Bill Impacts of Decarbonizing Existing Single Family Homes

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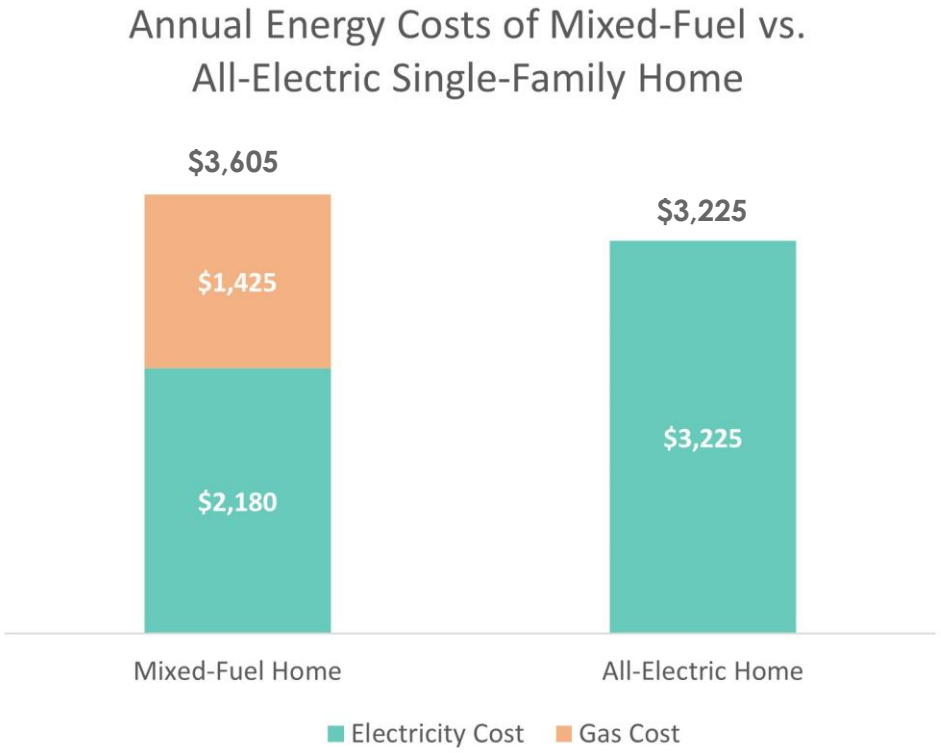
Executive Summary

This study evaluates the on-bill cost impacts of electrification in single-family homes, and found savings of roughly $380 per year ($32/mo) when switching from existing gas appliances to standard efficiency electric appliances, provided customers also switch to an electrification-friendly utility rate. Savings increase to $495 annually ($41/mo) when switching to high-efficiency electric appliances.

Understanding these energy cost impacts is critical for customers, utilities, installers, and policymakers as we work to decarbonize and make our homes safer environments for residents.



Background

Silicon Valley Clean Energy led a study in collaboration with Peninsula Clean Energy to determine the impact of electrification at a typical single-family home in their service territories. Real customer metered data was combined with modeled data in a unique approach we believe provides a more realistic perspective than traditional modeling alone.

The study is based on **median household customer data** in Climate Zone 4, and represents energy usage for a **single-family home** of approximately **1,830 square feet**.

The cost savings found in this study are consistent with E3's 2019 Analysis, Residential Building Electrification in California, which also found that electrification would save customers on energy bills.

Future versions of this study intend to evaluate additional savings potential, for example adding solar photovoltaics or taking advantage of load-shifting opportunities to move usage out of peak pricing periods.

Key Takeaways

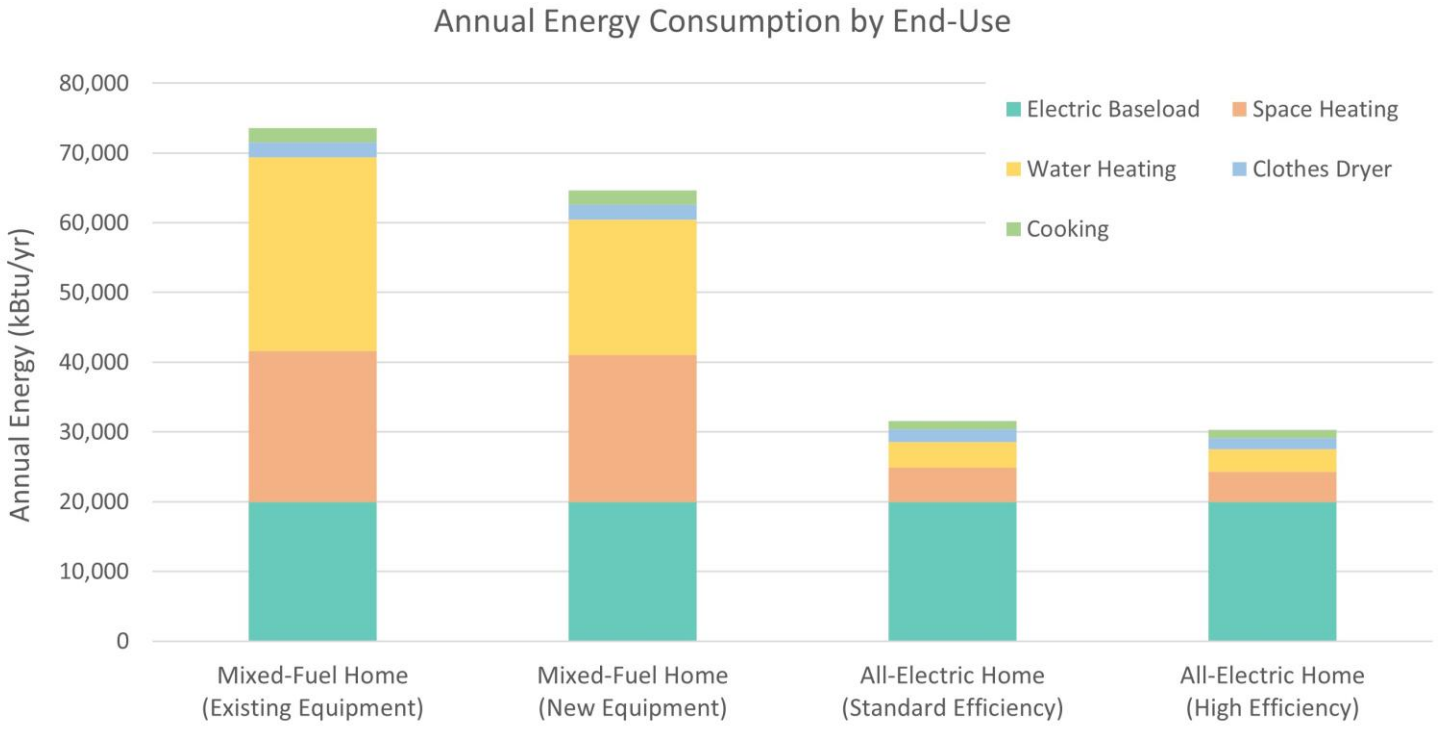
	Mixed-Fuel Home (Existing appliances)	**All-Electric Standard:** standard efficiency electric appliances	**All-Electric Efficient:** high-efficiency electric appliances
			
Bill Impact: (compared to mixed-fuel)	-	$32 / month **savings**	$41 / month **savings**
Site Energy Use:	-	 57%	 59%
CO_2 Impact*:		 42%	 44%

*Based on 0.720 lbs CO2e/kWh per SVCE 2022 GreenStart Power Content Label and 13.446 lbs CO2e/therm per PG&E.

Approach: Modeling Built on Real Customer Data

Baseline	Load Shapes	Normalization	Electrification	Rates
Total annual electricity and gas usage for the existing Mixed-Fuel home was **based on 2022 median customer hourly metered data** for single-family homes in SVCE territory.	**Hourly load profiles (Btu/hr) are based on modeling data from the CPUC**'s Database of Energy Efficiency Resources (DEER) for space heating, water heating, cooking, and clothes drying.	Hourly gas appliance energy use was **normalized to align with SVCE's 2019 Buildings Baseline Study** to match total annual therms consumed per device (e.g., 211 therms/yr for space heating).	The same hourly load profiles were used to calculate electric appliance energy consumption **based on equipment efficiency** (COP or HSPF). Space heating efficiency was **derated based on 2022 historical weather data** and sample equipment performance curves from NEEP.	Hourly electricity and natural gas consumption was combined with **detailed rate calculations and PG&E's latest 2023 gas cost forecast and 2023 electric rates** to determine total annual energy costs.

Annual Energy Comparison



Electrification reduces site energy use by **nearly 60%**.

While upgrading to new gas appliances saves energy, the impact is minimal

Results: Electrifying the home lowered energy bills in all scenarios provided the right rate is used

	Total Annual Gas & Electric Costs				
Residential Rate	**Mixed-Fuel *New Equipment***	**Mixed-Fuel *Existing Equipment***	**All-Electric *Minimum Efficiency***	**All-Electric *Standard Efficiency***	**All-Electric *High Efficiency***
E1 (B)	$3,410	$3,655	$3,810	$3,705	$3,540
E1 (H) (Electric Heating)	-	-	$3,720	$3,615	$3,450
TOU-C (B)	**$3,360**	**$3,605**	$3,690	$3,585	$3,430
TOU-C (H) (Electric Heating)	-	-	$3,600	$3,495	$3,345
EV-2A	-	-	$3,325	$3,245	$3,125
E-ELEC	-	-	**$3,300**	**$3,225**	**$3,110**

Bill savings were seen, even when electrifying with minimum efficiency equipment, as long as the right rate is used. We recommend switching to E-ELEC or EV-2A.

Summary of Key Findings

Through this effort several key takeaways were identified that should be kept in mind when developing policy and programs to support electrification:

- **Electrification lowers customer bills** for the existing single-family home, even when installing minimum efficiency appliances
- If remaining on standard rates (e.g., TOU-C) most customers are likely to see bills increase when electrifying their home.
- Enrolling in an **electrification-friendly rate (especially E-ELEC)** is key to reducing bill impacts and unlocking customer savings
    - Incorporating E-ELEC awareness and enrollment into electrification programs is critical
- Despite providing a **60% reduction in site energy use**, the on-bill savings from electrification are muted by California's high electricity rates
    - This makes the economics of electrification highly sensitive, especially to changes in natural gas costs

Recommendations for Home Electrification

When electrifying a residence we recommend customers follow these guidelines to minimize the on-bill impact and increase likelihood of monthly cost savings:

- Choose an **electrification-friendly rate**, particularly **E-ELEC** or EV-2A
- If remaining on the E-1 or TOU-C rates, call PG&E to make sure your home is on the "**all-electric baseline allowance**" (or "Code H")
- If installing solar, consider **upsizing the system** to accommodate future electrification loads (systems can be sized up to 50% larger than current electricity needs)
- **Shifting usage** from Peak (4-9pm) to Off-Peak (12am - 3pm) increases savings. Consider:
    - Using automated managed charging apps or timers when charging your electric vehicle
    - Programming your HPWH to pre-charge the water tank during Off-Peak hours
    - Running large appliances (such as dryers and dishwashers) in the morning or early afternoon

APPENDIX

Methodology: High-level Overview

Hybrid Modeling Approach

Real-world metered data from 62,000 customer accounts

CPUC simulated end-use data

SVCE and PCE used a “hybrid modeling” approach to this cost analysis by incorporating real customer usage data to minimize reliance on simulations and assumptions. Aggregated customer electricity data was used to generate an “electric baseload”, which captured energy consumption of lighting, plug loads, air-conditioning, and other miscellaneous electrical end-uses.

Simulated data was layered on top of this to incorporate space and water heating energy consumption, as well as clothes dryers and cooking. This modeled data provided load “shapes” in terms of how energy is used throughout the year, while the level of energy consumption was normalized to match annual equipment data provided by trusted resources such as EnergySTAR, the Statewide IOU’s Codes and Standards Program, and SVCE’s comprehensive 2019 Building Baseline Study.

Inputs At-a-Glance

	Mixed-Fuel Home	All-Electric Standard	All-Electric Efficient
			
Space Heating:	Existing Natural Gas Furnace, UEF = 0.78	Central Heat Pump, UEF = 3.5	Central Heat Pump, UEF = 4.0
Water Heating:	Existing Natural Gas Tank Water Heater, UEF = 0.46	Heat Pump Water Heater, UEF = 3.5	Heat Pump Water Heater, UEF = 4.0
Cooking:	Natural Gas Range	Induction Range	Induction Range
Clothes Drying:	Natural Gas Dryer	Vented Electric Dryer	Ventless Electric Dryer

Methodology: Details

- A “hybrid” combination of real customer usage data (AMI) and modeled data
- Mixed-fuel baseload usage from AMI data
  - 5,850 kWh and 447 therms annually (new gas equipment + cooking & clothes dryers)
  - Median SVCE 2022 single-family, non-NEM res customers on E-TOU-C (62k SAIDs)
  - Represents a median SFH size of 1,830 square feet
- Space & Water Heating: DEER database usage profiles
  - Natural-gas fired space and water heating equipment load profiles from CPUC database
  - Normalized annual gas appliance usage to align with SVCE AMI total usage data
    - Space Heating (COP=3.5) : 322 → 211 therms/yr
    - Water Heating (UEF=3.5): 167 → 194 therms/yr
  - Electric space/water heating appliance loads converted from gas profiles using COPs
- All-Electric SFH Usage Profile (Hybrid)
  - 9,505 kWh/yr (Code Min), 9,255 kWh/yr (Std. Effic.) & 8,880 kWh/yr (High Effic.)
  - Does not assume load shifting
  - Modeling accounts for Baseline usage (for both the All-Electric and Mixed-Fuel cases)
    - Includes A/C, plug loads, lighting, appliance fans and motors (e.g., dryer tumbler)

“Baseline” electricity use for this study comes from real customer metered data.

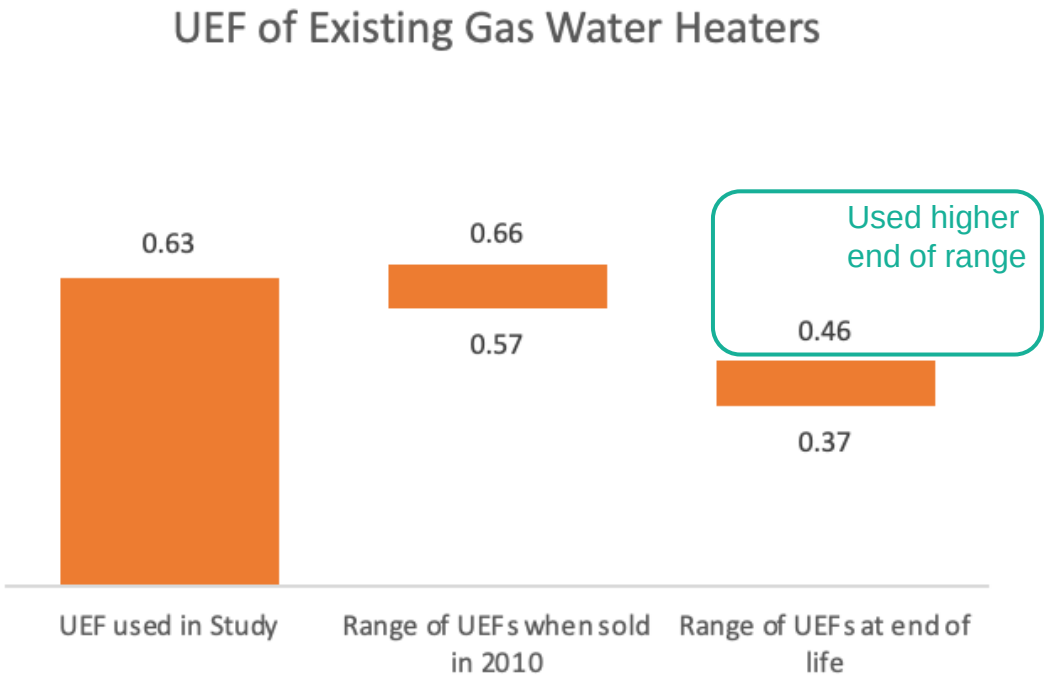
This is important because underestimating this usage can distort projected bill impacts of electrification.

Efficiency Assumptions

Assumption	Value	Data source
HPWH UEF (low efficiency)	3.0	Based on lowest available in the market
HPWH UEF (standard)	3.5	EnergySTAR, average of all EnergyStar HPWH (no derate)
HPWH UEF (high eff)	4.0	EnergySTAR, average of best in class EnergyStar HPWH (no derate)
Heat Pump Space Heater HSPF (Code Min)	8.8	Federal minimum efficiency (rating at 17F)
Heat Pump Space Heater HSPF (standard effic.)	11.7	COP = 3.5 equivalent (at 47F), derated via local weather data
Heat Pump Space Heater HSPF (high effic.)	13.3	COP = 4.0 equivalent (at 47F), derated via local weather data
Existing Tank Water Heater UEF	0.46	EIA/NBSIR
New Tank Water Heater UEF	0.66	EnergySTAR
Existing Gas Furnace Efficiency	0.78	Pre-2015 D.O.E. minimum furnace efficiency standard
New Gas Furnace Efficiency	0.80	U.S. Department of Energy minimum efficiency standards
Percentage of dryer energy use that is from tumbler	10%	assumption

What is the efficiency of an existing water heater?

- According to the US EIA's Residential End Uses, Historical Efficiency Data study, most gas water heaters shipped in 2010 were between 0.575 and 0.66 EF.
- NIST's The Degradation of Gas-Fired Water Heaters finds a recovery efficiency of 65-70% at end of life.
- Meaning, the UEF of units being replaced is likely 0.37-0.46.



How were space heating systems derated?

- COPs were **calculated on an hourly basis** using 2022 hourly historical weather data for San Jose.
- COPs were derated via **linear interpolation** between their rated performance at 47°F and 17°F.
- COPs were capped at the 47°F rated performance for all heating hours with outside temperatures above 47°F **in order to avoid overestimating efficiency**.
- 17°F COPs for the "standard" and "high efficiency" scenarios were based on the median COP of 2.62 found in Joule's "Coming in from the cold: Heat pump efficiencies at low temperature" (Sept 2023).
- 17°F COP for the Code-Minimum system was based on the Federal minimum efficiency requirement for the South-West region of 8.8 HSPF.

Heat Pump Space Heating Description	Rated COP at 47F	Rated COP at 17F	Net Annual COP
Code Minimum System	3.3	2.58	3.27
Standard Efficiency	3.5	2.62	3.43
High Efficiency	4.0	2.62	3.89

Energy Rate Assumptions

- Electric rates based on SVCE bundled rates (current as of 8/25/2023)
  - Includes:
    - PG&E Transmission and Distribution (T&D) rate components
    - SVCE Generation rate (4% discount to PG&E Gen rate), including PCIA and FFS
  - Used current electricity rates for all 12-months of the analysis (conservative approach)
- Gas rates based on PG&E Residential Gas Rate Forecast (August 2023)
  - Actual monthly rates: Jan-July 2023
  - Forecasted monthly rates: Aug-Dec 2023
- Baseline allowances incorporated based on PG&E Territory X
  - Represents 99.8% of SVCE customers
  - Represents 63% of PCE customers

Annual bill costs are most sensitive to fluctuations in gas prices, especially during the Winter season when space heating dominates.

Electricity Rate Details

TOU Period / Residential Rate	E1	TOU-C	EV-2A	E-ELEC
Off-Peak	$0.34646	$0.39904	$0.26684	$0.28828
Partial-Peak	$0.34646	$0.39904	$0.43460	$0.30160
Peak	$0.34646	$0.43606	$0.45080	$0.32290
Off-Peak	$0.34646	$0.42713	$0.26656	$0.33514
Partial-Peak	$0.34646	$0.42713	$0.46693	$0.39002
Peak	$0.34646	$0.51771	$0.57564	$0.54793

Notes: 1. Rates reflect 2023 SVCE Bundled Rates as of 8/25/2023, including PCIA and FFS charges
2. Generation rates reflect a 4% discount compared to PG&E
3. E-ELEC rate includes a $15 monthly fixed customer charge
4. TOU = Time-of-Use

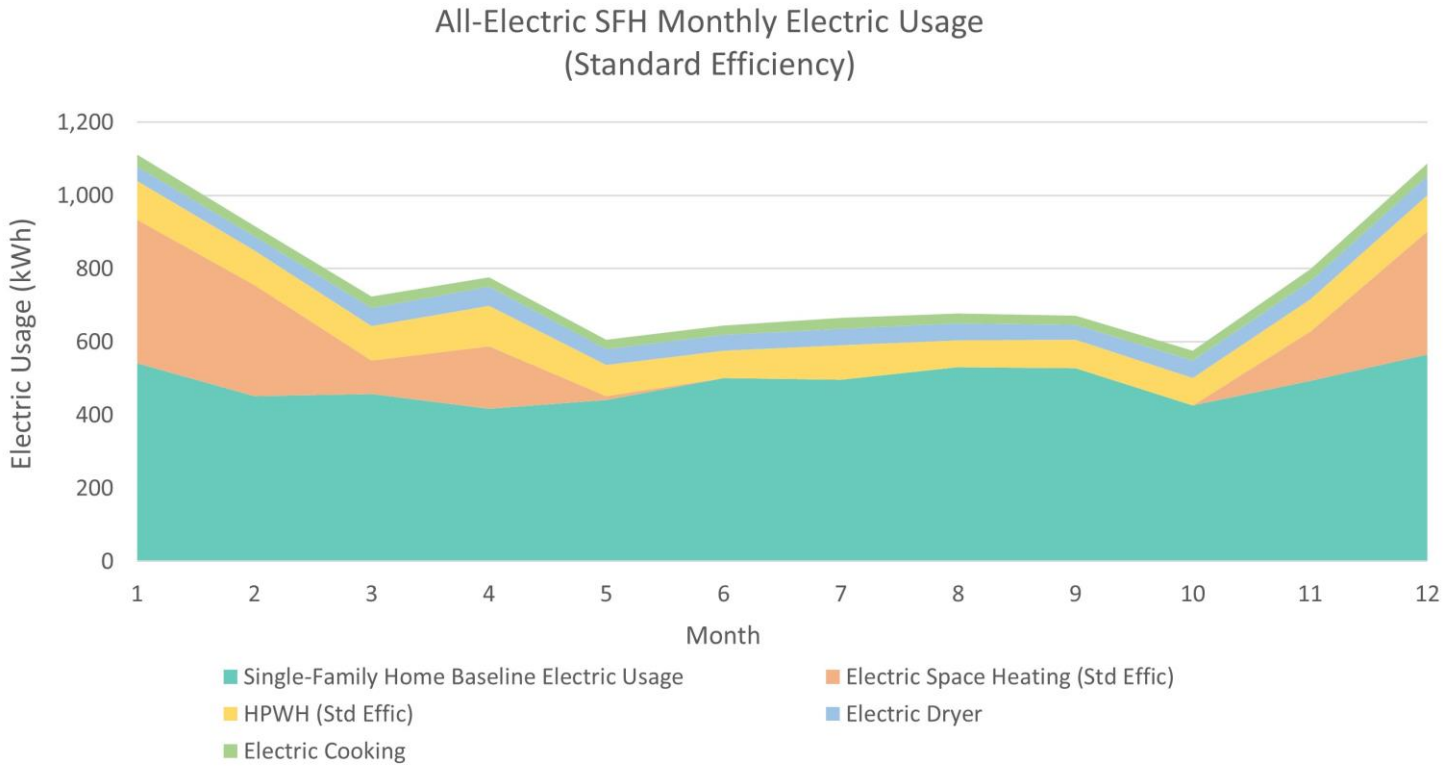
Annual Usage Summaries

	kWh	therms
Mixed-Fuel Home (New Gas Equip)	5,850	447
Mixed-Fuel Home (Existing Gas Equip)	5,850	536
All-Electric Home (Low Efficiency)	9,504	-
All-Electric Home (Std Effic)	9,253	-
All-Electric Home (Hi Effic)	8,880	-
Gas Furnace (New)	-	211
Gas Furnace (Existing)	-	216
Heat Pump Space Heater (Low Effic)	1,514	-
Heat Pump Space Heater (Std Effic)	1,441	-
Heat Pump Space Heater (Hi Effic)	1,271	-
Gas Water Heater (New)	-	194
Gas Water Heater (Existing)	-	278
Heat Pump Water Heater (Low Effic)	1,249	-
Heat Pump Water Heater (Std Effic)	1,071	-
Heat Pump Water Heater (Hi Effic)	937	-
Gas Clothes Dryer	-	21
Electric Clothes Dryer (Vented)	547	-
Electric Clothes Dryer (Ventless)	478	-
Gas Cooking	-	21
Electric Cooking	344	-

High-efficiency space and water heating equipment can save as much as 25% over low-efficiency devices.

This table reflects total annual usage, but *when* energy is consumed has significant implications - **using less electricity between 4-9pm increases customer savings** on most residential rates, and provides greater grid-level emissions reductions

Annual Electric Usage Profile - All-Electric Home



Electrification increases total annual electricity consumption by **roughly 60%**.