AMI) by Bay Area Countyⁱⁱⁱ

Household size	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma
1	\$82,840	\$82,840	\$98,000	\$72,560	\$98,000	\$98,000	\$101,520	\$63,040	\$71,720
2	\$94,640	\$94,640	\$112,000	\$82,960	\$112,000	\$112,000	\$116,040	\$72,080	\$82,000
3	\$106,480	\$106,480	\$126,000	\$93,320	\$126,000	\$126,000	\$130,520	\$81,080	\$92,240
4	\$118,320	\$118,320	\$140,000	\$103,680	\$140,000	\$140,000	\$145,040	\$90,080	\$102,480

ⁱ U.S. Department of Health and Human Services. "2025 Poverty Guidelines: 48 Contiguous States" [detailed-guidelines-2025.pdf](#)

ⁱⁱ U.S. Census Bureau, U.S. Department of Commerce. "Tenure by Household Income in the Past 12 Months (in 2023 Inflation-Adjusted Dollars)." American Community Survey, ACS 5-Year Estimates Detailed Tables, Table B25118, [https://data.census.gov/table/ACSDT5Y2023.B25118?q=California+Income+and+Poverty&t=Owner/Renter+\(Householder\)+Characteristics&g=050XX00US06001,06013,06041,06055,06075,06081,06085,06095,06097&y=2023](https://data.census.gov/table/ACSDT5Y2023.B25118?q=California+Income+and+Poverty&t=Owner/Renter+(Householder)+Characteristics&g=050XX00US06001,06013,06041,06055,06075,06081,06085,06095,06097&y=2023). Accessed on 9 Dec 2025.

ⁱⁱⁱ *ibid*

Owner-Occupied Household Data and Potential Exemption Estimates

Table 4. Estimate of Owner-Occupied Households under 80% Area Median Income (AMI)* by countyⁱ (Option B)

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano**	Sonoma**
Total Households, all incomes, incl. Renters	593,117	411,662	103,201	49,663	362,650	264,424	654,467	109,060	161,923
# Owner-Occupied Households ≤80% AMI*	107,220	104,403	24,694	12,331	54,462	56,785	129,826	23,625	40,550
% Owner-Occupied Households ≤80%AMI*	18.1%	25.4%	23.9%	24.8%	15.0%	21.5%	19.8%	21.7%	25.0%

**80% AMI: utilizing 4-person household income threshold. Note that number signifies total households in the Bay Area earning under the income threshold, but number of actual persons in each household is unknown.*

***includes fractions of county households within Bay Area Air District's jurisdiction (0.7 for Solano and 0.85 for Sonoma).ⁱⁱ*

Table 5. Estimate of Owner-Occupied Households under 250% FPG* by countyⁱⁱⁱ

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano**	Sonoma**
Total Households, all incomes, incl. Renters**	593,117	411,662	103,201	49,663	362,650	264,424	654,467	109,060	161,923
# Owner-Occupied Households ≤250% FPG*	69,273	65,263	13,965	9,548	30,716	30,807	66,688	20,377	30,092
% Owner-Occupied Households ≤250% FPG of Total Households, all incomes, incl. Renters**	11.7%	15.9%	13.5%	19.2%	8.5%	11.7%	10.2%	18.7%	18.6%

**250% FPG: utilizing 4-person household income threshold. Note that number signifies total households in the Bay Area earning under the income threshold, but number of actual persons in each household is unknown.*

***includes fractions of county households within Bay Area Air District's jurisdiction (0.7 for Solano and 0.85 for Sonoma).*

Table 6. Housing Cost Burdened (HCB) Owner-Occupied Households, all income levels, by county^{iv}**

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano**	Sonoma**
Total Households, incl. renters	593,117	411,662	103,201	49,663	362,650	264,424	654,467	109,060	161,923
# HCB** Owner Occupied Households	70,735	64,879	17,487	7,997	32,502	35,558	73,855	15,791	25,322
%HCB** Owner-Occupied Households of Total Households, incl. renters	11.9%	15.8%	16.9%	16.1%	9.0%	13.4%	11.3%	14.5%	15.6%

***Housing Cost Burdened (HCB): household paying $\geq 35\%$ income to housing costs, including mortgage, taxes, insurance and utilities.*

***includes fractions of county households within Bay Area Air District's jurisdiction (0.7 for Solano and 0.85 for Sonoma).*

Table 7. Estimated Exemptions from Housing Cost Burdened (HCB)* and 250% FPG Owner-Occupied Households^v (Option A)**

	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano***	Sonoma***
HCB* Owner-Occupied Households	70,735	64,879	17,487	7,997	32,502	35,558	73,855	15,791	25,322
Owner-Occupied Households ≤250% FPG**	69,273	65,263	13,965	9,548	30,716	30,807	66,688	20,377	30,092
HCB* Owner-Occupied Households ≤250% FPG**	(40,450)	(38,542)	(8,956)	(5,169)	(17,352)	(18,563)	(37,755)	(10,992)	(16,703)
Combined Net Total (CNT)	99,558	91,600	22,496	12,376	45,866	47,802	102,788	25,176	38,711
CNT % of Total Households, incl. renters	17%	22%	22%	25%	13%	18%	16%	23%	24%

**HCB: household paying ≥35% income to housing costs, including mortgage, taxes, insurance and utilities.*

***250% FPG: utilizing 4-person household income threshold. Note that number signifies total households in the Bay Area earning under the income threshold, but number of actual persons in each household is unknown.*

****includes fractions of county households within Bay Area Air District's jurisdiction (0.7 for Solano and 0.85 for Sonoma).*

ⁱ California Department of Housing and Community Development. "State Income Limits." [Income Limits 2023](#)

ⁱⁱ Association of Bay Area Governments (ABAG). Plan Bay Area 2050. <https://planbayarea.org/>

ⁱⁱⁱ calculated based on U.S. Census Bureau, U.S. Department of Commerce. "Tenure by Household Income in the Past 12 Months (in 2023 Inflation-Adjusted Dollars)." American Community Survey, ACS 5-Year Estimates Detailed Tables, Table B25118, [https://data.census.gov/table/ACSDT5Y2023.B25118?q=California+Income+and+Poverty&t=Owner/Renter+\(Householder\)+Characteristics&g=050XX00US06001,06013,06041,06055,06075,06081,06085,06095,06097&y=2023](https://data.census.gov/table/ACSDT5Y2023.B25118?q=California+Income+and+Poverty&t=Owner/Renter+(Householder)+Characteristics&g=050XX00US06001,06013,06041,06055,06075,06081,06085,06095,06097&y=2023). Accessed on 9 Dec 2025.

^{iv} U.S. Census Bureau, U.S. Department of Commerce. "Household Income by Selected Monthly Owner Costs as a Percentage of Household Income in the Past 12 Months." American Community Survey, ACS 5-Year Estimates Detailed Tables, Table B25095, https://data.census.gov/table/ACSDT5Y2023.B25095?q=ZCTA5+02131+Business+and+Economy&t=Income+and+Poverty&g=040XX00US06_050XX00US06001,06013,06041,06055,06075,06081,06085,06095,06097. Accessed on 8 Jan 2026.

^v *ibid.*

December 2022

Socioeconomic Impact Analysis of Proposed Amendments to Regulation 9, Rule 4: Residential Central Furnaces; and Regulation 9, Rule 6: Natural Gas-Fired Boilers and Water Heaters

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1. INTRODUCTION

INTRODUCTION

The Bay Area Air Quality Management District (BAAQMD or Air District) has proposed amendments to Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces (Rule 9-4); and Regulation 9, Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters (Rule 9-6). Rule 9-4 primarily applies to gas-fired space-heating furnaces that are primarily found in single-family residences, while Rule 9-6 applies to natural-gas-fired water heaters that have residential and commercial applications. Larger commercial boilers are regulated under Rule 9-7, and thus not applicable to the proposed amendments. The 2017 Clean Air Plan identified the importance of reducing NOx emissions from residential space heaters.

Both Rule 9-4 and Rule 9-6 currently regulate nitrogen oxide (NOx) emissions, and set emission limits for the applicable appliance categories governed by those rules. The proposed rule amendments seek to significantly reduce NOx emissions, and natural gas-fired furnaces and water heaters constitute a major source of those pollutants.

The proposed amendments to Rule 9-4 include a near-term reduction in the emission limit from 40 nanograms (ng) of NOx per joule to 14 ng/joule. Products meeting this standard are widely available and can generally be fitted into existing installations without substantial upgrades.

However, over the longer-term the primary change that the Rule 9-4 and 9-6 amendments will introduce is a zero-NOx emissions standard for both furnaces and water heaters. Currently, while technologies exist that do not emit NOx, these technologies are largely electric appliances, rather than natural gas-fired appliances. If natural gas-fired appliances that meet the zero-NOx standard are not developed before it is implemented, retailers would be expected to sell, and consumers would be expected to purchase and install, electric appliances that do not emit NOx. This would entail a broad change to the market for those types of appliances, because while zero-NOx appliances are available today, they have had limited market adoption. In addition, they can incur greater costs than existing appliances because in addition to the higher appliance costs, the transition to those technologies may also include necessary electric panel upgrades. Because the market has not yet seen the large-scale introduction of appliances that would meet the zero-NOx emissions standard, BAAQMD is considering a timeline that would see the introduction of this standard from 2027 to 2031.

Rule 9-4 and Rule 9-6 currently apply to new devices, and do not mandate retrofitting of existing appliance installations. The proposed amendments do not change this part of the rules. While the regulation applies to wholesalers, retailers, and installers, its potential impact will primarily affect consumers at the time that they need to replace an existing natural gas-fired furnace or water heater at the end of its useful life.

REPORT ORGANIZATION

After this introduction, the report discusses the proposed rule amendments in Section 2. Section 3 describes the socioeconomic impact analysis methodology and data sources. Section 4 goes over the population and economic trends within the nine-county San Francisco Bay Area, and provides context for the BAAQMD rule amendments. Lastly, the socioeconomic impacts from the proposed rule amendments are discussed in Section 5.

The report is prepared pursuant to Section 40728.5 of the California Health and Safety Code, which requires an assessment of socioeconomic impacts of proposed air quality rules and amendments. The findings in this report can assist BAAQMD in understanding the socioeconomic impacts of the proposed requirements, and can assist staff in preparing refined versions of the rule amendments, if needed.

2. BACKGROUND AND OVERVIEW OF PROPOSED RULE 9-4 AND RULE 9-6 AMENDMENTS

OVERVIEW

The proposed amendments to Rule 9-4 and Rule 9-6 aim to substantially reduce NOx emissions in the Bay Area. Residential natural gas-fired furnaces and water heaters make up a substantial source for these emissions. The types of appliances covered under Rule 9-4 and 9-6 are primarily installed in residences. The proposed rule amendments would not mandate retroactive appliance upgrades, and would only apply for new installations and replacement units.

The proposed amendments to Rule 9-4 would first introduce a new “ultra-low-NOx” requirement for central furnaces in 2024. This would lower the allowable NOx emissions from 40 ng/joule to 14 ng/joule, and only apply to residential installations. This would align the BAAQMD with emission standards already enforced by the SCAQMD in the Southern California region and SJVUAPCD in the Central Valley region.

The Rule 9-4 amendments, as currently proposed, would introduce a zero-NOx standard to take effect in 2029. This would apply to residential and commercial space heating appliances.

The Rule 9-6 amendments, as currently proposed, would introduce a zero-NOx standard to take effect between 2027 - 2031. This would apply to residential and commercial water heating devices.

NATURAL GAS USE

Natural gas is the most frequently used heating fuel for Bay Area homes. The 2017 Clean Air Plan found that natural gas appliances in residential buildings represent the primary source of NOx emissions, with a greater tonnage of emissions than passenger vehicles. While other building appliances can also consume natural gas and generate NOx emissions, about 89 percent of the residential NOx emissions come from furnaces and water heaters.

The Bay Area is currently designated a non-attainment area for particulate matter and ozone pollution. NOx emissions are considered a precursor to the formation of both secondary particulate matter and ozone. Therefore, reductions in NOx levels can also help reduce particulate matter and ozone. While the focus of Rule 9-4 and Rule 9-6 is NOx emissions reduction, natural gas-fired furnaces and water heaters also represent 96 percent of the greenhouse gas (GHG) emissions originating from residential buildings.

EMISSION CONTROL METHODS

The substantial NOx emission reductions entailed by the proposed rule amendments will largely occur through a transition from currently designed natural gas-fired appliances to appliances that will have

zero-NOx emissions at the source. Existing natural gas-fired appliances currently have a direct impact on regional air quality because they vent the NOx emissions outside from point sources inside places of residence.

Rule 9-4 includes an initial reduction in the allowable NOx emissions from furnaces from 40 ng/joule to 14 ng/joule. This mandate for ultra-low NOx emission furnaces would follow similar rules already enacted by the SCAQMD and SJVUAPCD, and can be met using technologies and products that are widely used and available in volume.

The proposed zero-NOx standard would begin to phase-in starting in 2027 for small water heaters and 2029 for space heating appliances. While the proposed rule amendments do not specify technologies or emission control methods to meet the zero-NOx standard, the appliances currently available on the market that do not emit NOx mainly consist of electric-powered appliances. The proposed rule amendments would allow the use of natural gas and other technologies if appliances that meet the zero-NOx standard become available.

Initial emission reductions projected by the Air District show that the mandate for ultra-low NOx furnaces will result in a 65 percent reduction in per-unit NOx emissions as older units are replaced between 2024 and 2029. The introduction of the zero-NOx standards will further reduce the NOx emissions with an overall reduction of 95 percent by 2046, when complete equipment changeout is reached.

Additional reductions in GHGs will also occur, as some natural gas-fired appliances will be replaced by electric appliances. However, the overall reduction will vary depending on whether zero-NOx appliances in future also include natural gas-fired units that are designed to meet this standard, and if so, how many consumers choose to purchase those units versus electric appliances.

3. METHODOLOGY

Because the proposed amendments to Rule 9-4 and Rule 9-6 will likely have the greatest potential economic impact on residential consumers, the analysis is focused on consumer spending behavior and how the potential added expenses from appliance upgrades might factor into those spending patterns. Applied Development Economics (ADE) began this analysis by looking at the income distribution patterns in the Bay Area to see how the proposed rule amendments might impact households based on their income, poverty status, and whether they are homeowners or renters.

In order to identify household characteristics and accompanying spending patterns, ADE used data from the U.S. Census American Community Survey (ACS) and the Bureau of Labor Statistics Consumer Expenditure Survey (CES). The ACS is an annual survey of households that is used to identify socioeconomic characteristics by geographic area, and how they change on an annual basis. Because the analysis focused on the nine Bay Area counties served by the Air District, all of the data comes from the combined county-level data.

The analysis used the one-year sample ACS data for 2019, because the 2020 ACS data had data collection issues from the COVID-19 pandemic. The reported data for 2020 is considered experimental by the Census Bureau, and might not be comparable to previous years. The median incomes used in the analysis come directly from the ACS data. Because the Bay Area combines data from the nine counties, the median income was estimated by proportionally weighting the number of households within the income range where the midpoint of total households stands.

The CES data is an ongoing household survey of consumer spending administered by the Bureau of Labor Statistics in order to calculate the Consumer Price Index (inflation rate). This data includes spending information by category, including housing, transportation, retail goods, services, and investments. For the socioeconomic analysis, the CES data is used to identify the proportion of household spending that goes towards major appliance and household equipment purchases. The data is cross-tabulated based on income range, homeownership status, and other household characteristics. This provides a useful benchmark for comparing existing household spending patterns with the potential cost of compliance for the Rule 9-4 and Rule 9-6 amendments.

Because the CES data is a national survey, some of the household spending patterns had to be scaled to Bay Area household incomes, which are generally higher than the national averages. For the renter and homeowner spending patterns, the analysis took the national averages and scaled the spending to the Bay Area median incomes using the CES cross-tabulations by income range.

In order to determine potential impacts on household consumers, the analysis considers the costs of zero-NOx upgrades for both water heaters and central space heaters. Because the only currently available zero-NOx appliances are electric-powered, this analysis assumes for purposes of a conservative “worst case” estimate of costs that consumers will purchase electric appliances as well as incur additional ancillary installation costs (including potential electric panel upgrades) that would be associated only with switching from natural gas-fired to electric appliances.

Households already need to account for potential space heating and water heater replacement costs. Because of this, the analysis focuses on the incremental difference in household costs that would result from the proposed rule amendments. The Energy Information Administration uses an assumed equipment lifetime of 13 years for water heaters and 18 years for space heating appliances, and those benchmarks were used to annualize the compliance costs.

The compliance costs used in the analysis are primarily from a study completed in 2021 by Lawrence Berkeley National Laboratory. The data from this study was used because it includes the project costs for current gas-fired appliances, as well as electric appliances. This allows for a more comparable review of the incremental cost differences between existing gas-fired appliances and zero-NOx emission models that would be required under the Rule 9-4 and Rule 9-6 amendments. It should be noted that these comparisons are based on existing costs using current technologies and volumes of scale. The analysis does not make any assumptions about future cost reductions, nor any rebate programs that may be available to provide incentives for consumers to upgrade appliances.

4. ECONOMIC AND DEMOGRAPHIC TRENDS

This section of the report discusses the larger context of the Air District region within which the proposed Rule 9-4 and Rule 9-6 amendments would apply. This section includes a broad overview of demographic and economic trends, and discussion of households potentially affected by the proposed rule amendments.

REGIONAL POPULATION TRENDS

Table 4-1 tracks population growth in the nine-county San Francisco Bay Area between 2008 and 2021, including data for the year 2015. Between 2008 and 2015, the region grew by 0.6 per year, compared to 0.3 percent for the state as a whole. Since 2015, the Bay Area region has had a lower growth rate than the state. Overall, there are about 7,703,000 people in the region. At 1,934,200, Santa Clara County has the most people, while Napa has the least, at 137,600. Contra Costa grew the fastest between 2008 and 2021, at 0.7 percent a year, while Marin and Sonoma lost population.

Table 4-1: Population Trends: Bay Area Counties, Region, and California, 2008-2021

JURISDICTION	2008	2015	2021	08-15 CAGR	15-21 CAGR	08-21 CAGR
California	38,292,687	39,131,307	39,782,870	0.3%	0.3%	0.3%
SF Bay Area	7,375,678	7,671,279	7,703,016	0.6%	0.1%	0.3%
Alameda	1,556,657	1,632,599	1,656,591	0.7%	0.2%	0.5%
Contra Costa	1,060,435	1,128,405	1,153,854	0.9%	0.4%	0.7%
Marin	258,618	263,327	257,774	0.3%	-0.4%	0.0%
Napa	137,571	141,607	137,637	0.4%	-0.5%	0.0%
San Francisco	845,559	872,723	875,010	0.5%	0.0%	0.3%
San Mateo	745,858	767,921	765,245	0.4%	-0.1%	0.2%
Santa Clara	1,857,621	1,931,565	1,934,171	0.6%	0.0%	0.3%
Solano	426,729	430,530	438,527	0.1%	0.3%	0.2%
Sonoma	486,630	502,602	484,207	0.5%	-0.6%	0.0%

Source: ADE, Inc., based on California Dept. of Finance E-5 Reports (note: CAGR = compound annual growth rate)

REGIONAL ECONOMIC TRENDS

Data in Table 4-2 describe the larger economic context within which officials are contemplating the proposed amendments to Rules 9-4 and 9-6. Employers in the region employ 3.7 million workers. The number of jobs in the region grew annually by 1.3 percent between 2008 and 2015, the period that included the Great Recession. This was almost twice the rate of job growth statewide during this period. Since 2015, the region's job growth showed no growth, as the COVID-19 pandemic had a devastating impact on the leisure and hospitality sectors. By comparison, the state had a modest 0.2 percent job growth.

The economic sectors in Table 4-2 are sorted by the share of total employment in 2020. The top-five sectors in the Bay Area in terms of total number of workers are Professional and Business Services (NAICS 54-55) (745,400 workers); Educational and Health Services (NAICS 61-62) (575,300 workers); Trade, Transportation and Utilities (523,500 workers); Government (443,600 workers), which also includes public sector health and education jobs; and Manufacturing (NAICS 31-33) (352,700).

Table 4-2: San Francisco Bay Area Employment Trends By Sector: 2008 - 2020

INDUSTRY SECTOR		2008	2015	2020	2020 % OF TOTAL	2020 CA % OF TOTAL	SFBA CAGR* 08-15	SFBA CAGR 15-20	CA CAGR 08-15	CA CAGR 15-20
Total, All Industries		3,377,300	3,692,400	3,693,500	100.0%	100.0%	1.3%	0.0%	0.7%	0.2%
54-56	Professional and Business Services	593,200	699,300	745,400	20.2%	15.9%	2.4%	1.3%	1.5%	0.9%
61-62	Educational and Health Services	455,600	550,500	575,300	15.6%	16.2%	2.7%	0.9%	5.1%	2.2%
42, 44-45, 48-49, 22	Trade, Transportation, and Utilities	552,400	566,300	523,500	14.2%	17.6%	0.4%	-1.6%	0.4%	-0.1%
	Government	478,400	466,200	443,600	12.0%	14.7%	-0.4%	-1.0%	-0.5%	0.3%
31-33	Manufacturing	342,900	334,300	352,700	9.5%	7.7%	-0.4%	1.1%	-1.4%	-0.3%
71-72	Leisure and Hospitality	336,300	405,700	297,400	8.1%	9.1%	2.7%	-6.0%	2.2%	-4.0%
51	Information	118,100	166,000	240,100	6.5%	3.2%	5.0%	7.7%	0.4%	1.8%
11, 21, 23	Natural Resources and Construction	199,600	194,200	219,900	6.0%	7.8%	-0.4%	2.5%	-0.3%	1.8%
52-53	Financial Activities	188,100	187,400	191,600	5.2%	5.0%	-0.1%	0.4%	-0.9%	0.6%
81	Other Services	112,900	122,900	104,000	2.8%	2.8%	1.2%	-3.3%	-5.1%	-2.4%

Source: Applied Development Economics, based on State of California, Employment Development Department Labor Market Information Division, "Quarterly Census of Employment and Wages" *Note: CAGR = compound annual growth rate; **Note: Public sector education and public sector health included in government.

The fastest job growth rates since 2015 have been in Information Services, which includes many internet businesses, followed by Natural Resources and Construction; Professional and Business Services; and Educational and Health Services.

The table demonstrates the advanced nature of the regional economy, as over 26 percent of all jobs are in the combined Professional, Business, and Information services categories, compared to 19.1 percent for the state. In addition, manufacturing in the Bay Area grew at an average annual rate of 1.1 percent between 2015 and 2020, while the sector declined by 0.3 percent during this period statewide. This is due in large part to the many technology-driven industries that are concentrated in that category in the Bay Area.

TRENDS FOR HOUSEHOLDS SUBJECT TO PROPOSED RULE AMENDMENTS

INCOME DISTRIBUTION

As shown in Table 4-3, the income distribution for the nine Bay Area counties shows a very high proportion of households (25.4 percent) with an annual income above \$200,000. San Francisco, San Mateo, and Santa Clara counties each have over 30 percent of households in this high-income range.

Solano (10.1 percent) and Sonoma (13.3 percent) have the lowest concentration of households with over \$200,000 in annual income.

Table 4-3: Income Distribution for Bay Area Region and Counties, 2019

HOUSEHOLDS BY INCOME RANGE	BAY AREA REGION	ALAMEDA COUNTY	CONTRA COSTA COUNTY	MARIN COUNTY	NAPA COUNTY
Total Households	2,733,300	574,700	393,700	105,100	48,800
Less than \$15,000	172,700	43,500	24,300	6,200	3,200
\$15,000 to \$29,999	178,300	41,800	23,900	7,400	2,900
\$30,000 to \$39,999	127,100	25,100	20,700	5,700	2,300
\$40,000 to \$49,999	125,600	25,800	17,100	5,800	3,900
\$50,000 to \$69,999	256,700	53,900	38,200	8,800	5,600
\$70,000 to \$99,999	360,400	74,100	59,000	13,800	8,200
\$100,000 to \$149,999	481,400	109,400	74,400	16,800	8,500
\$150,000 to \$199,999	336,700	73,500	47,900	10,600	5,500
\$200,000 and more	698,900	127,600	88,200	30,000	8,700
Median Income (Bay Area Estimated)	\$115,400	\$108,300	\$107,100	\$110,800	\$92,800
HOUSEHOLDS BY INCOME RANGE	SAN FRANCISCO COUNTY	SAN MATEO COUNTY	SANTA CLARA COUNTY	SOLANO COUNTY	SONOMA COUNTY
Total Households	368,100	263,800	640,400	151,100	187,700
Less than \$15,000	33,300	11,100	30,700	9,800	10,600
\$15,000 to \$29,999	26,800	15,400	35,700	11,400	13,100
\$30,000 to \$39,999	13,900	10,600	28,400	9,200	11,200
\$40,000 to \$49,999	13,700	11,300	24,300	9,900	13,700
\$50,000 to \$69,999	29,600	21,200	55,500	19,100	24,800
\$70,000 to \$99,999	37,600	28,900	74,800	28,500	35,600
\$100,000 to \$149,999	54,900	44,700	105,900	30,900	35,800
\$150,000 to \$199,999	43,700	33,600	85,000	16,400	20,500
\$200,000 and more	112,400	88,100	203,400	15,200	25,300
Median Income	\$123,900	\$138,500	\$133,100	\$86,700	\$87,800
PERCENT OF TOTAL	BAY AREA REGION	ALAMEDA COUNTY	CONTRA COSTA COUNTY	MARIN COUNTY	NAPA COUNTY
Less than \$15,000	6.3%	7.4%	6.1%	5.9%	6.7%
\$15,000 to \$29,999	6.5%	7.1%	6.0%	7.0%	5.9%
\$30,000 to \$39,999	4.6%	4.3%	5.2%	5.4%	4.7%
\$40,000 to \$49,999	4.6%	4.4%	4.3%	5.5%	8.2%
\$50,000 to \$69,999	9.3%	9.2%	9.6%	8.4%	11.6%
\$70,000 to \$99,999	13.1%	12.7%	14.8%	13.1%	17.0%
\$100,000 to \$149,999	17.5%	18.7%	18.6%	15.9%	17.8%
\$150,000 to \$199,999	12.2%	12.6%	12.0%	10.0%	11.4%
\$200,000 and more	25.4%	21.8%	22.1%	28.5%	18.1%
PERCENT OF TOTAL	SAN FRANCISCO COUNTY	SAN MATEO COUNTY	SANTA CLARA COUNTY	SOLANO COUNTY	SONOMA COUNTY
Less than \$15,000	9.1%	4.2%	4.8%	6.5%	5.6%
\$15,000 to \$29,999	7.3%	5.8%	5.5%	7.6%	6.9%
\$30,000 to \$39,999	3.8%	4.0%	4.4%	6.1%	5.9%
\$40,000 to \$49,999	3.8%	4.3%	3.8%	6.6%	7.2%
\$50,000 to \$69,999	8.1%	8.0%	8.6%	12.7%	13.0%
\$70,000 to \$99,999	10.3%	10.9%	11.6%	18.9%	18.7%
\$100,000 to \$149,999	15.0%	16.9%	16.5%	20.5%	18.8%
\$150,000 to \$199,999	11.9%	12.7%	13.2%	10.9%	10.7%
\$200,000 and more	30.7%	33.3%	31.6%	10.1%	13.3%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.
 Note: Median income for the Bay Area is a computed average using the combined household counts for the nine Bay Area counties.

In the lower range, about 12.8 percent of Bay Area households have an annual income below \$30,000. San Francisco (16.4 percent) has the highest concentration of households in this lower income range, while San Mateo (10.0 percent) and Santa Clara (10.3 percent) counties have the lowest concentration.

Using data from the ACS, the nine-county Bay Area region had an estimated median household income of approximately \$115,400 in 2019 (Table 4-4). San Mateo (\$138,500) and Santa Clara (\$133,100) counties had the highest median incomes, while Sonoma (\$86,700) and Solano (\$87,800) had the lowest.

INCOME GROWTH BY HOUSING TENURE

Since 2010, the Bay Area has had relatively modest household growth, increasing from 2.61 million households in 2010 to 2.73 million households in 2019 (Table 4-4). However, during this time, the income levels have increased significantly in real dollar terms, as shown in Table 4-4. In 2019, the estimated median income for Bay Area households was \$115,400. This represents a compounded annual growth rate (CAGR) of 4.7 percent compared to 2015 (\$96,100), and 3.3 percent compared to 2010 (\$86,300). The median income for renter households grew at a faster rate than for homeowners, with 5.5 percent CAGR between 2015 and 2019, and a 5.1 percent CAGR between 2010 and 2019. The median income for homeowners grew at a CAGR of 3.2 percent going back to 2015 and a 2.3 percent CAGR from 2010 to 2019.

Table 4-4: San Francisco Bay Area Household Income Growth by Housing Tenure

INCOME BY HOUSING TENURE	TOTAL BAY AREA HOUSEHOLDS (2019)	OWNER-OCCUPIED (2019)	RENTER-OCCUPIED (2019)	TOTAL BAY AREA HOUSEHOLDS (2015)	OWNER-OCCUPIED (2015)	RENTER-OCCUPIED (2015)	TOTAL BAY AREA HOUSEHOLDS (2010)	OWNER-OCCUPIED (2010)	RENTER-OCCUPIED (2010)
Total Households	2,733,300	1,515,100	1,218,200	2,664,600	1,466,100	1,198,500	2,606,300	1,459,900	1,146,400
Less than \$5,000	56,300	18,000	38,300	59,100	18,900	40,300	68,400	18,600	49,800
\$5,000 to \$9,999	34,500	10,100	24,500	54,900	14,100	40,800	61,200	14,900	46,300
\$10,000 to \$14,999	81,800	18,900	62,900	97,600	23,000	74,500	111,200	28,000	83,200
\$15,000 to \$19,999	55,400	20,400	35,000	78,100	27,600	50,500	96,800	31,300	65,500
\$20,000 to \$24,999	61,300	23,700	37,600	89,200	33,300	55,900	107,300	37,700	69,700
\$25,000 to \$34,999	127,000	52,400	74,600	162,100	63,800	98,400	185,300	74,600	110,700
\$35,000 to \$49,999	186,500	77,900	108,700	242,200	105,200	136,900	282,100	122,200	159,900
\$50,000 to \$74,999	320,900	148,700	172,200	372,100	180,200	191,900	414,000	215,400	198,500
\$75,000 to \$99,999	295,000	148,800	146,200	313,200	169,900	143,300	324,200	194,700	129,500
\$100,000 to \$149,999	480,600	278,000	202,600	467,200	292,400	174,700	449,000	310,000	139,000
\$150,000 or more	1,034,100	718,400	315,700	729,000	537,600	191,400	507,000	412,600	94,300
Estimated Median Income (2019 Dollars)	\$115,400	\$142,900	\$84,500	\$96,100	\$125,800	\$68,300	\$86,300	\$116,100	\$54,200

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

Note: Median income for the Bay Area is a computed average using the combined household counts for the nine Bay Area counties.

INCOME DESIGNATIONS

The U.S. Department of Housing and Urban Development (HUD) designates an upper limit for different income classifications. These thresholds are based on the percentage of the median household income for a particular geographic region. The base income definitions include low-income (80 percent of median income), very low-income (50 percent of median income), and extremely low-income (30

percent of median income). The upper limits are adjusted based on regional housing costs and other factors.

For the nine-county Bay Area region, there are six different metro areas as shown below.¹ Each of these metro areas has a different definition for low, very low, and extremely low income.

- Oakland-Fremont, CA HUD Metro FMR Area (Alameda and Contra Costa)
- San Francisco, CA HUD Metro FMR Area (San Francisco, San Mateo, and Marin)
- Napa, CA MSA (Napa County)
- San Jose-Sunnyvale-Santa Clara, CA HUD Metro FMR Area (Santa Clara County)
- Vallejo-Fairfield CA MSA (Solano County)
- Santa Rosa, CA MSA (Sonoma County)

In 2021, the upper limit of what HUD classified as low-income for a family of four in the Bay Area ranged from \$77,600 in Solano County to \$146,350 in San Francisco, San Mateo, and Marin counties. The incomes considered very low for a family of four ranged from \$48,550 to \$91,350, while the extremely low-income limit ranged from \$29,150 to \$54,800, as shown in Table 4-5.

Table 4-5: Income Designations by County, 2019 to 2021

INCOME LEVELS BY COUNTY FOR FAMILY OF FOUR	2021 LOW INCOME (80%)	2021 VERY LOW INCOME (50%)	2021 EXTREMELY LOW INCOME	2019 LOW INCOME (80%)	2019 VERY LOW INCOME (50%)	2019 EXTREMELY LOW INCOME
Alameda County	\$109,600	\$68,500	\$41,100	\$98,550	\$61,650	\$37,150
Contra Costa County	\$109,600	\$68,500	\$41,100	\$98,550	\$61,650	\$37,150
Marin County	\$146,350	\$91,350	\$54,800	\$129,150	\$80,600	\$48,350
Napa County	\$90,050	\$56,850	\$34,100	\$79,500	\$50,200	\$30,100
San Francisco County	\$146,350	\$91,350	\$54,800	\$129,150	\$80,600	\$48,350
San Mateo County	\$146,350	\$91,350	\$54,800	\$129,150	\$80,600	\$48,350
Santa Clara County	\$117,750	\$82,850	\$49,700	\$103,900	\$73,150	\$43,900
Solano County	\$77,600	\$48,550	\$29,150	\$68,550	\$42,850	\$25,750
Sonoma County	\$93,050	\$58,150	\$34,900	\$86,400	\$54,000	\$32,400

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

¹ The metropolitan statistical area (MSA) definitions are maintained by the Office of Management and Budget (OMB). However, HUD will use a custom geographic area for purposes of calculating the fair market rent used to adjust the income group definitions.

POVERTY

In 2019, the Bay Area had a combined 79,100 families living in poverty (Table 4-6). This represents 4.4 percent of the total families in the Bay Area (this does not include non-family households that comprised 35 percent of the total Bay Area households), as shown in Table 4-6. Compared to 2010 and 2015, the proportion of families living under the federal poverty line has gone down.

Table 4-6: San Francisco Bay Area Families with Income Below Poverty Level, 2010 to 2019

BAY AREA COUNTY	FAMILIES (2019)	INCOME BELOW POVERTY LEVEL (2019)	PERCENT BELOW POVERTY LEVEL	FAMILIES (2015)	INCOME BELOW POVERTY LEVEL (2015)	PERCENT BELOW POVERTY LEVEL	FAMILIES (2010)	INCOME BELOW POVERTY LEVEL (2010)	PERCENT BELOW POVERTY LEVEL
Bay Area Region	1,790,600	79,100	4.4%	1,792,900	119,200	6.6%	1,669,800	123,100	7.4%
Alameda	381,900	20,300	5.3%	383,300	28,700	7.5%	350,200	32,400	9.3%
Contra Costa	283,800	15,800	5.6%	280,500	21,100	7.5%	261,700	17,700	6.8%
Marin	64,600	2,400	3.7%	66,100	2,800	4.2%	64,700	3,400	5.3%
Napa	31,600	1,500	4.7%	33,100	2,400	7.3%	32,600	3,200	9.8%
San Francisco	167,900	8,200	4.9%	164,200	11,800	7.2%	149,600	11,400	7.6%
San Mateo	180,900	5,700	3.2%	185,700	9,400	5.1%	171,200	7,500	4.4%
Santa Clara	452,200	14,800	3.3%	456,200	24,500	5.4%	424,900	29,100	6.8%
Solano	105,500	6,600	6.3%	103,100	9,900	9.6%	99,100	9,400	9.5%
Sonoma	122,300	3,800	3.1%	120,800	8,500	7.0%	115,900	9,000	7.8%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

As shown in Table 4-7, the federal poverty thresholds will vary depending on the size of the household/family, ranging from \$12,490 for a single-resident household/family to \$43,430 for a family/household of eight residents in 2019. This increased to a range of \$12,880 (one person) to \$44,660 (eight persons) in 2021. A family of four had a poverty line of \$26,500 in 2021 and \$25,750 in 2019.

Table 4-7: Federal Poverty Levels by Number of Persons in Family or Household, 2019 to 2021

PERSONS IN FAMILY OR HOUSEHOLD	2021 FEDERAL POVERTY GUIDELINES	2019 FEDERAL POVERTY GUIDELINES
1	\$12,880	\$12,490
2	\$17,420	\$16,910
3	\$21,960	\$21,330
4	\$26,500	\$25,750
5	\$31,040	\$30,170
6	\$35,580	\$34,590
7	\$40,120	\$39,010
8	\$44,660	\$43,430

Source: Applied Development Economics, based on U.S. Department of Health and Human Services "Poverty Guidelines Computations Page."

RENTERS

In the Bay Area, renters represent about 44.6 percent of all households, as shown in Table 4-8. This ranges from a low of 33.9 percent in Napa County to a high of 62.9 percent in San Francisco. No other county has renters as a majority of all households. In 2019, the median income for renters ranged from a low of about \$63,400 in Sonoma County to a high of more than \$105,300 in San Francisco County.

Table 4-8: San Francisco Bay Area Households by Housing Tenure, 2019

HOUSING TENURE BY COUNTY	TOTAL HOUSEHOLDS	HOUSEHOLDS (OWNER-OCCUPIED)	HOUSEHOLDS (RENTER-OCCUPIED)	RENTERS AS PERCENT OF TOTAL HOUSEHOLDS
Bay Area Region	2,733,300	1,515,100	1,218,200	44.6%
Alameda	574,700	304,700	270,000	47.0%
Contra Costa	393,700	257,500	136,100	34.6%
Marin	105,100	65,200	39,900	38.0%
Napa	48,800	32,300	16,500	33.9%
San Francisco	368,100	136,700	231,400	62.9%
San Mateo	263,800	156,300	107,500	40.7%
Santa Clara	640,400	351,800	288,600	45.1%
Solano	151,100	94,000	57,100	37.8%
Sonoma	187,700	116,600	71,000	37.8%

MEDIAN INCOME BY HOUSING TENURE AND COUNTY	MEDIAN INCOME (ALL HOUSEHOLDS)	MEDIAN INCOME (OWNER-OCCUPIED HOUSEHOLDS)	MEDIAN INCOME (RENTER-OCCUPIED HOUSEHOLDS)	RENTER INCOME AS PERCENT OF OVERALL MEDIAN INC.
Bay Area Region (Estimated)	\$115,400	\$142,900	\$84,500	73.2%
Alameda	\$108,300	\$145,100	\$76,500	70.6%
Contra Costa	\$107,100	\$130,800	\$72,700	67.9%
Marin	\$110,800	\$146,800	\$73,700	66.5%
Napa	\$92,800	\$110,700	\$73,200	78.9%
San Francisco	\$123,900	\$151,700	\$105,300	85.0%
San Mateo	\$138,500	\$164,800	\$101,200	73.1%
Santa Clara	\$133,100	\$167,100	\$97,300	73.1%
Solano	\$86,700	\$102,000	\$64,200	74.0%
Sonoma	\$87,800	\$106,800	\$63,400	72.2%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

Table 4-9 shows that the median monthly rent in the Bay Area ranged from just over \$1,700 in Solano County to a high of nearly \$2,500 in San Mateo County in 2019. The median housing costs as a percentage of median monthly household income ranges from 22.3 percent in San Francisco to 34.4 percent in Marin County. Dedicating 30 percent or more of income towards housing is considered “cost-burdened.” This indicates that median housing costs for renters in Alameda, Contra Costa, Marin, Napa, Solano, and Sonoma counties are already considered cost-burdened for average wage earners. Median housing costs for renters in San Mateo (29.8 percent) and Santa Clara (29.5 percent) are just below the threshold for cost-burdened.

Table 4-9: Housing Costs as Percentage of Income for San Francisco Bay Area Counties, 2019

COUNTY	MEDIAN MONTHLY HOUSEHOLD INCOME	MEDIAN MONTHLY HOUSING COSTS	HOUSING COSTS AS PERCENT OF INCOME	MEDIAN MONTHLY HOUSEHOLD INCOME (OWNER-OCCUPIED)	MEDIAN MONTHLY HOUSING COSTS (OWNER-OCCUPIED)	HOUSING COSTS AS PERCENT OF INCOME	MEDIAN MONTHLY HOUSEHOLD INCOME (RENTER)	MEDIAN MONTHLY HOUSING COSTS (RENTER)	HOUSING COSTS AS PERCENT OF INCOME
Alameda	\$9,000	\$2,160	24.0%	\$12,100	\$2,470	20.4%	\$6,400	\$1,980	30.9%
Contra Costa	\$8,900	\$2,100	23.6%	\$10,900	\$2,250	20.6%	\$6,100	\$1,950	32.0%
Marin	\$9,200	\$2,400	26.1%	\$12,200	\$2,830	23.2%	\$6,100	\$2,100	34.4%
Napa	\$7,700	\$1,840	23.9%	\$9,200	\$1,850	20.1%	\$6,100	\$1,840	30.2%
San Francisco	\$10,300	\$2,150	20.9%	\$12,600	\$2,700	21.4%	\$8,800	\$1,960	22.3%
San Mateo	\$11,500	\$2,590	22.5%	\$13,700	\$2,730	19.9%	\$8,400	\$2,500	29.8%
Santa Clara	\$11,100	\$2,480	22.3%	\$13,900	\$2,640	19.0%	\$8,100	\$2,390	29.5%
Solano	\$7,200	\$1,780	24.7%	\$8,500	\$1,860	21.9%	\$5,400	\$1,720	31.9%
Sonoma	\$7,300	\$1,840	25.2%	\$8,900	\$1,930	21.7%	\$5,300	\$1,760	33.2%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

HEATING FUEL SOURCE

For heating fuel, about a two-thirds majority of Bay Area households use utility-provided gas, as shown in Table 4-10. However, owner-occupied housing units have a higher utilization of utility gas for home heating, with 76.5 percent. Households in rental housing have a lower proportion of utility gas utilization at 53.5 percent. About 18.5 percent of owner-occupied housing units use electricity for home heating, compared to 40.6 percent of renter-occupied units. This likely reflects the generally higher utilization of electric space heating in multifamily housing units and apartments.

Table 4-10: Source of Heating Fuel for San Francisco Bay Area Households, 2019

HEATING FUEL SOURCE	BAY AREA HOUSEHOLDS	PERCENT OF TOTAL
Total Households	2,733,300	
Utility Gas	1,809,900	66.2%
Electricity	775,100	28.4%
Solar Energy	23,700	0.9%
No Fuel Used	50,500	1.8%
All Other Heating Fuels	74,100	2.7%
Owner-Occupied Housing Units	1,510,800	
Utility Gas	1,156,100	76.5%
Electricity	278,800	18.5%
Solar Energy	20,500	1.4%
No Fuel Used	8,600	0.6%
All Other Heating Fuels	46,900	3.1%
Renter-Occupied Housing Units	1,222,500	
Utility Gas	653,800	53.5%
Electricity	496,300	40.6%
Solar Energy	3,300	0.3%
No Fuel Used	41,900	3.4%
All Other Heating Fuels	27,200	2.2%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample.

5. SOCIOECONOMIC IMPACT ANALYSIS OF PROPOSED RULE 9-4 AND RULE 9-6 AMENDMENTS

COSTS OF RULE COMPLIANCE

This section of the report analyzes the socioeconomic impacts resulting from implementation of the Rule 9-4 and 9-6 amendments. This analysis assumes, based on technology available today and to provide a conservative estimate of potential costs, that compliance with the proposed rule amendments will see costs incurred primarily through gas-to-electric conversions of existing water heaters and space heaters by end users and accompanying ancillary costs. Because the proposed rule amendments do not require retrofitting of existing appliances, the costs of compliance will only take effect at the time that the appliances require replacement or when the consumer chooses to upgrade.

The costs of compliance do not affect consumers that already use electric appliances for water heating and/or space heating, since those appliances already comply with the zero-NOx emissions standard. Because these appliances are typically already installed in housing units and require periodic replacement, the cost of compliance used in the analysis assumes that the cost of compliance represents the cost difference between purchase and installation of a currently designed natural gas-powered appliance and an electrical one. The analysis does not make any assumptions about future zero-NOx appliance cost reductions and rebate program availability.

In addition to the direct costs to consumers to purchase and install new equipment, there are a number of indirect cost and revenue impacts from the proposed rule amendments.

- Heat pump water heaters are cheaper to operate in terms of monthly household energy bills. The same is true for air source heat pumps that heat and cool indoor air as compared to a building with a natural gas fired furnace and a traditional air conditioning system. Note that in cases where an air source heat pump may introduce new cooling functionality (i.e., an installation in a household without existing air conditioning), consumers may elect to increase their heat pump usage for these new functions. However, this analysis only focuses on the usage of this new equipment that is comparable to the existing usage of the equipment being replaced.
- Despite the potential energy cost savings, the net cost to consumers will shift their spending away from other retail goods and services, which may result in incremental loss of jobs in those sectors.
- The wholesale appliance distributors and construction trades will see an increase in the cost of doing business for the higher priced appliances, but this will be offset by higher prices to consumers for the equipment.

- Manufacturers of the equipment, of which there are none of the Bay Area, will have to invest in new technologies and manufacturing processes to supply the new equipment to the Bay Area market. If the manufacturers choose not to make investments in the new designs, they will lose market share from the Bay Area.
- PG&E will likely need to invest in increased electricity generation, transmission and distribution to meet the increased demand for electricity from the new appliances. This may result in higher electricity rates for consumers.

In the discussion below, the direct consumer costs and the effects of the first two bullet points above are addressed quantitatively for households at various income levels and also in aggregate across the Bay Area region. Impacts to the supply chain for the new appliances are addressed qualitatively. In terms of impacts to the electric grid, the discussion presents estimated costs for PG&E under two background scenarios. However, it is not clear at this time if or how the costs may affect consumer electricity rates. Air District staff may report on rate changes as part of its Implementation Working Group and interim reporting process to the Board of Directors.

RULE 9-4 COST OF COMPLIANCE

For Rule 9-4, the analyzed cost of compliance will largely stem from the difference between a gas-fired furnace and an electric heat pump. According to a 2021 study from Lawrence Berkeley National Laboratory, the median installed cost for a gas-fired furnace is about \$5,100, while the median cost for an electric heat pump is \$8,000, as shown in Table 5-1.² This cost includes the cost of the appliance unit and the installation, but not potential electric service upgrades which are discussed later. The cost does not factor in any rebates or performance differences. The difference between the cost of a gas-fired furnace compared to an electric heat pump is approximately \$2,900 and this represents the major portion of the cost of compliance used in this socioeconomic analysis.

However, heat pump units can also incorporate cooling functionality similar to a central air conditioning unit. So, the costs are not always directly comparable strictly as a gas-fired furnace replacement. In addition, the appliance costs can vary considerably depending on the performance characteristics of the particular model chosen by the consumer (and in the gas-fired appliances, whether the unit is a standard or Ultra-low NOx emission model). In general, electric heat pumps operate with a lower heating capacity than comparably priced gas-fired furnaces.

² Less, Brennan, Iain Walker, Nuria Casquero-Modrego, and Leo Rainier; Lawrence Berkeley National Laboratory, Building Technologies & Urban Systems Division; *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes*; 2021; pp.70-81.

Table 5-1: Comparison of Project Costs for Electric Heat Pump and Gas Furnace

LAWRENCE BERKELEY NATIONAL LAB STUDY MEDIAN COSTS BY SPACE HEATER TYPE	PROJECT COSTS
Electric Heat Pump	\$8,027
Gas Furnace	\$5,096
E3 STUDY COST ASSUMPTIONS	PROJECT COSTS
Gas Furnace + Central AC (Existing)	\$12,000 to \$24,000
Packaged Terminal Heat Pump	\$7,000 to \$8,000
Minisplit Heat Pump	\$18,000 to \$20,000
Ducted Split Heat Pump	\$9,000 to \$17,000

Source: Lawrence Berkeley National Laboratory, and Energy and Environmental Economics, Inc.

When comparing the cost scenarios for a gas-fired furnace and an electric heat pump, a 2019 study from Energy and Environmental Economics, Inc. (E3) combined the costs for a gas furnace with a central air conditioning unit, and used that combined project to compare against the cost of electric heat pumps that combines both functions.³ Using that comparison, the study used a cost assumption ranging from \$12,000 to \$24,000 for the furnace/central air conditioning system. The heat pump would cost between \$7,000 and \$20,000, depending on the type of heat pump and its level of performance. Under this scenario, where the installation accounts for both heating and cooling functions, the heat pump installation would cost less in many cases.

In the short-term, there is also a cost difference between the standard gas-fired furnaces and those gas-fired models that meet the ultra-low NOx emission standard. In a brief comparison of retail pricing for models with equivalent performance, the ultra-low NOx emission models generally cost between \$400 and \$700 more.⁴ This cost difference would apply from 2024 until the zero-NOx emissions standard takes effect. Note that for the purposes of the socioeconomic impact analysis, the compliance cost associated with the zero-NOx standard reflects the highest potential cost and socioeconomic impacts from the proposed amendments to Rule 9-4. Therefore, the costs associated with the zero-NOx standard are used in the subsequent impact analysis (see “Compliance Costs Used in Impact Analysis” section below).

RULE 9-6 COST OF COMPLIANCE

For water heaters under Rule 9-6, costs for compliance for the proposed rule amendments are highly variable when comparing different options. In addition, the compliance costs have to consider the full cost of both the appliance and the installation. For example, according to a study from Lawrence Berkeley National Laboratory, the lowest cost water heater option is an electric tank water heater, while the most expensive options are tankless gas-fired water heaters. However, the resistive electric tank water heaters are generally small capacity units for point-of-use rather than whole-home installations, compared to the more common 50 to 80-gallon gas-fired tank water heaters. Tankless

³ Energy and Environmental Economics, Inc.; *Residential Building Electrification in California*; April 2019; pp.29-31. Note: While the dollar values referenced in this study have likely increased with inflation since 2019, they are presented here for comparison only. The socioeconomic impact analysis is based on the more recent LBL figures.

⁴ Retail pricing data for space heating and water heater appliances was collected by BAAQMD staff in 2020 and 2022. This pricing only reflects the unit costs and does not include any rebate programs that might offset the costs of upgrading to a lower emission option.

water heaters allow for on-demand water heating; and while they use less natural gas, the models currently available do not meet the zero-NOx emission standard.

The zero-NOx option that is available today and is most comparable to the commonly used gas-fired water tank heaters would be an electric heat pump attached to a similarly sized water tank. As shown in Table 5-2, the median cost of a conventional natural gas-fired tank water heater is about \$1,970.

By comparison, the LBNL study indicates that an electric heat pump water heater has a median cost of about \$2,820, with the cost difference of around \$850 representing the cost of compliance used in the socioeconomic analysis. It should be noted that the electric heat pump water heater costs in this dataset could also include some direct replacements of existing electric heat pump water heater units rather than gas-to-electric conversions.

Other cost data from the Sacramento Municipal Utilities District (SMUD) shows a cost range of approximately \$4,150 to \$4,400 for gas-to-electric conversions to heat pump water heaters between 2018 and 2020. The data includes the cost for the appliance unit as well as installation and other costs. These cost averages are higher than the median costs from the LBNL study. However, the SMUD gas-to-electric water heater conversion costs were balanced out by a rebate program for gas-to-electric conversions that reduced the consumer costs by up to \$3,000.

Table 5-2: Comparison of Project Costs for Water Heaters by Type

LAWRENCE BERKELEY NATIONAL LAB STUDY MEDIAN COSTS BY WATER HEATER TYPE	PROJECT COSTS
Tankless Gas	\$4,004
Electric Heat Pump	\$2,824
Storage Gas Power Vent	\$1,972
Storage Electric	\$888
SMUD AVERAGE COST DATA FOR GAS-TO-ELECTRIC HEAT PUMP WATER HEATER CONVERSION	PROJECT COSTS
50-Gallon	\$4,155
65/80-Gallon	\$4,374
E3 STUDY COST ASSUMPTIONS	PROJECT COSTS
Gas-Fired Water Heater (Existing)	\$2,000 to \$2,600
Tankless Gas Water Heater	\$3,700 to \$5,700
Electric Heat Pump	\$3,000 to \$4,700

Source: Lawrence Berkeley National Laboratory, Sacramento Municipal Utilities District, and Energy and Environmental Economics, Inc.

THE NEED FOR ELECTRIC PANEL UPGRADES

In older homes, if both the HVAC and water heater systems are converted from gas to electric at the same time, it is possible that the electric panel in the home will also need to be upgraded. The E3 study assumed this would happen in homes built in 1978 or earlier and that the cost would be \$4,256 for single family homes and \$2,744 for low-rise multi-family homes. The census provides data on housing units constructed in 1979 or earlier, which includes about 65 percent of all units in the Bay Area (Table 5-3).

Table 5-3: Age of Housing Units by County, 2015-2020 Average

COUNTY	OCCUPIED HOUSING UNITS	BUILT IN 1979 OR EARLIER	PERCENT
Alameda	573,174	387,959	67.7%
Contra Costa	398,299	220,707	55.4%
Marin	104,900	80,534	76.8%
Napa	48,484	28,550	58.9%
San Francisco	362,141	288,834	79.8%
San Mateo	263,351	198,374	75.3%
Santa Clara	635,314	399,737	62.9%
Solano	151,191	71,043	47.0%
Sonoma	188,958	100,572	53.2%
TOTAL	2,725,812	1,776,310	65.2%

Source: ACS, 5 Year Sample, 2015-2020.

COMPLIANCE COSTS USED IN IMPACT ANALYSIS

The combined cost of equipment to comply with both Rule 9-4 and 9-6 is estimated at \$10,851, of which \$8,027 is for space heating and \$2,824 is for water heating. This is about \$3,783 more expensive than equivalent gas powered appliances. In addition, older homes would need to upgrade their electric service, at a cost of \$4,256 for single family units and \$2,744 for multi-family units. It is likely these costs can be financed, but that may not always be possible.

The replacement schedule for a water heater is typically 13 years, while the replacement schedule for a space heating appliance is 18 years.⁵ We also assume electric panels have a lifespan of 30 years. Since households do not all replace heating appliances at the same time and the proposed rule amendments do not apply until the time that the appliances are replaced, this means that the aggregate cost of compliance across all households will be spread out over time. In order to annualize the costs per household, we have applied a capital recovery factor pursuant to Best Available Control Technology (BACT) guidelines.⁶

Using this approach, the annualized cost of compliance used in the socioeconomic analysis comes out to \$241 for space heaters and \$88 for water heaters when looking at gas-to-electric conversions, as shown in Table 5-4. This added cost only applies to those households that currently use gas as the fuel source for powering the appliances.

The annualized costs of installation of electric panels are \$261 for single family homes and \$168 for multi-family homes, with a weighted average for all units of \$220. These figures are used in the analysis of impacts to average households and contribute to the total compliance costs of \$402 for space heaters and \$147 for water heaters (Table 5-4). Further below in the analysis of aggregate

⁵ Environmental Energy and Economics, Inc.; p.41.

⁶ (<https://www.baaqmd.gov/~/media/files/engineering/bact-tbact-workshop/bact-tbact-policy-and-implementation/policy-and-implementation-procedure.pdf?la=en>). The calculation uses a discount rate of 4.5%.

regionwide costs, we also adjust for the fact that only 65 percent of households are likely to need a panel upgrade.

Table 5-4: Average Annualized Installed Costs for Space Heating Appliances and Water Heaters

ANNUALIZED INSTALLED COST	GAS	ELECTRIC	ANNUALIZED DIFFERENCE	ELECTRIC PANEL	TOTAL COST DIFFERENCE
Space Heating	\$419	\$660	\$241	\$161	\$402
Water Heater	\$204	\$292	\$88	\$59	\$147

Source: Lawrence Berkeley National Laboratory

Notes: The annualized costs represent the median costs for space heating appliance and water heater installations, assuming an 18-year lifespan for a space heating appliance and a 13-year lifespan for a water heater. The gas option for water heaters is a gas-fired tank water heater, while the electric options for both space heating and water heaters are electric heat pumps.

The costs presented in this table do not account for potential savings associated with funding or financing programs, which are growing in availability and accessibility to Bay Area consumers. Current programs are discussed in the Staff Report to which this analysis is an Appendix. Additionally, Air District staff will track the development of these programs through their Implementation Working Group and interim reporting process.

RATE SAVINGS DUE TO ELECTRIC CONVERSION

In addition to differences in the appliance costs, another key potential difference is with the potential utility costs. In shifting from utility gas-powered appliances to electrical models, the power source and associated utility costs also change. The E3 study found that an all-electric home would likely see significant utility cost savings when compared to homes that use a combination of natural gas and electricity to power household appliances.

For HVAC gas-to-electric conversions, the E3 study found that converting to an electric heat pump would potentially result in an average annual savings of about \$600 in utility bills. It should be noted that this cost savings considers the combined effect of converting to an electric heat pump system that replaces both a gas-fired furnace and a central air conditioning, which would not be a direct result of the proposed rule amendments, but could present an indirect benefit. In addition to replacing the natural gas usage for space heating, electric heat pumps would also reduce electricity usage for cooling compared to a central air conditioning unit. The utility bill savings could be substantial when considering the 18-year service life for these HVAC appliances.⁷ Note that in cases where an air source heat pump may introduce new cooling functionality (i.e., an installation in a household without existing air conditioning), consumers may elect to increase their heat pump usage for these new functions. However, this analysis only focuses on the usage of this new equipment that is comparable to the existing usage of the equipment being replaced.

Also, the cost savings can vary considerably depending on the utility service pricing. For example, the E3 study projected that households in the SMUD utility service area would save up to \$600 in utility costs by converting to an HVAC heat pump, while households in other utility service territories were

⁷ Environmental Energy and Economics, Inc.; pp. 59-60.

projected to save up to \$400 annually. Households in Bay Area utility service areas would see savings of between \$100 and \$400 for single-family homes and \$10 to \$90 for multi-family homes. The study also indicated that if gas rates increase faster than electric rates over the long-term, then that would further increase the utility cost savings. Since 2019 when the E3 analysis was done, PG&E has raised both electric and gas rates, but gas rates have had higher percentage increases. For purposes of this analysis, we have assumed an average rate savings of \$250 for single family homes and \$50 per year for multi-family homes, which is lower than the maximum possible but acknowledges the uncertainty of the changing utility rate environment.

For water heaters, the E3 study indicated that retrofitting a heat pump water heater into a home that currently uses a gas-fired tank water heater would generate utility cost savings. For Bay Area single-family homes, replacing a gas-fired tank model with a heat pump water heater could result in annual utility cost savings of about \$50 for single family homes and \$40 for multi-family units.

Based on this analysis, the combined rate savings would range from \$300 for single family homes to \$90 for multi-family units. It has been reported recently that the average PG&E residential customer bill is \$166 per month, or \$1,992 per year.⁸ The rate savings from the electric appliances would represent 4.5 to 15 percent of the average bill.

ADJUSTMENT TO COST OF COMPLIANCE

In analyzing the cost impacts to individual households, we have deducted the average rate savings from the average costs in Table 5-4 above. The cost of compliance for space heaters of \$402 is reduced by \$150 $[(\$250 + \$50)/2]$, equaling **\$252**. The cost for water heaters of \$147 is reduced by average rates savings of \$45, to equal **\$102**.

IMPACT OF AVERAGE COSTS ON HOUSEHOLDS

As discussed in Section 4, the income distribution in the San Francisco Bay Area is concentrated towards households earning over \$100,000 annually, with over one-quarter of households earning over \$200,000. As shown on Table 4-3, the overall median income for Bay Area households is approximately \$115,400. However, with 79,100 families living below the poverty line, and nearly 13 percent of households earning less than \$30,000 annually, the incremental costs have a disproportionately higher potential impact on more economically vulnerable populations.

EXPENDITURES AND COSTS BY INCOME GROUP

Data from the Consumer Expenditure Survey (CES), which is administered by the Bureau of Labor Statistics (BLS) to track cost-of-living data and estimate the Consumer Price Index (CPI), shows that expenditures do not change at the same rate as income.

As shown in Table 5-5, lower income households will still have to make expenditures to maintain a household, and those expenditures can exceed the household income, as defined by the Census. For example, households that earn less than \$15,000 annually make an average of \$25,240 in

⁸ George Avalos, "PG&E Monthly Bills are Set to Jump Again This Year, Jolting Customers." San Jose Mercury News, February 10, 2022.

expenditures annually. The expenditures include housing, food, transportation, and all other expenses. Some of these expenses are potentially covered by public assistance or other non-income sources, such as debt or family support. By comparison, those households earning between \$150,000 and \$199,999 annually make an average of \$107,900 in annual expenditures.

The expense category that covers water heaters and space heating appliances combines major appliances and miscellaneous household equipment. The average expenditures in this category will range from \$430 for households earning less than \$15,000 to \$3,700 for households earning more than \$200,000.

Spending for major appliances/household equipment ranges from 5.7 percent of the total annual income for households earning less than \$15,000 to 1.1 percent for households earning more than \$200,000. However, when looking at the major appliance/ miscellaneous household equipment spending as a percentage of the actual expenditures (rather than income), the trends are very similar from income group to income group. Overall, the spending in this category ranges from 1.8 to 2.3 percent of total annual expenditures.

Table 5-5: Total Household Expenditures and Appliance/Household Equipment Expenditure by Income Group, 2019

ANNUAL HOUSEHOLD INCOME	BAY AREA PERCENT OF TOTAL HOUSEHOLDS	AVERAGE HOUSEHOLD INCOME (CES)	ANNUAL HOUSEHOLD EXPENDITURE (CES)	APPLIANCE AND HOUSEHOLD EQUIPMENT EXPENDITURE (CES)	APPLIANCE AND HOUSEHOLD EQUIP. PERCENT OF INCOME	APPLIANCE AND HOUSEHOLD EQUIPMENT PERCENT OF EXPENDITURE
Less than \$15,000	6.3%	\$7,600	\$25,200	\$430	5.7%	1.7%
\$15,000 to \$29,999	6.5%	\$22,200	\$34,000	\$710	3.2%	2.1%
\$30,000 to \$39,999	4.6%	\$34,800	\$40,400	\$750	2.2%	1.9%
\$40,000 to \$49,999	4.6%	\$44,800	\$47,600	\$920	2.0%	1.9%
\$50,000 to \$69,999	9.4%	\$59,300	\$54,900	\$1,200	2.0%	2.2%
\$70,000 to \$99,999	13.2%	\$83,600	\$67,100	\$1,300	1.6%	1.9%
\$100,000 to \$149,999	17.6%	\$121,400	\$86,000	\$1,800	1.5%	2.1%
\$150,000 to \$199,999	12.3%	\$171,100	\$107,900	\$2,100	1.3%	2.0%
\$200,000 and more	25.5%	\$343,500	\$161,100	\$3,700	1.1%	2.3%
Overall Total	2,754,400					

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES).

As shown in Table 5-6, under the proposed Rule 9-4 amendments, the annualized cost difference for converting to a zero-NOx space heating with a gas-to-electric conversion of \$252 represents nearly a 60 percent increase in such costs for the lowest income households. This represents 3.3 percent of annual income and 1.0 percent of annual expenditures for households earning less than \$15,000 annually. For households earning the median income of \$115,000, the increased expenditures represent a 13.8 percent increase in appliance expenditures, but only a 0.3 percent increase in total expenditures and 0.2 percent of total income.

Under the proposed Rule 9-6 amendments, the annualized cost difference of \$102 to convert a natural gas-fired water heater to a zero-NOx appliance would increase appliance expenditures for the lowest income households by about 23 percent, and represent 1.3 percent of total income. At the median income level, the compliance cost would increase appliance expenditures by less than five percent and represent 0.1 percent of annual income.

Table 5-6: Incremental Costs for Gas-to-Electric Heating Appliance Conversion as Percentage of Annual Income and Expenditures

ANNUAL HOUSEHOLD INCOME	ANNUALIZED GAS-TO-ELECTRIC COST INCREASE OF \$252 FOR SPACE HEATING			ANNUALIZED GAS-TO-ELECTRIC COST INCREASE OF \$102 FOR WATER HEATER		
	INCREMENTAL PERCENT OF APPLIANCE EXPENDITURES	INCREMENTAL PERCENT OF INCOME	INCREMENTAL PERCENT OF EXPENDITURE	INCREMENTAL PERCENT OF APPLIANCE EXPENDITURES	INCREMENTAL PERCENT OF INCOME	INCREMENTAL PERCENT OF EXPENDITURE
Less than \$15,000	58.0%	3.3%	1.0%	23.4%	1.3%	0.4%
\$15,000 to \$29,999	35.5%	1.1%	0.7%	14.3%	0.5%	0.3%
\$30,000 to \$39,999	33.7%	0.7%	0.6%	13.6%	0.3%	0.3%
\$40,000 to \$49,999	27.5%	0.6%	0.5%	11.1%	0.2%	0.2%
\$50,000 to \$69,999	21.3%	0.4%	0.5%	8.6%	0.2%	0.2%
\$70,000 to \$99,999	19.4%	0.3%	0.4%	7.8%	0.1%	0.2%
\$100,000 to \$149,999	13.8%	0.2%	0.3%	5.6%	0.1%	0.1%
\$150,000 to \$199,999	11.8%	0.1%	0.2%	4.8%	0.1%	0.1%
\$200,000 and more	6.8%	0.1%	0.2%	2.7%	0.0%	0.1%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES).

EXPENDITURES AND COSTS BY HOUSING TENURE

One potential cost difference comes between homeowners and renters. Presumably, the cost of compliance would fall upon the property owner. If the property owner rents the housing unit to a renter, then presumably at least some portion of the appliance upgrade costs will be passed along to the tenant through rent increases.

Reviewing the CES data, owner-occupied housing units will generally see a higher proportion of overall expenditures go towards major appliance/other household equipment expenses than renter-occupied units. While the overall median income for Bay Area households is approximately \$115,400, the estimated median income for Bay Area households living in owner-occupied housing units was about \$142,000 in 2019, compared to \$84,400 for Bay Area households residing in rental units. Normalizing the expenditures to the median household income for Bay Area households, the total expenditures for owner-occupied households average about \$95,500, and \$67,500 for renters.

The annual major appliance/miscellaneous household equipment expenditures average out to \$2,200 for a median income owner-occupied housing unit, and \$900 for a median income renter-occupied housing unit. For homeowners, this represents 1.5 percent of total household income, and 1.0 percent of total income for renters (Table 5-7). This would indicate that many of these expenses are paid for by the property owners of rental housing, and recouped through rent payments.

Table 5-7: Total Household Expenditures and Appliance/Household Equipment Expenditure by Housing Tenure, 2019

HOUSING TENURE	BAY AREA MEDIAN INCOME (ESTIMATED)	ANNUAL EXPENDITURE (ESTIMATED)	ANNUAL APPLIANCE AND HH EQUIP EXPENDITURE (ESTIMATED)	ANNUAL APPLIANCE AND HH EQUIP EXPENDITURE (ADJUSTED)	APPLIANCE AND HH EQUIP. PERCENT OF INCOME	APPLIANCE AND HH EQUIP. PERCENT OF EXPENDITURE
All Housing Units	\$115,400	\$82,900	\$63,200	\$1,700	1.5%	2.1%
Owner Occupied	\$142,900	\$95,500	\$73,200	\$2,200	1.5%	2.3%
Renter Occupied	\$84,400	\$67,500	\$63,200	\$900	1.0%	1.3%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES).

In Table 5-8, the annualized cost increase is differentiated by housing tenure. The \$252 annualized cost of compliance for space heating represents 0.2 percent of the median income for all Bay Area households. The \$271 cost for owner-occupied single-family homes is also 0.2 percent of income for those households while the \$229 cost for renter occupied multi-family homes is 0.3 percent of income for typical renter households.⁹ The costs for the water heater conversion, ranging from \$92 for renters to \$109 for home owners, is 0.1 percent of income for both groups.

Table 5-8: Incremental Costs for Gas-to-Electric Heating Appliance Conversion as Percentage of Annual Income and Expenditures

HOUSING TENURE	ANNUALIZED GAS-TO-ELECTRIC COST INCREASE (HVAC)	ANNUALIZED GAS-TO-ELECTRIC COST INCREASE (WATER HEATER)	INCREMENTAL PERCENT OF INCOME (HVAC)	INCREMENTAL PERCENT OF EXPENDITURE (HVAC)	INCREMENTAL PERCENT OF INCOME (WATER HEATER)	INCREMENTAL PERCENT OF EXPENDITURE (WATER HEATER)
All Housing Units	\$252	\$102	0.2%	0.3%	0.1%	0.1%
Owner Occupied	\$271	\$109	0.2%	0.3%	0.1%	0.1%
Renter Occupied	\$229	\$92	0.3%	0.3%	0.1%	0.2%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES).

Renters typically do not directly absorb the costs for central furnace and/or water heater replacements. Rather, these expenses are often made by the property owners. Applying the same upgrade schedule assumption for homeowners to rental properties, the incremental cost difference averages out to \$19.04 for central heating and \$7.69 for water heaters when calculated on a monthly basis. These costs can be potentially passed along to tenants in the form of rent increases. As shown in Table 5-9, the cost differences for a gas-to-electric conversion with central heating represent between 0.8 percent to 1.1 percent of the median monthly rents in the Bay Area counties, under the

⁹ The homeowner and renter costs reflect single family vs. multi-family costs, with the utility rate savings prorated from the regionwide average.

proposed Rule 9-4 amendments. Under the proposed Rule 9-6 amendments, a gas-to-electric conversion for water heaters would represent between 0.3 to 0.4 percent of the median monthly rent.

Table 5-9: Incremental Costs for Gas-to-Electric Heating Appliance Conversion as Percentage of Monthly Median Rents by County

LOCATION	MEDIAN HOUSEHOLD INCOME (RENTERS)	MEDIAN MONTHLY RENT	INCREMENTAL MONTHLY COST (HVAC)	INCREMENTAL MONTHLY COST (WATER HEATER)	INCREMENTAL PERCENT OF MONTHLY RENT (HVAC)	INCREMENTAL PERCENT OF MONTHLY RENT (WATER HEATER)
Alameda County	\$76,500	\$2,000	\$19.04	\$7.69	1.0%	0.4%
Contra Costa County	\$72,700	\$1,900	\$19.04	\$7.69	1.0%	0.4%
Marin County	\$73,700	\$2,100	\$19.04	\$7.69	0.9%	0.4%
Napa County	\$73,200	\$1,800	\$19.04	\$7.69	1.0%	0.4%
San Francisco County	\$105,300	\$2,000	\$19.04	\$7.69	1.0%	0.4%
San Mateo County	\$101,200	\$2,500	\$19.04	\$7.69	0.8%	0.3%
Santa Clara County	\$97,300	\$2,400	\$19.04	\$7.69	0.8%	0.3%
Solano County	\$64,200	\$1,700	\$19.04	\$7.69	1.1%	0.4%
Sonoma County	\$63,400	\$1,800	\$19.04	\$7.69	1.1%	0.4%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES).

EXPENDITURES AND COSTS BY POVERTY STATUS

The poverty line will vary by family/household size. As indicated in Section 4, about 79,100 families in the Bay Area were below the poverty line (not including non-family households). For a family of four, an annual household income of \$25,750 represented the federal poverty threshold in 2019 (Table 5-10). At that income level, the marginal annualized expenditure increase (based on renter costs) from the proposed Rule 9-4 amendments would be 0.9 percent of total income and 0.6 percent of total expenditures for a household at that income level, as shown in Table 5-11. Increased expenses for water heaters from the proposed Rule 9-6 amendments would total about 0.4 percent of total income and 0.3 percent of total expenditures for a family of four at the federal poverty threshold. The combined annual expenditure increase from both rule amendments would, as a worst case, constitute a 45 percent increase in average appliance expenditures for these households.

Table 5-10: Total Household Expenditures and Appliance/Household Equipment Expenditure for Families at Poverty Level, 2019

	POVERTY LEVEL INCOME	ANNUAL EXPENDITURE (EXTRAPOLATED FROM CES)	ANNUAL APPLIANCE AND HH EQUIP EXPENDITURE	APPLIANCE AND HH EQUIP. PERCENT OF INCOME	APPLIANCE AND HH EQUIP. PERCENT OF EXPENDITURE
Federal Poverty Level for Family of Four (2019)	\$25,750	\$35,810	\$710	2.8%	2.0%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES), and U.S. Department of Health and Human Services "Poverty Guidelines Computations Page."

Table 5-11: Incremental Costs for Gas-to-Electric Heating Appliance Conversion as Percentage of Annual Income and Expenditures for Families at Poverty Level

	ANNUALIZED GAS-TO-ELECTRIC COST INCREASE (HVAC)	ANNUALIZED GAS-TO-ELECTRIC COST INCREASE (WATER HEATER)	INCREMENTAL PERCENT OF INCOME (HVAC)	INCREMENTAL PERCENT OF EXPENDITURE (HVAC)	INCREMENTAL PERCENT OF INCOME (WATER HEATER)	INCREMENTAL PERCENT OF EXPENDITURE (WATER HEATER)
Federal Poverty Level for Family of Four (2019)	\$229	\$92	0.9%	0.6%	0.4%	0.3%

Source: Applied Development Economics, based on U.S. Census American Community Survey, One-Year Sample, and U.S. Bureau of Labor Statistics Consumer Expenditure Survey (CES), and U.S. Department of Health and Human Services "Poverty Guidelines Computations Page."

IMPACTS OF SHIFTS IN CONSUMER SPENDING

The higher net costs for space and water heating will have the effect of shifting discretionary household spending away from other retail products and services, including items such as food service, personal services, education, social assistance and recreation and amusement expenditures. Lower expenditures in these categories could lead to reduced job growth from businesses providing the products and services, a number of whom may be small businesses. In order to estimate the magnitude of these jobs changes, it is necessary to estimate the aggregate expenditures that the proposed rule amendments would entail in the Bay Area region for space and water heating. The following section discusses the estimates of total affected households and related compliance cost net expenditures.

Table 4-10 earlier in the report shows the source of space heating fuel for households in the Bay Area. For Rule 9-4, we assume that households that use electricity or solar for heating are already in compliance with the rule and would not need to convert their HVAC systems. Therefore, households subject to costs for Rule 9-4 would be those currently using Utility Gas or Other Fuels for heating, which would be 79.6 percent of owner-occupied homes and 55.7 percent of renter-occupied homes. In contrast, for lack of other data, we assume all households would need to convert their water heaters to electric. This is a conservative assumption that could potentially overestimate the true costs of compliance for the Rule 9-6 amendments.

Table 5-12 below reproduces data from Table 4-8 showing the distribution of owner and renter-occupied housing by county. Based on the useful life of HVAC systems of 18 years, we assume 5.6% (1/18) of affected households will convert their HVAC systems per year. Combining the data from Table 4-1 and Table 5-12, with the cost data in the previous section, Table 5-13 shows the estimated annual aggregate costs for Rule 9-4 (excluding electric panel upgrades) of \$25.2 million.

Table 5-12: Distribution of Owner Occupied and Renter Occupied Households in the Bay Area, 2019

COUNTY	TOTAL HOUSEHOLDS	HOUSEHOLDS (OWNER-OCCUPIED)	HOUSEHOLDS (RENTER-OCCUPIED)	RENTERS AS PERCENT OF TOTAL HOUSEHOLDS
Bay Area Region	2,733,300	1,515,100	1,218,200	44.6%
Alameda	574,700	304,700	270,000	47.0%
Contra Costa	393,700	257,500	136,100	34.6%
Marin	105,100	65,200	39,900	38.0%
Napa	48,800	32,300	16,500	33.9%
San Francisco	368,100	136,700	231,400	62.9%
San Mateo	263,800	156,300	107,500	40.7%
Santa Clara	640,400	351,800	288,600	45.1%
Solano	151,100	94,000	57,100	37.8%
Sonoma	187,700	116,600	71,000	37.8%

Source: ACS 1 Year estimates, 2019.

Table 5-13: Aggregate Cost Estimates for HVAC Conversion by County

COUNTY	OWNER OCCUPIED SUBJECT TO HVAC RULE	RENTER OCCUPIED SUBJECT TO HVAC RULE	TOTAL	ANNUALIZED	HVAC CONVERSION COST (\$MIL)
Bay Area Region	1,206,424	678,549	1,884,973	104,721	\$25.24
Alameda	242,623	150,405	393,027	21,835	\$5.26
Contra Costa	205,039	75,815	280,854	15,603	\$3.76
Marin	51,917	22,227	74,143	4,119	\$0.99
Napa	25,719	9,191	34,911	1,939	\$0.47
San Francisco	108,850	128,903	237,752	13,208	\$3.18
San Mateo	124,457	59,883	184,340	10,241	\$2.47
Santa Clara	280,127	160,766	440,893	24,494	\$5.90
Solano	74,849	31,808	106,657	5,925	\$1.43
Sonoma	92,845	39,551	132,396	7,355	\$1.77

Source: ADE, Inc.

As noted above, we assume all households would require a water heater conversion. With a useful life of 13 years, we estimate 7.7% of households (1/13) would convert annually. Table 5-14 shows the resulting annualized cost impacts for water heater conversion (\$18.5 million).

Table 5-14: Compliance Cost Impacts for Water Heater Conversions

COUNTY	TOTAL HOUSEHOLDS	ANNUAL HOUSEHOLDS SUBJECT TO WATER HEATER RULE	WATER HEATER CONVERSION COST (\$MIL.)
Bay Area Region	2,733,300	210,254	\$18.50
Alameda	574,700	44,208	\$3.89
Contra Costa	393,700	30,285	\$2.66
Marin	105,100	8,085	\$0.71
Napa	48,800	3,754	\$0.33
San Francisco	368,100	28,315	\$2.49
San Mateo	263,800	20,292	\$1.79
Santa Clara	640,400	49,262	\$4.33
Solano	151,100	11,623	\$1.02
Sonoma	187,700	14,438	\$1.27

Source: ADE, Inc.

Following the E3 analysis, electric panel upgrades are assumed to be needed for all houses built before 1980 and which require both an HVAC and water heater conversion. Table 5-4 above shows the census estimate of housing built in 1979 or earlier by county in the Bay Area.

For purposes of this analysis, we apply the percentages in Table 5-4 to both single family and multi-family housing subject to HVAC conversion. The resulting number of units and electric panel upgrade costs are shown in Table 5-15 (\$15.98 million).

Table 5-15: Electric Panel Upgrade Costs by County

COUNTY	ANNUAL SINGLE FAMILY UNITS SUBJECT TO ELECTRIC PANEL UPGRADE	COST (\$MIL)	ANNUAL MULTI-FAMILY UNITS SUBJECT TO ELECTRIC PANEL UPGRADE	COST (\$MIL)	TOTAL ELECTRIC PANEL COSTS (\$MIL)
Bay Area Region	46,616	\$12.18	22,559	\$3.80	\$15.98
Alameda	10,383	\$2.71	4,775	\$0.80	\$3.52
Contra Costa	7,095	\$1.85	1,788	\$0.30	\$2.15
Marin	2,427	\$0.63	799	\$0.13	\$0.77
Napa	908	\$0.24	254	\$0.04	\$0.28
San Francisco	3,878	\$1.01	6,373	\$1.07	\$2.09
San Mateo	5,487	\$1.43	2,311	\$0.39	\$1.82
Santa Clara	10,830	\$2.83	4,893	\$0.82	\$3.65
Solano	2,332	\$0.61	566	\$0.10	\$0.70
Sonoma	3,277	\$0.86	799	\$0.13	\$0.99

Source: ADE, Inc.

UTILITY RATE SAVINGS

As discussed above on pp. 20-21, households that convert from gas powered appliances to electric appliances may experience lower monthly utility rate costs for space and water heating. Based on the data in Table 4-10 above, we have estimated how many households would make this conversion. Applying the annual utility rate savings by type of unit and type of appliance conversion from the discussion above to the numbers of units making the conversion annually, suggests that nearly \$30 million in annual costs for rule compliance would be offset by lower utility bills for space and water heating (Table 5-16).

Table 5-16: Estimated Utility Rate Savings from Conversion to Electric Appliances (\$Millions)

COUNTY	SINGLE FAMILY RATE SAVINGS FOR HVAC	MULTI-FAMILY RATE SAVINGS FOR HVAC	SINGLE FAMILY RATE SAVINGS FOR WATER HEATER	MULTI-FAMILY RATE SAVINGS FOR WATER HEATER	TOTAL RATE SAVINGS
Rates Savings per Unit	-\$250	-\$50	-\$50	-\$40	
Bay Area Region	-\$18.33	-\$1.66	-\$6.38	-\$3.31	-\$29.68
Alameda	-\$3.83	-\$0.35	-\$1.33	-\$0.70	-\$6.22
Contra Costa	-\$3.20	-\$0.16	-\$1.11	-\$0.32	-\$4.80
Marin	-\$0.79	-\$0.05	-\$0.27	-\$0.10	-\$1.22
Napa	-\$0.39	-\$0.02	-\$0.13	-\$0.04	-\$0.58
San Francisco	-\$1.22	-\$0.40	-\$0.42	-\$0.79	-\$2.83
San Mateo	-\$1.82	-\$0.15	-\$0.63	-\$0.31	-\$2.91
Santa Clara	-\$4.30	-\$0.39	-\$1.50	-\$0.77	-\$6.96
Solano	-\$1.24	-\$0.06	-\$0.43	-\$0.12	-\$1.85
Sonoma	-\$1.54	-\$0.08	-\$0.54	-\$0.15	-\$2.30

Source: ADE, Inc.

TOTAL ANNUALIZED COMPLIANCE COSTS

The annualized compliance costs and rate savings are summarized in Table 5-17. The aggregate cost analysis is divided into three time periods: 1) the 2027-2028 period when households begin converting their water heaters, 2) the subsequent eleven years (2029 through 2039) when households are converting both their water heaters and their HVAC systems, and 3) the seven years (2040-2046) when the remaining households are converting their HVAC systems. During the initial period, total annualized net compliance costs would be nearly \$9 million per year, and they increase to about \$30 million during the middle period. In the third period, total net annualized costs are about \$21 million across the region (although presumably some households would be replacing their water heaters for a second time under a normal lifecycle). These net costs subtract the estimated rate savings from the compliance costs in each period.

Table 5-17: Total Net Annual Costs by Time Period (\$Millions)

COUNTY	NET ANNUAL COSTS FOR WATER HEATERS 2027-2028	COMBINED NET ANNUAL COSTS 2029 - 2039	NET ANNUAL COSTS FOR HVAC 2040-2046
Bay Area Region	\$8.81	\$30.04	\$21.23
Alameda	\$1.85	\$6.45	\$4.59
Contra Costa	\$1.23	\$3.78	\$2.55
Marin	\$0.33	\$1.25	\$0.92
Napa	\$0.15	\$0.49	\$0.34
San Francisco	\$1.27	\$4.93	\$3.66
San Mateo	\$0.85	\$3.16	\$2.32
Santa Clara	\$2.06	\$6.93	\$4.87
Solano	\$0.47	\$1.30	\$0.83
Sonoma	\$0.59	\$1.74	\$1.15

Source: ADE, Inc.

During the 2029-2039 period when both water heaters and space heaters are being replaced, the shift in consumer spending could lead to a direct loss of 196 jobs in retail, personal services, entertainment and education across the entire region (Table 5-18). Economic multiplier effects could increase the total job loss to 286 jobs. As shown in Table 4-2 above, the Bay Area had nearly 3.7 million total jobs in 2020, of which 1.5 million are in sectors whose market could be affected by these shifts in consumer spending. The potential job losses shown in Table 5-18 are about 2 one-hundredths of a percent of jobs within the trade and services sectors directly affected.

Table 5-18: Potential Job Losses Due to Shifted Consumer Spending

LOCATION	2027-2028			2029-39			2040-46		
	DIRECT EFFECT	INDIRECT & INDUCED	TOTAL EFFECT	DIRECT EFFECT	INDIRECT & INDUCED	TOTAL EFFECT	DIRECT EFFECT	INDIRECT & INDUCED	TOTAL EFFECT
Bay Area	58	26	84	196	90	286	139	63	202
Alameda County	12	6	18	42	19	61	30	14	44
Contra Costa County	8	4	12	25	11	36	17	8	24
Marin County	2	1	3	8	4	12	6	3	9
Napa County	1	0	1	3	1	5	2	1	3
San Francisco County	8	4	12	32	15	47	24	11	35
San Mateo County	6	3	8	21	9	30	15	7	22
Santa Clara County	13	6	20	45	21	66	32	15	46
Solano County	3	1	4	8	4	12	5	2	8
Sonoma County	4	2	6	11	5	17	8	3	11

Source: ADE, Inc.; data from IMPLAN input-output model

UTILITY COSTS

In order to meet the potential increased demand for electricity under the likely scenario that households will choose to replace gas fired appliances with electric appliances to meet the zero-NOx standards, PG&E will need to expand its electricity generation, distribution and transmission infrastructure. BAAQMD commissioned E3, Inc. to analyze the electric grid impacts associated with the widespread adoption of heat pumps to comply with the proposed amendments to Rules 9-4 and 9-6. E3 determined that over the next 28 years PG&E would need to spend \$100 million on transmission capacity increases and \$384 million to upgrade its distribution capacity. In addition, 2,180 MW of utility scale solar generation capacity would need to be added along with 680 MW of new battery storage, at a combined cost of \$1.95 billion.

PG&E and other statewide power providers are planning major expansions of electrical capacity over the next 20-30 years. The CA Independent System Operator (CAISO) is planning \$11 billion in transmission capacity projects over the next 20 years, which covers 80 percent of the entire state service area, and PG&E is planning to spend \$400 million **per year** on distribution projects. The incremental costs for capacity increases associated with the amendments to Rules 9-4 and 9-6 represent about 2.4 percent of transmission investments prorated within PG&E's service area and 3.2 percent of PG&E planned distribution capacity projects.

E3 has modeled a scenario in which the state's utilities make major investments in electric system capacity to meet the needs of the full range of climate change policies (high policy scenario), vs. a scenario in which such investments are not forthcoming and the added capacity needed to support the amendments to Rules 9-4 and 9-6 stand alone for the Bay Area (low policy scenario). In addition, the overall investments are discounted to net present value for the scenarios. The results indicate that under the high policy scenario, the net effect of the proposed rule amendments would be a 2021 NPV of \$243 million, while under the low policy scenario the NPV of incremental costs would be about \$1 billion. It is not clear to what extent these costs fit within PG&E's existing rate structure and what impact to rates may occur in the future, although utilities across California are planning for significantly increased electric uptake in the coming years. It is possible that these investments will result in some future rate increases, which would reduce the cost savings to households from converting to all electric appliances. However, these planned investments are spread out over a large base of rate-payers and electric rate increases associated with infrastructure build-out may be outpaced by natural gas rate increases associated with maintaining existing infrastructure for a shrinking rate base. Air District staff may report on rate changes as part of its Implementation Working Group and interim reporting process to the Board of Directors.

IMPACT FINDINGS

For consumers, the level of potential impact will vary considerably by income range. For most households in the Bay Area, the added costs combined from both rule amendments would increase average annual appliance costs by about 25 percent or less, but this represents less than 0.3 percent of annual income. However, for families below the poverty line, the costs represent a 45 percent increase in annual appliance expenditures and 1.3 percent of annual income.

Also, the analysis assumes that households can finance the conversion and would experience the cost impact over time. However, if emergency replacements are needed due to existing equipment failure, or if financing is not available at the time replacements need to occur, the upfront capital cost of the conversion could be a significant burden to many households.

Potential impacts to renters from the proposed rule amendments are particularly complex and will continue to be evaluated throughout the implementation timeline including during a working group process. Renters generally have a lower average annual income and a greater cost burden associated with housing expenses than homeowners. While renters are not directly impacted by the upfront costs of heating appliance expenses, there is the potential for pass through costs, evictions as the result of renovations, and rent increases due to capital improvements. Air District staff intends to gather further information on these potential impacts through the Implementation Working Group, and will continue to evaluate and report on these impacts as part of the first interim report to the Board of Directors, as required in the proposed rule amendments.

The analysis did not account for any rebate programs; however, programs for electric appliance conversions are commonplace and can help to mitigate potential impacts from the added cost of gas-to-electric conversions, particularly if targeted to lower income households. As the market for zero-NOx appliances increases, there are also potential future economies of scale and technological advances that could also lower costs.

The shift in consumer expenditures toward higher appliance costs and away from other retail goods and services would have a measurable but not significant effect on jobs in those sectors. However many retail and personal services businesses are classified as small businesses and could experience some reduction in sales, estimated at a maximum of \$30 million per year across the entire Bay Area during the initial conversion period between 2027 and 2046.

There would be some disruption and increased costs in the space and water heater supply chain, including wholesalers and construction trades who sell and install the equipment in new and existing homes. Workers in both sectors would require additional training on the new equipment and would face higher costs for inventory for the more expensive appliance units. However, these costs would ultimately be passed on to consumers. A study for space heating conversion by the South Coast Air Quality Management District concluded that there would be job gains in the wholesale sector, but these would be offset by job losses in the construction and real estate sectors.¹⁰

In addition, manufacturers of the appliances, which are located outside the Bay Area, would need to increase production of compliant units and would see a reduction in demand for currently designed gas-fired units. This could involve costs for additional product development, retooling production lines, retraining personnel and possibly reconfiguring supply chains. Incurring these costs to supply the Bay Area market alone may not make financial sense for some companies and they may lose market share

¹⁰ South Coast Air Quality Management District, *Socioeconomic Report For Proposed Amended Rule 1111□NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces*, October 2009. P. 6.

as a result. However, if the overall market for these appliances expands nationally and globally, these product development costs would be recouped over time.

The proposed amendments would increase the demand for electricity, requiring infrastructure expansions from PG&E. The Air District has commissioned studies that suggest the cost for these expansions would range from \$243 million to \$1 billion (net present value 2021 dollars). These costs would likely have some impact on future electricity rates, which is undetermined at this time.