DOCKETED	
Docket Number:	18-IEPR-09
Project Title:	Decarbonizing Buildings
TN #:	224498
Document Title:	Cost of Residential Electrification
Description:	In March 2018, CBIA funded a study conducted by Navigant, a consultancy, to better understand the costs customers might incur from switching from a mixed-fuel home to an all-electric one, also known as “electrifying”. In Phase I, Navigant looked at single-family existing homes in several Southern California locations.
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Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	8/16/2018 8:33:19 AM
Docketed Date:	8/16/2018

Cost of Residential Electrification

In March 2018, CBIA funded a study conducted by Navigant, a consultancy, to better understand the costs customers might incur from switching from a mixed-fuel home to an all-electric one, also known as "electrifying". In Phase I, Navigant looked at single-family existing homes in several Southern California locations.

This is what their research found:

Switching to all-electric appliances would cost CA consumers over $7200 and increase energy costs by up to $388 per year.

Key Findings:

- Homeowners would need to pay roughly $2,600 for the purchase and installation of new electric appliances.
- Many homes are not wired to handle the electric load from having all-electric stoves, space heaters, and water heaters in addition to their usual electric appliances. Homeowners would need to pay roughly $4,600 to upgrade their wiring and electric panel.
- **The cost to upgrade wiring and electrical panels plus the cost of purchasing new electric appliances is more than $7,200 per home.**
- **The net annual increase in utility costs from added electrical consumption is up to $388 per home.**
- According to the California Air Resources Board, residential buildings in California account for about 6% of the state's total GHG emissions today. Electrification of the residential sector would only decrease total GHG emissions by about 2%.

- The $613 - $877 combined annual cost increase to homeowners represents an estimated 1-2% of median household income for California customers.

- This would result an annual cost increase of $4.3 to $6.1 billion across California's 7 million single-family homes.

This analysis does not include the cost of necessary infrastructure upgrades to the local and statewide electricity grid to accommodate the additional load on the system. The costs to achieve a slight reduction in residential GHG emissions (about 2%) will be even more substantial when these infrastructure costs are included.

Navigant will expand the analysis in Phase 2 to include single-family new homes, multi-family existing homes, additional home locations, as well as 2030 appliance and utility costs.

THE COST OF RESIDENTIAL APPLIANCE ELECTRIFICATION

PHASE 1 REPORT – EXISTING SINGLE-FAMILY HOMES

APRIL 19, 2018

CBIA CELEBRATING 75 YEARS
California Building Industry Association

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EXECUTIVE SUMMARY – PROJECT OVERVIEW

Background

- California's electricity renewable portfolio standard (RPS) targets of 33% by 2020 and 50% by 2030 will substantially decrease greenhouse gas (GHG) emissions for residential and commercial buildings. The electric IOUs expect to exceed these targets.
- With this electricity RPS trend, various stakeholders have proposed for full electrification of building energy loads to achieve greater GHG emissions savings.
- Replacing natural gas appliances with electric options can offer GHG emissions savings, but may pose issues for California homeowners, builders, and other parties.

Statement of Objective

- To conduct an objective analysis of the impacts to homeowners in different regions from appliance electrification, including GHG emissions, appliance cost, electrical infrastructure upgrade cost, annual utility cost, and other attributes.

Expected Outputs

- An analysis of the costs to homeowners of appliance electrification covering the following dimensions:
  - Existing and new construction homes
  - Single- and multi-family homes
  - Homes with and without solar PV systems
  - Climate zone and electric utility differences
  - Home size differences
  - Temporal differences between 2020 and 2030

EXECUTIVE SUMMARY – PHASE 1 RESULTS

- Phase 1 investigated single-family existing homes in several Southern California locations.
- Navigant will expand the analysis in Phase 2 to include single-family new homes, multi-family existing homes, additional home locations, as well as 2030 appliance and utility costs, and the relative cost of carbon reduction.

Phase 1 Summary (Existing Single-Family Homes)

- **Cost for Electric Appliances and Upgrades:** $2,674 installed cost increase for electric appliances; $4,671 for higher capacity panel and branch circuit and utility service connection fee; total incremental costs of $7,345.
- **Annual Utility Bill Increase:** $123 to $388 per year for existing homes with baseline natural gas appliances; 11-19% increase depending on home location.
- **Homeowner Cost Comparison:** If the upgrade costs are spread over 15 years and combined with utility bill increase, the result is a $613 to $877 annual cost increase; 1-2% of median household income for California customers, and an annual cost increase of $4.3 to $6.1 billion across 7 million California single-family homes.
- **GHG Emissions Savings**: Appliance electrification reduces an existing home's total GHG emissions by 35-39% in 2020. These savings account for approximately 2% of California statewide GHG emissions.

METHODOLOGY

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APPROACH AND METHODOLOGY

- Phase 1 investigated single-family existing homes in several Southern California locations.
- Navigant will expand the analysis in Phase 2 to include single-family new homes, multi-family existing homes, additional home locations, as well as 2030 appliance and utility costs, and the relative cost of carbon reduction.

Parameter	Phase 1	Phase 2
Location (Climate Zone, Utility)	• Bakersfield (CZ 13, PG&E) • Riverside (CZ 10, SCE) • Compton (CZ 8, LADWP)	• Bakersfield (CZ 13, PG&E) • Riverside (CZ 10, SCE) • Compton (CZ 8, LADWP) • Oakland (CZ 3, PG&E) • Sacramento (CZ 12, SMUD) • San Diego (CZ 7, SDG&E)

Home Design	• Single-family existing homes
	  ○ 2,100 SF, 1 story
	  ○ 2,700 SF, 2 story with and without 3 kW solar PV system
		• Single-family existing homes
		• Single-family new homes
		• Multi-family existing home

Timeframe	• Near-term appliance costs and utility rates (2020)	• Near-term appliance costs and utility rates (2020) • 2030 appliance costs and utility rates

Appendix A details assumptions for building parameters, appliance cost, electrical upgrade costs, GHG emissions factors, and utility rates.

NATURAL GAS AND ELECTRIC TECHNOLOGIES

- California homes have a choice of appliance fuel type for major end uses within the home and many existing California homes use natural gas for water heating, space heating, cooking, and clothes drying, if they have such an appliance installed.
- For this analysis, Navigant selected an electric heat pump water heater as the baseline electric option rather than an electric resistance model due to the prevailing discussions around appliance electrification approaches.*

Appliance Type	Natural Gas Option	Electric Option
Water Heating	Baseline gas storage water heater	Baseline electric HPWH
Space Heating	Baseline gas furnace	Baseline electric ASHP
Cooking	Baseline gas range/oven	Baseline electric range/oven
Clothes Dryer	Baseline gas dryer	Baseline electric dryer

Appendix A outlines the key attributes for the natural gas and electric appliances

*If using an electric resistance water heater, appliance purchase and installation costs would decrease, and annual utility consumption and GHG emissions would increase.

ADDITIONAL KEY ASSUMPTIONS FOR THE PHASE 1 ANALYSIS

Parameter	Assumption
Energy Consumption / Home Characteristics	Prototypical residential building models within the CBECC-RES 2019 modelling software and adjusted key parameters for existing and new construction building characteristics.
Appliance Installed Cost	Appliance costs estimates are based on 2016 SoCalGas data that represents the estimated fully installed costs, including the equipment purchase, installation, contractor overhead, profit, permit fees, and other factors. 2016 data increased by 5% to reflect estimated 2020 values.
Electrical Infrastructure Upgrade Cost	Estimated electrical infrastructure upgrade costs from a 2016 TRC Report for the City of Palo Alto. Upgrades include a higher capacity electrical panel (100 Amp to 200 Amp, estimated $3,181), branch circuit to the HPWH (15 Amp to 30 Amp, estimated $640), and utility service connection fee (estimated $850).
GHG Emissions Factor	For 2020, Navigant estimated a GHG emissions factor for delivered electricity of 0.20 metric tonnes of carbon dioxide equivalent (mtCO2e) GHG emissions per MWh in Southern California based on E3 Pathways model and historical estimates from SCE, PG&E, and EPA eGrid. Natural gas emissions factor of 0.0053 mtCO2e per therm (11.71 lbs CO2e per therm) from EIA estimates.

Appendix A details assumptions for building parameters, appliance cost, electrical upgrade costs, GHG emissions factors, and utility rates.

RESULTS OF PHASE 1 ANALYSIS

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RESULTS – GHG EMISSIONS SAVINGS

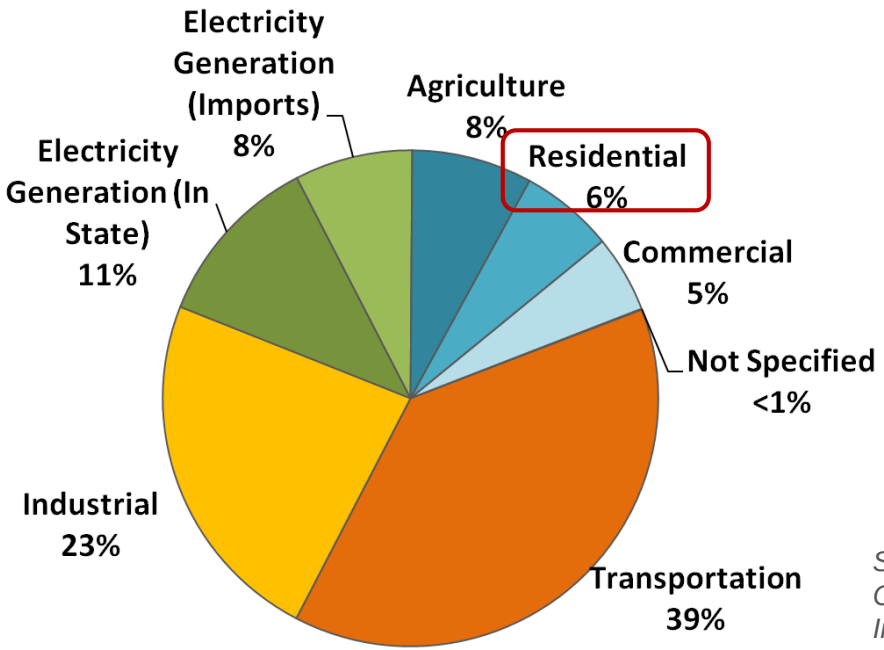
- Appliance electrification provides an estimated GHG emissions savings of 35-39% in 2020 for existing homes without solar PV systems, or approximately 2% of California statewide emissions.

Home Design	Location	Household GHG Emissions (mtCO2e / yr)		GHG Emissions Savings (mtCO2e / yr)	GHG Emissions Savings
		Natural Gas Appliances	Electric Appliances		
Home A 2,100 SF	Bakersfield	3.5	2.1	1.4	39%
	Riverside	2.5	1.6	0.9	36%
	Compton	2.2	1.4	0.8	38%
Home B 2,700 SF w/o Solar PV	Bakersfield	4.3	2.7	1.7	38%
	Riverside	3.0	2.0	1.0	35%
	Compton	2.6	1.6	0.9	36%
Home B 2,700 SF w/ 3kW Solar PV	Bakersfield	3.4	1.8	1.7	49%
	Riverside	2.1	1.0	1.0	51%
	Compton	1.6	0.7	0.9	57%

Note: Results represent energy consumption for all major appliances. For 2020, Navigant estimated a GHG emissions factor for delivered electricity of 0.20 mtCO2e per MWh for delivered electricity to Southern California homes.

CONTEXT FOR GHG EMISSIONS SAVINGS

- In 2015, the residential sector accounted for approximately 6% of California's total GHG emissions of 440.4 million metric tonnes of CO2e.
- The 35-39% estimated GHG emissions savings for existing homes in 2020 would account for approximately 2% of California statewide emissions.



Source: California Air Resources Board. California Greenhouse Gas Emission Inventory - 2017 Edition. June 2017. https://www.arb.ca.gov/cc/inventory/data/data.htm

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RESULTS – COST FOR ELECTRIC APPLIANCES AND UPGRADES

- The estimated total installed cost increase for replacing natural gas appliances at end of life with electric appliances in an existing home is $2,674.
- An existing home would likely require an electrical infrastructure upgrade to accommodate an electric HPWH at an estimated cost of $4,671.
- Combined with net appliance costs, an existing home converting from natural gas to electric appliances would experience total costs of $7,345.

Appliance Type	Natural Gas Appliance Cost	Electric Appliance Cost	Cost Difference
Water Heating	$1,520	$4,529	$3,009
Space Heating	$8,586	$8,560	$(26)
Cooking	$990	$740	$(250)
Clothes Dryer	$593	$534	$(59)
All Appliances	**$11,689**	**$14,363**	**$2,674**
Electrical Upgrade	N/A	$4,671	$4,671
Total Cost	**$11,689**	**$19,034**	**$7,345**

Source: Appliance costs estimated from SoCalGas data for 2016 and increased by 5% to reflect 2020 values. Electrical upgrade cost from TRC, Palo Alto Electrification Final Report, City of Palo Alto, 2016. Link

Notes: Combined purchase, installation, and upgrade costs, including contractor overhead, profit, permit fees, and other factors that homeowners would experience with professional installation. Electrician cost for HPWH removed to avoid double counting upgrade cost.

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RESULTS – ANNUAL UTILITY BILL INCREASE

- Appliance electrification increases a homeowner's annual utility bill by $123 to $388 in 2020 for existing homes (11-19% for homes without solar PV systems).
- This utility bill analysis reflects annual average electricity rates, and does not analyze time-of-use or multi-tiered utility rate structures that have higher prices during peak periods.

Home Design	Location	Annual Utility Bill		Annual Utility Bill Increase	
		Home with Natural Gas Appliances	Home with Electric Appliances		
Home A 2,100 SF	Bakersfield	$1,728	$2,052	$324	19%
	Riverside	$1,288	$1,476	$189	15%
	Compton	$1,042	$1,165	$123	12%
Home B 2,700 SF w/o Solar PV	Bakersfield	$2,160	$2,547	$388	18%
	Riverside	$1,581	$1,800	$219	14%
	Compton	$1,251	$1,390	$140	11%
Home B 2,700 SF w/ 3kW Solar PV	Bakersfield	$1,294	$1,681	$388	30%
	Riverside	$706	$925	$219	31%
	Compton	$464	$604	$140	30%

Note: Results represent energy consumption for all major appliances. Annual utility bill for natural gas home represents combined natural gas and electric utility bill.

RESULTS – HOMEOWNER COST COMPARISON

- If spread over 15-year life of many electric appliances, appliance electrification installation and upgrade cost could be considered as $490 per year.
- In total, California homeowners would experience a combined $613 to $877 annual cost increase due to annualized appliance electrification cost.
- This increase represents an estimated 1-2% of median household income for California customers, and an annual increase of $4.3 to $6.1 billion across 7 million single-family homes.

Home Design	Location	Net Electrification Cost	Annualized Electrification Cost (15 yrs)	Annual Utility Bill Increase	Combined Annual Cost Increase	Median Household Income (2016)
Home A 2,100 SF	Bakersfield	$7,345	$490	$324	$813	$59,000
	Riverside	$7,345	$490	$189	$678	$59,000
	Compton	$7,345	$490	$123	$613	$45,000
Home B 2,700 SF (Both Solar PV options)	Bakersfield	$7,345	$490	$388	$877	$59,000
	Riverside	$7,345	$490	$219	$708	$59,000
	Compton	$7,345	$490	$140	$629	$45,000

Note: Annualized electrification cost assumes the net electrification cost is spread over a 15-year period, without considering adjustments for finance, NPV, and other factors. Median Household Income from U.S. Census Bureau 2012-2016 American Community Survey 5-Year Estimates.

CONCLUSIONS

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PHASE 1 RESULTS – SUMMARY

Phase 1 Summary

- **Cost for Electric Appliances and Upgrades:** $2,674 installed cost increase for electric appliances; $4,671 for higher capacity panel and branch circuit and utility service connection fee; total incremental costs of $7,345.
- **Annual Utility Bill Increase:** $123 to $388 per year for existing homes with baseline natural gas appliances; 11-19% increase depending on home location.
- **Homeowner Cost Comparison:** If the upgrade costs are spread over 15 years and combined with utility bill increase, the result is a $613 to $877 annual cost increase; 1-2% of median household income for California customers, and an annual increase of $4.3 to $6.1 billion across 7 million California single-family homes.
- **Impact of Solar PV System:** GHG emissions, upgrade costs, and utility bill impacts are similar. If the electrical panel for the existing home was previously upgraded for solar PV, the upgrades would be less extensive and have lower cost.
- **GHG Emissions Savings**: Appliance electrification reduces an existing home's total GHG emissions by 35-39% in 2020. These savings would account for approximately 2% of California's statewide GHG emissions.

ADDITIONAL FACTORS FOR APPLIANCE ELECTRIFICATION DISCUSSION

- This analysis relies on a number of assumptions about the California housing stock, and the table below highlights some of factors that may be explored further in future research.

Factor	Discussion
Homeowner Preferences	Past research suggests that customers prefer natural gas appliances compared to electric models, which may affect homeowner satisfaction, resale values, and other attributes.*
Electricity Grid Impacts	This analysis focused on electrical infrastructure upgrades on the customer side of the electrical meter, but increased loads from appliance electrification in existing homes will have wider impacts the California electricity grid.
Increased Space Cooling in Existing Homes	Many existing homes in moderate California climates do not have air conditioning systems, and installing electric heat pumps may increase electricity usage for space cooling.
Electrical Upgrade Costs	This analysis leverages research performed by TRC Solutions for the City of Palo Alto on electrical upgrade costs in California, but anecdotal estimates range widely based on the type of electrical appliance, age of building, contractor prices, etc.
Utility Electricity Rates	Additional research is necessary to understand the impacts that appliance electrification could have in future years as more homeowners install solar PV systems and transition to more complex electricity rate structures offered by California utilities.
Installation, Operation, and Maintenance	This analysis does not consider additional installation, operation, and maintenance considerations for major household appliances. For example, electric HPWHs have additional considerations for condensate, airflow, size, noise, filters, etc.

*Meyers Research LLC, Visions Home Preference Survey, SoCalGas, 2014. Link

NEXT STEPS

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NEXT STEPS

- Navigant to continue with Phase 2 to include single-family new homes, multi-family existing homes, additional locations, as well as 2030 appliance and utility costs, and the relative cost of carbon reduction.
  - We will also prepare a marginal abatement cost curve (MACC) demonstrating the cost of GHG savings from electrification ($ per GHG savings), and how cost reduction potential for electric technologies impacts the MACC between 2020 and 2030.

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APPENDIX A

HOME DESIGNS AND PARAMETERS

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APPENDIX A—MODEL BUILDING CONFIGURATIONS

- Navigant used the historical data from Title 24 – 2016 Residential Compliance Manual for the default insulation and infiltration values for home from 1978 to 2014.
- Navigant used the 2009 Residential Appliance Saturation Survey to determine the distribution of the year built of the homes in each utility area.
- Multiplying the values per year built by the distribution, Navigant calculated the average insulation and infiltration for each climate zone.

*Note: The historical data from the Title 24 - 2016 Residential Compliance Manual indicate the duct leakage to be 15%, but CBECC-Res software did not allow any changes to their default setting of 5%, sealed and tested ducts.

Parameter	Home A 2,100 SF	Home B 2,700 SF
Dwelling Units	1	1
Area (sq.)	2,100	2,700
Number of Floors	1	2
HVAC System	Central AC and gas furnace (3 ton)	Central AC and gas furnace (3 ton)
Water Heating System	50 gal gas storage, 0.62 EF	50 gal gas storage, 0.62 EF
Framing / Insulation	Framing: 2x6 @ 16 in O.C. CZ 13: R-value 5.6 CZ 10: R-value 5.5 CZ 8: R-value 3.6	Framing: 2x6 @ 16 in O.C. CZ 13: R-value 5.6 CZ 10: R-value 5.5 CZ 8: R-value 3.6
Attic Type / Insulation	CZ 13: R-value 18 CZ 10: R-value 18 CZ 8: R-value 14	CZ 13: R-value 18 CZ 10: R-value 18 CZ 8: R-value 14
Internal Insulation	CZ 13: R-value 5.6 CZ 10: R-value 5.5 CZ 8: R-value 3.6	CZ 13: R-value 5.6 CZ 10: R-value 5.5 CZ 8: R-value 3.6
Infiltration	7.7 ACH @ 50Pa	7.7 ACH @ 50Pa
Windows	NFRC U-factor: 1.19 Btuh/ft2-F, Solar Heat Gain Coef: 0.83	NFRC U-factor: 1.19 Btuh/ft2-F, Solar Heat Gain Coef: 0.83
Duct Insulation, Leakage*	5%,Sealed and Tested	5%,Sealed and Tested
Kitchen, Laundry Appliances	Title 24	Title 24
Lighting	Title 24	Title 24

APPENDIX A – APPLIANCE ASSUMPTIONS

Appliance Type	Home with Gas Appliances		Home with Electric Appliances	
	Type	Cost	Type	Cost
Water Heating	0.62 EF gas storage water heater (50 gal)	• Equipment Cost: $628 • Total Installed Cost: $1,520	Heat pump water heater (50 gal, AOSmith HPTU 50, 2.78 EF)	Equipment Cost: $1,680 Total Installed Cost: $4,529
Space Heating	14 SEER A/C; 80% gas furnace (3 ton)	• Equipment Cost: $1,739 • Total Installed Cost: $8,586	14 SEER, 8.6 HSPF heat pump (3 ton)	Equipment Cost: $1,855 Total Installed Cost: $8,560
Cooking	Baseline gas range/oven	• Equipment Cost: $990 • Total Installed Cost: $990	Baseline electric range/oven	Equipment Cost: $740 Total Installed Cost: $740
Clothes Dryer	Baseline gas dryer	• Equipment Cost: $593 • Total Installed Cost: $593	Baseline electric dryer	Equipment Cost: $534 Total Installed Cost: $534

Source: Appliance costs estimated from SoCalGas data for 2016 and increased by 5% to reflect 2020 values. Electrical upgrade cost from TRC, Palo Alto Electrification Final Report*, City of Palo Alto, 2016. https://www.cityofpaloalto.org/civicax/filebank/documents/55069*
Notes: The estimated costs assume the combined purchase, installation, and upgrade costs, including contractor overhead, profit, permit fees, and other factors that homeowners would experience with professional installation. Electrician subcontractor cost for HPWH removed to avoid double counting upgrade cost.

APPENDIX A – UTILITY COST ASSUMPTIONS

- Navigant extracted the following average residential electricity rates from the January 2017 IEPR Forecast. For natural gas, Navigant used the SoCalGas utility rate from the August 2017 IEPR Forecast.

Location	Title 24 Climate Zone	Natural Gas Utility & Rate	Electricity Utility & Rate
Bakersfield	13	$1.09	PG&E: $0.187
Riverside	10	$1.09	SCE: $0.179
Compton	8	$1.09	LADWP: $0.166

Source: Natural gas and electricity rates from California Energy Commission, IEPR Forecasts.
Electricity: Mid Case Final Baseline Demand Forecast - 2016 California Energy Demand Electricity Forecast Update. January 2017. Link
Gas: California Energy Demand 2018-2028 Preliminary Baseline Forecast - Mid Demand Case. August 2017. Link

- Based on the timeline and goals for the project, Navigant made several simplifying assumptions to focus the analysis, particularly utility rate structures. Navigant used the CBECC-Res modelling software, which provides annual energy consumption data but cannot not directly analyze the time-of-use or multi-tiered utility rate structures.

APPENDIX A – EMISSIONS FACTOR ASSUMPTIONS

- Navigant estimated a GHG emissions factor for delivered electricity in Southern California based on E3 Pathways model and historical estimates from SCE, PG&E, and EPA eGrid.
- The table below highlights the historic emissions factors for delivered electricity statewide, PG&E territory, and SCE territory.
- Natural gas emissions factor of 0.0053 mtCO2e per therm (11.71 lbs CO2e per therm) from EIA estimates (Link).

Electricity Territory	2012	2013	2014	2015	2016	Source
Statewide	0.29	-	-	-	0.24	EPA eGrid 2012 (2014), 2016 (2018)
PG&E	-	0.20	0.20	0.19	-	PG&E annual report
SCE	-	0.37	0.26	0.23	0.24	SCE annual reports

Source: Statewide: EPA, Emissions & Generation Resource Integrated Database (eGRID). Link
PG&E: PG&E Corporation. Corporate Responsibility and Sustainability Report 2017. 2017. Link (accessed February 2018).
SCE: SCE. 2016 Corporate Responsibility & Sustainability Report, October 2017. Link

Year	California RPS Targets and GHG Emissions Factor	
	RPS Target (%)	Emissions Factor (mtCO2e per MWh)
2016	25%	0.24
2017	30%	0.22
2018		0.21
2019		0.20
2020	33%	0.20
2021		0.19
2022		0.19
2023		0.19
2024	40%	0.18
2025		0.19
2026		0.18
2027	45%	0.18
2028		0.17
2029		0.17
2030	50%	0.16

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APPENDIX B

DETAILED MODELING RESULTS

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APPENDIX B – RESULTS FOR HOME A (2,100 SF, ONE-STORY, EXISTING HOME)

- GHG emissions range from 1.4 to 3.5 mtCO2e for the Home A. The energy bill ranges from $1,042 to $2,052.

Home Design	Location	Appliance Fuel Type	Electric Energy Consumption [kWh]	Gas Energy Consumption [therms]	GHG Emissions [mtCO2e]	Total Annual Energy Utility Bill
Home A 2100 SF	Bakersfield	Natural Gas	6,875	406	3.5	$1,728
		Electric	10,974	0	2.1	$2,052
	Riverside	Natural Gas	5,559	268	2.5	$1,288
		Electric	8,246	0	1.6	$1,476
	Compton	Natural Gas	4,703	240	2.2	$1,042
		Electric	7,019	0	1.4	$1,165

APPENDIX B – RESULTS FOR HOME B (2,700 SF W/O SOLAR PV, TWO-STORY, EXISTING HOME)

- GHG emissions range from 1.6 to 4.3 mtCO2e for the Home B without Solar PV. The energy bill ranges from $1,251 to $2,547.

Home Design	Location	Appliance Fuel Type	Electric Energy Consumption [kWh]	Gas Energy Consumption [therms]	GHG Emissions [mtCO2e]	Total Annual Energy Utility Bill
Home B 2,700 SF w/o Solar	Bakersfield	Natural Gas	8,665	495	4.3	$2,160
		Electric	13,622	0	2.7	$2,547
	Riverside	Natural Gas	6,938	311	3.0	$1,581
		Electric	10,055	0	2.0	$1,800
	Compton	Natural Gas	5,757	271	2.6	$1,251
		Electric	8,375	0	1.6	$1,390

APPENDIX B – RESULTS FOR HOME B (2,700 SF W/ 3KW SOLAR, TWO-STORY, EXISTING HOME)

- Net electric energy consumption is equal to the home's remaining annual electricity consumption after subtracting out solar PV production (net electric energy consumption = total annual electricity consumption – solar PV electricity production).

Home Design	Location	Appliance Fuel Type	Net Electric Energy Consumption [kWh]	Gas Energy Consumption [therms]	GHG Emissions [mtCO2e]	Total Annual Energy Utility Bill
Home B 2,700 SF w/ 3kW Solar PV	Bakersfield	Natural Gas	4,033	495	3.4	$1,294
		Electric	8,990	0	1.8	$1,681
	Riverside	Natural Gas	2,052	311	2.1	$706
		Electric	5,169	0	1.0	$925
	Compton	Natural Gas	1,018	271	1.6	$464
		Electric	3,636	0	0.7	$604

