BERKELEY LAB

200A Electric Service Guide for New Homes

January 2026

INTRODUCTION

This guide has been developed by researchers at Lawrence Berkeley National Laboratory (LBNL) to help builders avoid costs related to high power requirements in new homes. The primary goal is to demonstrate approaches to build new homes with a 200 ampere (200A) or less electrical service, while minimizing the impact on usability/customer experience. Specifically, this guide is focused on ensuring that National Electrical Code (NEC) service load calculations remain below 200A. While the guide is targeted to new single family home construction, much of the content is relevant for existing homes undergoing renovation as well.

There are three key approaches presented in this guide in our recommended order of priority. For each approach, this document includes a concise explanation and provides example illustrative NEC load calculations[1] for an example new home.

1. **Strategic electrical service load calculations:** NEC calculations that use existing pathways in the code to get to a 200A or less panel/service requirement represent the lowest effort option, because others involved in the construction process (e.g., Authority Having Jurisdiction [AHJ], electric contractors, specifiers) will see the fewest changes to business-as-usual.
2. **Reducing loads through appliance and equipment selection:** An increasing number of lower-power options are available for space heating, space cooling, hot water, clothes drying, cooking, pool heating, etc., where the use of their nameplate power ratings can be simply integrated into NEC calculations. However, careful selection and installation may be needed, as well as considering other aspects of the construction process, such as changes in suppliers.
3. **Managing loads using control solutions:** This option has the highest potential for acceptance issues with local utilities or building departments and may cause customer concerns.

The vast majority of new homes can be served by 200A. Building new homes with 200A service may require planning and the use of appliances, equipment and controls that might not be the current “business-as-usual” for most builders. Builders should work with electrical subcontractors to familiarize them with new technologies and approaches and get them to strategically use the NEC to keep service ratings at 200A or less. Asking electrical designers to ensure a home does not exceed 200A service ratings is an important first step, along with requesting careful review of current service load calculations, in order to identify opportunities for reducing load, such as using actual equipment power ratings rather than conservative defaults. Builders should also use suppliers and distributors that can provide lower-power solutions and/or control equipment. Finally, it may be important to coordinate with local AHJs to ensure their acceptance of the project’s compliance approach with the NEC. For some end-uses there may be non-electric alternatives that reduce home power requirements. The guidance in this document is intended to accommodate the full spectrum of consumer choices, while keeping to a 200A limit.

[1] See APPENDIX: ELECTRICAL LOAD CALCULATIONS for detailed load calculation tables

STRATEGIC ELECTRICAL SERVICE LOAD CALCULATIONS

Traditionally, load calculations prioritize code compliance without a specific goal for service size. To build new homes using 200A (or less) electrical service will require a change in approach by electrical designers and contractors, requiring discussion and collaboration.

Step 1: Communicate the 200A goal

The initial and crucial step is to clearly communicate to the electrical designer the objective to achieve a 200A (or less) electrical service for the home.

Step 2: Review load calculation assumptions

The next step is to request a detailed review of the assumptions and approaches used in the current electrical load calculation and sizing design. Key areas to focus on include:

- **Correct demand factors:** With the exception of heating and cooling equipment, ensure that all loads (including electric vehicle chargers) are included in the General Loads. These General Loads should be treated with a 40% demand factor after the first 10 kW of load is treated at 100% calculations (per NEC 220.82(B)2).
- **125% treatment:** Verify that only Electric Vehicle Supply Equipment (EVSE) loads are treated at 125%, and this 125% factor is applied before the 40% adjustment for general loads (per NEC 625.42).
- **Load diversity for multiple panels:** If the home has multiple panel boards or a main panel feeding one or more subpanels, ensure that load diversity is correctly accounted for at the whole-home electrical service. Simply adding the loads calculated for each subpanel is incorrect; load diversity across the entire service should be considered.
- **Correct default values:** Electrical designers should avoid using overly conservative or incorrect default values for appliances and equipment (e.g., using 6 kW for a water heater when most are rated lower, around 4.5 or 5.5 kW). Actual equipment power ratings should be used where available. Avoid using the breaker rating as a default value (e.g., 7.2 kW for an electric clothes dryer on 30A circuit).
- **Credit for power-efficient appliances/equipment:** Take full credit for any power-efficient appliances or equipment being installed by using their actual nameplate ratings, rather than relying on default or minimum code values (per NEC 220.82(B)(3)).
- **Credit for load control solutions:** Account for any installed load control solutions, such as EVSE with energy management features, in the load calculations (per NEC 220.70; 220.60; 625.42(A)).

[2] These (and other similar numbers) refer to paragraphs/sections of the latest (2023) NEC.

Benefits of Strategic Load Calculations

The four scenarios below illustrate recommendations for NEC service load calculations for an example 3,200 ft^2 home. The first three scenarios illustrate issues/practices observed in actual project plans that fail to reduce calculated loads below 200A. The three scenarios are combined in a cumulative manner to illustrate how load reductions can be compounded. The Reference scenario implements the recommended NEC approach. Detailed calculations for each of the four scenarios are provided in the Appendix. The scenarios include:

1. Large continuous loads, such as Electric Vehicle Chargers (EVC), treated at 100%, poor default values, and no diversity for subpanel loads
2. Large continuous loads treated at 100% and poor default values
3. Large continuous loads treated at 100%
4. Reference design

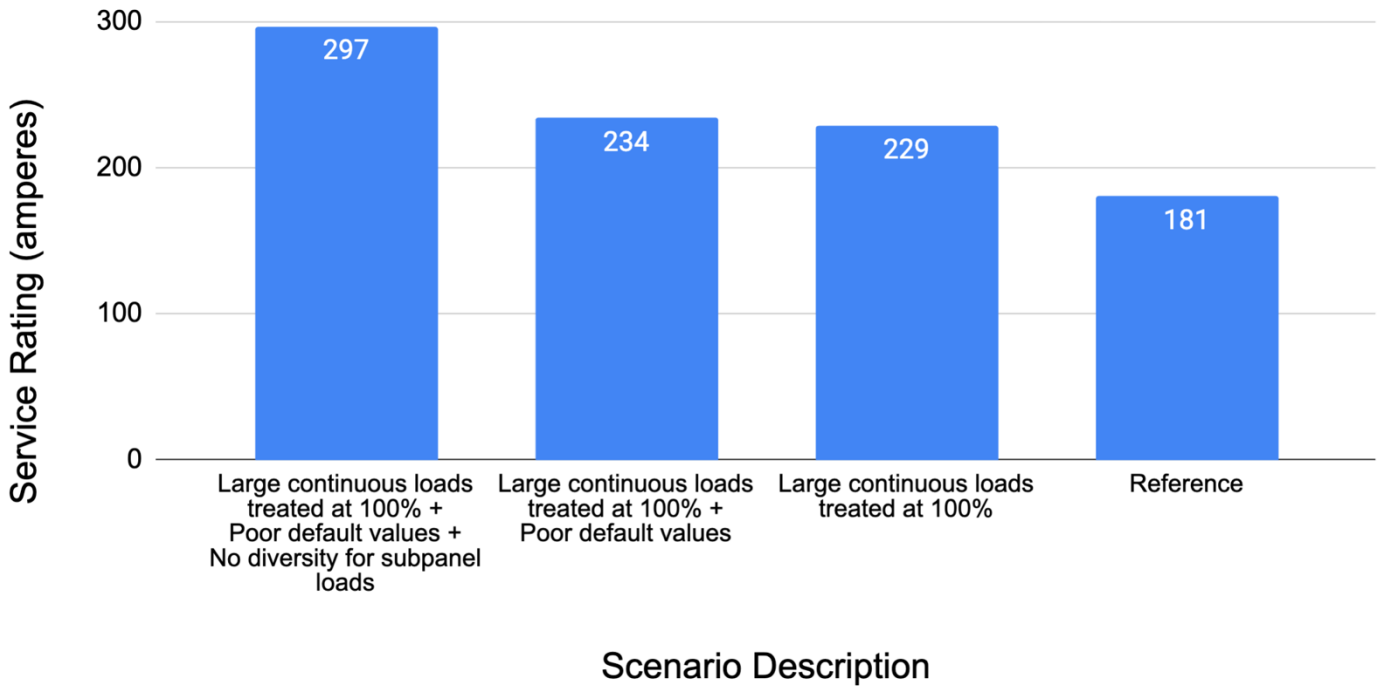


Figure 1: Reductions in service rating using strategic load calculations

In this example, the newly built home can use a 200A service when all calculations are done per the Reference NEC approach. For the calculations that do not follow the Refence approach, the resulting service rating incrementally increases from around 230A up to almost 300A in the worst-case calculation scenario.

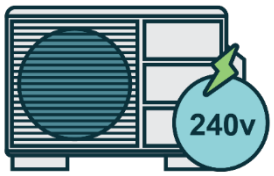
Pre-Wiring for Future Loads

When pre-wiring for future electric appliances, equipment, or non-utility power sources, it is crucial to include these anticipated loads in service sizing calculations. This ensures the busbar, panel, and service can safely accommodate them. For electrical load calculations, avoid using the branch circuit rating. A better approach involves using typical or prescriptive values from the electrical code (e.g., 5 kVA for an electric clothes dryer (220.54)). The same approach applies when homeowners supply their own appliances, such as clothes dryers.

REDUCING LOADS THROUGH EQUIPMENT SELECTION

The following sections outline how to make lower-power choices for appliance and equipment selection. In many homes, it may not be necessary to use the lowest-power option in every category. Instead, this is a menu of options to choose from for reducing loads to meet the 200A limit. See EXAMPLE ELECRICAL LOAD CALCULATIONS USING LOAD CONTROLS AND LOWER POWER APPLIANCES for an illustration of how equipment selection can help reduce electrical loads.

HEATING



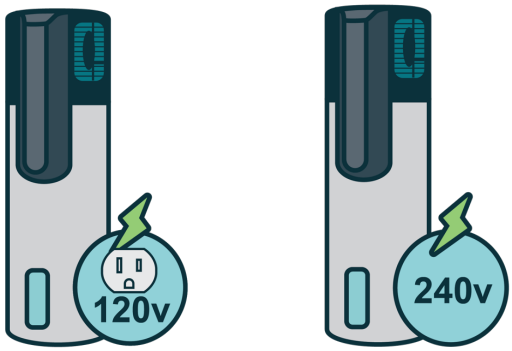
Current electric heating systems include both electric resistance and heat pumps, with both technologies available as central systems and as smaller systems serving one room or just part of a home. Central resistance heating systems typically have power requirements in the 10-50 kW range. Individual room resistance heaters will add up to the same large number of kW, but can take advantage of diversity benefits in NEC 220.82(C).

Some heat pump systems have “backup” resistance heating elements that usually add 5–20 kW per system. A key strategy in limiting HVAC peak power is to minimize the installation of electric resistance backup heating, which can be easily achieved in milder climates. New cold-climate heat pumps can help avoid resistance backup heat in colder climates, although extreme cold climates (DOE CZ 6 and higher) may be challenging unless a high-performance building envelope is used to reduce winter heating loads.

For heating systems, reducing peak load depends on the following factors:

- **Using heat pumps instead of electric resistance heating.** The ability of heat pumps to output much more power than they use (typically factors of 3-5 for modern high-performance systems) is an essential part of lowering heating peak power and energy use.
- **Minimizing the heating loads for the home**. High-performance new homes should have relatively low loads already, but any additional load reduction through improved insulation or air sealing can be used to install equipment of lower capacity with less impact on electrical loads. Duct systems in unconditioned space (e.g., attics) should be very tight and well insulated, to avoid reducing capacity.
- **Avoiding electric resistance backup**. The use of electric resistance systems is not recommended due to high power requirements and low efficiency leading to higher costs for occupants. After minimizing heating loads, the use of cold climate certified heat pump technologies can significantly reduce the need for and size of backup heating. If backup resistance heating is necessary, consider installing lower capacity (5-8 kW) heaters. Alternatively use gas as a backup heat source in a “dual-fuel” system. Another option is to have the heat pump compressor not operate at the same time as the backup heating elements which allows the load calculation to exclude the smaller of the two heat sources.

WATER HEATING

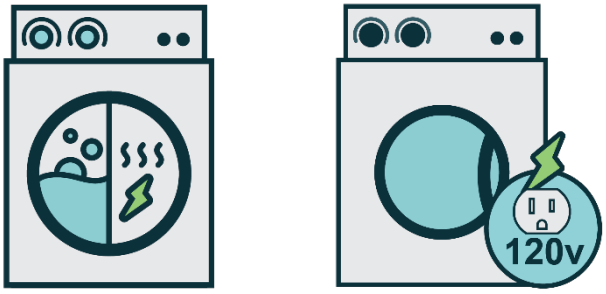


Water heating options span a wide range of power ratings, and careful selection can reduce the calculated service load. Instant electric water heaters have high power requirements and should be avoided. Single point-of-use instant water heaters are typically 30A (7 kW)—with one required for each end use. Central systems range from 60–150A (14–36 kW). Storage electric water heaters require much less power, and use electric resistance heating elements typically rated at 4.5 or 5.5 kW. Most hybrid electric heat pump water heaters (HPWH) also have electric resistance elements for backup heat. This backup reduces the chance of hot water runout and increases recovery speeds after runouts. Combined with the heat pump compressor, HPWHs have marginally higher nameplate power ratings of around 5.0 kW.

For water heating, reducing peak load depends on the following factors:

- **Not using instant (sometimes called "tankless") electric water heaters.**
- **Selecting a lower-power HPWH.** Some HPWH have smaller backup heaters with lower power requirements. However, it is important to note that concerns about hot water runout and recovery time are greater with the smaller backup. Our recommendation for new construction is to use a 240V, 12A (2.88 kW) HPWH.
- **Installing an 80-gallon HPWH.** To reduce concerns about hot water runout, install an 80-gallon HPWH that is capable of having a high temperature set-point (140F minimum) to increase hot water storage capacity. This approach requires a mixing valve for safety. Some newer HPWH models have integrated mixing valves for simpler, lower-cost installation.
- **Using low-flow plumbing fixtures.** Higher flow outlets are more likely to result in hot water runouts.

LAUNDRY



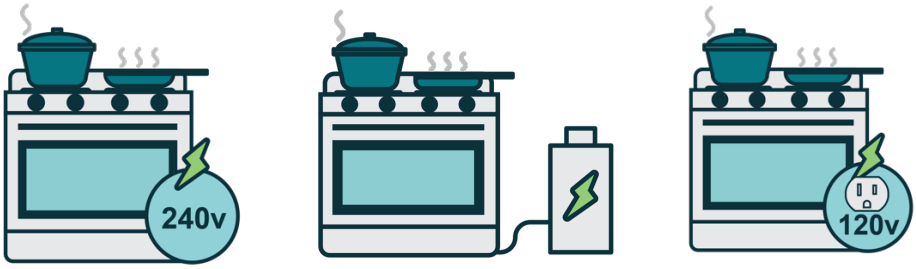
Combination washer/dryer

A typical electric resistance dryer has a power requirement of about 5.5–6 kW. Clothes dryer power requirements can be reduced to less than 1.5 kW when choosing lower-power options, but it is important to consider the "customer experience" with lower-power clothes drying options. Unvented heat pump dryers often take longer to dry a load of clothes but are considered more gentle on clothes due to lower temperatures. A primary selling point of combination washer/dryer appliances is that customers do not have to switch laundry between two machines, and the customer experience overall is simpler and easier. Preference varies tremendously between households, so this might be a point of discussion with potential occupants. Also, while most of these lower-power dryers do not require venting to outside, they do require access to a sink or drain for the condensate.

For laundry, reducing peak load depends on appliance selection:

- **Considering lower-power unvented, heat pump, or combination options:**
  - 240V, 11A (2.6 kW) condensing electric resistance clothes dryer
  - 240V, 3A (0.8 kW) heat pump electric clothes dryer
  - 120V, 8A (1.0 kW) heat pump clothes dryer
  - 120V, 13A (1.6 kW) combination washer/dryer

COOKING



Integrated battery

Cooking is often the single largest end use when it comes to power requirements. An individual standard-sized electric range, using either resistance or induction cooktop technologies, requires 11–14 kW. More complex kitchens, with multiple ovens and larger cooktops with more burners, further increase power requirements.

For cooking, reducing peak load depends on the following factors:

- **Reducing the number of permanently installed electric cooking appliances**. For example, using an integrated cooking range instead of separate cooktop and oven(s), or reducing the number of separate ovens (e.g., from two to one).
- **Using cooktops (or ranges) with fewer heating elements**. Power ratings are lower for four-burner cooktop appliances, compared with five- and six-burner options.

Note about 120v Battery-integrated ranges. These ranges have desirable features, such as the ability to allow cooking during power outages. However, they are currently expensive (about $1,000-3,000 more than an equivalent without a battery) and not widely available. Therefore, these are not a recommend option right now but may become viable in the future.

ELECTRIC VEHICLE CHARGING

There is a large range of charging power options for EVs. The lowest is level 1 (120V, 10–15A), commonly used in existing homes but not recommended for new construction due to slower charging times. Level 2 (240V, 15–40+ A) charging is the most appropriate for home charging, with a large range of available equipment. Level 3 fast charging is very high power and not recommended for residential use.

For EVs, reducing peak load depends on the following factors:

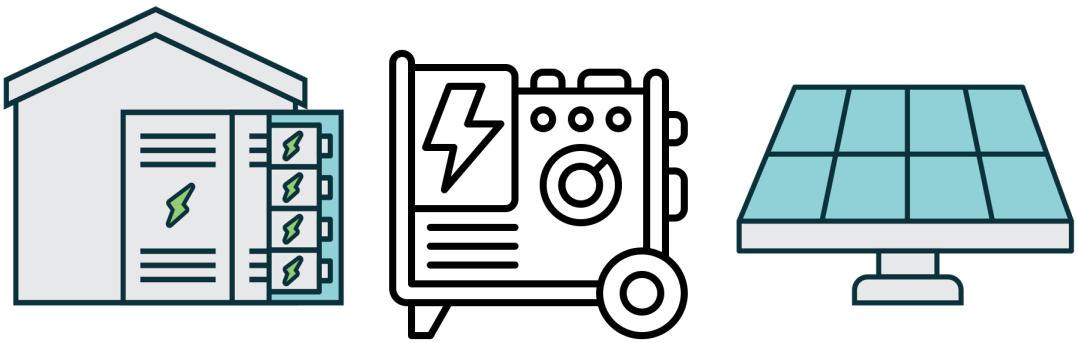
- **Reducing the number of chargers.**
- **Installing lower-power level 2 charging:** 240V, 16–24A (2.9–5.8 kW).
- **Avoiding higher-power charging, including 32, 40, and 48A level 2 charging or level 3 fast charging.**
- **Using load controls to reduce EV electrical loads** might be the best approach to address charging time concerns. There are two primary options for controlling EVs:
  - **"Smart" EVSE with whole-home power metering**. The rate of EV charging is controlled to ensure the whole home never demands more than 80% of the panel rating (160A for a 200A panel). This type of control is a feature of many "Smart Panels."

    NEC treatment: treat controlled EVSE load as 0 kVA (or other minimum setting) when using load balancing smart EVSE (per NEC 220.70)

  - **"Smart" EVSE for multiple chargers.** Multiple chargers are powered from a single circuit, and an energy management system automatically distributes power between vehicles (e.g., instead of three 8.4 kW chargers (25 kW), install one 12 kW charger with load balancing to two or three EV receptacles).

    NEC treatment: use only the rating of the load balancing EVSE or the control setting for the charging control EMS (per 220.70, 625.42(B))

NON-UTILITY POWER SOURCES



Homes can integrate non-utility power sources (e.g., solar, batteries, generators, bi-directional EVC) using connections on either the line-side (before the main disconnect) or the load-side (after the main disconnect).

Load-side connections are generally cheaper and most appropriate for smaller power sources. They use a circuit breaker and connect through the panel's busbar. However, the NEC 120% rule limits the connected power to prevent "breaker masking."[3] The power source's rating multiplied by 125% cannot exceed 20% of the busbar rating (e.g., 32A for a 200A busbar)[4], and its breaker must be at the opposite end of the busbar from the main disconnect.

Line-side connections are useful when breaker slots are full or the power source(s) exceeds the 120% rule (e.g., a 46A solar PV system for a 200A busbar). This connection usually occurs outside the electrical panel (e.g., via a meter socket adapter or other line-side tap) and avoids the size restrictions of the 120% rule.

If connection of other power sources is driving your need for increased service size, consider the following non-exhaustive list alternative solutions.

Load-side options:

- **Main breaker derating**: When supported by Reference NEC load calculations, installing a smaller main breaker (e.g., 150A or 175A on a 200A panel) allows larger external power sources. For example, 52A of solar can be connected to a 200A busbar when the main breaker is derated to 175A. See a more detailed example in Table 1 on the next page.
- **Panel with a higher busbar rating**: Panels with oversized busbars (e.g., 225A busbar with a 200A service disconnect) also allow more external power (e.g., total of 56A).
- **Solar-ready main panel**: These panels avoid back-feeding solar through the busbar by providing an alternative connection.

[3] "Breaker masking" is a potentially dangerous condition where, due to the presence of multiple power sources feeding a busbar, the current (amps) flowing through the busbar could exceed its safe capacity yet fail to trip the main circuit breaker.
[4] Other power source = 80% x (120% x busbar – main disconnect breaker).

Line-side options:

- **Meter socket adapters (MSA)**: MSA are installed at the utility meter, requiring utility approval and coordination. They bypass the limitations of the panel and busbar and are limited only by the service rating.

Combined load- and line-side options:

- **Power control system**: This system meters and manages multiple power sources and loads on a single busbar, actively avoiding "breaker masking" by adjusting input power based on demand of appliances/equipment.
- **Power sources gateway**: This gateway combines multiple power sources (e.g., solar and battery) before connecting to the home's wiring with a single line- or load-side connection. This avoids treating each source independently for the 120% rule (e.g., combining 30A solar and 30A battery into a single 40A connection means a 175A main breaker derate is sufficient, instead of 150A or less).

Table 1 provides an example of the allowable added load (in amperes) for busbar and main breaker derating scenarios. The allowable amperes that could be added for a given service rating and service load are provided for each connection type. Line-side connections can be used if the power source exceeds the values in Table 1.

Table 1: Allowable added load (in amperes) for busbar and main breaker derating scenarios

	Amperes					
	Ratings		***Connection Type***			
Scenario Description	***Service Rating***	***Service Load***	***Load-side***	***Load-side with main breaker de-rated (25A for a 200A service and 50A for 300A service)***	***Load-side with 25A oversized busbar***	***Load-side with main breaker de-rated and with 25A oversized busbar***
EVC treated at 100% + Poor default values + No diversity for subpanel loads	300	297	48	No derating*	72	No derating
EVC treated at 100% + Poor default values	300	234	48	88	72	112
EVC treated at 100%	300	229	48	88	72	112
NEC Reference	200	181	32	No derating	56	No derating
NEC Reference + Load Control EVC	200	165	32	52	56	76
NEC Reference + Lower Power Appliances	200	160	32	52	56	76
NEC Reference+ Load Control EVC+ Lower Power Appliances	200	152	32	52	56	76

* The service load is too close to the service rating to allow for derating of the main breaker.

MANAGING LOADS USING CONTROL SOLUTIONS

Load control technologies reduce or shut off power to controlled loads under certain conditions. Load controls are most effective when used to control higher-powered appliances or equipment; there is less value in controlling a low-power, 120V water heater, for example. In contrast, controlling a 40A EV charger should be a high priority for reducing service load and panel size.

Most homes only need to control 1-2 devices to stay on 100 or 200A panels and EVSE and water heaters are most commonly controlled. Load control power interruption is short in duration (usually 15 minutes and almost always less than one hour) and infrequent (typically 1% of annual hours, and never occurring in some homes).

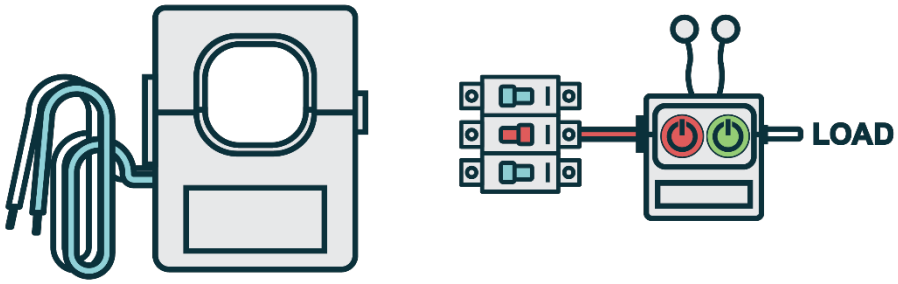
Only a few key loads should be actively controlled, in order to avoid disrupting customers. It is important to ensure that any loads that are shut off will correctly restart. Ideal loads to control are EV chargers and water heaters (and some other rarer loads such as pool and spa heaters and pumps). In the future, it may be possible to extend this list to include other devices, if they are equipped with controls that seamlessly restart and manage equipment settings (e.g., dishwashers, clothes dryers).

While load controls are permitted to be used in NEC load calculations, the treatment of load controls varies between NEC code versions and with interpretations by local authorities. The following NEC sections support use of load controls and can be useful to review with your electrical designer and building department:

- **220.60 Noncoincident loads** can be used to support circuit sharing load controls, where two loads are not allowed to operate at the same time (e.g., EV and cooking range). Only the larger of the two loads is included in the load calculation.
- **220.70 Energy Management Systems (EMS)** (new in the 2023 NEC) permits the use of EMS that limit the current on a feeder or service. Installation must be in accordance with NEC 750.30. A single value that is the maximum ampere setting of the EMS may be used in load calculations and is considered a continuous load, which entails treatment at 125%. In effect, this means the EMS control setting must be 80% (or less) of the circuit being metered and managed, which can be an individual circuit or the whole home electric service. For example, a 200A service panel would have a control setting of 160A or less.
- **625.42(B) for EVSE EMS** permits the use of EV EMS and for the EV load to be the maximum setting established for the EMS. See the “Smart” EVSE for multiple chargers description above.
- **130 and 120.7 for Power Control Systems (PCS)** will reflect changes to load control requirements when a jurisdiction adopts the 2026 NEC.

See EXAMPLE ELECRICAL LOAD CALCULATIONS USING LOAD CONTROLS AND LOWER POWER APPLIANCES for an illustration of how load controls can help reduce electrical loads.

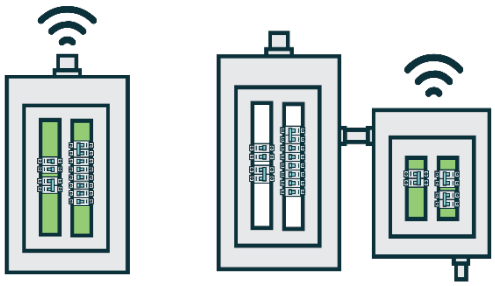
LOAD SHED CONTROL



Since new homes are unlikely to be restricted by the number of breakers in the electric panel, and may only need to control a single device, load shed controls are a low-cost option for reducing calculated electrical load/service size. These controls include a relay for switching power on and off, and the control signal comes from a metering clamp installed on the service wires entering the main panel. A control setting that is 80% of the rating of the circuit being metered should be used in these load shed controls. An evaluation of electrical demand data in nearly 1,000 U.S. homes found that very few homes ever exceed 80% of their panel rating. Therefore, power interruption by load shed controls is expected to be very infrequent and to only occur in a small number of homes (<10%). As with other load controls, when there is power interruption, analysis suggests it will not last long (<1-hour in 87% of cases).

NEC treatment: load shed controls are effectively single-device energy management systems. Metering for EMS control should be connected to the service or feeder, and the EMS control setting should be set at 80% of the service or feeder main breaker rating. NEC 220.70 (in the 2023 NEC) or 120.7 (in the 2026 NEC) permits removing the controlled load from the load calculation.

SMART PANELS



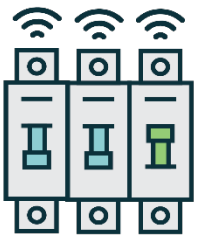
Smart panels are comprehensive energy management and power control systems that can control loads to satisfy a specified service limit, which is established by the installer and must not be easily adjusted by home occupants. Solutions exist for both main service panels and distribution subpanels.

Smart panels allow customers/installers to flexibly prioritize which loads are controlled to ensure the service limit is met (e.g., control the pool heater first, then the EVSE, then the water heater). Many smart panels can also manage the use of other interconnected power sources, including solar PV and home batteries (and in the future, bi-directional EV charging). Smart panels can also be used to save money in regions with time-of-use electricity rates, by scheduling energy use during low-cost hours. They also facilitate participation in utility or aggregator demand response programs. Finally, these systems may provide energy metering and occupant engagement via smartphone apps.

If the only goal is addressing the 200A service challenge, and other energy management features and the customer interface are not needed, then a smart panel is probably an unnecessary and expensive option (typically $3,000 or more for the hardware alone). Partially smart panels may also be an option, where individual breakers are installed with smart, communicating functionality (see Smart Breakers on p. 15). This may be a simpler, more cost-effective approach to solving the service constraint challenge, especially when only one or two devices need to be controlled to get the calculated load below 200A.

NEC treatment: Smart panels are treated as an Energy Management System using 220.70 (in the 2023 NEC) or 120.7 and 130 (in the 2026 NEC). The control setting for the smart panel should be established at 80% of the service (or panel) rating. The control setting becomes your home's service load for electrical sizing purposes. Other conventional load calculations are not necessary in this case, which may also save electrical design costs.

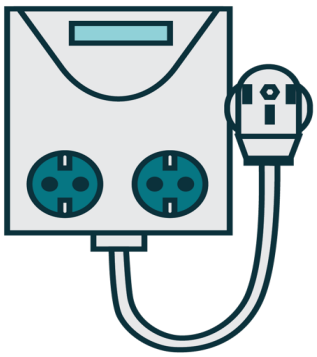
SMART BREAKERS



Smart breakers are control devices for individual circuits, rather than for the whole panel. They offer a lower cost option but have more limited control abilities than whole-panel approaches. They can incorporate timers or be responsive to other control signals, such as total panel power. Current options on the market offer limited functionality for service panel capacity management and are more oriented towards scheduling of loads and other energy management tasks. In some cases, smart breakers managing current on the service or feeder require several additional breaker spaces: two for the 240V device itself, two for the control module, and two for the metering module. These extra breaker spaces need to be accounted for when considering the physical space available in the panel. Smart breakers that provide off-the-shelf panel capacity management may soon be available on the market.

NEC treatment: smart breakers are a modular, expandable energy management system. Metering for EMS control should be connected to the service or feeder, and the EMS control setting should be set at 80% of the service or feeder main breaker rating. NEC 220.70 (in the 2023 NEC) or 120.7 (in the 2026 NEC) permits removing the controlled load(s) from the load calculation.

CIRCUIT SHARING



Circuit sharing, one of the most commonly used load controls, allows two loads to connect to a single circuit with an automatic or manual switch that allows only one load to operate at a time. Preferences are set by the customer/installer. A typical use-case is a clothes dryer and EVSE in the same garage sharing one 240V receptacle. Power to the EVSE is paused during clothes dryer operation and then automatically resumed when drying is finished. Another example is to pause water heater operation to prioritize the clothes dryer or cooking range. In most homes, load control will be infrequent and of short duration (typically 15 minutes and almost always less than one hour) and is unlikely to be disruptive to occupants, because it is extremely rare for homes to exceed or approach their service limit.

NEC treatment: circuit sharing controls are not explicitly mentioned in the 2023 NEC, but section 220.60 permits load calculations to use only the larger of two loads that are unlikely to operate at the same time. Circuit sharing controls ensure (or guarantee) that two devices will not operate at the same time, so section 220.60 can be used to justify these controls; the smaller of the two loads can be removed from the electrical load calculation. Notably, the 2026 NEC explicitly allows the use of listed controls for this purpose (see 120.6).

EXAMPLE ELECRICAL LOAD CALCULATIONS USING LOAD CONTROLS AND LOWER POWER APPLIANCES

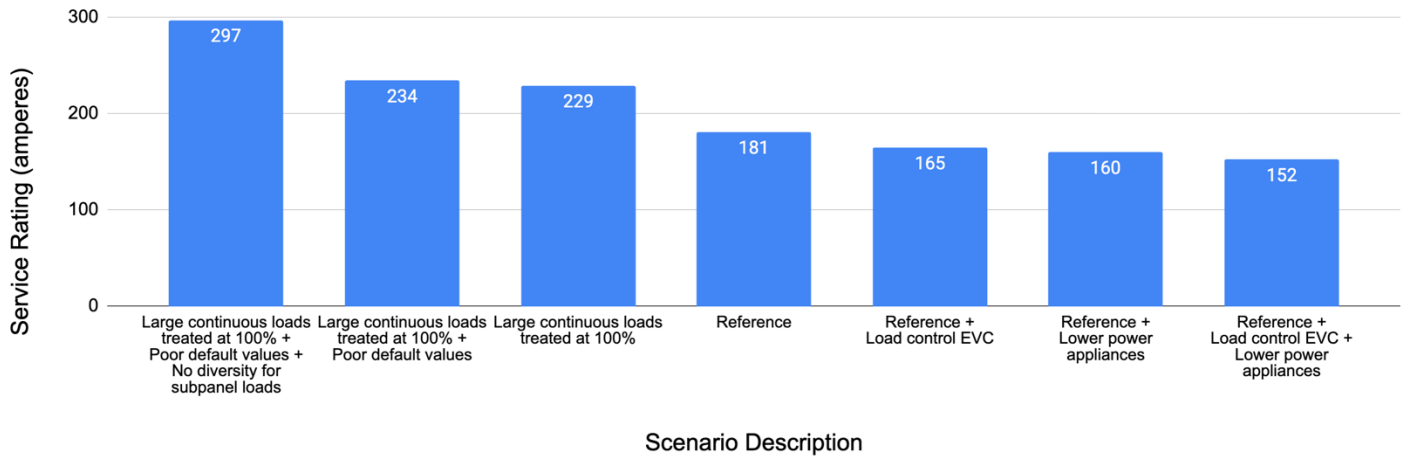
Building on the Reference load calculations, here are additional load calculations that include power efficient solutions:

1. Load control electric vehicle charging (EVC)
2. Lower power appliances
3. Load control EVC + lower power appliances

Using lower power appliances or load controls for EVC reduce the calculated load by roughly 20A at 240V relative to the reference strategic calculation. The Reference + Load control EVC case replaces two 9.2 kW EV chargers with a single 9.2 kW EVC (40A, 240V) that includes load balancing and can charge two vehicles from one branch circuit. The Reference + Lower power appliances case replaces conventional higher-powered appliances with lower-power options, including a 120V heat pump clothes dryer, a 120V heat pump water heater, and two slightly lower-power EV chargers (at 7.2 kW each (30A, 240V)). Both of these strategies could also be combined, for a total reduction in the service rating from 181A down to 152A when both load controls for EV charging and other lower power appliances are used. The Appendix provides tables showing detailed load calculation examples for these scenarios.

These power efficient designs and load calculations leave additional headroom (even on a 200A panel) for other items that might be desirable for home buyers, such as separate cooktop and oven, a pool/spa heater or heated towel racks. Alternatively, the load calculations including either controls or lower power appliances would allow the electrical designer to derate the main breaker from 200A to 175A. This derating would allow additional solar PV or other power sources, consistent with the NEC 120% rule. A 200A main breaker on a 200A busbar panel permits 32A of solar, while a 175A main breaker on the same panel permits 52A of solar.

Figure 2: Reductions in service rating using load controls and lower power appliances



APPENDIX: ELECTRICAL LOAD CALCULATIONS

Example 1. EVC at 100%, Poor Default Values, and No Diversity for Subpanel Loads

Category	*Unit Load (volt-amperes or watts)*	*Count*	*Connected Load (volt-amperes or watts)*	*Comments*
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Air Handler	1100	1	1100	
General Loads Unadjusted`			*16200*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*2480*	
General Loads Adjusted			***12480***	
Subpanel Load Calculation				
Clothes Dryer (Resistance) (Subpanel)	7200	1	7200	*Using 30A, 240V branch circuit as load, rather than 5.5 kW nameplate*
Storage Water Heater (Resistance) Subpanel)	6000	1	6000	*Using conservative default value of 6 kW that is greater than water heater rating of 4.5 kW*
Cooking Range (Induction) (Subpanel)	12000	1	12000	
Subpanel Load Unadjusted			***25200***	*Using unadjusted subpanel load directly in service load calculation, not accounting for diversity of subpanel loads*
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Electric Vehicle Chargers (40A, 240V) at 100%	9600	2	19200	*Treating EVC at 100%, not including in 220.82(B) General Loads calculation*
Heating and Air-Conditioning Load Unadjusted			***33600***	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Subpanel Load Unadjusted + Heating and Air-Conditioning Load Unadjusted)			***71280***	
Service Volt Rating			*240*	
Service Ampere Rating			***297***	
Round up to standard service rating			*300*	
Other Power Sources				
Other power sources at 125%	48A	1	11520	
Other power sources at 125% with 25A oversized busbar	72A	1	17280	

Example 2. EVC Treated at 100% and Poor Default Values

Category	Unit Load (volt-amperes or watts)	Count	Connected Load (volt-amperes or watts)	Comments
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Clothes Dryer (Resistance) (Subpanel)	7200	1	7200	*Using 30A, 240V branch circuit as load, rather than 5.5 kW nameplate. Subpanel load treated with 40% demand factor in General Loads.*
Storage Water Heater (Resistance) (Subpanel)	6000	1	6000	*Using conservative default value of 6 kW that is greater than water heater rating of 4.5 kW. Subpanel load treated with 40% demand factor in General Loads.*
Cooking Range (Induction) (Subpanel)	12000	1	12000	*Subpanel load treated with 40% demand factor in General Loads.*
Air Handler	1100	1	1100	
General Loads Unadjusted			*41400*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*12560*	
General Loads Adjusted			***22560***	
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Electric Vehicle Chargers (40A, 240V)	9600	2	19200	*Treating EVC at 100%, not including in 220.82(B) General Loads calculation*
Heating and Air-Conditioning Load Unadjusted			***33600***	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			***56160***	
Service Volt Rating			*240*	
Service Ampere Rating			***234***	
Round up to standard service rating			*300*	
Other Power Sources				
Other power sources at 125%	48A	1	11520	
Other power sources at 125% with main breaker de-rated to 250A	88A	1	21120	
Other power sources at 125% with 25A oversized busbar	72A	1	17280	
Other power sources at 125% with main breaker de-rated to 250A and with 25A oversized busbar	112A	1	26880	

Example 3. EVC Treated at 100%

Category	Unit Load (volt-amperes or watts)	Count	Connected Load (volt-amperes or watts)	Comments
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Clothes Dryer (Resistance) (Subpanel)	5500	1	5500	*Using 5.5 kW nameplate. Subpanel load treated with 40% demand factor in General Loads.*
Storage Water Heater (Resistance) (Subpanel)	4500	1	4500	*Using 4.5 kW nameplate. Subpanel load treated with 40% demand factor in General Loads.*
Cooking Range (Induction) (Subpanel)	12000	1	12000	*Subpanel load treated with 40% demand factor in General Loads.*
Air Handler	1100	1	1100	
General Loads Unadjusted			*38200*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*11280*	
General Loads Adjusted			***21280***	
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Electric Vehicle Chargers (40A, 240V)	9600	2	19200	*Treating EVC at 100%, not including in 220.82(B) General Loads calculation*
Heating and Air-Conditioning Load Unadjusted			***33600***	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			***54880***	
Service Volt Rating			*240*	
Service Ampere Rating			***229***	
Round up to standard service rating			*300*	
Other Power Sources				
Other power sources at 125%	48A	1	11520	
Other power sources at 125% with main breaker de-rated to 250A	88A	1	21120	
Other power sources at 125% with 25A oversized busbar	72A	1	17280	
Other power sources at 125% with main breaker de-rated to 250A and with 25A oversized busbar	112A	1	26880	

Example 4. Reference Approach

Category	*Unit Load (volt-amperes or watts)*	*Count*	*Connected Load (volt-amperes or watts)*
220.82(B) General Loads			
General Lights and Receptacles (3 watts/ft2)	3	3200	9600
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000
Laundry Circuit (1500 watts per circuit)	1500	1	1500
Garage Door Opener	500	1	500
Garbage Disposal	500	1	500
Clothes Dryer (Resistance) (Subpanel)	5500	1	5500
Storage Water Heater (Resistance) (Subpanel)	4500	1	4500
Cooking Range (Induction) (Subpanel)	12000	1	12000
Electric Vehicle Chargers (40A, 240V)	9600	2	19200
Air Handler	1100	1	1100
General Loads Unadjusted			*57400*
First 10 kW at 100%			*10000*
Remaining at 40%			*18960*
General Loads Adjusted			***28960***
220.82(C) Heating and Air-Conditioning Load			
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400
Heating and Air-Conditioning Load Unadjusted			***14400***
Total Load and Service Rating			
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			***43360***
Service Volt Rating			*240*
Service Ampere Rating			***181***
Round up to standard service rating			*200*
Other Power Sources			
Other power sources at 125%	32A	1	7680
Other power sources at 125% with 25A oversized busbar	56A	1	13440

Example 5. Reference Approach and Load Control for EVC

Category	*Unit Load (volt-amperes or watts)*	*Count*	*Connected Load (volt-amperes or watts)*	*Comments*
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Clothes Dryer (Resistance) (Subpanel)	5500	1	5500	
Storage Water Heater (Resistance) (Subpanel)	4500	1	4500	
Cooking Range (Induction) (Subpanel)	12000	1	12000	
Electric Vehicle Chargers, Load Balancing (30A, 240V)	9600	1	9600	*Using one load balancing EVC rather than two separate EVC*
Air Handler	1100	1	1100	
General Loads Unadjusted			*47800*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*15120*	
General Loads Adjusted			***25120***	
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Heating and Air-Conditioning Load Unadjusted			***14400***	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			*39520*	
Service Volt Rating			*240*	
Service Ampere Rating			***165***	
Round up to standard service rating			*200*	
Other Power Sources				
Other power sources at 125%	32A	1	7680	
Other power sources at 125% with main breaker de-rated to 175A	52A	1	12480	
Other power sources at 125% with 25A oversized busbar	56A	1	13440	
Other power sources at 125% with main breaker de-rated to 175A and with 25A oversized busbar	76A	1	18240	

Example 6. Reference Approach and Lower Power Appliances

Category	*Unit Load (volt-amperes or watts)*	*Count*	*Connected Load (volt-amperes or watts)*	*Comments*
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Clothes Dryer (Resistance) (Subpanel)	1200	1	1200	*120V heat pump clothes dryer*
Storage Water Heater (Resistance) (Subpanel)	1200	1	1200	*120V heat pump water heater*
Cooking Range (Induction) (Subpanel)	12000	1	12000	
Electric Vehicle Chargers (30A, 240V)	7200	2	14400	*Lower power EVC*
Air Handler	1100	1	1100	
General Loads Unadjusted			*45000*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*14000*	
General Loads Adjusted			***24000***	
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Heating and Air-Conditioning Load Unadjusted			***14400***	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			***38400***	
Service Volt Rating			*240*	
Service Ampere Rating			***160***	
Round up to standard service rating			*200*	
Other Power Sources				
Other power sources at 125%	32A	1	7680	
Other power sources at 125% with main breaker de-rated to 175A	52A	1	12480	
Other power sources at 125% with 25A oversized busbar	56A	1	13440	
Other power sources at 125% with main breaker de-rated to 175A and with 25A oversized busbar	76A	1	18240	

Example 7. Reference and Lower Power Appliances and Load Control EVC

Category	*Unit Load (volt-amperes or watts)*	*Count*	*Connected Load (volt-amperes or watts)*	*Comments*
220.82(B) General Loads				
General Lights and Receptacles (3 watts/ft2)	3	3200	9600	
Small Appliance Kitchen Circuits (1500 watts per circuit)	1500	2	3000	
Laundry Circuit (1500 watts per circuit)	1500	1	1500	
Garage Door Opener	500	1	500	
Garbage Disposal	500	1	500	
Clothes Dryer (Resistance) (Subpanel)	1200	1	1200	*120V heat pump clothes dryer*
Storage Water Heater (Resistance) (Subpanel)	1200	1	1200	*120V heat pump water heater*
Cooking Range (Induction) (Subpanel)	12000	1	12000	
Electric Vehicle Chargers, Load Balancing (40A, 240V)	9600	1	9600	*Using one load balancing EVC rather than two separate EVC*
Air Handler	1100	1	1100	
General Loads Unadjusted			*40200*	
First 10 kW at 100%			*10000*	
Remaining at 40%			*12080*	
General Loads Adjusted			***22080***	
220.82(C) Heating and Air-Conditioning Load				
Central Heat Pumps (2.5 tons) at 100%	7200	2	14400	
Heating and Air-Conditioning Load Unadjusted			*14400*	
Total Load and Service Rating				
Total Load (Sum of the General Loads Adjusted + Heating and Air-Conditioning Load Unadjusted)			*36480*	
Service Volt Rating			*240*	
Service Ampere Rating			***152***	
Round up to standard service rating			*200*	
Other Power Sources				
Other power sources at 125%	32A	1	7680	
Other power sources at 125% with main breaker de-rated to 175A	52A	1	12480	
Other power sources at 125% with 25A oversized busbar	56A	1	13440	
Other power sources at 125% with main breaker de-rated to 175A and with 25A oversized busbar	76A	1	18240	