Monterey Bay Community Power Inventory and Market Characterization

July 2019

Final Report

Prepared for:

Monterey Bay Community Power

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Overview

The Inventory and Market Characterization report is task 1 of Monterey Bay Community Power's Electrification Roadmap.[1] The inventory and market characterization used data from various sources, defined in Appendix A, Data Sources, to characterize the market components, energy use, and emissions calculations for the built environment (i.e. existing buildings) and various categories of vehicles. The data sources typically provided county level data that allowed us to profile each of the four counites in MBCP's services territory. Where county level estimates were not available, we applied an appropriate ratio (e.g. county percent of state population) to California state or regional data to define county characteristics. In addition to this report, Tierra has provided the following support documents as part of Deliverable 1:

- An Excel spread sheet of various data defining market charactertiscs at the county level, referred to as County Metrics.
- An online portal, developed in Tableau[2], allowing any interested party to review various tables and charts for market characertiscs defined in this report. The Tableau screens can be accessed at this link[3].

Table 1 provides a summary of select county demographic characteristics showing that the four counties include 29 cities and 351,280 households accounting for 2.67% of state total population. The counites are distributed across CEC planning area climate zones 3 and 4 and these climate zones are temperate compared to central valley and mountainous regions of the state and feature relatively moderate space heating and cooling requirements. When considering the energy required to produce hot water, groundwater temperatures across the service territory generally stay constant throughout the year at a specific location and range between 57^0F and 62^0F.[4] As such, the temperate climate may present some challenges in the adoption of high efficiency heating and air conditioning measures because paybacks on incremental investments will likely be longer that in more extreme climates. Because of the consistency in groundwater temperatures and constant demand for hot water throughout the year, hot water heating presents a more predictable energy use and economically beneficial opportunity.

When considering economic burden, CalEnviroscreen[5] (CES 3.0) indicates that the counties generally fall in the midrange for poverty when compared to all California counties. The California Alternative Rate for Energy (CARE) program is a subsidy program for electricity and natural gas for households at or below 200% of Federal poverty level and is also an indicator of poverty. Our review of CARE records shows the average household eligibility for CARE is about 32% of households, below the state average of 35%. Of note is the relatively low CARE participation rate of 77% across the four counties. Heavily

[1] 2019 Request for Proposals for Electrification Strategic Plan, 9/11/2019
[2] https://www.tableau.com/
[3]https://public.tableau.com/views/MBCPMetricsDraft07_25_19/MBCP?:embed=y&:display_count=yes&publish=yes&:origin=viz_share_link
[4] At https://www.bradleycorp.com/sizing-tankless-water-heaters/united-states-groundwater-temperatures accessed June 2019
[5] At https://oehha.ca.gov/calenviroscreen accessed March 2019

disadvantaged areas in the state, such as the central valley, usually see CARE participation rates near 100%.

Table 1. Select County Characteristics

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Population	435,594	61,537	284,010	274,255	1,055,396
% of State Population	1.10%	0.16%	0.72%	0.69%	2.67%
Number of Cities	13	3	8	5	29
Total Number of Households	130,585	17,483	110,403	92,809	351,280
CEC Climate Zone	3	4	4	3	-
Average Groundwater Temperature (^{0}F)	57	62	62	57	-
CES 3.0 Poverty Percentile	55th	43rd	47th	42nd	49th
Number of CARE Eligible Households	46,164	5,816	32,486	26,985	111,451
CARE Eligibility - % Households	35%	33%	29%	29%	32%
Number of CARE Participating Households	42,044	4,824	19,078	20,045	85,991
CARE Penetration	91%	83%	59%	74%	77%
% Residents Living in 5+ Multifamily	27%	13%	10%	22%	20%

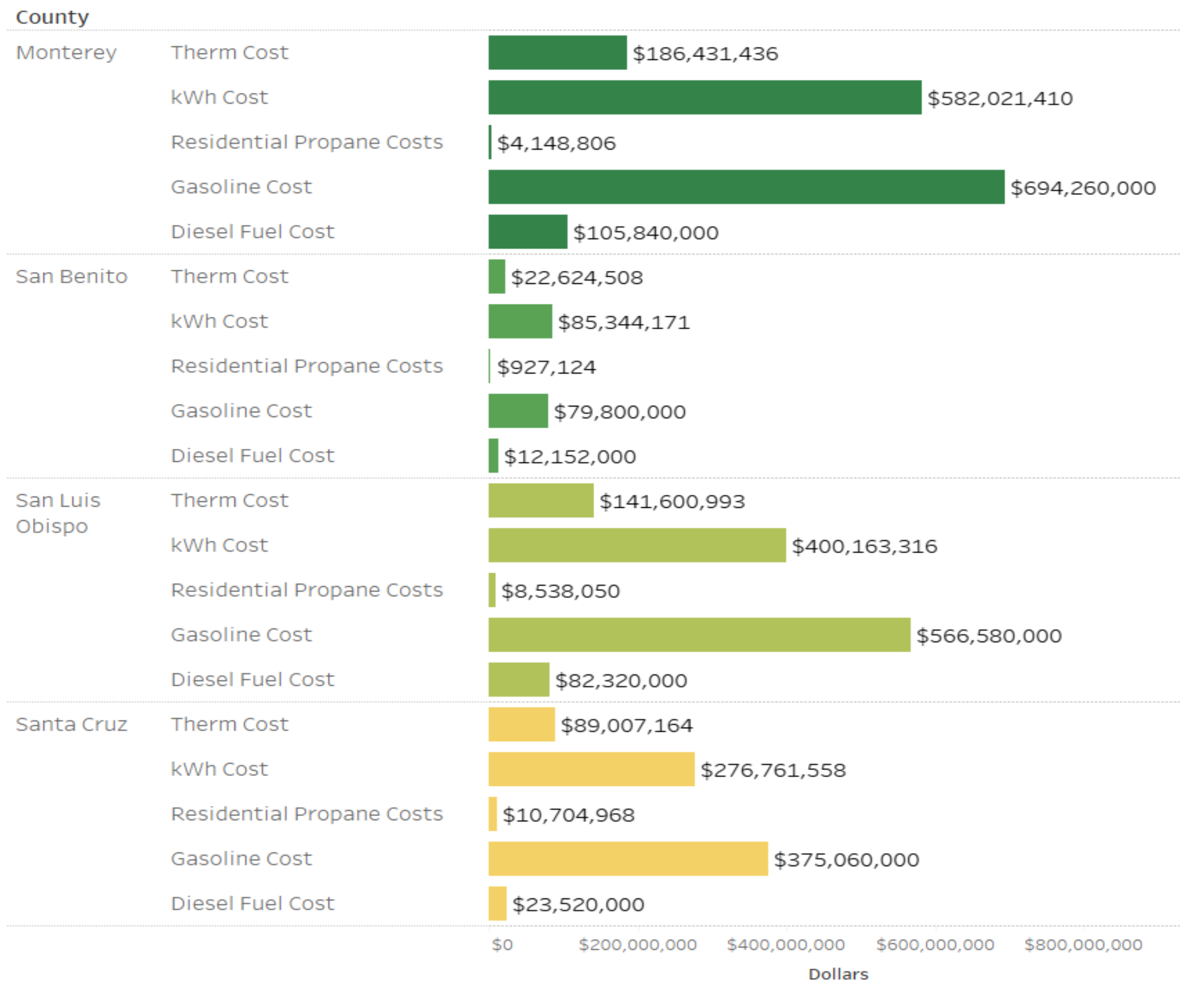
Based on fuel usage data for 2017[6] and current prices as of June 2019 our analysis indicates that total spending for fuel across the four counties was approximately $3.7B, of which $2.4 is spent on fossil fuels for which most applications can be converted to electric fuel (i.e. electrification) with the exception of natural gas used in agricultural and industrial production processes. Figure 1 shows how this annual expense is distributed across the four counties, showing that gasoline is the largest fuel expense, followed in descending order by electricity, natural gas, diesel, and propane fuels. Additional county level fuel consumption data can be found in the Economic Considerations section of the report.

Table 2. Combined County Fuel Costs

Fuel	Units	Unit Cost	Units Consumed	Total Cost
Electricity	kWh	$0.23	5,974,624,247	$1,344,313,870
Natural Gas	Therm	$1.69	260,156,273	$439,664,101
Residential Propane	Therm	$2.39	9,234,755	$22,071,064
Gasoline	Gallons	$3.99	430,000,000	$1,715,700,000
Diesel	Gallons	$3.92	56,279,070	$220,613,954
			Total Annual	$3,742,362,990

[6] Defined in Appendix A, Data Sources

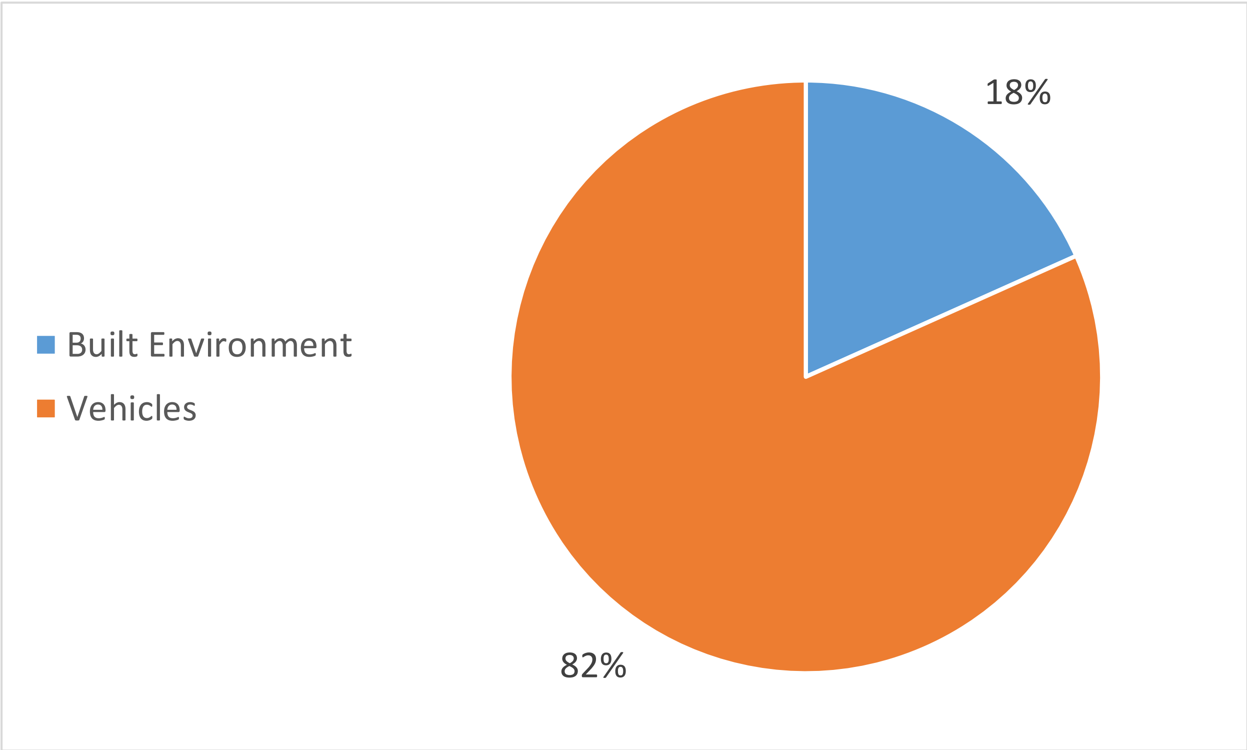
Figure 1: Annual County Fuel Costs



Because vehicle fuels, natural gas, and propane, which comprise $2.4B, or 70% of total annual fuel spending, are not produced in the counties we consider these 'imported' fuels and the implementation of distributed energy resources (DERs), including building electrification and the adoption of electric vehicles, will change where fuel is generated and how efficiently it's used. These changes present a new set of economic opportunities at the community level as the annual outflow of funds spent on imported fuels converts to wealth in the form of locally produced electricity, increased jobs, additional expendable income (much of which will be spent locally), and the increased value of locally owned assets. This will also result in ancillary benefits to local governments such as increased local sales tax revenue and increased property values and resulting tax income. There will also be some disruptions, such as decreases in local remittances of gasoline and diesel taxes. The Economic Considerations section of the report provides a high-level estimate of gasoline and diesel taxes paid by each county.

Figure 2 provides a summary of total annual carbon dioxide emissions (CO_2e) for the four counties for natural gas consumption for the residential and commercial built environment uses and fossil fuels used for the vehicles we analyzed. These estimates, further defined throughout the report, show that the majority, 82%, of CO_2e are associated with vehicle exhaust. This distribution likely differs from emission estimates provided by various climate actions plans (CAPs), which may present a more complete accounting of all CO_2e sources.

Figure 2: Total Annual CO_2e by Source

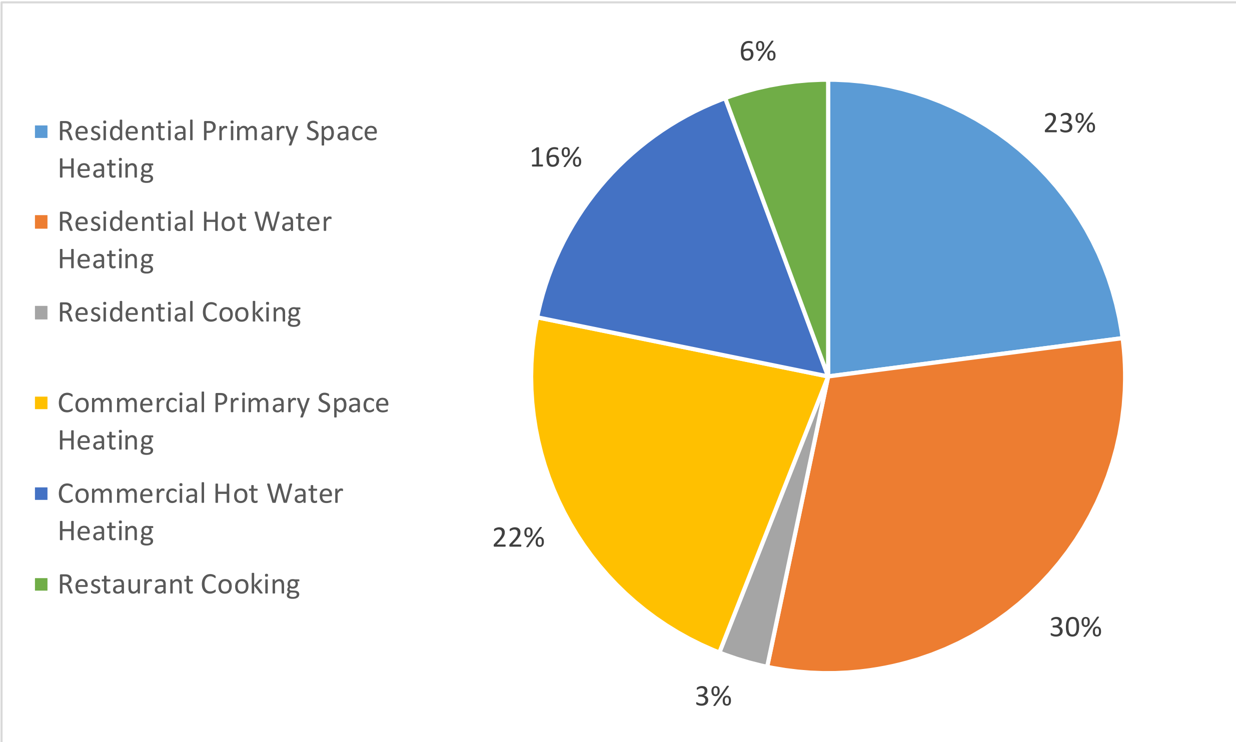


Built Environment

Built Environment Summary

The built environment is defined as existing buildings in the residential and commercial market sectors. For our analysis the definition of the commercial market does not include industrial or agriculture facilities. Because the nature of energy use for industrial or agriculture customers is highly variable and dependent on production processes, data is typically not available to allow characterization at the market level and these sectors were excluded from our work. As discussed in more detail in the following sections, Figure 3 shows the distribution of CO_2e for the natural gas and propane end-uses we analyzed for the residential and commercial sectors. The combined output from water heating is the highest at 46% of emissions, followed by space heating at 45%. Cooking accounted for 9% of emissions and the majority of this use is associated with restaurant cooking. As electric cooking technologies develop, such as commercial induction cooking, this market segment will offer a significant leverage opportunity because restaurants comprise a relatively small number of facilities that can be accessed through targeted outreach and incentives.

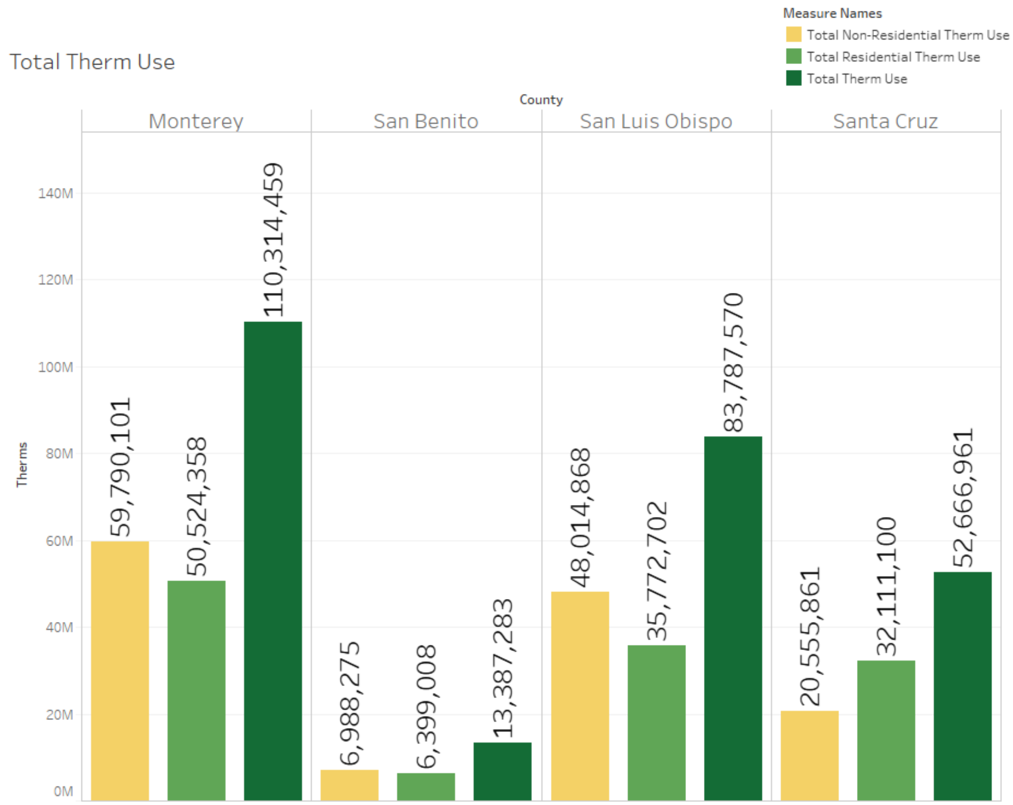
Figure 3: Total CO_2e by Built Environment End-Use



To set the baseline for building electrification opportunities, we reviewed data provided by the California Energy Commission[7] and PG&E[8] showing natural gas sales by county and by year, and Figure 4 provides PG&E natural gas therm sales[9] for 2017 for the residential and non-residential market sectors. Non-residential sales exceeded residential in all counties except Santa Cruz. In general, natural gas consumption varies each year for various reasons, such as increased use for heating on cold years, but the distribution between the residential and non-residential sectors likely stays fairly constant.

[7] http://www.ecdms.energy.ca.gov/gasbycounty.aspx
[8] https://pge-energydatarequest.com/public_datasets
[9] PG&E reports non-residential sales as the combined total of the commercial, industrial, and agricultural market sectors.

Figure 4: Total Therm Consumption by End Use and County



Residential Built Environment

Residential Market Overview

To define the housing stock, we used the American Community Survey (ACS) to describe the number of units by housing type for the residential market and Table 3 provides a summary of housing unit inventory by type. Single-family detached and attached homes[10] (i.e. condominiums), account for the majority of units in every county, and about 72% of all housing units across the four-county area.

Multifamily properties with one to four units account for about 8.8% of all housing units. These properties are considered residential for tax and investment purposes and are generally owned by individuals and trusts, with a few limited liability corporation (LLC) owners. Properties with 5 or more units account for 13.4% of all units and are considered commercial properties for tax and investment purposes and are generally owned by corporations, limited partnerships, and LLCs. These properties are also typically clustered by zoning requirements

[10] Defined in the ACS as 1-unit detached, and 1-unit attached

Table 3. Housing Units by Type

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Total Housing Units	140,662	18,159	118,725	104,897	382,443
1-unit, detached	87,859	14,039	79,509	67,872	249,279
1-unit, attached	8,985	890	6,527	8,079	24,481
2 units	3,846	220	4,007	3,499	11,572
3 or 4 units	8,432	1,066	6,505	6,077	22,080
5 to 9 units	10,387	369	4,863	3,804	19,423
10 to 19 units	7,024	213	2,814	3,222	13,273
20 or more units	7,635	434	4,315	6,160	18,544
Mobile Homes	6,494	928	10,185	6,184	23,791

Based on assessor parcel numbers (APN) specific data,[11] Table 4 shows single family residences consistently average around 2,000 sq. ft., however average property vintages varied by county with Santa Cruz county showing the oldest vintage at 52 year versus San Benito county at 39 years. The average age across all counties is 45 years, built in 1973. This analysis is based on the accuracy of parcel information at the county assessor's office and variances in vintage may be due, in part, to the accuracy of those records.

Table 4. Average Housing Units Size and Vintage

Measure	Monterey	San Benito	San Luis Obispo	Santa Cruz
Average vintage	1970	1984	1980	1967
Average sq. ft.	2,055	1,966	1,924	1,937

Table 5 provides our analysis of multifamily housing in the four counties for properties indicating that 41% of combined county residents are renters who occupy about 148,000 units with the lowest percent in San Benito and the highest in Monterey. Table 5 also shows the estimated percent of residents living in properties with five or more units.

Table 5. Multifamily Housing Characteristics

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
% Renters	49%	36%	40%	40%	41%
Estimated # Renter Occupied Units	62,066	6,337	41,992	38,544	148,939
% Residents Living in 5+ Multifamily	27%	13%	10%	22%	20%

[11] Landvision at https://www.digmap.com/platform/landvision/ accessed May 2019

Understanding the market for rental properties with five of more units is importance for various reasons, including:

- These properties are considered commercial properties and the ownership structure often requires market interventions that are different from properties with one to four units, which are typically viewed as residential properties under tax and investment rules.
- Commercial properties present good leverage opportunities for market intervention, such as EV charging initiatives or DER applications including electrification. Table 6 is an example of an analysis completed by Tierra of the multifamily housing market in Fresno indicating that commercial properties comprise 60% all rental units and 4.5% of APNs. While we could not complete this same analysis for this project we anticipate a similar distribution within the four counties.

Table 6. Example of the Distribution of Rental properties by Unit Count

Units per APN	Total Units	% of Units	Total APNs	% of APN
>100	29,320	34%	146	0.50%
5<100	22,524	26%	1,188	4.00%
2-4	8,117	10%	2,774	9.40%
1	25,421	30%	25,421	86.10%
All	85,382	100%	29,529	100.00%

- Data from recent CPUC Low Income Needs Assessment (LINA)[12], also presented in Figure 5, shows statewide data indicating that the percentage of owner-occupied units decreases significantly as income diminishes, to around 12% at the lowest income levels when income is measured as a percentage of Federal Poverty Level (FPL). LINA data also indicates that the percent of low-income resident residing in larger complexes of 5 of more units increases significantly as income drops, as shown in Figure 6.

[12] Needs Assessment for the Energy Savings Assistance and the California Alternate Rates for Energy Programs. Evergreen Economics, Volume 1 of 2 Final Report. December 15, 2016

Figure 5: Distribution Renters by Income Cohort

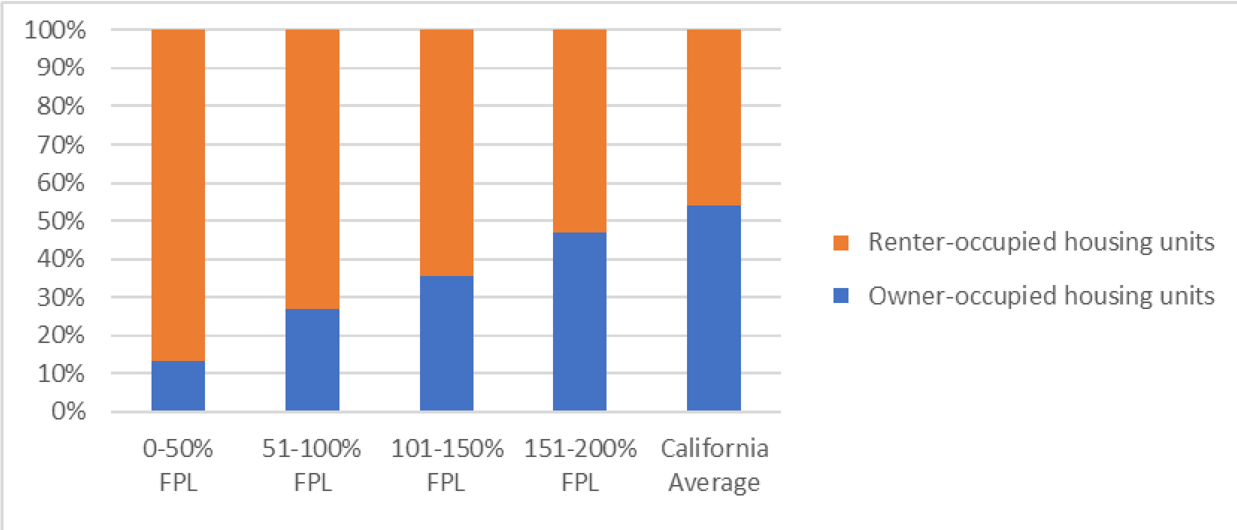
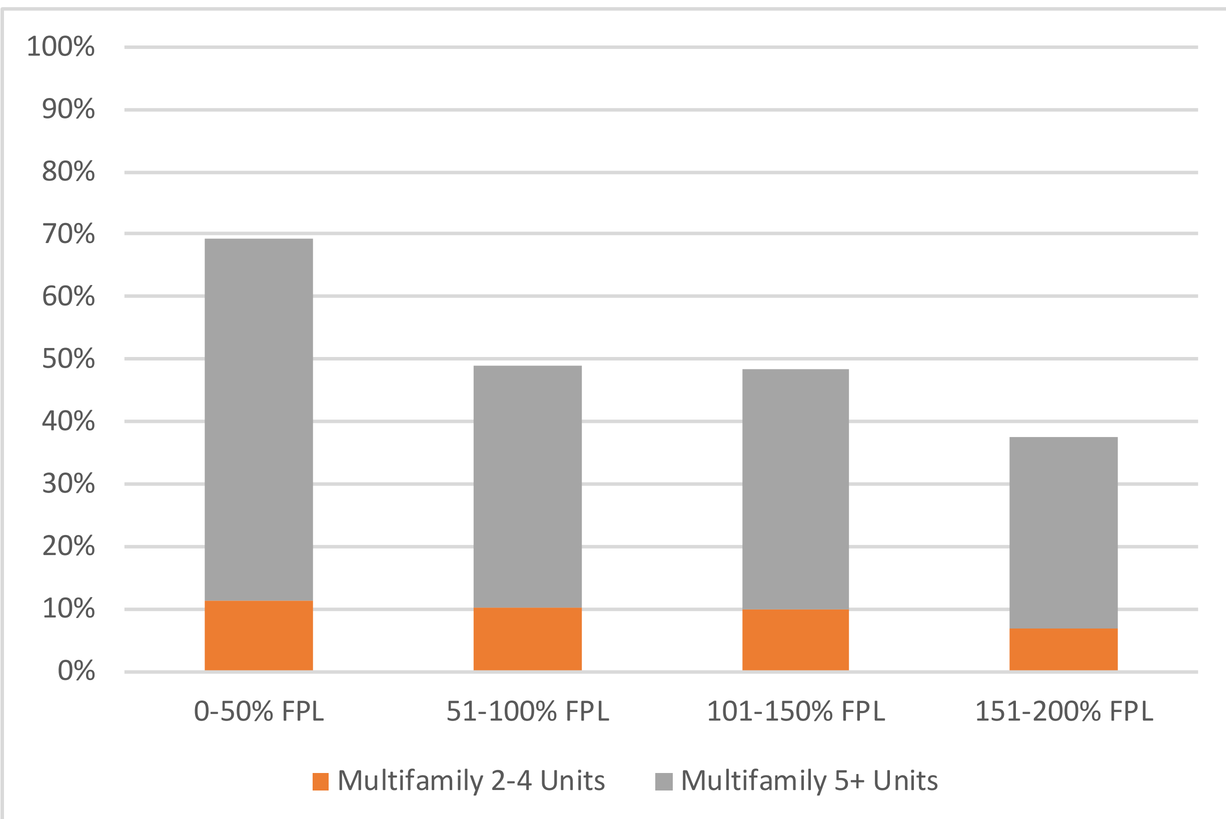
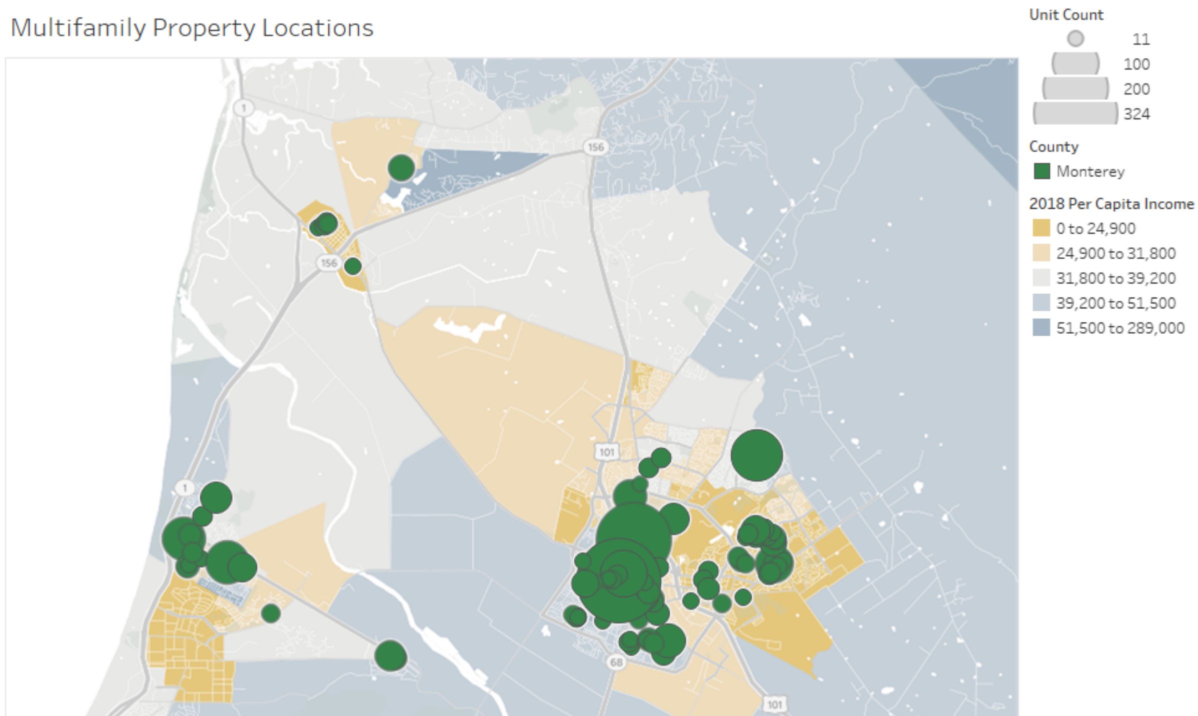


Figure 6: Distribution Rental Unit Types by Income Cohort



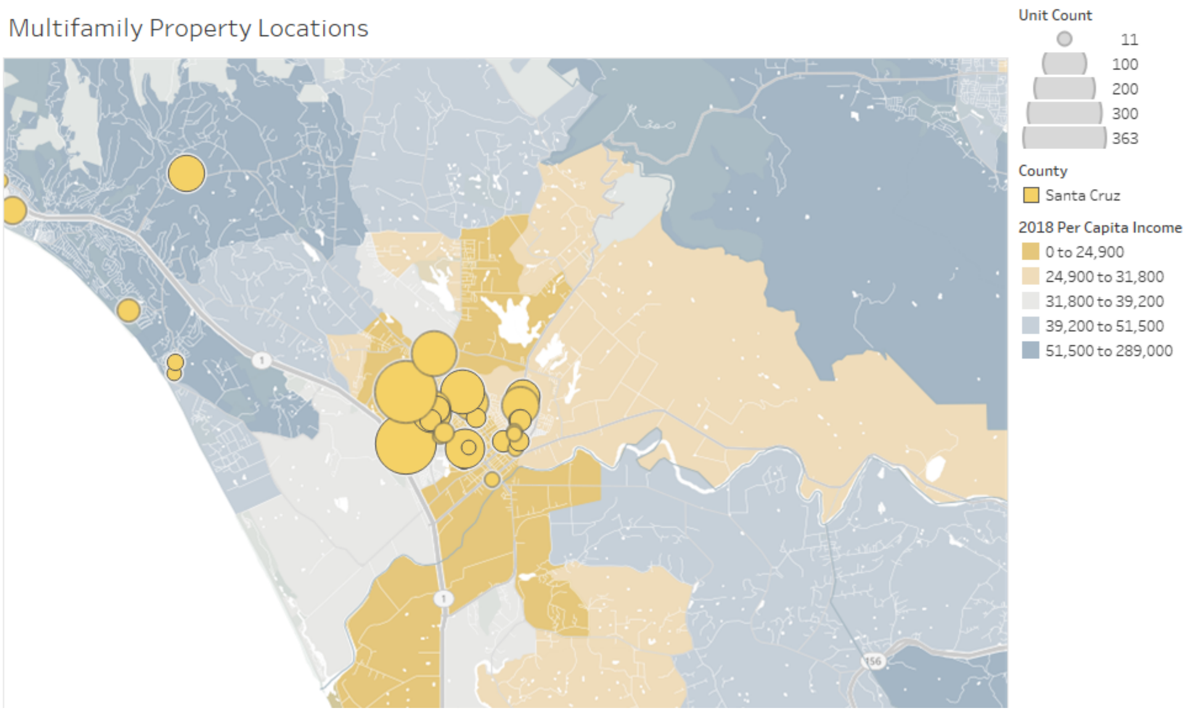
These combined market characteristics support the idea that targeting commercial multifamily properties provides a significant leverage opportunity to address various equity issues involving building and transportation electrification, especially among low-income residents.   To assess locational characteristics, our analysis of data provided by Landvision[13] allows multifamily parcel locations to be mapped such that targeted outreach campaigns can be defined or geographic analysis can be completed, such as identifying EV charger locations relative to multifamily dwelling units (MDUs) in low income areas. Figure 7 and Figure 8 shows an example of the locations of multifamily properties with more than 10 units (shaded circles) by area income levels (shaded map areas) in Monterey and Santa Cruz counties. Such mapping allows for targeted efforts such as EV charger installation or low-income neighborhood initiatives.

Figure 7: Select Multifamily Property Locations in Monterey County



[13] Landvision at https://www.digmap.com/platform/landvision/ accessed May 2019

Figure 8: Select Multifamily Property Locations in Santa Cruz County



Residential Natural Gas Use and GHG Output

We estimated natural gas usage and resulting CO_2e for three residential end-uses, including:

1. Space heating, including central, packaged unit, and wall mounted natural gas heaters;
2. Hot water heating involving natural gas tank heaters;
3. Residential cooking involving primarily gas cook tops.

The estimate of annual natural gas usage was completed for each measure and each housing unit type using the following equation:

Annual natural gas usage by end-use type = number of housing units by type X unit energy consumption by end-use and housing unit type X measure saturation by end-use and housing unit type.

These three end-uses consume about 91% of average annual household natural gas unit energy consumption (UEC) as defined in the California Energy Commission's (CEC) Residential Appliance Saturation Survey (RASS)[14], as shown in Table 7. To vet our analysis, we also compared our total estimated natural gas usage at the end-use level against 2017 PG&E residential natural gas sales and confirmed that our combined estimated residential natural gas usage of 108.7 million therms (MMTherms) accounts for 87.1% of PG&E total residential sales of 124.8 MMTherms, indicating reasonable alignment between end-use level analysis and top down utility sales values.

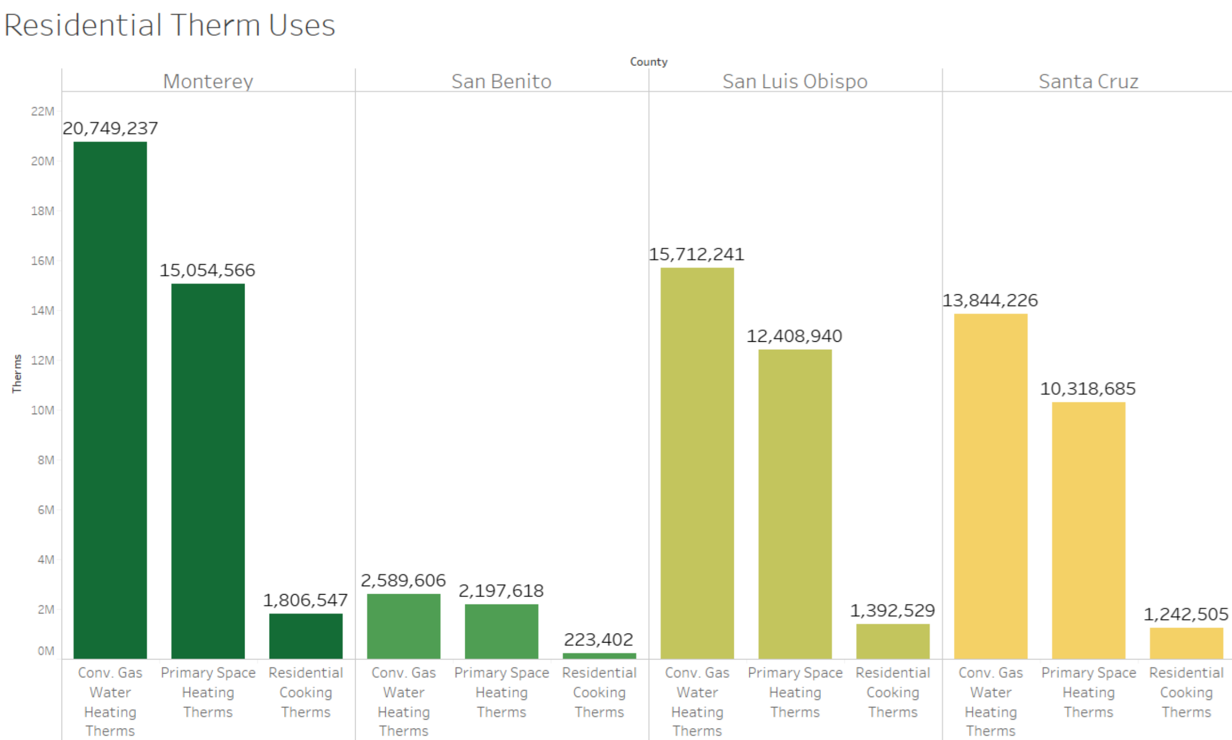
[14] Saturation % weighted based on RASS unit energy consumption profile for climate zone 3

Table 7. Summary of Residential Natural Gas Use Analysis

Measure	Value
Total 2017 Residential PG&E Therm Sales	124,807,168
Residential Therms Profiled	108,734,955
Saturation Weighted RASS Unit Energy Consumption Profiled	91.0%
% of PG&E 2017 Residential Gas Sales Profiled	87.1%

Figure 9 shows that across the four counties, water heating consumed the greatest amount of natural gas followed by primary space heating at 56.9 and 43.8 MMTherms, respectively. Consumption of natural gas for residential cooking is estimated at 7.9 MMTherms and is a minor usage in all counties.

Figure 9: Quad County Residential End-Use Natural Gas Usage



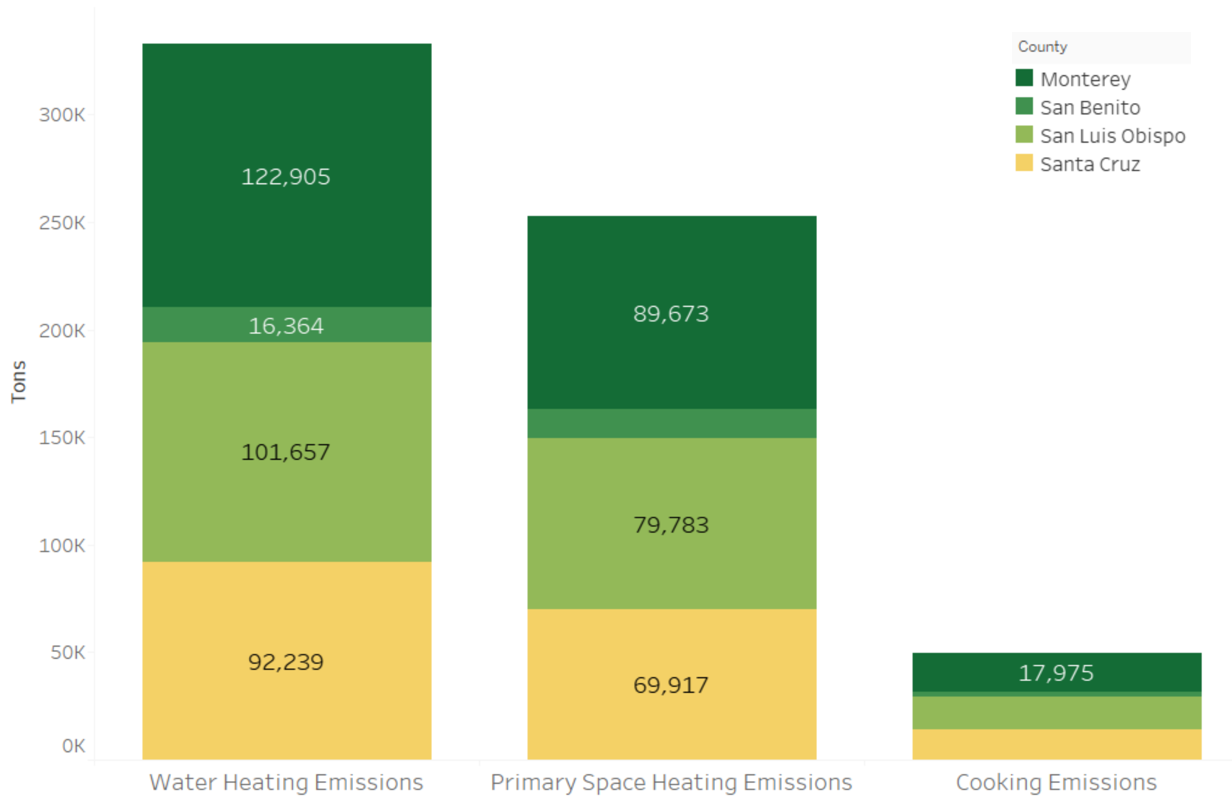
Once natural gas consumption was defined at the measure level, carbon dioxide emissions (CO_2e) were calculated using a factor of 11.7 pounds of CO_2e per therm, or 0.00585 metric tons of carbon dioxide emissions per therm ($MTCO_2e$/Therm).[15] A common emission factor was used across all end-uses because combustion efficiency was accounted for in the unit energy consumption estimates for each end-use. Table 8 provides a summary of residential natural gas consumption estimates by end-use while Figure 10 shows the resulting annual CO_2e by end-use by county.

[15] At https://www.eia.gov/environment/emissions/co2_vol_mass.php accessed May 2019

Table 8. Summary of Residential End-Use Natural Gas Consumption and CO_2e Impact

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Therm Use					
Primary Space Heating Therms	15,328,705	2,328,874	13,638,094	11,951,716	43,247,389
Water Heating Therms	21,009,473	2,797,190	17,377,251	15,767,313	56,951,226
Cooking Therms	3,072,684	418,481	2,605,741	2,374,647	8,471,553

Figure 10: Residential CO_2e Emissions by End-Use



Residential Propane Use and GHG Output

We completed an analysis of propane usage at the county level using the following methodology:

1. We established a baseline number of propane candidate homes by comparing the number of PG&E electric and gas service accounts at the zip code level data to define the number of electric accounts that did not have a gas account. We defined this as the number of propane candidate homes.
2. We decreased the number of propane candidate homes by subtracting the estimated number of fully electric homes (i.e. homes using electric resistance and heat pump heating) based on RASS saturation estimates. We compared this to ACS estimates of homes using propane and

established that we had a general alignment and concluded that ACS provide a reasonable estimate of propane homes. ACS provides this estimate at the census tract level which we consolidated to define our final estimate of propane homes at the zip code level.

3. Once we defined our final estimate of propane homes, we estimated propane therm use and emissions numbers using natural gas UEC values for primary space heating, hot water heating, and cooking therms based on 1-unit, detached UECs provided by RASS. We used the 1-unit, detached UECs as our value for propane measures because LandVision data indicated that rural homes, the most likely propane fueled homes, are generally the same size as urban homes.

As shown in Table 9 we estimate that approximately 24,500 of homes rely on propane across the four counties and that overall propane use accounts for about 10.2 MMTherms, or about 3.9% of total therms annually. Figure 11 shows our total estimate of residential propane therm consumption by county while Figure 12 provides our estimate of the saturation of propane homes across all residence types.

Table 9. Summary of Residential End-Use Propane Consumption and mtCO$_2$e Impact

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Homes Using Propane	4,193	937	8,629	10,819	24,578
Space Heating Therms	767,319	171,471	1,579,107	1,979,877	4,497,774
Water Heating Therms	817,635	182,715	1,682,655	2,109,705	4,792,710
Cooking Therms	150,948	33,732	310,644	389,484	884,808
Total GHG	10,155	2,269	20,899	26,203	59,525
Space Heating GHG	4,489	1,003	9,238	11,582	26,312
Water Heating GHG	4,783	1,069	9,844	12,342	28,037
Cooking GHG	883	197	1,817	2,278	5,176

Figure 11. Summary of Residential Propane Use by County

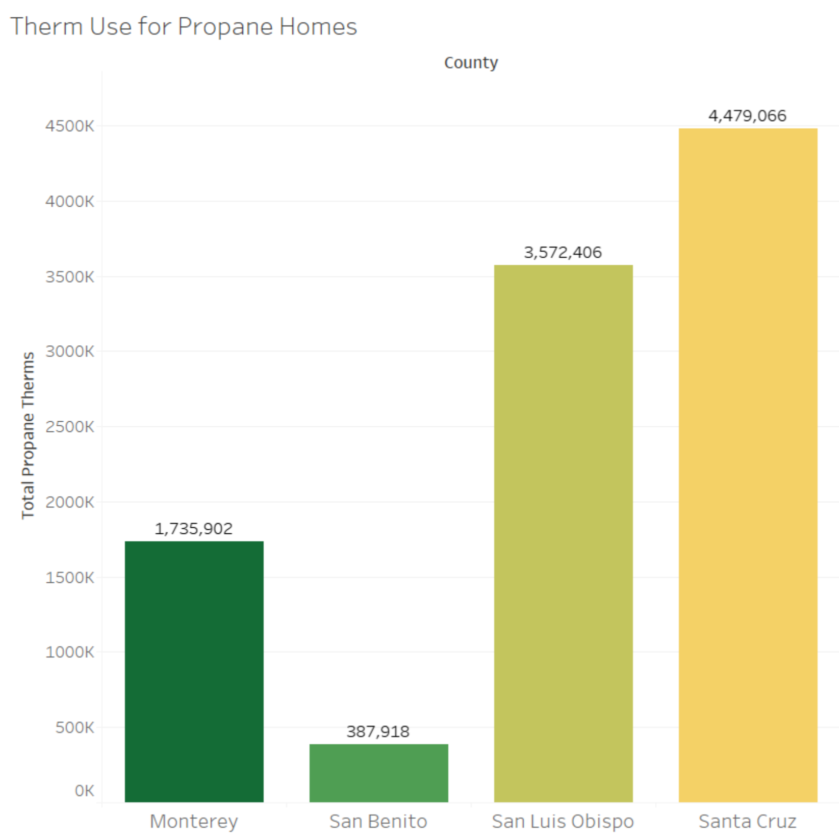


Figure 12. Estimated Saturation of Propane Homes by County

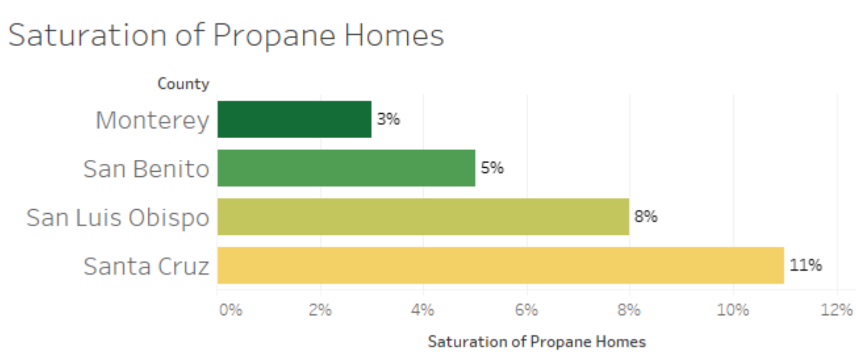


Figure 13 shows the distribution of homes with propane relative to total homes by zip code across the four counties based on our estimates. Based on our analysis of ACS zip code data, Figure 13 shows the distribution of propane homes by location and generally supports the assumption that rural areas are more likely to be heated by propane and a locational approach to electrification marketing efforts would be valid. In addition, in June of 2019 PG&E released maps indicating where fire hazard is highest, and Figure 14 provides a view of these locations, supporting our conclusion that targeted locational marketing campaigns to electrify propane usage might be most beneficial.

Figure 13: Percentage of Homes with Propane

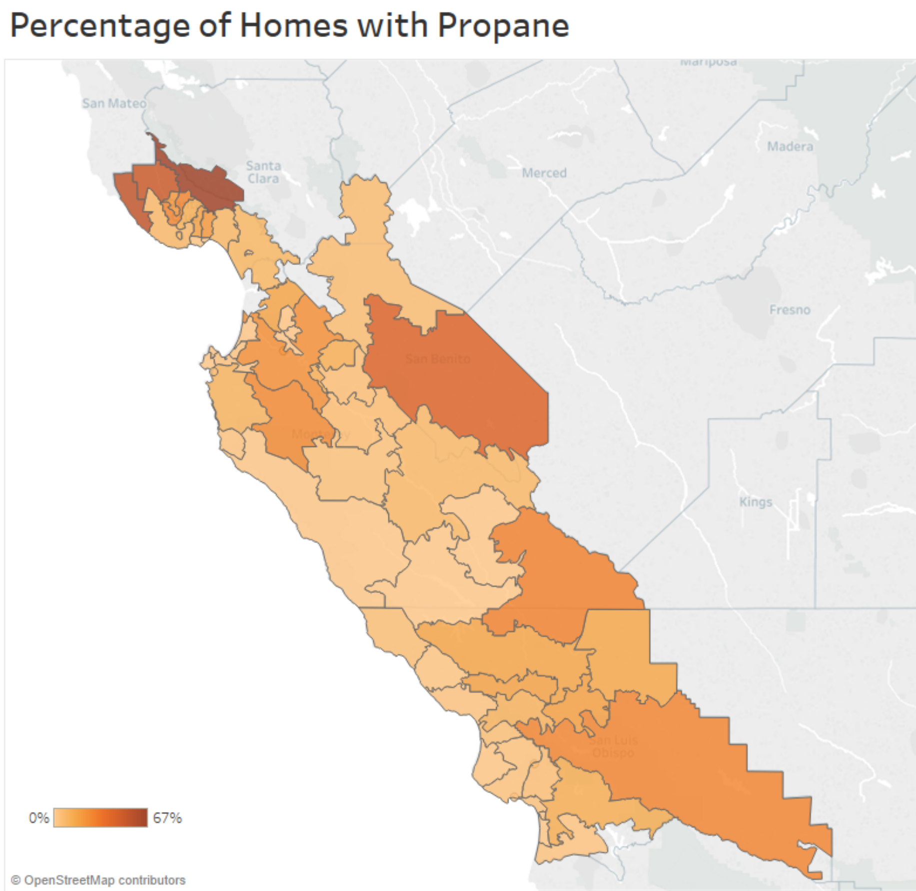
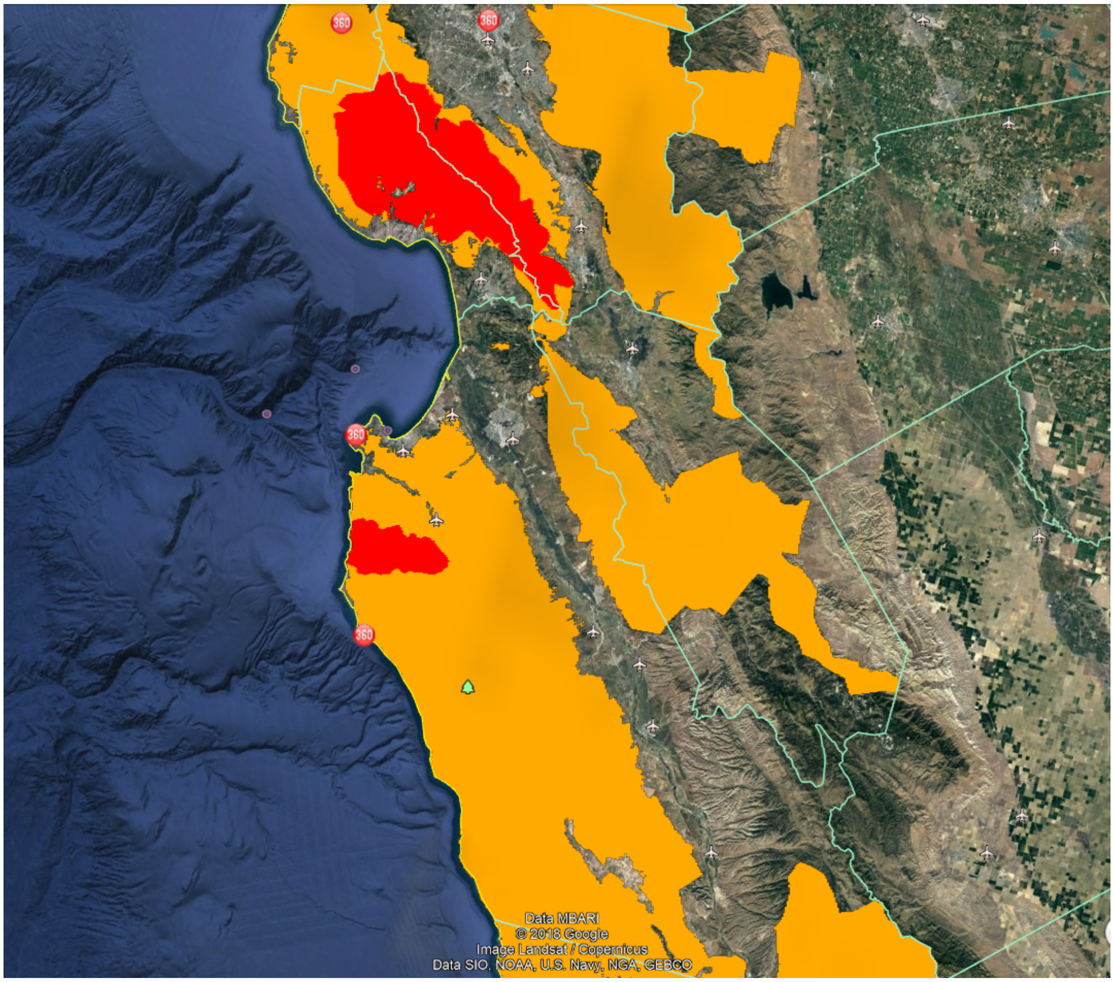


Figure 14: PG&E Fire Hazard Area



Observations Supporting the Residential Electrification Roadmap

1. Hot water heating is the highest user of natural gas and propane and offers several unique opportunities:
   a. Residential hot water heaters have a shorter useful life than primary space heating at 8 years versus 20 years, respectively. This means that this equipment has a higher annual stock turnover and therefore offers more frequent opportunities for market interventions.
   b. As further discussed below, electric hot water heaters offer grid interactive demand response opportunities such as heating water during off-peak periods or times when there is an oversupply of renewable power on the grid. Electric space heating can also be used for demand response (i.e. pre-heating or pre-cooling) but the performance of these systems from a demand response perspective is dependent on the thermal integrity of the building shell, and this will vary greatly from one structure to the next.
   c. There are several technology options including tank storage heater or on-demand solutions.
   d. Hot water heating can be combined with heat pumps to provide a whole house solution for space and water heating.

    e. Residential battery storage might be useful to mitigate on demand HWH load spikes.
2. Cooking with natural gas is related to gas cook-tops and is a relatively small end-use even though natural gas cooking saturation is near 75%. The acceptance of electric cooking (e.g. induction systems) in the residential market is not yet known and it may face resistance based on personal preference. This personal preference of fuel type may not be as prevalent for space or water heating.
3. There is significant regular interest in converting primary space heating from natural gas to electric heat pumps and new funding opportunities, such as SB 1477—which requires, from July 1, 2019 through June 30, 2023, the CPUC to allocate $50 million annually from gas corporations' GHG emissions allowance revenues for the BUILD Program and the TECH Initiative— may help drive more acceptance of heat pumps.[16] We are uncertain about market acceptance, however. Based on the most recent RASS saturation estimates, saturation of natural gas space heating is 85% to 88% but the market for this end use may face several barriers:
    a. The counties are in temperate climate zones that require some space heating but not a great deal of cooling, hence the payback on the incremental cost for high efficiency heat pump HVAC solutions may not be attractive in the built environment. Opportunities for high efficiency heat pump HVAC solutions in the new construction market, however, are excellent.
    b. Because the saturation of gas space heating is very high this indicates that this is where the trades and implementation contractors are focused and so a longer-term commitment to market transformation would be needed to train distributors and contractors and incent them to stock and sell this equipment.
    c. Heating and air conditioning equipment has a long useful life, between 16 and 20 years and so stock turnover is slow, furthering the need for a long-term commitment to increase market share.
4. Converting residences using propane for space and water heating to electricity presents good economic value for customers because propane is 50% more expensive that natural gas. While we are uncertain if propane presents any additional fire hazard, it is understood that most propone users are located in rural areas where there is no natural gas service and many of these residences are located in PG&E fire mitigation areas.
5. Interactive technologies such as WiFI enabled thermostats and water heating controls allow temperature settings to be adjusted to shift loads, while residential storage batteries can further help mitigate peak demands based on pricing or grid condition signals. These technologies present a broad set of economic opportunities for both end-users and electricity suppliers. For example, Figure 15 shows MBCP system forecast demand as of January and July of 2019, indicating system peaks in the morning and evening that may be exacerbated by electrification efforts. Figure 16 summarizes a load shifting analysis completed by Tierra on a separate project showing baseline water heating load shape and three different heat pump water heater strategies for an individual water heater illustrating how morning and evening peaks might be mitigated through controls that leverage the thermal storage capacity of water heaters.

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[16] The Commission opened a proceeding via Order Instituting Rulemaking 19-01-011 regarding building decarbonization on February 8, 2019 to address the implementation of these programs.

Shifting loads has implications for the marginal costs of electricity procurement and Figure 17 provides an illustrative example of differences in utility marginal procurement costs over an 8760 annul timeframe where darker shades of blue denote higher marginal kWh procurement costs. Figure 18 shows how interactive heat pump water heaters might be used to shift loads to leverage lower cost electricity and also benefit of grid reliability. Grid reliability is largely dependent on the condition of the distribution system, which can influence the value of grid interactivity based on the location of the device being controlled. Figure 19 shows PG&E's Integration Capacity Analysis (ICA) map illustrating where the distribution system in Monterey may be constrained for potential for new (DERs) projects. Such locational analysis can be used to focus program marketing and also help define appropriate incentive levels for grid interactivity based on locational value.

Figure 15: MBCP System Demand

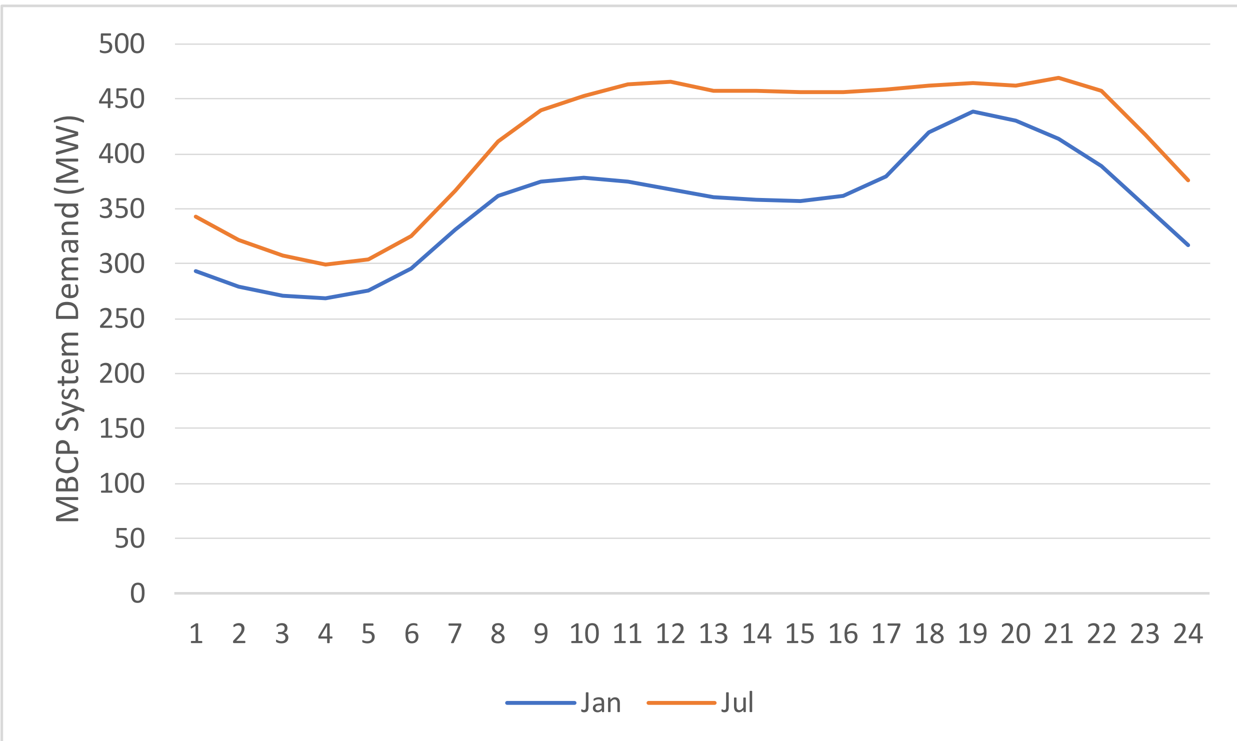


Figure 16: Residential Heat Pump Water Heater Load Profile

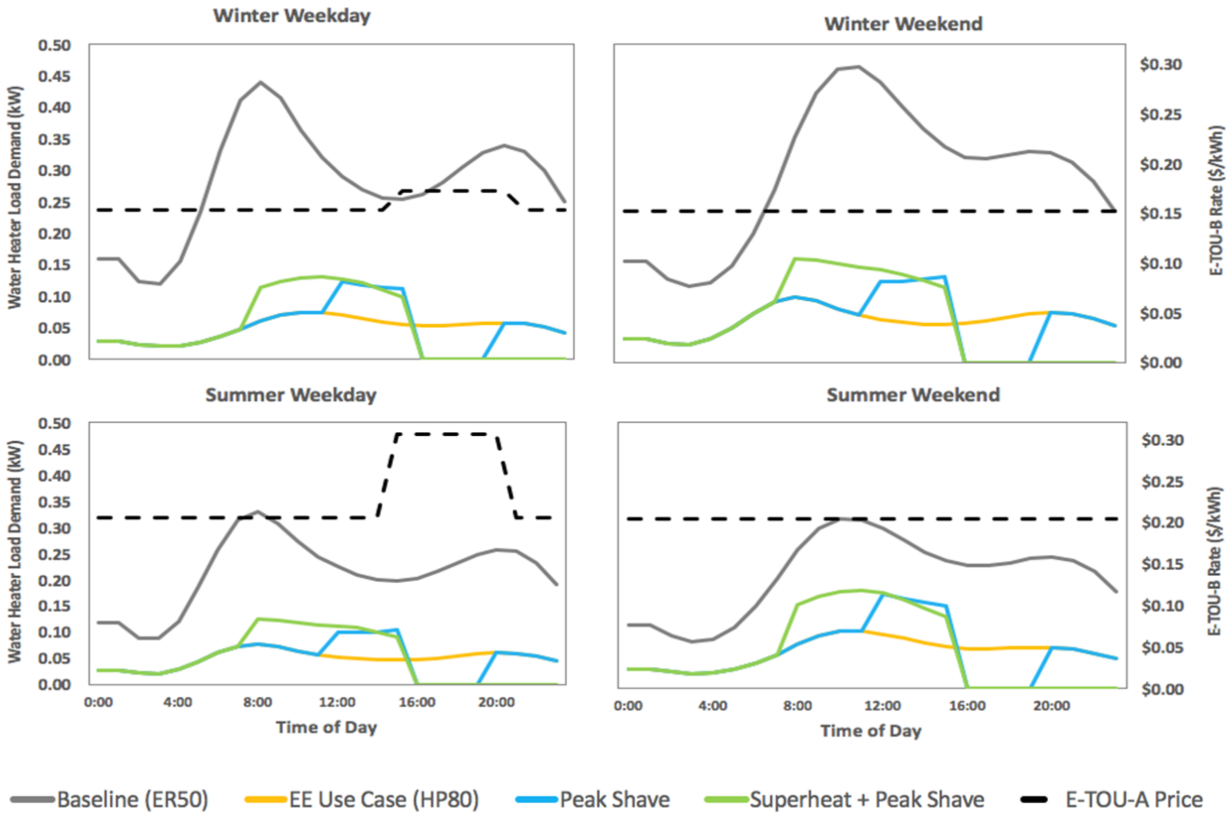


Figure 17: Illustrative Example of Differences in Marginal Procurement Costs

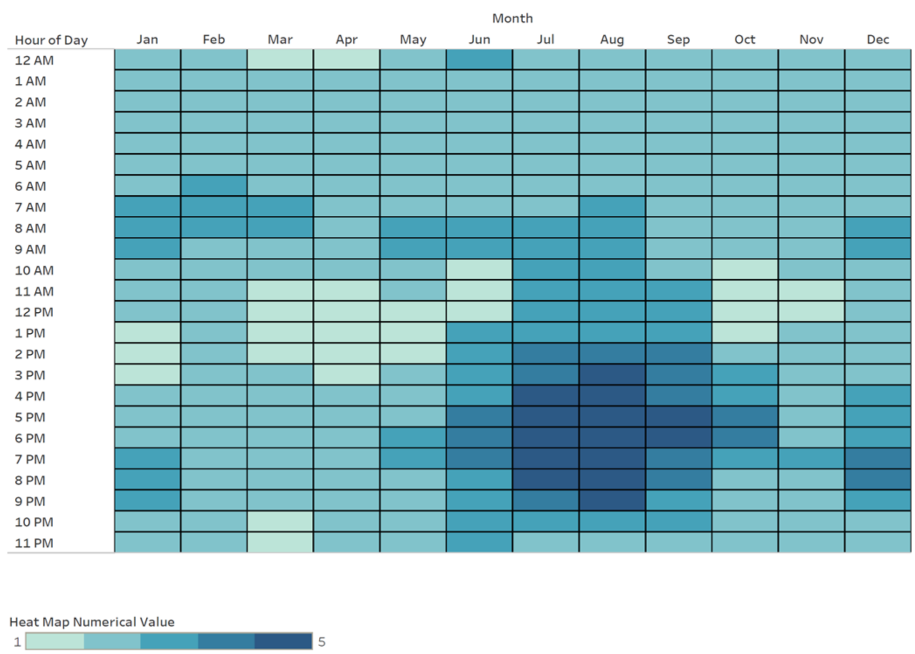


Figure 18: Illustrative Example of Heat Pump Water Heater Load Shapes and Marginal Costs

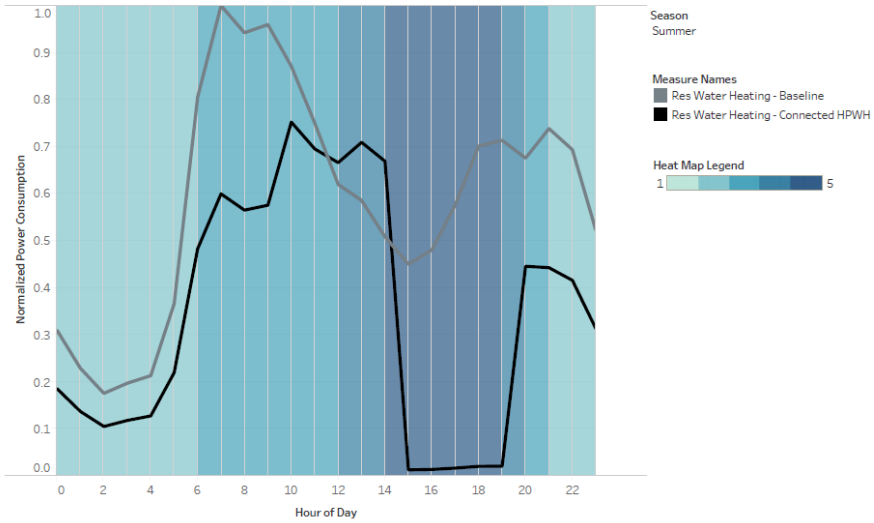
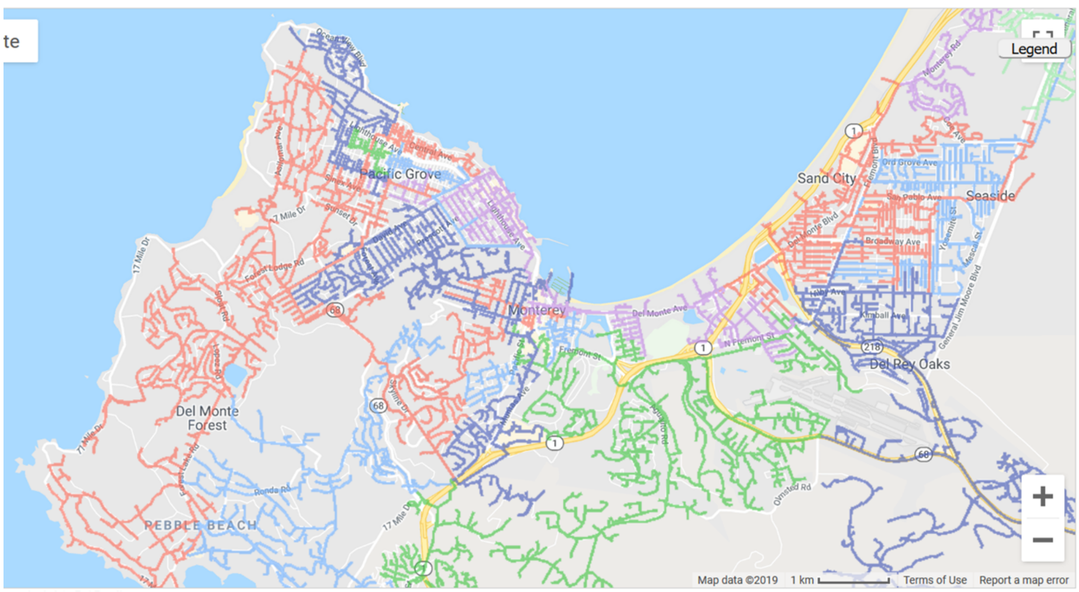


Figure 19: PVRAM Feeder Status



Commercial Built Environment

Commercial Market Overview

We used the U.S. Department of Energy's Commercial Building Energy Consumption (CBECS) database to determine the number of commercial units and total square footage of various building types for the quad counties. This involved scaling the commercial unit counts for the CBECS Pacific Census Region to the quad counties based on population size. This analysis also included some adjustments to CBECs building types to align with the types of buildings defined in the California Energy Commissions Commercial End Use Survey (CEUS). Based on this methodology, Figure 20 and Figure 22 provides our estimate of building counts and square footage respectively for various commercial market segments for the combined four counties.

Figure 20. Commercial Segment Building Counts

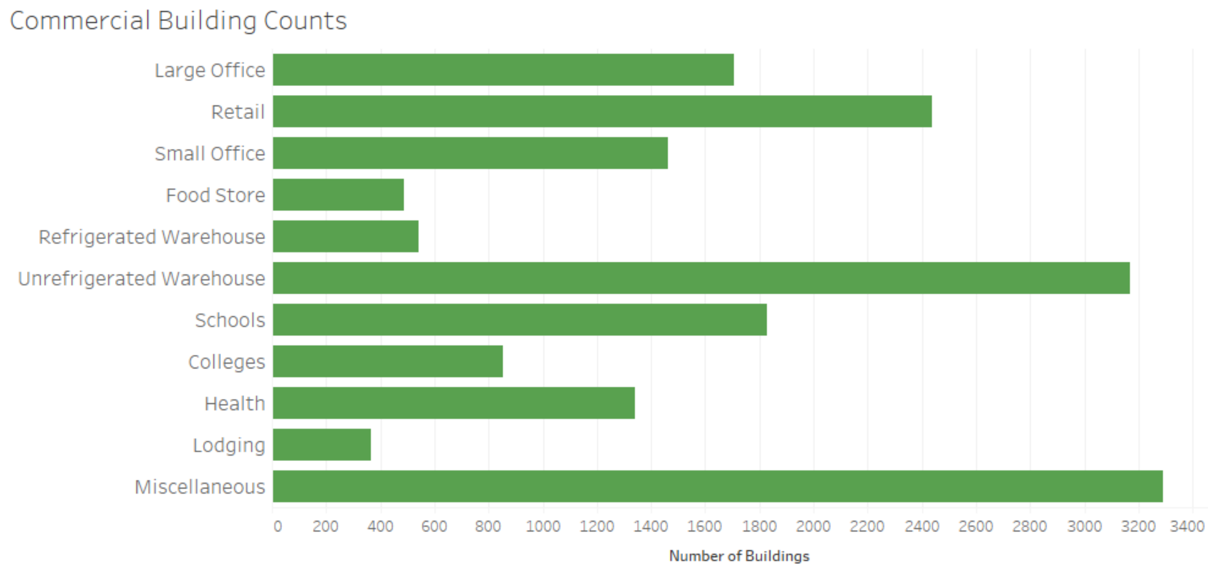
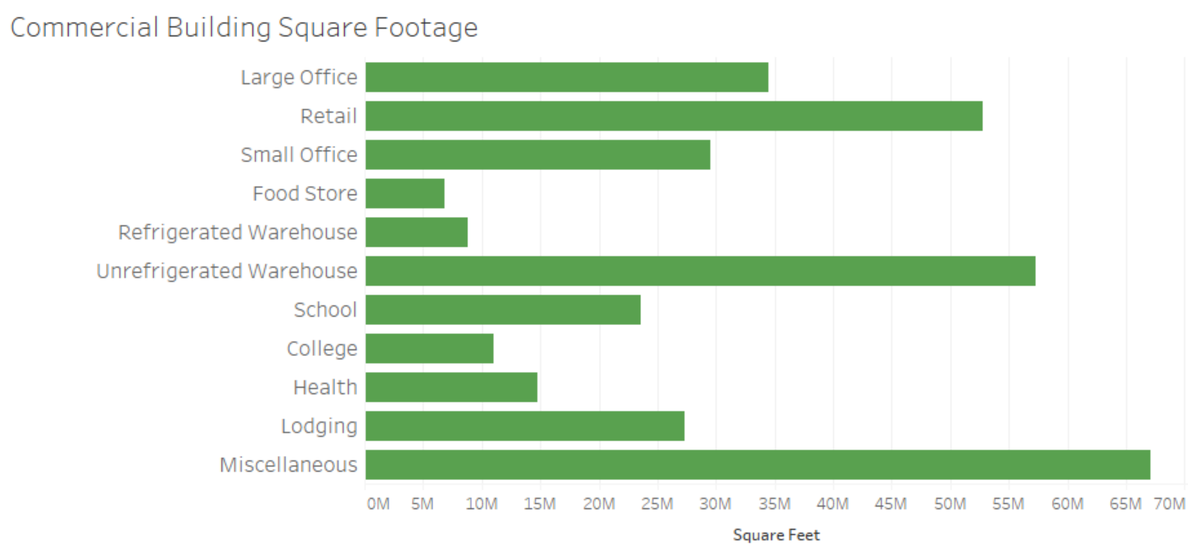


Figure 21. Commercial Segment Building Square Footage



Commercial Natural Gas Use and GHG Output

We estimated natural gas usage and resulting carbon dioxide emissions for three commercial end-uses, including:

1. Space heating
2. Hot water heating
3. Restaurant cooking

These three end-uses comprise about 68% of commercial building natural gas energy intensities as defined in CEUS[17], with the remainder of gas usage made up of multiple end-uses each of which accounts for a small amount of consumption. Once the square footage of commercial building segments was determined, we were able to apply segment specific end-use energy intensity values from CEUS to determine natural gas consumption for each end-use and commercial building type using the following equation:

> *Annual commercial natural and end-use type = Total building type square footage X building type end-use energy intensity (kBtu/ft2-yr) for climate zone 3 / 100 kBtu per therm.*

Based on this methodology, Table 10 provides our estimate of annual natural gas usage by end-use for each county.

Table 10. Summary of Commercial Natural Gas Use

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Space Heating Therms	11,975,791	1,594,697	7,773,010	7,570,604	28,914,101
Water Heating Therms	11,159,300	1,485,973	7,243,058	7,054,452	26,942,783
Restaurant Cooking Therms	4,066,076	541,439	2,639,128	2,570,406	9,817,049

These three end-uses consume an annual average of about 67 MMTherms as shown in Table 11. To vet our analysis, we also compared the sum of our estimated natural gas usage, estimated at the end-use level, to 2017 PG&E commercial natural gas sales and our combined estimated natural gas usage of 66.9 MMTherms accounts for 49.5 % of PG&E total non-residential sales in 2017 of 135.3 MMTherms.

Table 11. Summary of Commercial Building Natural Gas Use Analysis

Measure	Value
Total 2017 Commercial PG&E Therm Sales	135,349,105
Commercial Therms Profiled	66,980,889
Saturation % Weighted CEUS Energy Intensity Profiled	68.2%
% of PG&E 2017 Non-residential Gas Sales Profiled	49.5%

The difference in our estimate of natural gas usage in the commercial market and PG&E data for non-residential natural gas sales is likely because, as mentioned previously, PG&E does not disaggregate non-residential natural gas sales and includes sales to the commercial, industrial or agricultural segments. The industrial and agricultural segments use natural gas for multiple purposes, including space and water heating, but mostly for manufacturing, processing (e.g. food processing), and cogeneration. The four counties likely do not have much gas intensive industrial usage but likely have some agriculture usage. As a point of reference, Table 12 shows 2017 total PG&E non-residential natural gas sales by market sector indicating that the majority of sales are in the industrial sector. As such our estimate that natural gas sales to the four counties for the commercial market accounts for approximately one half of PG&E natural gas sales is reasonable but could be refined in subsequent requests to PG&E for more

[17] Saturation % weighted based on CEUS unit energy consumption profile for climate zone 3

detailed market segment natural gas sales data that would allow industrial and agricultural usage to be more accurately defined.

Table 12. 2017 Total PG&E Non-Residential Natural Gas Sales by Market Sector

Market Sector	Ag & Water Pump	Commercial Building	Commercial Other	Industry	Mining & Construction	Total Usage
2017 Sales	36	865	68	1,701	171	2,841
% of Sales	1%	30%	2%	60%	6%	100%

Consistent with the residential analysis, carbon dioxide emissions were calculated using a factor of 11.7 pounds CO_2e per therm or 0.00585 metric tons of carbon dioxide emissions per therm ($MTCO_2e$/Therm). As with the residential analysis, a common factor was used across all end-uses because combustion efficiencies in the built environment are accounted for in the energy intensities defined in CEUS. Figure 22 provides the distribution of total commercial building emissions by county and Figure 23 provides emissions by county by end-use.

Figure 22: Total Commercial Building Emissions ($MTCO_2e$)

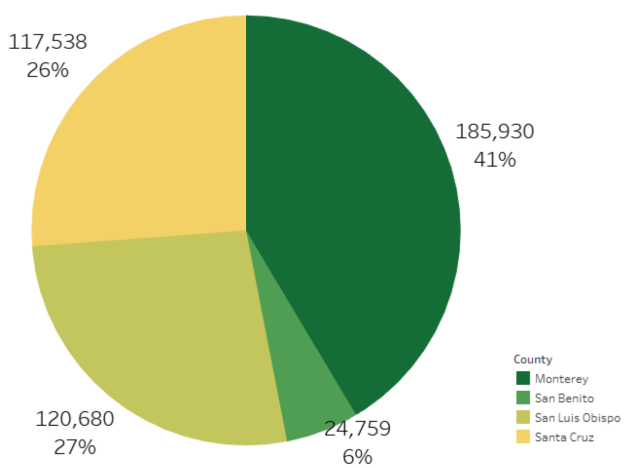
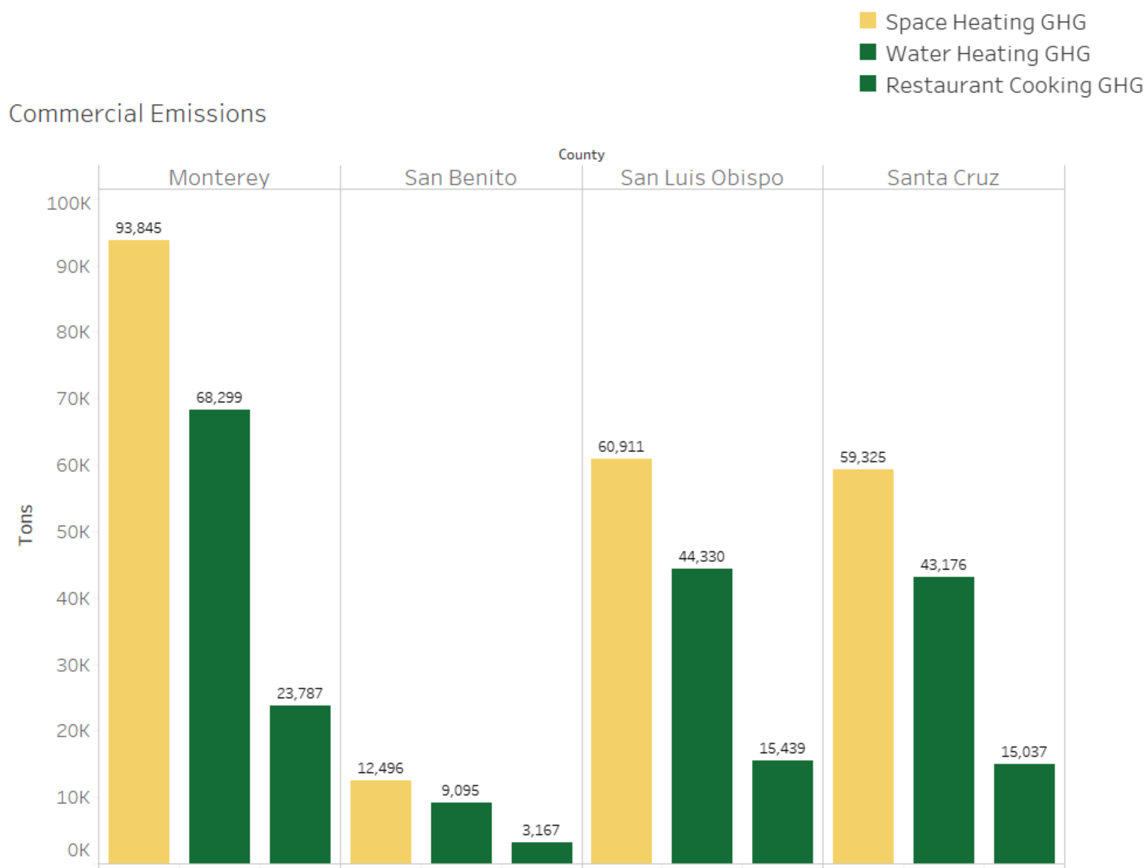


Figure 23: Commercial $MTCO_2e$ Emissions by End-Use



Observations Supporting the Commercial Electrification Roadmap

1. Hot water heating in the commercial market is the second highest natural gas use and offers opportunities that are similar to the residential market:
    a. Many commercial properties use tank style hot wat heaters that have a relatively short useful life and may offer high annual stock turnover and resulting opportunities for market interventions.
    b. Electric hot water heating in the commercial market might offer demand response opportunities such as heating water during off-peak periods or times when there is an oversupply of renewable power on the grid.
    c. Hot water heating can be combined with heat pumps to provide a whole building solution for space and water heating, though this might be limited to smaller facilities.
    d. As part of the water heating process heat pump water heaters exhaust air that is cooler than ambient air and may serve the dual purpose of air conditioning spaces that are consistency heated through normal operations, such as commercial kitchens or laundry facilities.
2. Natural gas usage in the restaurant and food service segments is considerable, accounting for approximately 15% of commercial natural gas use. This offers a greater leverage opportunity than the residential market because it represents a large opportunity in a relatively small number of facilities. While the acceptance of electric cooking (e.g. induction systems) in the commercial

market is nascent and not fully understood, it might not face the same preference bias as induction cooking in the residential market.

3. The commercial market benefits from the same value of grid interactivity of electric space and water heaters as presented in the previous discussion on benefits in the residential market. Commercial systems tend to be larger, thus amplifying these benefits, including:
    a. Capacity to leverage load shifting capability to utilize electricity that has lower marginal costs.
    b. Capacity to leverage interactive controls or couple with storage batteries to manage peak demand.
    c. Ability to target marketing efforts and incentives to benefit grid reliability based on locational considerations.
4. Microgrids deployments in the commercial market can offer electrification potential and the selection process used to assess microgrid locations should include the following criteria:
    1. Building equipment electrification potential:
        a. Built environment with NG space and water heating systems that are at or approaching useful life (i.e. has some older building which can be retrofit/replaced).
        b. New construction planned or likely.
    2. Grid reliability and resiliency criteria including:
        a. Located within PG&E fire mitigation areas and distribution systems with high potential for shut down.
        b. Indicates DER grid constrained (through system tools such as PVRAM).
    3. Resource savings potential as defined CA resource loading order, including:
        a. Energy efficiency.
        b. Demand response, including batteries for demand management and critical load.
        c. Distributed solar generation.
    4. Locational potential for economic growth, including:
        a. Low-income or disadvantaged community designation or located in adjacent areas.
        b. Identified within jurisdictional planning as areas of interest, such as economic develop areas defined in general plans, local and regional transportation plan development areas, etc.
        c. Potential for brownfield development of ground mounted solar.
    5. Includes islanding capability options:
        a. Islanding full distribution interconnect.
        b. Islanding only critical loads within an interconnect such as health, safety, and communication systems. This features distributed grid interactive systems that allows multiple loads to be aggregated from locations not within a defined distribution node.
    6. Has sustainability funding potential, including:
        a. Has commercial funding potential (i.e. developers willing to invest some incremental dollars).
        b. May be part of a larger municipal funding effort, such as sustainability bonds or an energy investment district.
        c. Has characteristics in alignment with agency program funding (i.e. aligns with CARB funding mechanisms, DAC funds, etc.).

Vehicles

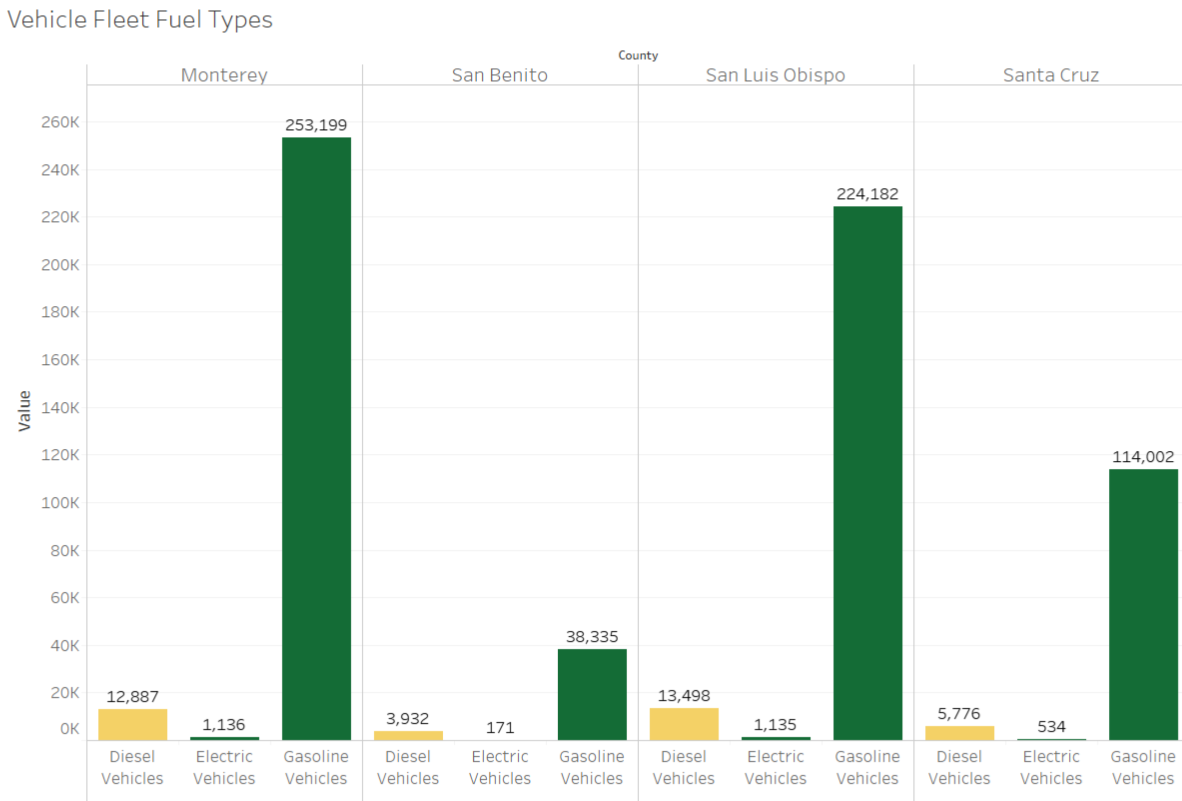
Vehicle Fleet Summary

Data from the California Air Resources Board (CARB) Online Fleet database, an online database that provides access to aggregated vehicle counts from the vehicle registration data at the census block group level including information on vehicles' model year, weight classes, fuel technology, electric miles range for plug-in electric vehicles, and household attributes, provided us with estimates vehicle fleets by vehicle category and fuel type by county as shown in Table 13, while Figure 24 provides a summary of vehicles by fuel type.

Table 13. Summary of Vehicle Fleet Populations

Vehicle Category	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
All Other Buses	262	13	128	17	420
Light-Duty Trucks	62,880	9,086	58,268	29,917	160,151
Light-Heavy-Duty Trucks	10,471	2,279	12,113	4,461	29,324
Medium-Duty Trucks	46,757	7,786	36,292	16,799	107,634
Motor Coach	87	4	21	6	118
Motor Homes	1,207	289	2,174	798	4,468
Motorcycles	6,562	1,464	8,559	4,282	20,867
Other Buses	174	16	193	62	445
Passenger Cars	133,077	19,281	116,993	61,390	330,740
Power Take Off	0	0	0	0	0
School Buses	293	27	179	101	600
Urban Buses	128	12	88	97	324
Medium-Heavy Duty Truck	3,514	477	2,404	1,866	8,261
Heavy-Heavy Duty Truck	1,811	1,703	1,403	518	5,435
Grand Total	267,221	42,438	238,814	120,312	668,785

Figure 24: Summary of Vehicle Fleet Fuel Types



To vet our CO_2e estimate we calculated emissions based on the gallons of gasoline and diesel sold in the counties in 2017, shown in Table 14, and compared this to our estimate emissions defined at the vehicle type level using the CARB tool. As defined by the U.S. Energy Information Administration, about 19.64 pounds of carbon dioxide are produced from burning a gallon of gasoline that does not contain ethanol and about 22.38 pounds are produced by burning a gallon of diesel fuel. [18] Our estimated total vehicle emissions of 4,549,629 tons, shown by county in Figure 25, is 93.8% of the 4,852,363 tons we calculated based on actual fuel sales. This indicates that the two calculation methods are in agreement and that discrepancies in number is likely due to a small percentage of vehicles that we did not account for, such as agricultural equipment (e.g. tractors) that are not registered with the DMV and that are not in the CARB Online Fleet database. Figure 26 shows our estimate of CO_2e by select vehicle types.

Table 14. Estimated CO_2e Based on County Fuel Sales

Fuel	Gallons Consumed	CO_2e / Gallon	CO_2e Tons
Gasoline	430,000,000	19.64	4,222,600
Diesel	56,279,070	22.38	629,763

[18] U.S. Energy Information Administration

Total	4,852,363

Figure 25: Annual CO_2e for all Vehicles by County

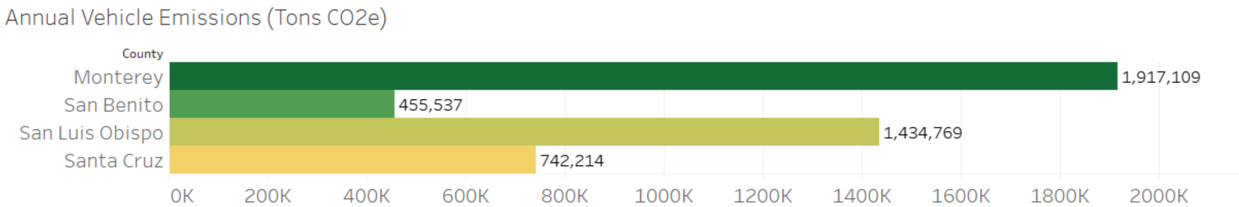
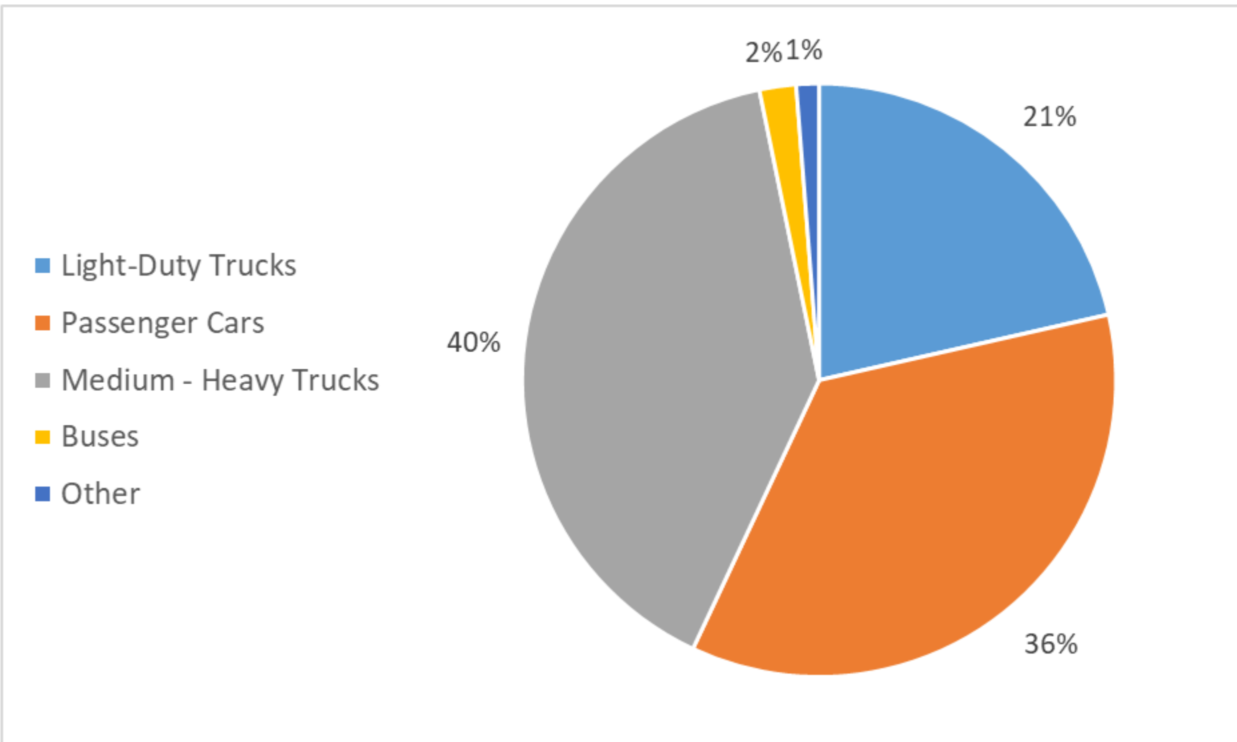


Figure 26: Total CO_2e by Vehicle Type



The subsequent discussions provide additional details on each vehicle category.

Light Duty Vehicles

As defined by the California Air Resource Board (CARB) light duty vehicles include passenger cars, light-duty trucks, and medium-duty vehicles from 8,501 to 14,000 lbs. gross vehicle weight (GVWR). Table 15 provides a summary of the light vehicle fleet by fuel type indicating that while there are very few electric trucks in this weight class, the fleet of electric passenger cars, which include both battery electric and hybrid machines, is over 72% the size of the diesel car fleet, though these still account for less than 0.9% of all passenger cars. As a class, these vehicles account for 2,592,905 tons CO_2e as shown in Figure 27.

As further discussed in Appendix D, Low-income MultiFamily EV Charging Roadmap Excerpt, low-income customers in particular benefit from the reduced fuel and maintenance costs associated with light duty vehicles. Table 16 provide our estimate of the light duty fleet owned by low-income customers based on CARE eligibility to define the number of low-income households and analysis completed by Tierra on behalf of the California Energy Commission indicating that the number of vehicles owned by low-income households is consistent ownership among non-low-income households.

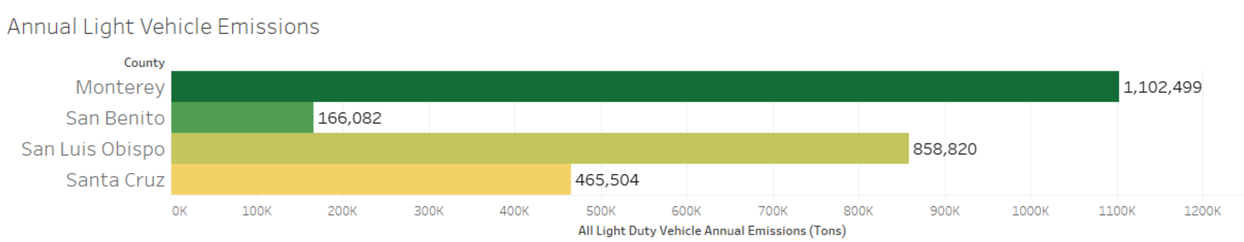
Table 15. Summary of Light Vehicle Fleet Fuel Types

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Light-Duty Trucks	62,880	9,086	58,268	29,917	160,151
Diesel	120	14	107	43	284
Electric	3	0	12	12	27
Gasoline	62,757	9,071	58,149	29,863	159,839
Passenger Cars	133,077	19,281	116,993	61,390	330,740
Diesel	1,306	217	1,575	982	4,081
Electric	1,132	171	1,123	523	2,949
Gasoline	130,638	18,893	114,295	59,885	323,711
Total	195,957	28,367	175,260	91,307	490,891

Table 16. Estimated Light Vehicle Fleet Fuel Types

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
CARE Eligibility - % Households	35%	33%	29%	29%	32%
Light-Duty Trucks	22,008	2,998	16,898	8,676	51,248
Passenger Cars	46,577	6,363	33,928	17,803	105,837
Total	68,585	9,361	50,826	26,479	157,085

Figure 27: Annual Light Vehicle Emissions



School Buses

School buses come in many size classes but are commonly categorized as shown in Table 17. During the course of our work AMBAG provided a survey of fleet information on 311 buses from 11 school districts, including 5 districts which provided vintage data on 172 buses indicating an average age of 17 years. While useful life varies depending on use, climate, maintenance, and funding, consensus generally centers around 16 to 20 years indicating the average age of the four-county fleet is near the end of useful life.

Table 17. School Bus Types and Weight Classes

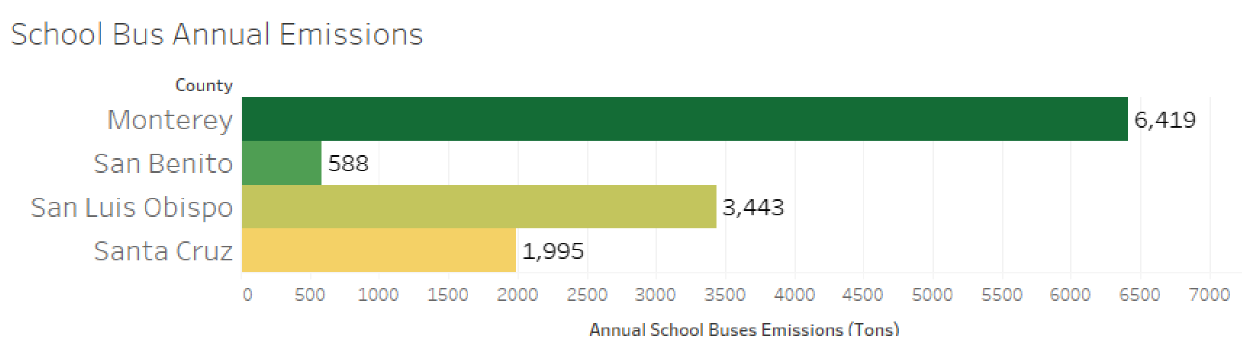
Type	Cutaway	Cutaway	Conventional	Transit bus
GVWR	<10,000	10,000 - 14,000	14,000 - 29,500	25,000 - 36,000

We assessed the school bus fleet using the CARB Online Fleet database of all registered vehicles, the National Transportation and Safety Board database of revenue vehicles, and the survey produced by AMBAG staff from individual school districts. Table 18 provides a summary of the school bus fleet by fuel type. Overall the fleet size is in agreement with the survey data, however the fuel mix in the CARB Online Fleet database indicates a higher saturation of gasoline buses than the district surveys for which AMBAG provided survey data. Both the CARB Online Fleet data and districts surveys indicate that there are no electric buses in operation, however interviews with the San Benito County Office of Education School District indicate they will be converting 2 cutaway buses from gasoline to electric in 2019. As a class, school buses account for 12,445 tons CO_2e as shown in Figure 28.

Table 18. Summary of School Bus Fleet Fuel Types

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
School Buses	293	27	179	101	600
Diesel	255	25	128	71	478
Gasoline	38	3	52	30	122
Total	293	27	179	101	600

Figure 28: School Bus Annual Emissions



Urban and Other Buses

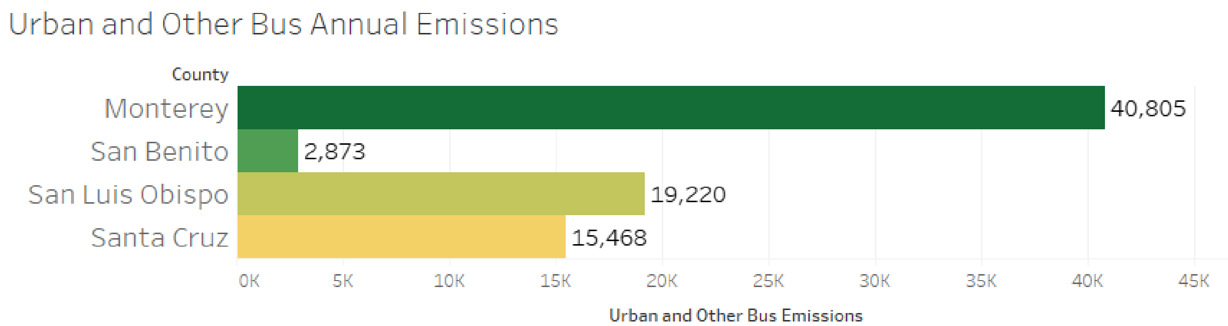
Urban and transit buses cover a wide range of vehicles but generally range between 14,000 to over 33,000 GVWR. Table 19 provides a summary of the urban and other bus fleets by fuel type. As a class, these vehicles account for 78,364 tons CO_2e as shown in Figure 29.

Table 19. Summary of Urban and Other Bus Vehicle Fleet Fuel Types

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
All Other Buses	262	13	128	17	420
Diesel	262	13	128	17	420
Other Buses	174	16	193	62	445
Gasoline	174	16	193	62	445

Urban Buses	128	12	88	97	324
Diesel	66	4	56	64	190
Gasoline	61	7	32	33	133
Total	563	41	409	176	1,189

Figure 29: Urban and Other Bus Annual Emissions



Commercial Trucks

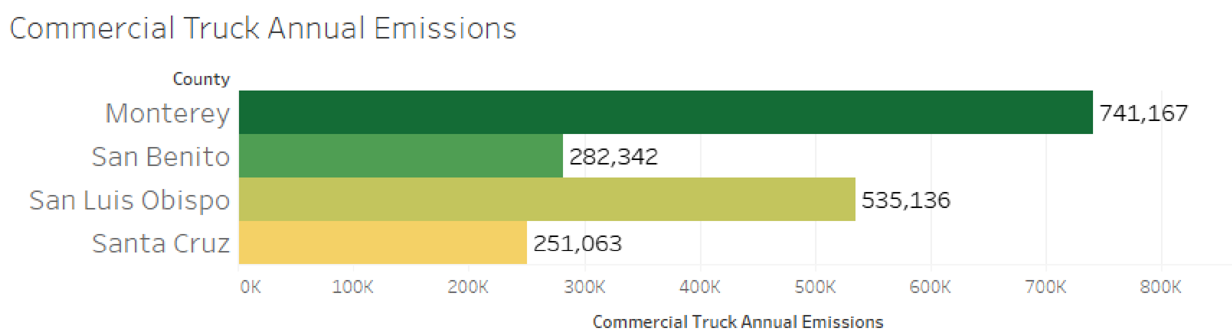
Commercial trucks cover a wide range of vehicles but generally range between 8,501 GVWR for light-heavy duty truck to heavy-duty trucks with a GVWR greater than 33,000 lbs. Table 20 provides a summary of the commercial truck fleet by fuel type and CO_2e as shown in Figure 30.[19]

Table 20. Summary of Commercial Truck Vehicle Fleet Fuel Types

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Light-Heavy-Duty Trucks	10,471	2,279	12,113	4,461	29,324
Diesel	5,196	1,395	7,132	2,084	15,807
Gasoline	5,275	884	4,980	2,377	13,516
Medium-Duty Trucks	46,757	7,786	36,292	16,799	107,634
Diesel	419	67	391	162	1,039
Gasoline	46,337	7,719	35,901	16,637	106,594
Medium-Heavy Duty Truck	3,514	477	2,404	1,866	8,261
Diesel	3,148	420	2,090	1,686	7,344
Gasoline	366	58	314	180	917
Heavy-Heavy Duty Truck	1,811	1,703	1,403	518	5,435
Diesel	1,791	1,701	1,382	510	5,384
Gasoline	19	2	21	8	51
Total	62,552	12,245	52,212	23,644	150,653

[19] At https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions accessed May 2019

Figure 30: Commercial Truck Annual Emissions



Observations Supporting the Vehicle Electrification Roadmap

1. The adoption of light duty vehicles (i.e. cars and light trucks) will likely occur in most markets without the need for market inventions with the exception of the low-income market. In addition to a lack of vehicles in the prices range acceptable to this market, many of these person live in larger (i.e. 5+ unit) multifamily housing residences (also referred to as multi-dwelling units or MDUs) where onsite charging will be a problem. Implementing EV charging capability at MDUs present multiple barriers as defined in the CEC's MultiCharge San Diego pilot project[20], including:
    - Outreach to building owners, property managers and electric vehicle drivers showed that recruiting eligible buildings is difficult for a variety of reasons. Specially, lack of awareness and demand for electric vehicles, installation costs, and the disruption to parking operations were the main challenges faced in recruiting buildings.
    - The cost of purchasing and installing electric vehicle service equipment (EVSE), the disruption to parking operations, and lack of demand for EVs are the largest barriers preventing wider adoption of EVSE at MDUs. At present there are very few numbers of EVs on the road and a disproportionately small share on the road that are owned by low-income MDU residents.
    - As discussed in the MultiCharge program report, "installing EVSE into existing MDUs can be challenging, and many site assessments performed concluded that it would either be cost prohibitive or technically unfeasible to install EVSE. Issues with capacity in the electrical panel and distances between utility meters, parking spaces and electrical panels, can be very expensive to upgrade in order install EVSE. As a result, numerous MDUs interested in EVSE dropped out after the site assessment and the estimate of installation costs was quantified. Also, the disruption to parking operations caused by EVSE presents a challenge in existing MDUs. Moving or assigning parking spots can be very disruptive to the leasing contracts that stipulate and assign private or shared public parking spaces".

    As discussed previously, low-income residents are a substantial component of the population in MBCP's service territory and addressing these barriers will likely require funding and innovative approaches to address purchase cost and charging infrastructure barriers.

[20] MultiCharge San Diego. Prepared by ChargePoint for the California Energy Commission. February 2016, CEC-ARV-12-024

2. Medium to heavy duty electric trucks and buses present good opportunities for electrification by 2030. The timeline for the electrification of commercial trucks will vary by vehicle type, but adoption will generally be slower than light duty vehicles, such as cars, because of the variety of trucks and uses at the market level for all trucks. Figure 31 provides guidance from the South Coast Air Quality Management District Clean Fuels Program[21] indicating the light to medium heavy-duty truck and buses have satisfactory technology readiness though near-term duty cycle requirement fulfilment remains a challenge. Over the 2020 to 2030 timeframe, however, almost all of the growth in alternative fuel trucks will be in the medium duty vehicles electric and hybrid-electric trucks and these vehicles will account for about 5% of trucks in according to the CEC Transportation Energy Demand Forecast, 2018-2030[22], as shown in Figure 32 and Figure 33[23]. Additionally, the CEC mid electricity demand forecast indicates that statewide electric school bus fleet will grow will from under 200 in 2019 to over 3800 by 2030[24] as shown in Figure 34. Many of these vehicles are operated by fleet owners and this presents an opportunity to implement microgrids at locations that include fleet operations where these vehicles will be stored and charged.

Figure 31: Commercial Truck Readiness Attributes

Technologies & Proposed Solutions	Environment & Health			Technology Maturity & Compatibility				Cost	
	Emissions Reduction	GHG/Petroleum Reduction	Health Benefits	Infrastructure Constructability	Technology Readiness	Near-Term Implementation/ Duty Cycle Fulfillment Capability	Operations Compatibility	Relative Cost & Economic Sustainability	Incentives Available
Electric/Hybrid Technologies & Infrastructure									
Plug-In Hybrid Heavy-Duty Trucks with Zero-Emission Range	Good	Satisfactory	Good	Excellent	Satisfactory	Good	Good	Poor	Unacceptable
Heavy-Duty Zero-Emission Trucks	Excellent	Good	Excellent	Good	Poor	Poor	Satisfactory	Unacceptable	Unacceptable
Medium-Duty Trucks	Good	Good	Excellent	Good	Satisfactory	Poor	Poor	Poor	Unacceptable
Medium- and Heavy-Duty Buses	Excellent	Good	Excellent	Good	Satisfactory	Poor	Satisfactory	Poor	Unacceptable
Light-Duty Vehicles	Good	Good	Excellent	Good	Good	Good	Good	Poor	Poor
Infrastructure	-	-	-	Good	Good	Good	Good	Satisfactory	Poor

Excellent Good Satisfactory Poor Unacceptable

[21] Clean Fuels Program 2017 Annual Report and 2018 Update. South Coast Air Quality Management District, March 2018
[22] Transportation Energy Demand Forecast, 2018-2030. November 2017. Table 5-1: Truck Stock Forecast by Fuel Type and Case
[23] Transportation Energy Demand Forecast, 2018-2030. November 2017. Figure 5-10: Alternative Fuel Classes 4 to 6 Truck Stock Forecast, Mid Case
[24] Medium and Heavy-Duty Vehicle Forecast, Bob McBride. California Energy Commission Transportation Energy Forecasting Unit, June 14, 2019

Figure 32: Commercial Truck Unit Adoption Scenario Forecasts by Fuel Type

		2017	2020	2025	2030
High case	Diesel	748,041	852,973	886,491	887,741
	Diesel-Electric Hybrid	2,802	10,449	21,169	41,715
	Electric	1,166	6,690	19,851	42,580
	Ethanol		756	2,639	16,085
	Gasoline	233,183	243,272	245,682	231,347
	Gasoline Hybrid		112	694	5,045
	Natural Gas	9,939	13,164	33,307	61,117
	Propane	1,996	3,156	4,785	5,829
Mid case	Diesel	710,322	757,938	827,310	866,487
	Diesel-Electric Hybrid	1,919	6,665	18,244	32,233
	Electric	1,020	4,207	16,562	29,722
	Ethanol		441	2,707	16,582
	Gasoline	229,129	229,248	235,893	237,505
	Gasoline Hybrid		54	597	3,826
	Natural Gas	9,642	11,919	17,938	29,653
	Propane	1,626	2,349	3,616	4,622
Low case	Diesel	712,314	754,492	823,344	877,244
	Diesel-Electric Hybrid	1,999	6,490	16,707	29,683
	Electric	830	819	1,099	5,085
	Ethanol		323	1,775	10,459
	Gasoline	229,485	231,473	241,053	242,483
	Gasoline Hybrid		99	679	4,429
	Natural Gas	9,658	11,562	15,090	18,664
	Propane	1,672	2,451	3,460	4,174

Figure 33: Light-Medium Duty Commercial Truck Adoption Forecast (Units)

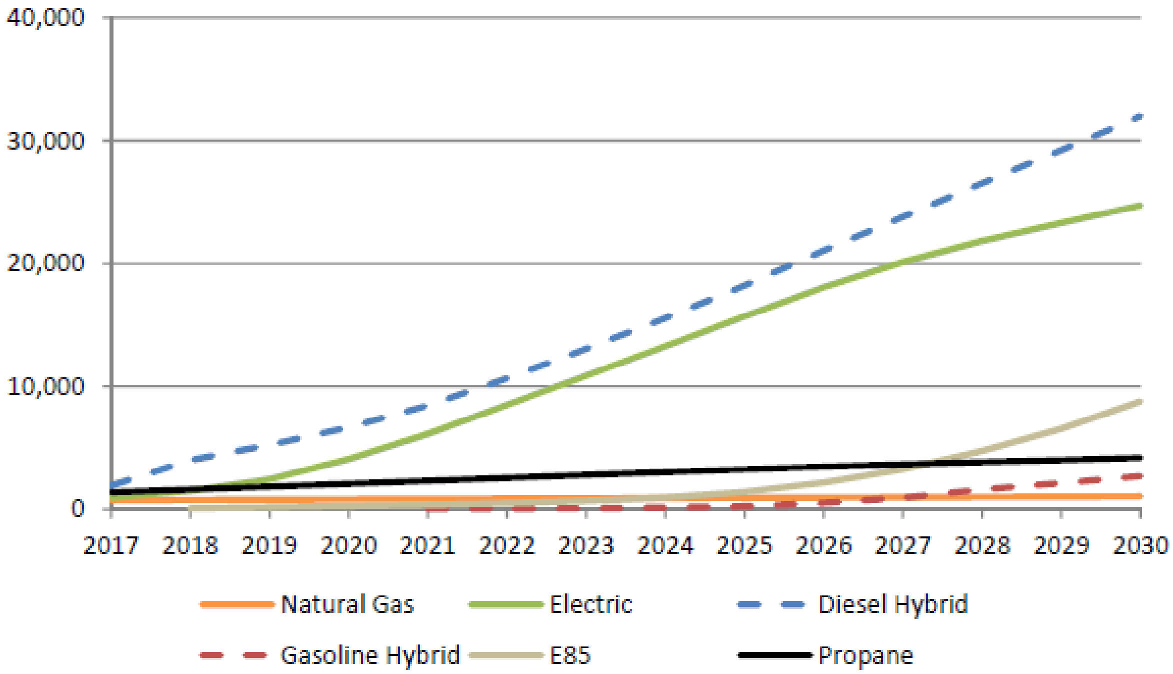
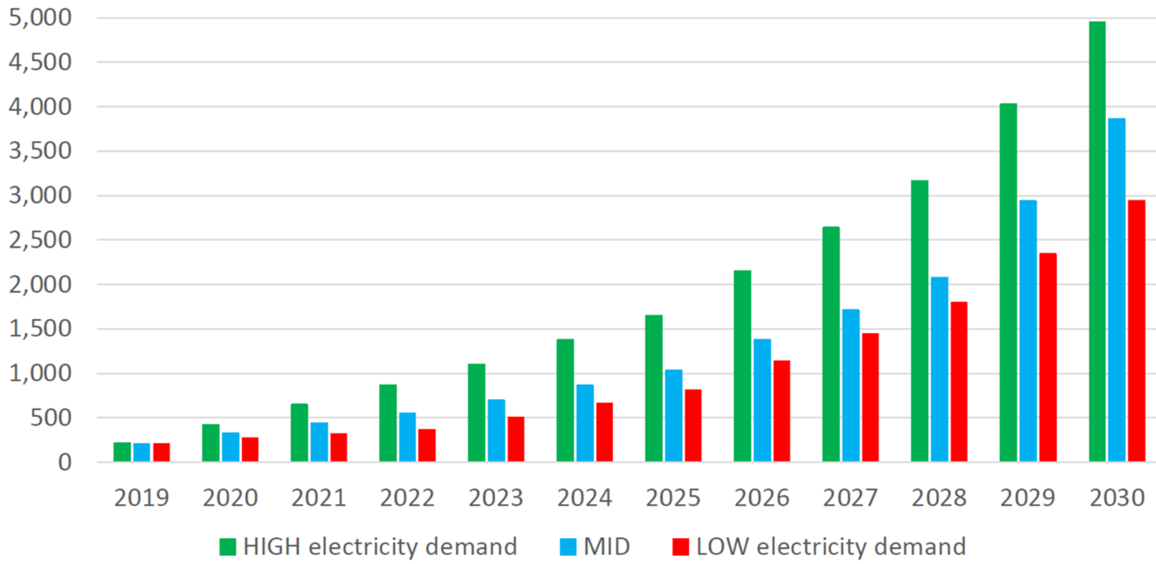


Figure 34: Electric School Bus Adoption Forecast (Units)



Economic Considerations

The following discussion provides additional economic considerations relevant to the electrification of the built environment and increasing market share of electric vehicles.

County Fuel Costs

Table 17 provides a county level breakdown of estimated fuel costs based on current fuel costs and fuel usage in 2017, totaling $3.7B. While we used 2017 fuel use data, it's important to note that fuel use typically does not undergo significant changes over the short term and these values are likely relevant to 2019. Our estimate is that approximately 57% to 67% of county fuel costs, or $2.4B of combined county costs, are associated with fossil fuels and of this amount most non-industrial and non-agricultural uses will be viable for electrification in coming years.

Table 21. Annual County Fuel Costs

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Electricity	$582,021,410	$85,344,171	$400,163,316	$276,761,558	$1,344,290,456
Natural Gas	$186,431,436	$22,624,508	$141,600,993	$89,007,164	$439,664,101
Propane	$4,148,806	$927,124	$8,538,050	$10,704,968	$24,318,948
Gasoline	$694,260,000	$79,800,000	$566,580,000	$375,060,000	$1,715,700,000
Diesel	$105,840,000	$12,152,000	$82,320,000	$23,520,000	$223,832,000
Total Annual Fuel Costs	$1,572,701,652	$200,847,803	$1,199,202,360	$775,053,690	$3,747,805,505
Total Annual Fossil Fuel Cost	$990,680,241	$115,503,632	$799,039,044	$498,292,132	$2,403,515,049
Percent Fossil Fuel Costs	62.9%	57.5%	66.6%	64.3%	64.1%

In the built environment, natural gas use is generally split evenly across the residential and commercial sectors, totaling and estimated $210M and $238M between these market sectors, respectively. The majority of these costs are for hot water heating and space heating, with contributions also from cooking.

Table 22. 2017 PG&E Natural Gas Costs by Sector

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Residential	$85,386,165	$10,814,324	$60,455,866	$54,267,759	$210,924,114
Non-Residential	$101,045,271	$11,810,185	$81,145,127	$34,739,405	$228,739,987
2017 Total	$186,431,436	$22,624,508	$141,600,993	$89,007,164	$439,664,101

We reviewed the cost of public purpose funds (PPF) as reported by the CPUC[25] and based on PPF charges per kWh and therm, and electricity and natural gas usage records. Our analysis indicates that the four counties contributed roughly $89.5M in PPF in 2017, the majority of which were associated with electricity as shown in Table 23. These represent funds paid from the counties to state agencies, but do not account for funds remitted to the counties for various PPF related activities. Table 24 shows our estimate of the distribution PPF paid out for electricity purchases and indicates that the majority, $42.7M, were paid to support low-income programs such as CARE or Energy Savings Assistance programs. Because subscription to CARE across the four counties is about 77%, it is unlikely that these funds are being fully remitted to the counties. Recent decisions from the CPUC indicate that funds paid for energy efficiency, totaling an estimated $18.1M may be used for built environment electrification activities.

[25] Electricity and Natural Gas Public Purpose Funds as Assembly Bill (AB) 67 in 2005, Public Utilities Code 913

Table 23. 2017 Estimated Annual Electricity and Natural Gas Public Purpose Funds Paid

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Electric	$32,300,000	$4,700,000	$22,200,000	$15,400,000	$74,600,000
Natural Gas	$6,300,000	$800,000	$4,800,000	$3,000,000	$14,900,000
2017 Total	$38,600,000	$5,500,000	$27,000,000	$18,400,000	$89,500,000

Table 24. 2017 Distribution of Annual Electricity Public Purpose Funds Paid

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Energy Efficiency	$7,840,000	$1,140,000	$5,390,000	$3,740,000	$18,110,000
Demand Response	$1,580,000	$230,000	$1,090,000	$750,000	$3,650,000
California Solar Initiative	$190,000	$30,000	$130,000	$90,000	$440,000
Self-Generation Incentive Program	$710,000	$100,000	$490,000	$340,000	$1,640,000
Electric Program Investment Charge	$2,120,000	$310,000	$1,460,000	$1,010,000	$4,900,000
New Home Solar Partnership	$1,090,000	$160,000	$750,000	$520,000	$2,520,000
California Alternative Rates for Energy	$15,630,000	$2,270,000	$10,740,000	$7,450,000	$36,090,000
Energy Savings Assistance	$2,880,000	$420,000	$1,980,000	$1,370,000	$6,650,000
Other Electric PPP Programs	$250,000	$40,000	$190,000	$120,000	$600,000
2017 Total	$32,290,000	$4,700,000	$22,220,000	$15,390,000	$74,600,000

Table 25 and Table 26 show cumulative costs and incentives paid on solar installations in the residential and commercial market based on reporting available through the CPUC. This report indicates that Monterey county has disproportionally lower solar incentive than other counties. Low participation rates imply that it is unlikely that PPF paid to support distributed energy installations (i.e. solar) are being fully remitted to Monterey county, if not other counties as well.

Table 25. Residential Solar Cumulative Costs and Incentives

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Total Cost	$22,427,674	$4,938,583	$44,023,437	$36,891,010	$108,280,703
Incentive Amount	$2,777,424	$546,155	$5,590,220	$5,011,633	$13,925,432

Table 26. Non-Residential Solar Cumulative Costs and Incentives

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Total Cost	$5,672,475	$2,007,201	$9,508,513	$10,106,217	$27,294,406
Incentive Amount	$281,508	$87,973	$693,265	$573,514	$1,636,260

We reviewed taxes and fees on gasoline and diesel, as shown in Table 27, and based on fuel usage data from 2017 estimate that the four counties pay $314M in taxes and fees on gasoline, and $69.9M on diesel related taxes and fees. We also estimate that about 38% of all taxes and fees are either local or remitted to the counties, and this revenue will decrease as electric vehicles take increasing shares of the vehicle market.

Table 27. Gasoline and Diesel Taxes and Fees

Gasoline Taxes and Fees	$/Gallon	Diesel Taxes and Fees	$/Gallon

Underground storage tank fee	$0.02	Underground storage tank fee	$0.02
Local sales taxes	$0.04	Local sales taxes	$0.16
State sales tax on gasoline	$0.08	State sales tax	$0.31
Variable state gas tax	$0.12	Federal excise tax	$0.24
Federal gas tax	$0.18	State excise tax	$0.36
State gas tax	$0.30		

Table 28. Estimated Annual Allocation of Gasoline Taxes and Fees

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Underground storage tank fee	$3,480,000	$400,000	$2,840,000	$1,880,000	$8,600,000
Local sales taxes	$6,298,800	$724,000	$5,140,400	$3,402,800	$15,566,000
State sales tax on gasoline	$14,094,000	$1,620,000	$11,502,000	$7,614,000	$34,830,000
Variable state gas tax	$20,358,000	$2,340,000	$16,614,000	$10,998,000	$50,310,000
Federal gas tax	$32,016,000	$3,680,000	$26,128,000	$17,296,000	$79,120,000
State gas tax	$52,200,000	$6,000,000	$42,600,000	$28,200,000	$129,000,000
Total Taxes and Fees	$128,446,800	$14,764,000	$104,824,400	$69,390,800	$317,426,000

Table 29. Estimated Annual Allocation of Diesel Taxes and Fees

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Underground storage tank fee	$540,000	$200,000	$420,000	$120,000	$1,280,000
Local sales taxes	$4,301,100	$1,593,000	$3,345,300	$955,800	$10,195,200
State sales tax	$8,370,000	$3,100,000	$6,510,000	$1,860,000	$19,840,000
Federal excise tax	$6,588,000	$2,440,000	$5,124,000	$1,464,000	$15,616,000
State excise tax	$9,720,000	$3,600,000	$7,560,000	$2,160,000	$23,040,000
Total Taxes and Fees	$29,519,100	$10,933,000	$22,959,300	$6,559,800	$69,971,200

Appendix A, Data Sources

In this section we present data sources that can be used to profile various transportation and building characteristics relevant to electrification efforts and the characterization of MBCP infrastructure. Data sources used in this report include:

1. ***American Community Survey (ACS)***. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml
    - Conducted every year to provide up-to-date information about the social and economic needs at the community level (by zip code)
    - Our research utilized the 2017 ACS update to understand housing and income characteristics relevant to low income populations.
2. ***California Vehicle Survey (CVS)***. https://www.energy.ca.gov/assessments/vehiclesurvey/
    - Conducted by the California Energy Commissions (CEC) periodically to understand vehicle ownership characteristics in both commercial and residential market segments
    - The survey includes assessments of vehicle attributes including fuel type, class, and price, through choices that respondents make in various situations
    - Designed to understand consumers' and businesses' current vehicle holdings and potential vehicle choices and preferences for different fuel and vehicle technologies
3. ***CalEnviroScreen (CES)***. https://oehha.ca.gov/calenviroscreen
    - A mapping tool that helps identify California communities that are most affected by many sources of pollution, and where people are often especially vulnerable to pollution's effects
    - Uses environmental, health, and socioeconomic information to produce scores for every census tract in the state
    - Our research used CES to assist in understanding demographic and burden characteristics for communities based on the CES characteristics of their census tract
4. ***California Alternative Rates for Energy (CARE)***. https://www.cpuc.ca.gov/iqap/
    - CARE provide a monthly discount of up to 39% or more on gas and electricity
    - Participants qualify through income guidelines or if enrolled in certain public assistance programs
    - Large statewide program with an overall 2017 program budget of $1.27B, of which $1.24B directly subsidized low income electricity and natural gas customers
    - Our research includes an analysis of CARE's current overall county level low-income population eligibility and population participation trends over time using the CPUC Income Qualified Assistance Programs reporting database.
5. ***Athens Data.*** https://www.cpuc.ca.gov/general.aspx?id=12154
    - Maintained by the CPUC
    - Data regarding household size in the PG&E territory (described as Investor owned utility (IOU) service territory)
    - This is a reporting requirement for IOUs
    - Data is reported by county

5. ***California Energy Consumption Database.*** http://ecdms.energy.ca.gov/elecbycounty.aspx
    - *Owned by CEC*
    - *Data: building energy use in each county*

6. ***California Electric and Gas Utility Cost Report (AB 67).*** https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/About_Us/Organization/Divisions/Office_of_Governmental_Affairs/Legislation/2018/California%20Electric%20And%20Gas%20Utility%20Cost%20Report.pdf
    - *CPUC owned*
    - *Data for PG&E service territory*

- *The total population from each county and the total kWh usage were used to calculate a per capita energy use by county. The PPF paid per kWh (Table 1.9) was then used to calculate an aggregate amount for each of the counties.*

7. ***California Motor Vehicle Fuel Types.*** https://www.dmv.ca.gov/portal/dmv/detail/pubs/media_center/statistics
    - *Shows number of registered Vehicles by county as of January 1 2018*
    - *(not as recent as our DMV requests)*

8. ***California DMV Estimated Fee Paid Vehicle Registrations by County.*** https://www.dmv.ca.gov/portal/dmv/detail/pubs/media_center/statistics
    - *DMV total dollar amount of vehicle registration fees paid by vehicle type (truck, autos, trailers) through for 2018 with 2017 comparison*
    - *Number of vehicle registrations per county*

10. ***California Energy Almanac.*** https://www.energy.ca.gov/almanac/
    - CEC
    - Current + historical:
      -Alternative Fuels & old (2015) vehicle data
      - California Retail Fuel Outlet Annual Reporting (CEC-A15) Results
    https://ww2.energy.ca.gov/almanac/transportation_data/gasoline/piira_retail_survey.html

      -Electricity & Natural Gas Sales**,** energy consumption (by county), NG supply/demand, Electricity Data, Facts & Statistics
      -Power Plants Data, Facts & Statistics
      -Renewables Data, Facts, Statistics; Wind Generation
11. ***CA Solar Statistics.*** https://www.californiasolarstatistics.ca.gov/reports/locale_stats/
    - Public Reporting site of the California solar Initiative (CSI
    - Solar Statistics (residential, nonresidential (commercial, nonprofit, govt)), (SASH/SOMAH applications), daily updates, NEM connections, 15 minute datasets by zip code

-
12. ***California Energy Maps.*** https://www.energy.ca.gov/maps/renewable/building_climate_zones.html
    - CEC sourced
    - GIS files w/transmission lines, substations, power plants and natural gas pipelines
    - Mapping of California power plants, electric generation facilities, peaker power plants, hydro, etc.
13. ***CARB Online Fleet Database.*** https://ww3.arb.ca.gov/msei/categories.htm
    - EMFAC (Emissions Factor?) emissions model is developed & used by CARB to assess emissions from cars, trucks, buses
    - EMFAC Web Database
    - GHG Emission Inventory

14. ***Open BOE.*** http://www.boe.ca.gov/DataPortal/PropTaxAssessedValueStateCountyIncorp.aspx
    - California State Board of Equalization
    - Fuel Taxes
    - Environmental Fees

15. ***Residential Energy Consumption Survey (RECS): US Energy Information Administration.*** https://ww3.arb.ca.gov/msei/categories.htm
    - Data (most current 2015): Fuels used & end uses, appliances, lighting, space heating, water heating (by house unit type, owner/renter/year of construction/number of household members)
    - Analysis & Projections: Residential Energy Consumption survey…

16. ***Residential Appliance Saturation Survey (RASS).***
https://www.energy.ca.gov/appliances/rass/previous_rass.html

- CEC study of residential energy use to collect energy consumption and appliance profiles to support residential energy demand forecast model.
- Calculate appliance saturations by home type fuel use
- Calculate estimates of annual energy for appliance by home type and fuel use
- Use to research residential saturation & consumption data.

17. ***Commercial Buildings Energy Consumption Survey (CBECS).*** https://www.eia.gov/consumption/commercial/

   - Data on building characteristics
   - Energy usage: consumption and costs
     - *About half of building respondents provide this info*
     - *The energy supplier is then surveyed if an accurate response can't be obtained*

   - *Data is used by building owners & managers, energy modelers, product developers, government, and Energy Star*
   - *Calculates commercial building counts, commercial building area, natural gas usage intensities and usage*

18. ***Commercial End-Use Survey (CEUS). http://capabilities.itron.com/CeusWeb/ChartsSF/Default2.aspx***
   - *Owned by CEC*
   - *Detailed building systems data, building geometry, electricity and gas usage, thermal shell characteristics, equipment inventories, operating schedules, and other commercial building characteristics*
   - *Calculates commercial building counts, commercial building area, natural gas usage intensities and usage*
   - *Data can be viewed interactively or downloaded in Excel workbooks*

19. ***Carbon Dioxide Emissions Coefficients.*** *https://www.eia.gov/environment/emissions/co2_vol_mass.php*
   - *Maintained by U.S. Energy Information Administration*
   - *Calculates annual commercial natural gas GHG, primary heat GHG, and conventional gas water GHG*
   - ***Provides carbon dioxide emissions coefficients by fuel type (**necessary for any GHG emissions calculations**)*

20. ***California Energy Data and Reporting System (CEDARS). https://cedars.sound-data.com/***
   - *Owned by CPUC*
   - *Calculates energy efficiency savings estimates*
   - *Download program documents and data showing:*
     - *Costs, kWh, kW, and therms saved as a result and GHG emissions reduced.*

21. ***Annual Database Revenue Vehicle Inventory. https://www.transit.dot.gov/ntd/data-product/2017-annual-database-revenue-vehicle-inventory***
   - *Calculates Transit bus fleets by type*
   - *Calculates school buses by bus type*
   - *Contains information on revenue vehicles by mode and type of service (TOS) on agency property at the end of each fiscal year.*

22. ***State by State Fuel Taxes. https://www.eia.gov/tools/faqs/faq.php?id=10&t=10***
   - *Maintained by the EIA (U.S. Energy information Administration)*

- *Calculates vehicle fuel consumptions, taxes and fees*
- *Links to Federal Highway Administration – another useful data source*

Appendix B, Built Environment Market Details

The following tables provide additional details on the analysis of the built environment.

Table 30. Residential Propane Use Analysis Results

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Homes Using Propane	4,193	937	8,629	10,819	24,578
Saturation of Propane Homes	3%	5%	8%	11%	7%
Total Therms	1,735,902	387,918	3,572,406	4,479,066	10,175,292
Primary Space Heating Therms Use	767,319	171,471	1,579,107	1,979,877	4,497,774
Conv. Gas Water Heat Therm Use	817,635	182,715	1,682,655	2,109,705	4,792,710
Cooking (Range/Oven) Therm Use	150,948	33,732	310,644	389,484	884,808
Total GHG	10,155	2,269	20,899	26,203	59,525
Primary Space Heating GHG (Tons)	4,489	1,003	9,238	11,582	26,312
Conv. Gas Water GHG (Tons)	4,783	1,069	9,844	12,342	28,037
Cooking (Range/Oven) GHG (Tons)	883	197	1,817	2,278	5,176

Table 31. Commercial Segment Building Units and Square Footage

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Commercial Building Counts					
All Commercial	7,440	991	4,829	4,703	17,963
Small Office	605	81	393	383	1,462
Large Office	706	94	458	447	1,705
Retail	1,009	134	655	638	2,436
Food Store	202	27	131	128	487
Refrigerated Warehouse	225	30	146	142	543
Unrefrigerated Warehouse	1,312	175	851	829	3,167
School	757	101	491	478	1,827
College	353	47	229	223	853
Health	555	74	360	351	1,340
Lodging	151	20	98	96	365
Miscellaneous	1,362	181	884	861	3,289
Restaurant	202	27	131	128	487
Commercial Building Area (sq. ft.)					
All Commercial	141,173,478	18,798,664	91,630,093	89,244,079	340,846,313
Small Office	12,237,771	1,629,582	7,943,051	7,736,217	29,546,620
Large Office	14,277,400	1,901,179	9,266,892	9,025,586	34,471,057
Retail	21,862,977	2,911,275	14,190,390	13,820,877	52,785,519
Food Store	2,819,276	375,415	1,829,880	1,782,230	6,806,800
Refrigerated Warehouse	3,654,444	486,626	2,371,954	2,310,189	8,823,214

Unrefrigerated Warehouse	23,753,886	3,163,068	15,417,703	15,016,231	57,350,888
School	9,785,915	1,303,093	6,351,649	6,186,254	23,626,911
College	4,566,760	608,110	2,964,103	2,886,919	11,025,892
Health	6,104,547	812,882	3,962,219	3,859,044	14,738,692
Lodging	11,331,469	1,508,899	7,354,806	7,163,289	27,358,462
Miscellaneous	27,773,360	3,698,301	18,026,584	17,557,178	67,055,423
Restaurant	3,005,674	400,236	1,950,864	1,900,064	7,256,837

Table 32. Summary of Commercial Building Natural Gas and GHG Characteristics

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Annual Commercial Natural Gas Usage					
Primary Space Heating Therms	11,975,791	1,594,697	7,773,010	7,570,604	28,914,101
Water Heating Therms	11,159,300	1,485,973	7,243,058	7,054,452	26,942,783
Restaurant Cooking Therms	4,066,076	541,439	2,639,128	2,570,406	9,817,049
Annual Commercial Natural Gas GHG					
Primary Space Heating GHG	93,845	12,496	60,911	59,325	226,577
Water Heating GHG	68,299	9,095	44,330	43,176	164,900
Restaurant Cooking GHG	23,787	3,167	15,439	15,037	57,430

Table 33. Commercial Building Characteristics

Commercial Building Counts					
All Commercial	7,440	991	4,829	4,703	17,963
Small Office	605	81	393	383	1,462
Large Office	706	94	458	447	1,705
Retail	1,009	134	655	638	2,436
Food Store	202	27	131	128	487
Refrigerated Warehouse	225	30	146	142	543
Unrefrigerated Warehouse	1,312	175	851	829	3,167
School	757	101	491	478	1,827
College	353	47	229	223	853
Health	555	74	360	351	1,340
Lodging	151	20	98	96	365
Miscellaneous	1,362	181	884	861	3,289
Restaurant	202	27	131	128	487
Commercial Building Area (sq. ft.)					
All Commercial	141,173,478	18,798,664	91,630,093	89,244,079	340,846,313
Small Office	12,237,771	1,629,582	7,943,051	7,736,217	29,546,620
Large Office	14,277,400	1,901,179	9,266,892	9,025,586	34,471,057
Retail	21,862,977	2,911,275	14,190,390	13,820,877	52,785,519
Food Store	2,819,276	375,415	1,829,880	1,782,230	6,806,800
Refrigerated Warehouse	3,654,444	486,626	2,371,954	2,310,189	8,823,214
Unrefrigerated Warehouse	23,753,886	3,163,068	15,417,703	15,016,231	57,350,888

School	9,785,915	1,303,093	6,351,649	6,186,254	23,626,911
College	4,566,760	608,110	2,964,103	2,886,919	11,025,892
Health	6,104,547	812,882	3,962,219	3,859,044	14,738,692
Lodging	11,331,469	1,508,899	7,354,806	7,163,289	27,358,462
Miscellaneous	27,773,360	3,698,301	18,026,584	17,557,178	67,055,423
Restaurant	3,005,674	400,236	1,950,864	1,900,064	7,256,837
Commercial Natural Gas Usage Intensities (kBtu/ft2-yr) by Building Type and End Use					
Heat (kBtu/ft2-yr)					
All Commercial	9.46	9.46	9.46	9.46	9.46
Small Office	8.62	8.62	8.62	8.62	8.62
Large Office	17.22	17.22	17.22	17.22	17.22
Retail	8.78	8.78	8.78	8.78	8.78
Food Store	9.51	9.51	9.51	9.51	9.51
Refrigerated Warehouse	0.08	0.08	0.08	0.08	0.08
Unrefrigerated Warehouse	2.68	2.68	2.68	2.68	2.68
School	10.01	10.01	10.01	10.01	10.01
College	19.83	19.83	19.83	19.83	19.83
Health	32.70	32.70	32.70	32.70	32.70
Lodging	7.28	7.28	7.28	7.28	7.28
Miscellaneous	7.04	7.04	7.04	7.04	7.04
Restaurant	7.75	7.75	7.75	7.75	7.75
Water Heating (kBtu/ft2-yr)					
All Commercial	8.27	8.27	8.27	8.27	8.27
Small Office	1.66	1.66	1.66	1.66	1.66
Large Office	2.60	2.60	2.60	2.60	2.60
Retail	0.78	0.78	0.78	0.78	0.78
Food Store	7.66	7.66	7.66	7.66	7.66
Refrigerated Warehouse	0.79	0.79	0.79	0.79	0.79
Unrefrigerated Warehouse	0.32	0.32	0.32	0.32	0.32
School	4.69	4.69	4.69	4.69	4.69
College	8.41	8.41	8.41	8.41	8.41
Health	31.37	31.37	31.37	31.37	31.37
Lodging	28.95	28.95	28.95	28.95	28.95
Miscellaneous	9.34	9.34	9.34	9.34	9.34
Restaurant	48.61	48.61	48.61	48.61	48.61
Cooking (kBtu/ft2-yr)					
Restaurant	135.28	135.28	135.28	135.28	135.28
Annual Commercial Natural Gas Usage					
Space Heating Therms					
All Commercial	11,975,791	1,594,697	7,773,010	7,570,604	28,914,101
Small Office	1,054,896	140,470	684,691	666,862	2,546,919
Large Office	2,458,568	327,383	1,595,759	1,554,206	5,935,916

Retail	660,262	87,920	428,550	417,390	1,594,123
Food Store	268,113	35,702	174,022	169,490	647,327
Refrigerated Warehouse	2,887	384	1,874	1,825	6,970
Unrefrigerated Warehouse	636,604	84,770	413,194	402,435	1,537,004
School	979,570	130,440	635,800	619,244	2,365,054
College	905,589	120,588	587,782	572,476	2,186,434
Health	1,996,187	265,812	1,295,646	1,261,907	4,819,552
Lodging	824,931	109,848	535,430	521,487	1,991,696
Miscellaneous	1,955,245	260,360	1,269,071	1,236,025	4,720,702
Restaurant	232,940	31,018	151,192	147,255	562,405
Water Heating Therms					
All Commercial	11,159,300	1,485,973	7,243,058	7,054,452	26,942,783
Small Office	203,147	27,051	131,855	128,421	490,474
Large Office	371,212	49,431	240,939	234,665	896,247
Retail	170,531	22,708	110,685	107,803	411,727
Food Store	215,957	28,757	140,169	136,519	521,401
Refrigerated Warehouse	28,870	3,844	18,738	18,250	69,703
Unrefrigerated Warehouse	76,012	10,122	49,337	48,052	183,523
School	458,959	61,115	297,892	290,135	1,108,102
College	384,065	51,142	249,281	242,790	927,277
Health	1,914,996	255,001	1,242,948	1,210,582	4,623,528
Lodging	3,280,460	436,826	2,129,216	2,073,772	7,920,275
Miscellaneous	2,594,032	345,421	1,683,683	1,639,840	6,262,976
Restaurant	1,461,058	194,555	948,315	923,621	3,527,548
Restaurant Cooking Therms					
Restaurant	4,066,076	541,439	2,639,128	2,570,406	9,817,049
Annual Commercial Natural Gas GHG					
Space Heating GHG					
All Commercial	93,845	12,496	60,911	59,325	226,577
Small Office	6,171	822	4,005	3,901	14,899
Large Office	14,383	1,915	9,335	9,092	34,725
Retail	3,863	514	2,507	2,442	9,326
Food Store	1,568	209	1,018	992	3,787
Refrigerated Warehouse	17	2	11	11	41
Unrefrigerated Warehouse	3,724	496	2,417	2,354	8,991
School	5,730	763	3,719	3,623	13,836
College	5,298	705	3,439	3,349	12,791
Health	11,678	1,555	7,580	7,382	28,194
Lodging	4,826	643	3,132	3,051	11,651
Miscellaneous	11,438	1,523	7,424	7,231	27,616
Restaurant	1,363	181	884	861	3,290
Water Heating GHG					
All Commercial	68,299	9,095	44,330	43,176	164,900

Small Office	1,188	158	771	751	2,869
Large Office	2,172	289	1,409	1,373	5,243
Retail	998	133	648	631	2,409
Food Store	1,263	168	820	799	3,050
Refrigerated Warehouse	169	22	110	107	408
Unrefrigerated Warehouse	445	59	289	281	1,074
School	2,685	358	1,743	1,697	6,482
College	2,247	299	1,458	1,420	5,425
Health	11,203	1,492	7,271	7,082	27,048
Lodging	19,191	2,555	12,456	12,132	46,334
Miscellaneous	15,175	2,021	9,850	9,593	36,638
Restaurant	8,547	1,138	5,548	5,403	20,636
Restaurant Cooking GHG					
Restaurant	23,787	3,167	15,439	15,037	57,430

Table 34. Summary of Residential Building Natural Gas and GHG Characteristics

County	Monterey	San Benito	San Luis Obispo	Santa Cruz	Total
Conventional Primary Space Heating Therm Use					
Single Family	10,857,739	1,901,689	10,796,101	8,381,419	31,936,948
Town Home	1,106,952	118,931	872,203	995,333	3,093,419
2-4 Unit Apt	1,520,042	174,788	1,345,387	1,222,637	4,262,853
5+ Unit Apt	3,025,792	128,819	1,647,925	1,625,254	6,427,791
Conventional Gas Hot Water Heat Therm Use					
Single Family	12,466,130	2,164,535	12,288,311	9,622,985	36,541,961
Town Home	1,270,928	135,369	992,757	1,142,775	3,541,829
2-4 Unit Apt	1,745,210	198,947	1,531,343	1,403,750	4,879,250
5+ Unit Apt	3,474,012	146,624	1,875,697	1,866,008	7,362,342
Cooking Therms					
Single Family	2,182,418	348,729	1,975,004	1,685,940	6,192,090
Town Home	175,387	17,373	127,407	157,702	477,869
2-4 Unit Apt	230,949	24,190	197,731	180,125	632,994
5+ Unit Apt	322,592	13,086	154,457	169,836	659,971
Conventional Primary Space Heating GHG					
Single Family	63,518	11,125	63,157	49,031	186,831
Town Home	6,476	696	5,102	5,823	18,096
2-4 Unit Apt	8,892	1,023	7,871	7,152	24,938

5+ Unit Apt	17,701	754	9,640	9,508	37,603
Conventional Gas Hot Water GHG					
Single Family	72,927	12,663	71,887	56,294	213,770
Town Home	7,435	792	5,808	6,685	20,720
2-4 Unit Apt	10,209	1,164	8,958	8,212	28,544
5+ Unit Apt	20,323	858	10,973	10,916	43,070
Cooking GHG					
Single Family	12,767	2,040	11,554	9,863	36,224
Town Home	1,026	102	745	923	2,796
2-4 Unit Apt	1,351	142	1,157	1,054	3,703
5+ Unit Apt	1,887	77	904	994	3,861

Appendix D, Vehicle Market Details

The following tables provide additional details used in the analysis of the vehicle market.

Table 35. Summary of Vehicle Fuel Charactertiscs

Type	Fleet	Gas %	Diesel	MPG Gasoline	MPG Diesel	Mile/kWh Electric	kWh / Mile	kWh / gal	VMT	Est. Annual Fuel Use (GGE) / Vehicle	Fossil Fuel per Vehicle mtCO2	kWh / Vehicle
All Other Buses	420	0.0%	100.0%	7.69	8.51	0.53	1.90	14.61	23,576	2,700	32.2	44,795
Light-Duty Trucks	160,151	99.8%	0.2%	22	24	2.78	0.36	7.79	11,346	462	5.5	4,085
Light-Heavy-Duty Trucks	29,324	99.8%	0.2%	17	19	1.43	0.70	12.01	11,712	601	7.2	8,198
Medium-Duty Trucks	107,634	99.0%	1.0%	7	7	0.47	2.15	14.28	13,116	1,739	20.7	28,200
Motor Coach	118	99.8%	0.2%	17	19	0.48	2.09	35.82	11,712	601	7.2	24,445
Motor Homes	4,468	99.8%	0.2%	17	19	0.48	2.09	35.82	11,712	601	7.2	24,445
Motorcycles	20,867	100.0%	0.0%	44	48	10.00	0.10	4.35	2,423	49	0.6	242
Other Buses	445	100.0%	0.0%	8	9	0.47	2.15	16.54	23,576	2,700	32.2	50,689
Passenger Cars	330,740	98.8%	1.2%	23	26	4.00	0.25	5.85	11,244	423	5.0	2,811
School Buses	600	20.3%	79.7%	6	7	0.53	1.90	12.02	12,000	1,671	19.9	22,800
Urban Buses	324	41.0%	59.0%	3	4	0.38	2.60	8.48	34,053	9,197	109.7	88,538
Medium-Heavy Duty Truck	8,261	11.1%	88.9%	3	3	0.38	2.60	6.58	25,000	3,760	103.8	24,742
Heavy-Heavy Duty Truck	5,435	0.9%	99.1%	5	6	0.40	2.50	13.22	68,155	4,169	135.4	55,112

Table 36. Summary of Fleet Fuel Charactertiscs

Type	Est. Gasoline Gallons	Est. Diesel Gallons	Total Gallons	Fleet kWh
All Other Buses	0	409,451	409,451	18,807,967
Light-Duty Trucks	73,847,951	52,059	73,900,010	654,144,354
Light-Heavy-Duty Trucks	17,598,009	12,406	17,610,414	240,406,197
Medium-Duty Trucks	185,389,643	653,237	186,042,880	3,035,242,795
Motor Coach	70,617	50	70,667	2,876,498
Motor Homes	2,681,209	1,890	2,683,099	109,215,069
Motorcycles	1,023,033	0	1,023,033	5,056,459
Other Buses	1,202,685	0	1,202,685	22,576,749
Passenger Cars	138,202,914	629,232	138,832,146	929,697,201
School Buses	203,806	288,383	492,189	13,679,028
Urban Buses	1,221,826	633,688	1,855,514	28,653,207
Medium-Heavy Duty Truck	3,447,521	340,207	3,787,728	204,394,883
Heavy-Heavy Duty Truck	579,089	22,078,266	22,657,355	299,527,421

Table 37. Summary of Vehicle Useful Life Charactertiscs

Type	Retirement VMT	Useful Life (Years)
All Other Buses	300,000	13
Light-Duty Trucks	120,000	11
Light-Heavy-Duty Trucks	120,000	10
Medium-Duty Trucks	150,000	11
Motor Coach	120,000	10
Motor Homes	120,000	10
Motorcycles	20,000	8
Other Buses	200,000	8
Passenger Cars	120,000	11
School Buses	200,000	17
Urban Buses	400,000	12
Medium-Heavy Duty Truck	200,000	8
Heavy-Heavy Duty Truck	700,000	10

Appendix D, Low-income MultiFamily EV Charging Roadmap Excerpt

The following appendix provides a summary of work completed by Tierra in June 2019 defining the market, challenges, and opportunities to provide electric vehicle charging solution to low-income multifamily residents.

Overview

With funding from the California Energy Commission (CEC), in June of 2019 Tierra Resource Consultants completed an EV Ready Low-Income Multifamily Community Blueprint, which highlighted various considerations for implementing electric vehicle service equipment (EVSE, i.e. charging systems) in Fresno, California. While the study looked at characteristics within the Fresno market, the work used publicly available data sets and was completed in such a way that the information and analytic tools can be applied to any community in California and in other states. The project is intended to help decision makers accelerate the adoption of electric vehicles and the buildout of EVSE within low-income multifamily communities and consists of four blueprint framework chapters including:

- A market characterization framework that defines the low-income multifamily sector including housing and vehicle characteristics.
- A policy framework that characterizes state, regional, as well as local policies and plans that are critical in guiding deployment of electric vehicles and charging infrastructure.
- An economic framework that defines key economic and financial factors that influence electric vehicle and charging infrastructure adoption as well as the impact on household incomes and communities from converting gasoline vehicles to electric vehicles.
- A community engagement framework that defines innovative community engagement approaches to driving adoption of electric vehicles in the low-income multifamily market community.

A prototype forecast model was also produced that provides an initial set of quantitative goals and timelines for electric vehicle adoption with locational modelling attributes that can be replicated for most California jurisdictions. This approach provides flexibility to explore various adoption scenarios that can be continually updated and applied broadly across market segments, geographies, policy, or technology development scenarios. The following summaries highlight key findings of this study, which will inform low-income multifamily sector strategies for jurisdictions pursuing electric vehicle readiness.

Market Framework Summary

The Market Framework reviewed data from multiple sources to define housing and vehicle characteristics in the low-income multifamily dwelling units (MDU) market segment. Our work focused on the city of Fresno, CA, however data sources used allow for the same analysis to be completed for cities throughout California. An analysis of the American Community Survey (ACS) and recent Low-income Needs Assessments (LINA) shows that approximately 50% of all Fresno county residents are renters, as shown in Figure 1 and that the percentage of renters increases significantly as income diminishes to around 88% at the lowest income levels. LINA data also indicates that the percentage of low-income residents residing in larger complexes of 5 of more units increases significantly as income drops, as shown in Figure 1.

Figure 1. Residential Occupant Types

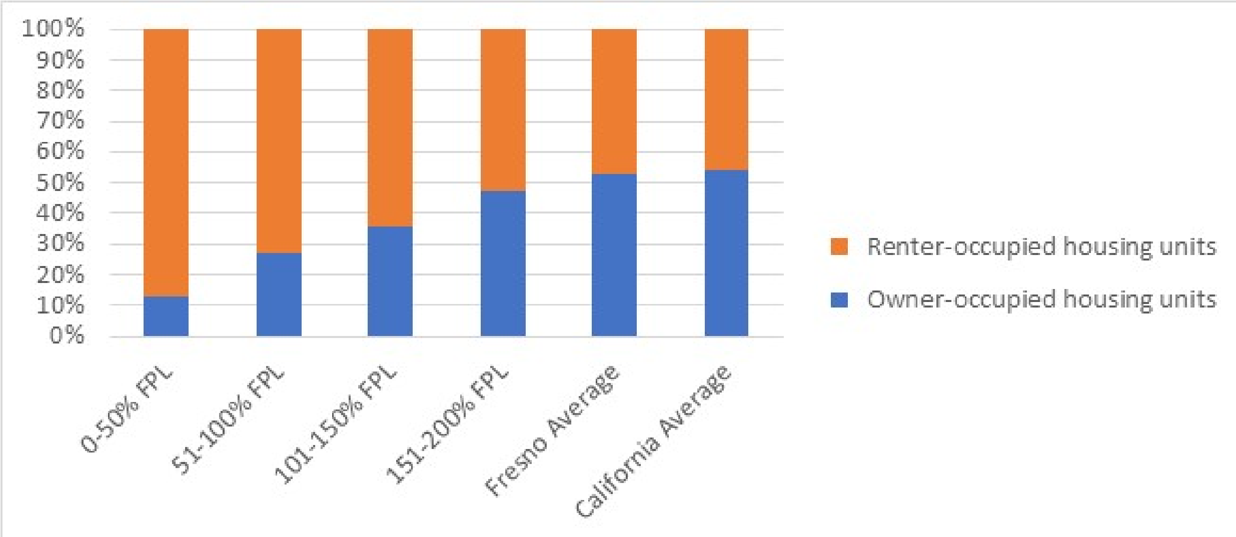
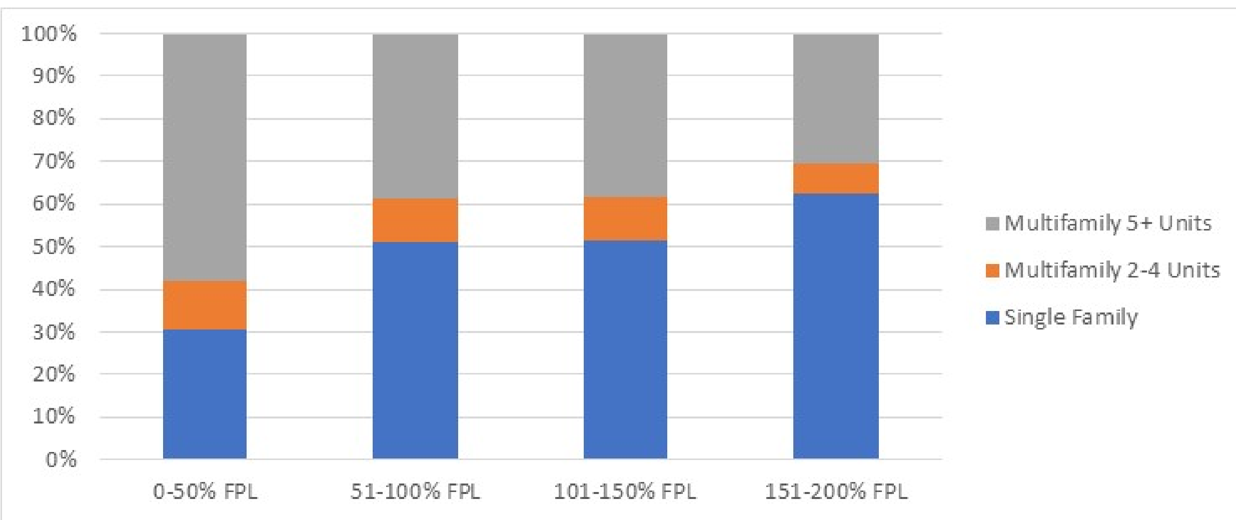
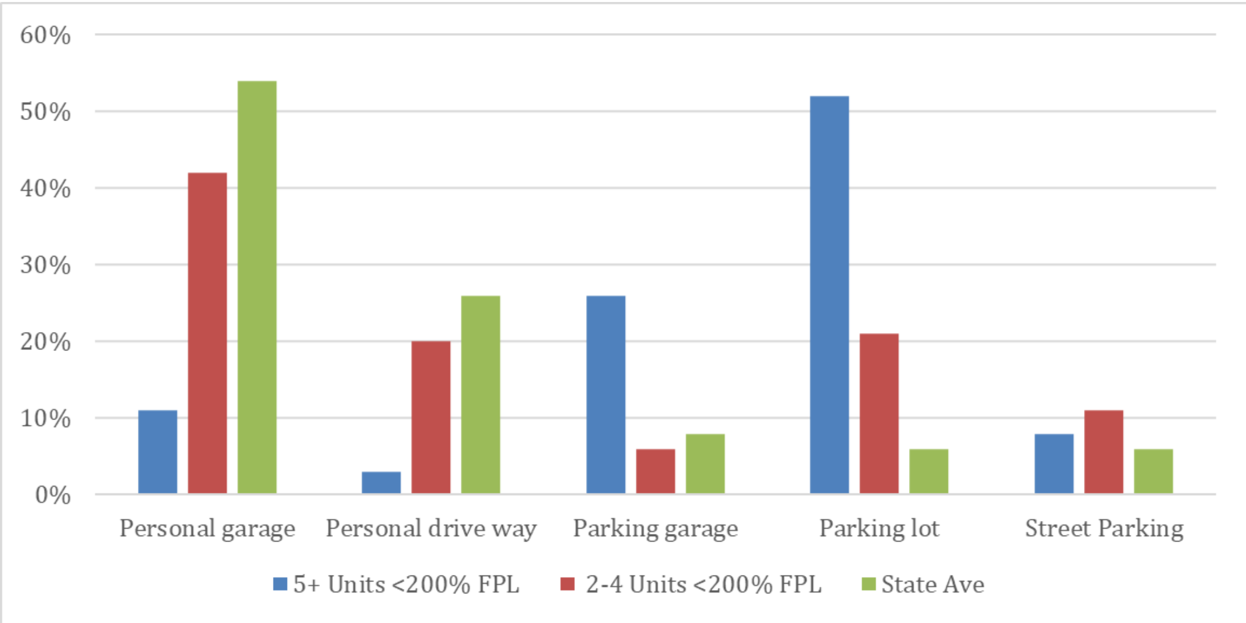


Figure 2. Residential Dwelling Types by FPL Income Cohort



Our review of California Vehicle Survey (CVS) data indicates that there is a material difference in parking options for persons below 200% of the Federal Poverty Level (FPL), including differences based on the type of multifamily dwelling, as shown in Figure 3. Residents living at 200% or below of FPL is a common threshold used to define eligibly for support and subsidy programs for low-income residents, such as the California Alternative Rate for Energy (CARE) program, and this income threshold was used to throughout our project to define the low-income market. The distribution of parking attributes, and the preceding discussion on housing characteristics, imply that the probability of parking in a parking lot increases as income drops. We consider this important because various studies suggest that market barriers make it difficult to install EVSE, including chargers, at these locations.

Figure 3. Residential Multifamily Parking Types by Income Cohort and Dwelling Type



A review of various local and commercial data sources, such as LandVision, indicate that larger multifamily properties comprise a large percentage of rental units, but a small numbers of properties. We used assessor parcel numbers (APN) information to profile the population of MDU properties and unit counts. For example, Table 1 shows that properties in Fresno with more than 5 units (i.e. commercial properties) account for 60% of all rental units but only 4.5% of APNs. These properties are generally clustered in areas defined through zoning as commercial use, and this suggests that providing EVSE at these locations - or providing commercial charging solutions at nearby commercial activity centers presents a significant leverage opportunity. We did not complete an analysis of the single family and 2 to 4-unit MDU market as we consider that residents in these properties generally have access to either a personal garage or personal drive way and existing market mechanisms will address EVSE needs at these locations.

Table 1. Rental Type Cohorts, Unit Counts, and APNs

Number of Units per APN	Total Units	% of Units	Total APNs	% of APN
>100	29,320	34%	146	0.5%
5<100	22,524	26%	1,188	4.0%
2-4	8,117	10%	2,774	9.4%
1	25,421	30%	25,421	86.1%
All	85,382	100%	29,529	100.0%

We analyzed data from the CVS to define vehicle use and driving characteristics by income cohort for Fresno county and the state of California. Table 2 shows that low-income CVS respondents drove more miles per year and operated higher mileage vehicles than the average residents, both at the city and state level. The number of vehicles per household is generally consistent across all income cohorts, though fuel economy was lowest for LI residents at the state level. An analysis of CVS data at only the state level indicates that the average age and cost of used replacement vehicles for low-income residents is 4.7 years at a price point of $18,437, compared to 2.0 years and $29,895 for the general population. A review of market data, such as Autotrader, indicates that several used electric vehicles models are available within low income market cost tolerance. Currently the range of vehicles choices is limited but this will improve over time.

Table 2. Vehicles Characteristics

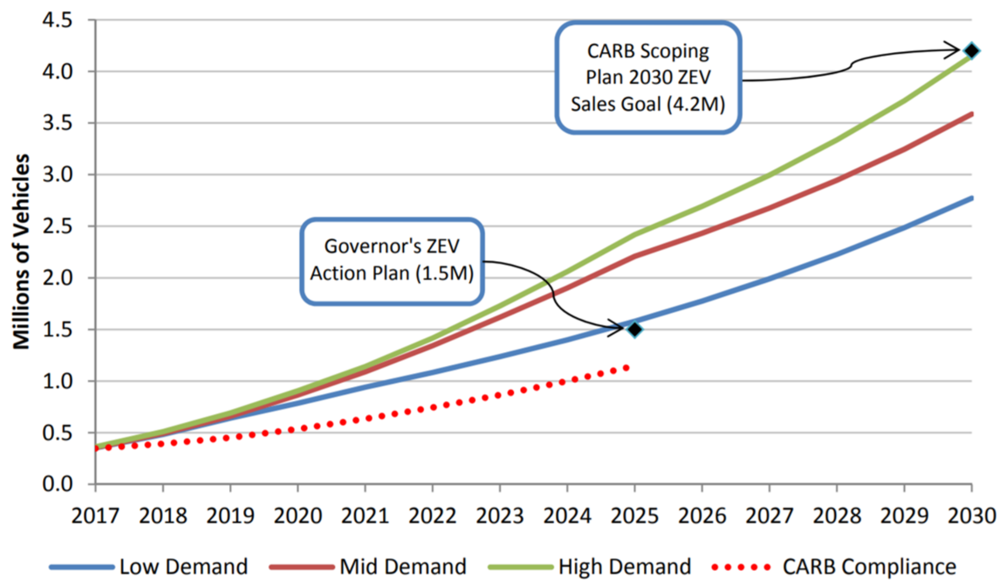
	Fresno			State		
Metric	Below 200% FPL	Above 200% FPL	Fresno County	Below 200% FPL	Above 200% FPL	State
Miles per year driven	14,568	12,134	12,874	10,281	9,760	9,810
Average Current Vehicle Mileage	129,982	76,279	92,623	97,626	76,913	78,881
Estimated vehicles per household	1.9	1.9	1.9	1.7	2.0	1.9
Miles per gallon	23.3	23.8	23.7	25.9	29.2	28.9

Policy Framework

The Policy Framework profiles state, regional, as well as local policies and plans that are critical in guiding deployment of electric vehicles and charging infrastructure. This includes Senate Bill 32, which is currently the primary legislation driving electrification of the transportation sector by setting a statewide goal of reducing greenhouse gas emissions 40 percent below 1990 levels by 2030. Of particular importance to the transportation sector is executive order B-48-18, which directs state entities to work with the private sector to put 5 million ZEVs on California roads by 2030 and install 250,000 zero emission vehicle (ZEV) charging stations by 2025.

In an effort to track and measure California's progress towards meeting these climate and ZEV goals, the Energy Commission produces a Transportation Energy Demand Forecast that estimates future vehicle stock and fuel consumption. As part of this forecasting, the Energy Commission produces a forecast of ZEV stock through 2030, shown in Figure 4. With only 9% of PEV owners living in an apartment or condominium despite MDUs accounting for approximately 40% of the State's housing stock, it is clear that outperforming the high demand forecast and obtaining the 5 million ZEVs on the road by 2030 from executive order B-48-18 will require innovative approaches such as those proposed in this report to overcome the current barriers to electric vehicle adoption in the multi-family sector.

Figure 4. Energy Commission's ZEV Stock Forecasts



One of the largest barriers the state faces is adequately planning and building-out a charging network capable of supporting these aggressive ZEV deployment goals and this may be partially addressed through SB 454. Table 3 provides a side by side comparison of statewide and Fresno County EV infrastructure need by EVSE type from the National Renewable Energy Laboratory's Electric Vehicle Infrastructure Projection (EVI-Pro) tool.

Table 3. Statewide and Fresno County Projected Charging Infrastructure Need

	Statewide			Fresno County		
EVSE Type	Charger Count (avg)	Lower Estimate	Upper Estimate	Charger Count (avg)	Lower Estimate	Upper Estimate
Multi-Family	120,843	120,843	120,843	781	781	781
Work L2	54,556	51,737	57,375	598	598	598
Public L2	61,746	47,596	75,895	596	418	774
Public DCFC	17,016	9,064	24,967	259	135	382
Total	254,161	229,240	279,080	2,234	1,932	2,535

Source: NREL's EV-Pro modified by Tierra Resource Consultants

Table 3 also shows that the multifamily sector presents the largest charging infrastructure need both statewide and in Fresno County. If the state and region are to meet current climate and ZEV goals, communities must design programs that address known barriers to multifamily and low-income adoption of electric vehicles including:

- High upfront costs for purchasing and installing electric vehicle and charging stations.
- Reliability concerns, especially regarding limited range and availability of public charging.
- Unfamiliarity with electric vehicle technology.

- The occurrence of a split incentive, in that the cost of installing and operating charging infrastructure is borne by the multi-dwelling unit property owner, but the benefits of cheaper fuel and reduced maintenance are reaped by residents.

Economic and Financial Framework Summary

The Economic and Financial Framework defines the key financial factors of electric vehicles and charging infrastructure, emphasizing the economic impact on household incomes, community spending and local government revenue of converting ICE vehicles to EVs. For example, Table 4 details our analysis of vehicle usage and cost characteristics by income cohorts in Fresno and the state.

Table 4. Vehicle Fuel Consumption by Fuel Type

	Fresno			State		
Income Cohort	Below 200% FPL	Above 200% FPL	Fresno	Below 200% FPL	Above 200% FPL	State
Est gasoline cost	$4,339	$3,556	$3,792	$2,475	$2,437	$2,437
Est kWh cost - Ave Statewide	$2,142	$1,799	$1,904	$1,360	$1,510	$1,494
Est kWh cost - PG&E Ave Off Peak	$877	$737	$780	$557	$618	$612
Annual Savings at Statewide kWh cost	$2,197	$1,757	$1,888	$1,115	$927	$943
Annual Savings at PG&E EV-A Off Peak kWh cost	$3,462	$2,820	$3,012	$1,918	$1,819	$1,825

Our most optimistic economic view is that a household converting to EVs and charging off peak will result an annual transportation fuel cost of approximately $877, or a decrease of $3,462 for the same VMT. Based on 1.9 vehicles per household, this equates to $1,851 per vehicle, which represents significant savings potential. For minimum wage earners these savings translate into a net wage increase of $1.06, or 9.6% of the current minimum wage, and are especially impactful in Fresno where multifamily rental households' transportation fuel burden is approximately 17% of net income. Table 5 compares this burden to several other household expenses including rent and residential fuel.

Table 5. Study Area Housing and Fuel Cost Burden

Expense	Annual Cost (Unsubsidized)	% of Itemized Cost	Estimated Subsidy	Annual Cost (Subsidized)	% of Itemized Cost	% Median Annual Net Income
Rent	$13,908	72%	$4,172	$9,736	65%	53%
Residential Fuel	$1,206	6%	$360	$846	6%	5%
Transportation Fuel	$4,339	22%	$0	$4,339	29%	17%
Total	$19,450	100%	$4,532	$14,921	100%	75%

This economic impact is particularly valuable to low-income populations because residential transportation fuel costs have no subsidy, unlike other major household costs which benefit from various subsidies, including:

- HUD or CA Section 8 housing vouchers for rent.
- Medicaid and Medi-Cal for medical expenses.

- Supplemental Nutrition Assistance Program (SNAP) and CalFresh for food costs.
- California Alternative Rates for Energy (CARE) for residential fuel costs.

Community Engagement Framework Summary

The Community Engagement Framework outlines demand and supply development approaches intended to increase awareness of EVs and EVSE requirements and address known market deficits and barriers. For example, Figure 5 shows an image of the locations of 18 gas stations in low-income areas in Southeast Fresno where there is no commercially available EVSE. Table 6 shows data from the California Department of Motor Vehicles indicating that the saturation of alternative fuel vehicles in disadvantaged communities (DAC) lags non-DAC areas at the zip code level. The discrepancy is likely due to a combination of limited vehicle availability, high vehicles costs, lack of consumer awareness, and lagging EVSE infrastructure.

Figure 5. Map Showing 18 Gas Stations Located in Southeast Fresno

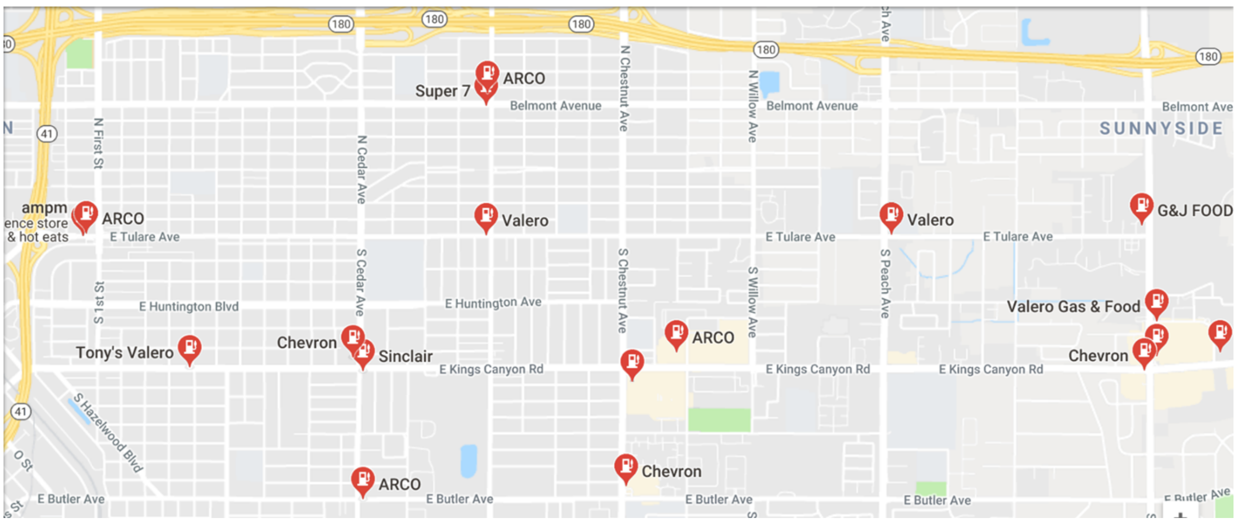
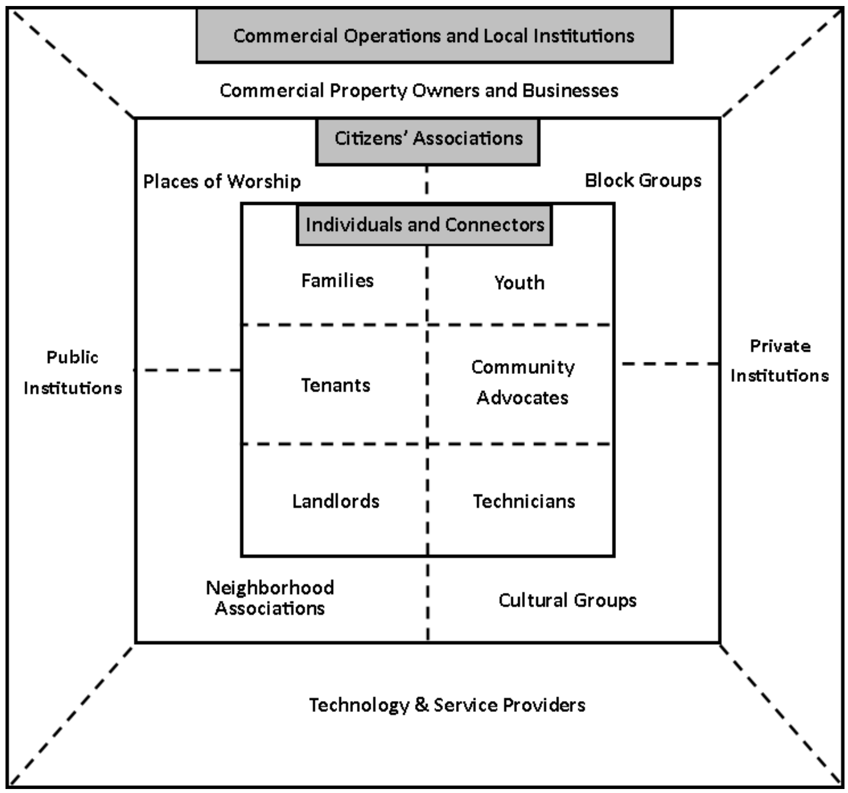


Table 6. Saturation of Plug-in Vehicles by CES Score

DAC Zip Code	Average CES 3.0 Score	Saturation			
		All Plug-in	Battery Electric	Plug-in Hybrid	Total
Yes	52.63	0.3%	0.2%	0.1%	0.6%
No	26.89	0.5%	0.4%	0.2%	1.0%
DAC saturations as % of non-DAC		59.4%	57.8%	63.3%	59.4%

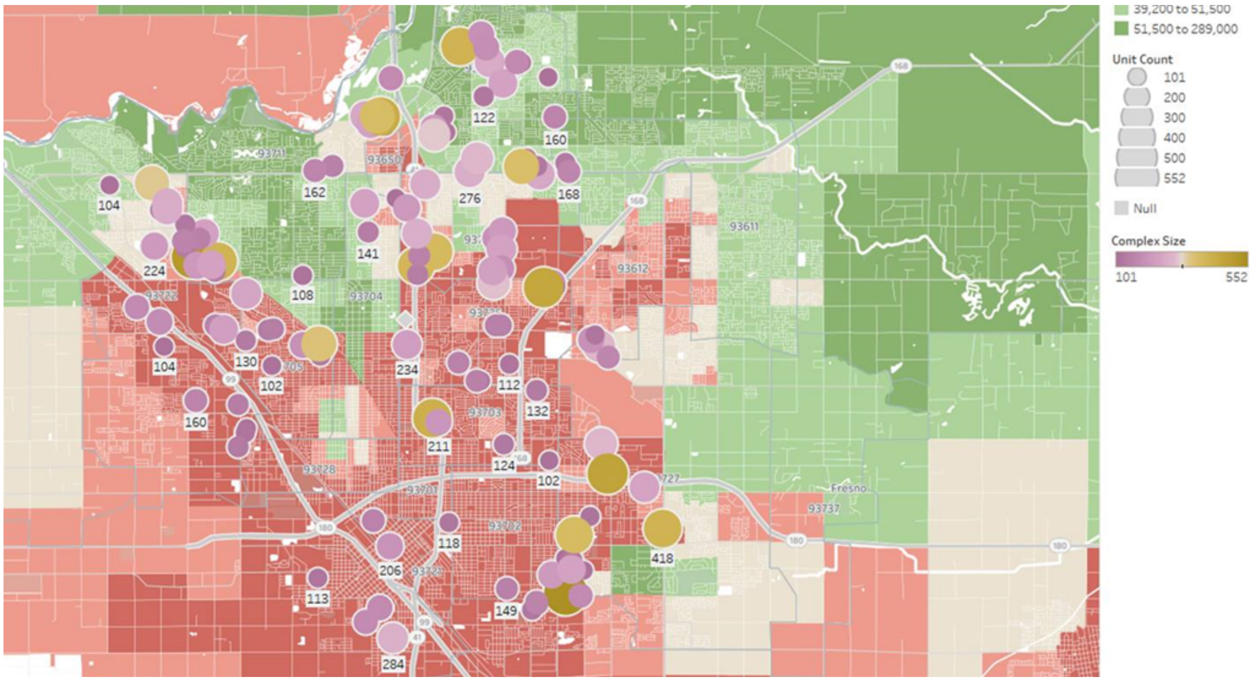
Demand development strategies focus on MDU tenants, commercial property owners, and community assets with the intent to reduce barriers to the adoption of EVs through 1) increasing awareness of EV benefits, and 2) supporting residents' ability to influence the installation of chargers at their resident MDU or at commercial locations in the immediate surrounding community where EV charging would be convenient. The conceptual approach to demand development is based largely on the Asset Based Community Development (ABCD) model for sustainable community development. The ABCD approach focusses on how to link micro-assets to the macro-environment. The appeal of this approach lies in its premise that communities can drive the development process themselves using the concept of social capital. Social capital represents the web of relationships that exist within any given community that allows people to succeed or advance market transformation by associating together. ABCD begins by identifying and categorizing various community assets such as those presented in Figure 6 that can be organized, connected, and mobilized to help achieve market transformation.

Figure 6. Asset Map Example



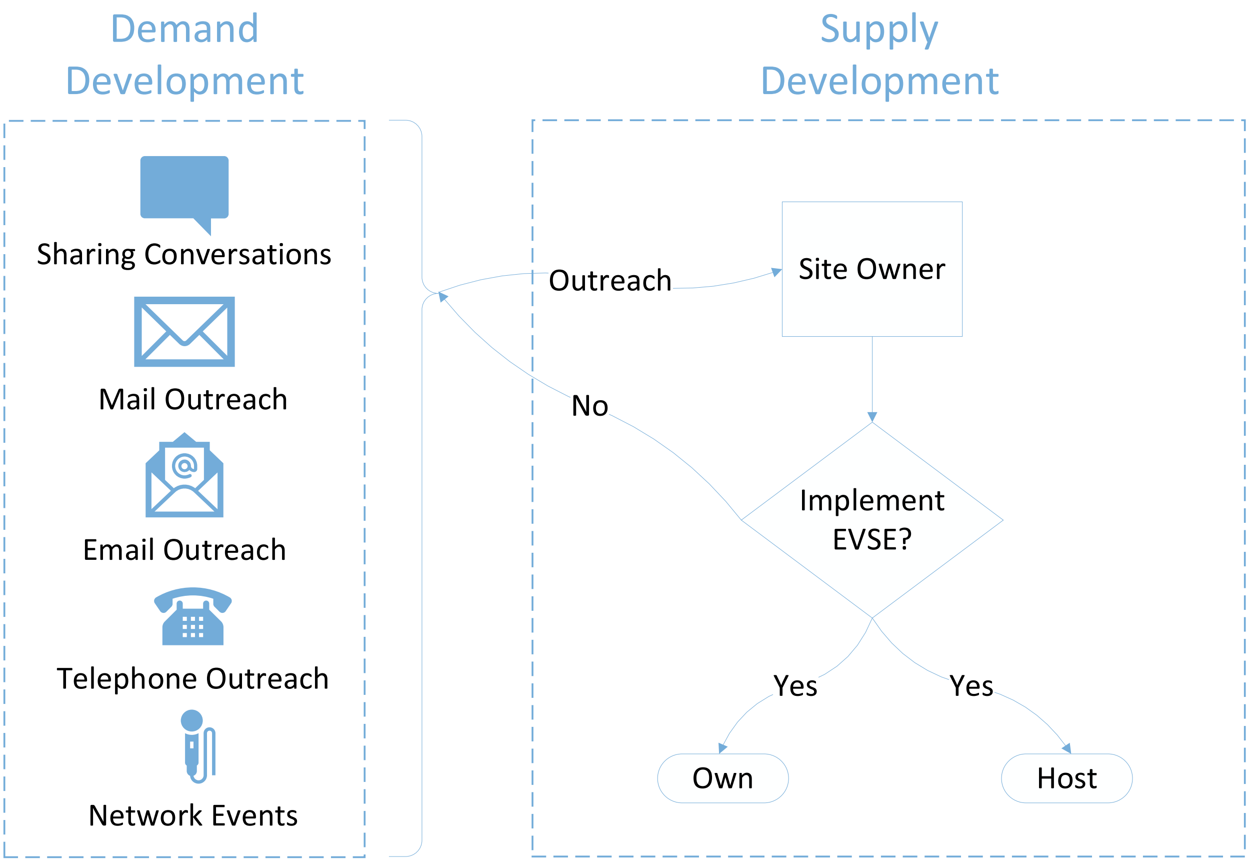
An ABCD approach to market transformation would begin by defining areas of a community where MDU properties are a significant presence and where average per capita income is at or below 200% FPL. For example, the colored circles in Figure 7 show the location of MDUs in low income areas of the city as defined in the areas shaded in red.

Figure 7. Multifamily Properties Located in Fresno's Low-Income Areas



Supply development efforts are intended to reduce barriers to EVSE implementation at both MDU properties and businesses located near MDUs where low-income residents work or frequent for commercial purposes (e.g. retail, restaurants, etc.). Supply strategies focus on 1) engaging with MDU property and commercial property owners to increase awareness of EV benefits, and 2) providing implementation support in the form of technical and financial assistance to complete EVSE installations as either an EVSE owner/operator or in partnership with 3rd party system providers. Supply development works in tandem with demand development efforts in targeted communities as shown in Figure 8.

Figure 8. Demand and Supply Development Nexus



We concluded that while viable strategies appear to be forming to implement Level 1 charging at MDU locations, we concur with various studies, such as the CEC funded MultiCharge San Diego pilot project report, that "installing EVSE in the MDUs built environment is likely to remain a challenge, and advancements in technology are unlikely to create pathways that will solve these major challenges". As stated in the MultiCharge San Diego pilot report, the largest barriers preventing wider adoption of EVSE at MDUs is that it is either cost prohibitive or technically unfeasible, disruptive to parking operations, and lack of demand for EVs. Of these barriers, lack of demand is likely a transient problem while the other barriers are more entrenched MDU structural issues. Collectively, these barriers made recruiting eligible buildings for the pilot study difficult and may portend difficulties for similar program designs intending to expand beyond pilot scale.

While lack of demand is likely a transient barrier based on early adoption issues, supply development strategies focusing on solutions that might be most effective include 1) providing cost effective Level 1 charging at MDUs and 2) building EVSE at commercial activity centers located near areas with a significant MDU presence and leveraging various provisions of SB 454 including:

- No membership requirement to use publicly available Electric Vehicle Service Equipment;
- Fees to use EVSE must be disclosed at point of sale;
- Credit card/mobile technology for payment;
- Location and payment info must be provided to National Renewable Energy Laboratory;
- State may adopt interoperability billing standards;

- Standardize starting a charging session experience for consumers;
- Facilitate non-member access to networked electric vehicle charging stations:
- Ubiquitous methods of payment;
- Ease of customer use;
    - Not locking out any consumer base;
- Provide a singular source of station location information.

An approach that focuses on developing EVSE at commercial activity centers would need to consider that low-income MDU residents without access to Level 1 (or 2) onsite charging would use this equipment at higher rates than the general residential population. They would most likely charge on both weekdays and weekends from 8 a.m. through 10:00 p.m. and would disproportionately generate load shapes most closely aligned with public and DC fast charging activities occurring, and not residential Level 1 and Level 2 profiles as shown in Figure 9.

Figure 9. Common PEV Charging Load Profiles