**Electrification & Community Microgrid–ready (ECMR) guidelines**

Every community can benefit from resilience, and microgrids can be a key part of a comprehensive resilience solution. Whether facing a wildfire, earthquake, or coordinated threat, microgrids enable continued access to energy by islanding from the utility grid during a grid outage. This page provides site definitions to support applying the specifications on the following page to various buildings and communities. Both microgrid types defined below electrify all on-site energy loads, incorporate high levels of local distributed energy resources (DER) like solar, energy storage, and load management, and provide resilience. Additionally, these solutions are cost-effective and can provide benefits to the grid and to other grid users by reducing the cost of grid operations and obviating the need for new grid infrastructure investments.

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| **Microgrid-ready site definitions** |
| Microgrids are capable of disconnecting from the grid in the event of a grid disruption; this functionality is known as “islanding.” Renewable energy microgrids must be equipped with on-site renewable generation (e.g., solar), energy storage (e.g., batteries), and a microgrid controller. Microgrids may include smart electric appliances and smart electric vehicle (EV) chargers, which provide additional functionality. The microgrid controller monitors, communicates with, and controls the DER and smart appliances; the microgrid controller must also be able to communicate with the grid operator.* **Microgrid Type 1: Single customer —** Loads and generation are behind a single customer’s utility meter. Islanding occurs behind the customer’s utility meter.
	+ **Facility examples:** Single-family home, office building, hospital, or campus.
* **Microgrid Type 2: Community-scale —** Loads and generation are behind or in front of multiple customers’ utility meters but are all downstream of a distribution substation. Islanding occurs in front of the customers’ utility meters (such as at the distribution feeder) and includes multiple utility customers, including Type 1 microgrids.
	+ **Facility examples:** Multi-family housing, housing subdivision, civic center with multiple buildings, or retail complex.
* **Critical loads:** When a microgrid is operating in island mode,load-shedding can extend the length of an outage through which a microgrid can maintain power continuity. Tier 1 loads are life-saving critical loads, Tier 2 loads are occasionally needed, and Tier 3 loads are non-critical.
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| **Normal operations** | **Emergency operations** |
| On-site DER deliver energy to all loads and may export excess energy generation to the grid, depending on interconnection and tariff. Smart electric appliances and smart EV chargers can perform demand response by turning on or off according to grid needs; resources are dispatched based on signals from grid operators. Energy storage enables self-powering and/or load-shifting to off-peak times. Utilities, Community Choice Aggregators (CCAs), or Type 1 on-site users maintain control over site operations in accordance with operations contracts.**Benefits:*** Reduced customer utility bills during peak times, with both energy and demand charges reduced
* Renewable energy for the broader grid
* GHG reductions of up to 69% or more\*
 | During a grid outage, the microgrid disconnects from the grid and operates in island mode. At minimum, DER serve predefined *critical loads*. *Non-critical loads* are powered based on real-time energy generation and storage availability. Increasing energy storage duration increases backup power capabilities. **Type 1:** On-site resources serve on-site loads only.**Type 2:** On-site resources may be used to power off-site loads, and vice-versa. Community-wide Tier 1 loads are prioritized.**Benefits:** * Increased resilience
* Energy and transportation security
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| \*Electricity, residential, commercial, and transportation comprise 69% of state GHG emissions, according to the [2018 C-ARB report](https://www.arb.ca.gov/cc/inventory/data/data.htm) |

**ECMR guidelines**

Residential properties participating in a microgrid and/or responding to emissions reduction targets are ideally all-electric. All-electric homes may provide increased value for microgrids and backup power because they rely on electricity for more essential services; however, all-electric homes may be impractical in some cold climates. If all-electric design is not currently possible, designs should at minimum include the electrical service features described below to facilitate future full electrification and on-site solar generation. The guidelines below vary by building; consult your electrician and/or engineer for site-specific recommendations.

**Wiring:** Install dedicated circuits and receptacles for all-electric appliances in SFDs:

* Connected [heat pump (HP) water heater](https://basc.pnnl.gov/code-compliance/heat-pump-water-heaters-code-compliance-brief) (15-30 amp, 240V)
* [HP](https://basc.pnnl.gov/resources/heat-pump-clothes-dryers) clothes dryer (30 amp, 240V)
* [Induction electric](https://www.greenbuildingadvisor.com/article/going-high-tech-with-an-induction-cooktop) range (50 amp, 240V)
* Connected [HP space conditioner](https://basc.pnnl.gov/code-compliance/ductless-mini-split-heat-pumps-code-compliance-brief) (30-60 amp, 240V)
* [Connected EV charger](https://www.enel.com/media/press/d/2017/10/enel-acquires-emotorwerks-to-provide-grid-balancing-solutions-and-tap-into-us-e-mobility-market) (40-80 amp, 240V)

**“Solar-ready” electrical service** **for future solar array:**

* Main service panel (MSP) rated 225 amps (allows for a 200-amp main breaker plus bus bar capacity for a solar array of up to 70 amps)
* Double-pole circuit breaker

Metallic conduit for future solar installation (from roof to inverter location/panelboard)

**“Energy Storage System (ESS)–ready”:**

* Designated area for ESS. Size of this area will depend on required/desired loads to be served by system (i.e., critical loads for backup only vs. full operability in grid outage)
* Main electrical main line “loop” to battery location, between electrical service meter and main panel or subpanel
* Loop main subpanel power lead to designated ESS location
* Separate subpanel for loads that require backup (can be added during remodel)
* “Emergency circuits” to serve critical loads (e.g., refrigerator, HVAC, water heating, microwave) and outlets with battery power during grid outages
* Ethernet line from main router to ESS location
* Conduit for communication from solar inverter(s) to ESS location

**Additional recommended features:**

* Main electrical panel sized for all existing and future loads, including solar and ESS
* Conduit or wiring for level 2 V2B infrastructure
* Eaton “[Pow-R-Command](http://www.eaton.com/ecm/groups/public/%40pub/%40electrical/documents/content/pa144001en.pdf)” main electrical panel (auto load sheds, monitors, and efficiency)
* Conditioned space [air sealing](https://basc.pnnl.gov/building-science-measures/tight-air-sealed-home) (less than 1.0 ACH @ 50m pascal)
* [Heat recovery / energy recovery ventilation](https://basc.pnnl.gov/resource-guides/whole-building-delivered-ventilation) (HRV or ERV; use w/ air sealing for high I.A.Q.)
* Communications conduit for demand response–capable electric appliances
* Connectivity; [Open ADR](https://www.openadr.org/openadr-and-der), [CTA 2045](https://www.greentechmedia.com/articles/read/a-new-standard-for-the-smart-grid-ready-home-appliance#gs.YkXhRp0) @ appliances, IEEE 2030.5 @ energy storage

**Microgrid-ready commercial structure/campus recommended features:**

* Interconnected Eaton “[Pow-R-Command](http://www.eaton.com/ecm/groups/public/%40pub/%40electrical/documents/content/pa144001en.pdf)” main electrical panel(s) and subpanels
* Wiring for level 2 and 3 DC-FC EV charging
* Wiring for level 2 (and 3 DC-FC) V2B and V2G