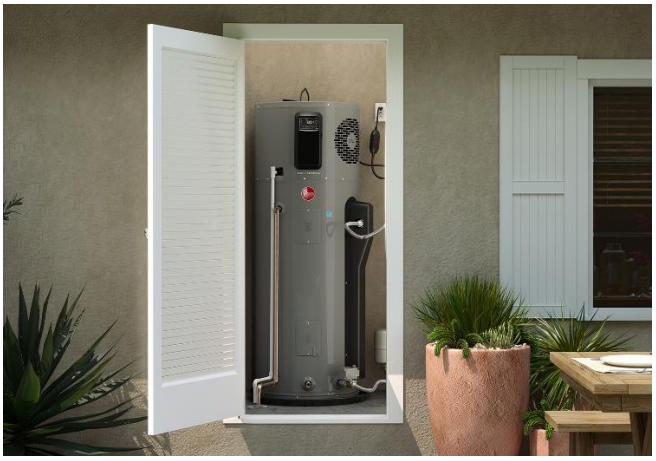
Single Family Detached Homes
Explainer

Typical pre-1980 single family home in the Bay Area.



A low-power 120V heat pump water heater.

Characteristics

Built before 1980

Poor insulation

Small electrical panels

Tight spaces

Energy Conservation Measures

Low Power HPWH

Low Power Packaged Terminal Heat Pumps

Solar PV

Light touch envelope improvements

Power management

This report examines electrification approaches for single-family residential properties and addresses common implementation challenges. Electric alternatives to gas equipment exist for all household end uses, and when combined with strategic energy management approaches, targeted insulation improvements, and thoughtful equipment sizing and placement, these technologies provide effective solutions for emissions reduction while managing peak electrical demands.

According to residential building stock analysis, approximately 80% of residential building square footage is classified as single-family detached housing, with nearly two-thirds of these structures having been constructed before 1980. Homes from this construction period demonstrate higher likelihood of inadequate insulation levels and limited electrical service capacity. Single-family homes are commonly older, detached residences with fossil fuel-based energy systems, no central cooling infrastructure, substandard thermal envelope performance, and significant space constraints in mechanical equipment locations.

Space Utilization Challenges
Mechanical equipment space limitations represent a common barrier in existing residential retrofits, particularly when converting from gas water heaters to heat pump water heater (HPWH) technology, as these systems typically require larger installation footprints than conventional gas equipment. When space constraints present challenges, potential solutions include relocating the water heating system to more accommodating areas, expanding or adding ventilation to the existing water closet, or implementing split-system HPWH configurations that separate tank storage and heat pump components.

Heat pump water heaters require appropriate ventilation, traditionally provided through ducted installations. If this is not possible, louvered panels or door undercuts can facilitate necessary airflow while maintaining system efficiency, provided that sound or thermal comfort is not a concern at the original closet location.

Building Envelope Improvements
Enhancing the thermal performance of residential envelopes significantly improves occupant comfort while reducing heating and cooling capacity requirements. The most cost-effective thermal improvement approach prioritizes sealing existing insulation gaps and augmenting attic insulation levels where installation complexity is minimal and performance benefits are maximized.

Crawlspace insulation upgrades can be effectively implemented through either rigid foam panel systems adhered directly to floor assembly undersides or blown cellulose methodologies depending on specific access conditions. Wall assembly thermal performance can be enhanced through drill-and-fill techniques utilizing either foam insulation products or dense-packed cellulose materials, with interior access points generally preferred to preserve exterior envelope weather resistance integrity.

Electrical Capacity Management
When implementing comprehensive electrification in residential applications, existing electrical service capacity frequently constrains system design options. Strategic electrical load calculation methodologies as defined in the National Electrical Code provide structured approaches to maximizing available capacity while minimizing costly service upgrades. This "Watt Diet" approach enables systematic planning for complete residential retrofits by informing equipment selection based on power requirement tradeoffs.

Utilization of 120-volt equipment significantly enhances electrical capacity management while reducing overall energy consumption and frequently eliminates requirements for new circuit installations. Conventional electric heating and water heating systems typically operate at 240-volt specifications. For residences with limited electrical service capacity (approximately 100 amperes or less), excessive deployment of 240-volt systems can potentially exceed service limitations. Additionally, new 240-volt equipment installations generally necessitate dedicated circuitry when implementing residential electrification measures.

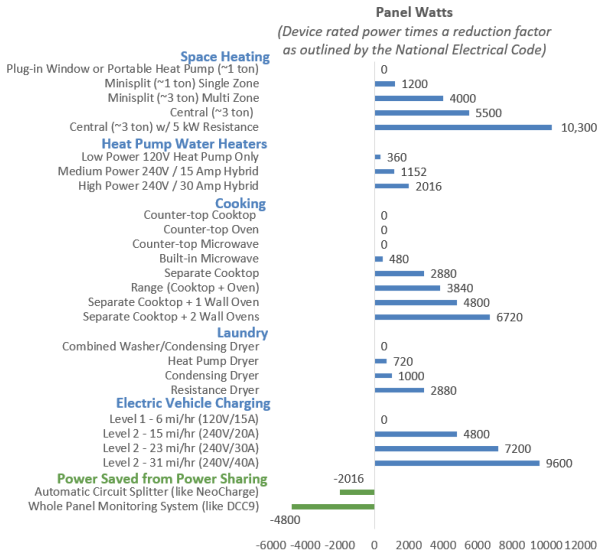


Figure 1: Power requirements for various equipment and appliances in a home. Panel Watts refers to the value that the load calculation will use (name plate rated power multiplied by a reduction factor).

Low-Power Equipment Options
Contemporary manufacturers now offer 120-volt alternatives across all essential residential systems. Ephoca's 120-volt Packaged Terminal Heat Pumps provide compact, installation-friendly solutions requiring no outdoor unit components, making them

particularly suitable for space-constrained environments. These systems accommodate wall or ceiling mounting configurations and offer optional Energy Recovery Ventilation capabilities for enhanced indoor air quality management.

Residential 120-volt heat pump water heaters, such as the Rheem ProTerra system, deliver high energy efficiency performance with streamlined installation requirements, making them appropriate for applications with limited electrical capacity. Various 120-volt cooking appliances, including induction cooktops and portable electric ranges, provide energy-efficient alternatives to gas cooking, though their limited heating element configurations (typically two elements per unit) may necessitate multiple units in comprehensive electrification scenarios.

Low-power 120-volt clothes drying solutions, including combination washer-dryer units, further reduce panel capacity requirements while optimizing space utilization. These multifunctional appliances incorporate heat pump drying technology that substantially reduces energy consumption compared to conventional resistance-based systems.

Power Management Technologies

Advanced power management systems including smart electrical panels and circuit-sharing devices enhance electrification flexibility. Smart panel technologies from manufacturers like Span or Leviton provide real-time monitoring and circuit-level control capabilities. These systems can automatically deactivate non-essential circuits when approaching capacity limitations, effectively managing peak demand while maintaining essential services.

Circuit sharing devices such as the NeoCharge Smart Splitter enable multiple appliances to utilize a single 240-volt outlet, facilitating arrangements such as shared connections between electric clothes dryers and electric vehicle charging equipment, thereby maximizing existing electrical infrastructure utilization.

Figure 2: Low power equipment and appliances (left to right): a ducted Mr. Cool "DIY" 120V central heat pump[1], the Epocha through-wall PTHP[2], Rheem 120V HPWH[3], GE combo washer dryer[4], and 120V countertop induction[5] and 120V countertop oven[6].

Emissions and Peak Demand Impacts

Residential HVAC and water heating systems typically represent the most significant contributors to household greenhouse gas emissions and peak electrical demands. For HVAC applications, envelope performance improvements combined with proper equipment sizing through comprehensive heating load calculations can substantially reduce heating requirements and corresponding heat pump capacity needs, thereby

[1] Image Credit: Mr. Cool (2025) https://www.mrcool.com/product/diy-4th-generation/specification
[2] Image Credit: Epocha (2025) https://ephoca.com/
[3] Image Credit: Rheem (2025) https://www.rheem.com/group/professional-prestige-plug-in-heat-pump-water-heater-with-hydroboost-shared-circuit/
[4] Image Credit: GE (2025) https://www.geappliances.com/ge/connected-appliances/ultrafast-2-in-1-washer-dryer-combo
[5] Image Credit: Amazon (2025) https://www.amazon.com/stores/duxtop/page/711D0140-552B-47D7-BF5D-24775859B2AD
[6] Image Credit: Oster (2025) https://www.oster.com/cooking-appliances/countertop-ovens/

decreasing peak power demands and electrical panel capacity requirements.

In moderate climate regions such as the Bay Area, contemporary heat pump technologies demonstrate reliable performance at reduced ambient temperatures, eliminating requirements for supplemental resistance heating that would otherwise substantially increase peak electrical demands.

Figure 3: Power management solutions include circuit sharing devices like the NeoCharge Smart Splitter[7] and smart electrical panels like the Span[8].

Renewable Energy Integration

Solar photovoltaic installation provides significant benefits when implemented alongside residential electrification initiatives, substantially reducing utility bill impacts associated with increased electricity consumption. Fully electrified homes with appropriately sized solar arrays offer opportunities for complete energy offset across all household systems while minimizing greenhouse gas emissions through reduced grid electricity requirements.

Solar systems with integrated battery storage capabilities can maintain essential household functions during grid outages, though these configurations typically involve higher implementation costs. Energy arbitrage strategies utilizing battery storage further reduce emissions impacts and peak demand challenges by shifting household consumption from high-cost or high-emissions periods to more favorable timeframes, thereby optimizing both economic and environmental performance.

[7] Image credit: NeoCharge (2025) https://getneocharge.com/

[8] Image credit: Span (2025) https://www.span.io/