Electrification & Community Resilience (ECR)
design standard and economic analysis

Every community can benefit from resilience. Nanogrids and microgrids are a key part of a comprehensive resilience solution. Whether facing a wildfire, earthquake, or coordinated threat, nanogrids and microgrids enable continued access to energy by islanding from the utility grid during a grid outage. Adding V2X capabilities enhances resilience even further, and enables use of EV's as mobile energy assets. EV's as mobile batteries can travel to "recharge" if necessary, then bring that energy wherever it is needed.

Below are site definitions to support applying the recommendations in the next section to various buildings and communities. Both nanogrid / microgrid types defined below electrify all on-site energy loads; incorporate high levels of local distributed energy resources (DER) such as 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.

<table>
<tr><th colspan="2">Nanogrid/Microgrid-ready site definitions</th></tr>
<tr><td colspan="2">Nanogrids and Microgrids are capable of disconnecting from the grid in the event of a grid disruption; this functionality is known as "islanding." Renewable energy nano/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 bidirectional 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, if demand response enabled.
● Nanogrid-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, condominium, apartment, office building, clinic.
● Microgrid-Type 2: Community Microgrid — 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 with separate metering, housing subdivision, civic center with multiple buildings, retail complex, hospital complex.
● Critical loads: When a microgrid is operating in island mode, load shedding can extend throughout an outage, through which a microgrid can maintain power continuity. Tier 1 loads are life-saving critical loads, Tier 2 loads are priority but not critical, and Tier 3 loads are the remainder of the load.</td></tr>
<tr><th>Normal operations</th><th>Emergency operations</th></tr>
<tr><td>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 can perform demand response, and smart bidirectional EV chargers can perform demand response and export to the grid 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*
● Revenue from export and aggregation of DERs</td><td>During a grid outage, the microgrid disconnects from the grid and operates in island mode. At minimum, DER serve predefined Tier 1 critical loads. Tier 2 and 3 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
● Ability to share energy throughout V2X systems</td></tr>
<tr><td colspan="2">*Electricity, residential, commercial, and transportation comprise 69% of state GHG emissions, according to the 2018 C-ARB report</td></tr>
</table>

- **For V2X - Two 40 amp sized wires/circuits (or conduit) from the EV Charger location to the main panel (or backed up loads panel) (Recommend placing the main (or backed up) panel in Garage next to EV Charger location)**
- **Place a 120V circuit and receptacle next to bidirectional Charger/Inverter for UPS / blackstart**
- **175 Amp 240V breaker in main panel, main wire to ATS location, and then to sub panel(s).**
- **Add signage for component locations for V2X and ESS prewired locations; "ATS", "Auto Transformer", "Battery", V2X "charger/inverter", etc. so that these locations are able to accommodate the components at a later date.**

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) **(For V2X**: **Place main service panel on exterior of garage near EV charger and solar inverter, and subpanel near V2X charger/inverter)**
- add or plan location for Backed up loads subpanel,) **OR** "smart" main panel with programmable breakers (e.g., Eaton, Leviton, Schneider) **Alternative: place subpanels and wiring to accomodate Lumin Smart Panel. Leave room in the main panel for a monitoring/communication device if possible.**
- Double-pole circuit breaker
- Metallic conduit for future solar installation (from roof to inverter location/panelboard)

Energy Storage System (ESS) ready:

- Designate area for ESS; size of this battery 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). Locate battery out of vehicular path of travel, or provide bollards for vehicular impact protection. Add signage if prewiring only.
- Main electrical line "loop" or junction box to ATS location, between electrical service meter and main panel / subpanel(s), and at designated battery location(s).
- Loop or junction box at backed up loads subpanel power lead to designated ESS location
- Separate subpanel for loads that require backup (can be added during remodel) **OR** load shedding main panel with programmable breakers, or programmable breakers for existing panel (e.g., Eaton, Leviton, Schneider) **(Alternative: place subpanels and wiring to accomodate Lumin Smart Panel)**
- Allow capacity in subpanel(s) for emergency circuits to serve critical loads (e.g., refrigerator, HVAC, water heater, microwave) and desired outlets with backup power during grid outages.
- Ethernet line from main router to ESS location, **to inverter, from main panel to bidirectional EV charger location, and from bidirectional charger/inverter to ESS location**
- **ESS, main and sub panels, and bidirectional EV Charger/inverter should be as close together as possible**
- **120V wiring over battery location for heat detector, which is interconnected to fire alarm bell.**
- **When planning component placement, consider future access issue for repair, etc.**

Additional recommended features for interconnection and communication:

- Communications conduit for demand response–capable electric appliances
- Connectivity; Open ADR, CTA 2045 for appliances, IEEE 2030.5 for energy storage **and V2X**

Estimated costs for additional features to make homes Nanogrid/V2X Ready

ITEM **APPX COST**

Energy Storage System (Nanogrid) 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); keep near "smart" main and/or backup loads subpanel, out of vehicular path of travel $___

- Main electrical line "loop" (8 feet) to ESS location, between electrical service meter and main panel or subpanel; keep ESS near main and subpanel (This is unnecessary is ESS is placed next to main electrical panel $___

- Separate subpanel for loads that require backup (can be added during remodel); keep next to main panel and ESS $___

  - OR -

  Capacity in subpanel or "smart" main panel (Eaton, Leviton, Schneider or similar) for emergency circuits to serve critical loads (e.g., refrigerator, HVAC, water heating, microwave, lights and outlets with ESS battery power during grid outages, including bidirectional EV-ready) **OR, use Lumin Smart Panel** $___

- Ethernet communications line from main router to ESS location (60') $___

- Ethernet line for communication from solar inverter(s) to ESS location $___

- Upgrade to certified smart inverter for islanding, plus ESS export to grid (optional); (this is often included in the ESS package price and user interface) $___

V2X bi-directional EV charge/inverter ready

- Two 40 amp wire runs from V2X charger/inverter to subpanel $___
- Ethernet communications line from main service panel to bidirectional charger location $___

Nanogrid + V2X Ready total **$___**