Distributed Generation and Grid Management

Powering Business Worldwide

120% Rule

- In the 2011 National Electrical Code (NEC), the language in 705.12(D)(2) is straightforward:

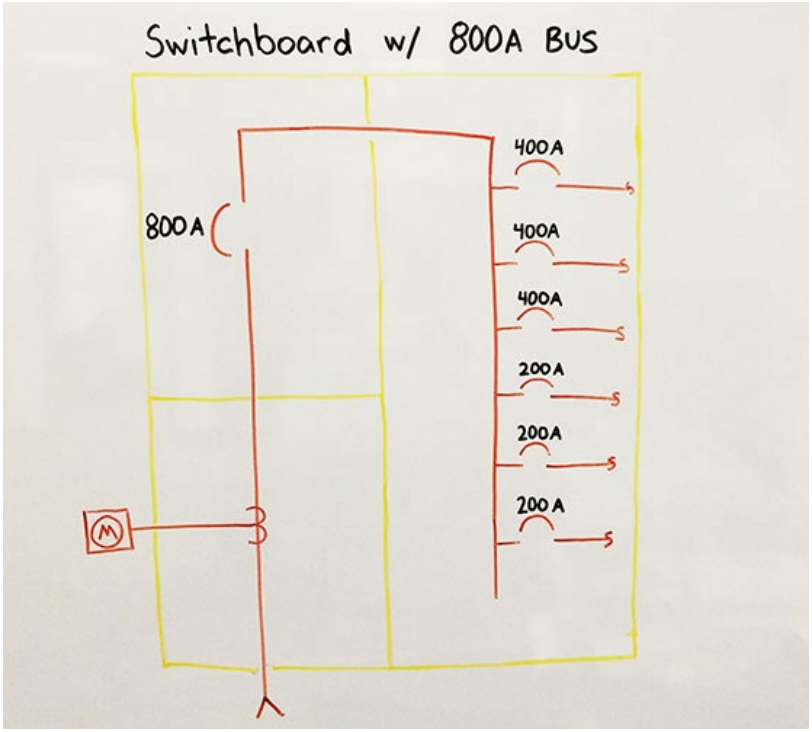
"Bus or Conductor Rating - The sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed 120% of the rating of the busbar or conductor."

- In the 2014 code, this one sentence was revised to several paragraphs with different scenarios. However, the philosophy holds true and by understanding the simpler 2011 version, you will be able to understand the more sophisticated modern versions

Typical Commercial Facility Electrical Service Equipment

This is a depiction of a typical commercial switchboard. It is very common for the sum of the branch circuit breakers to add up to more than the main circuit breaker.

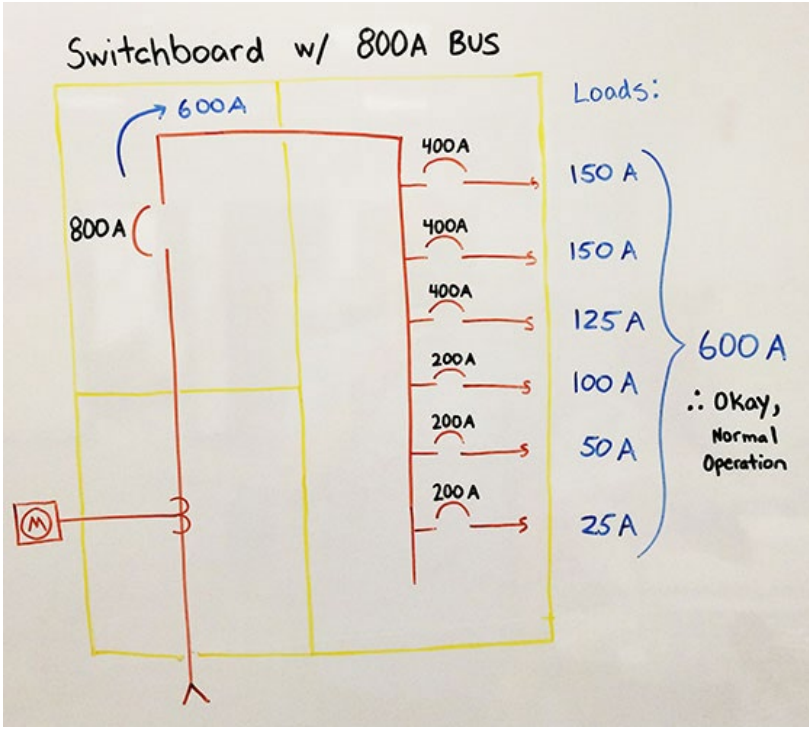
The engineer that originally designed the building and electrical system understood load diversity – since the loads are intermittent and very unlikely to be maxed out at the same time, and the conductor is always protected the NEC allows this scenario with the worst case being the 800A main breaker opening



https://www.purepower.com/blog/120-rule-explained-nec-705-12d2

System without solar, under normal load

This shows the system under a typical load. None of the branch breakers are pulling the full load, and the total current is less than the bus and main circuit breaker rating. Everything is operating normally and safely in this scenario.



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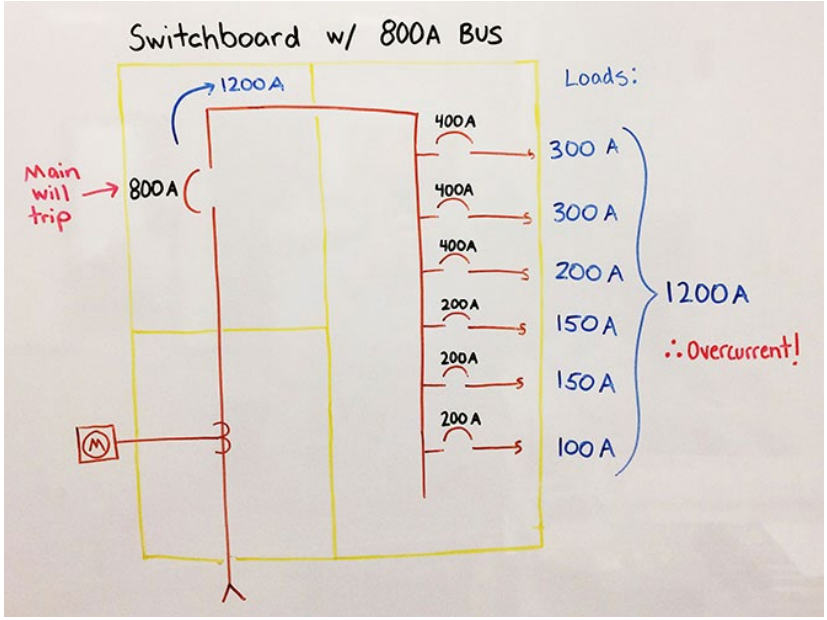
System without solar, under overload load

If the branch breakers draw more current than the main breaker's rating, the main will trip and protect the bus.



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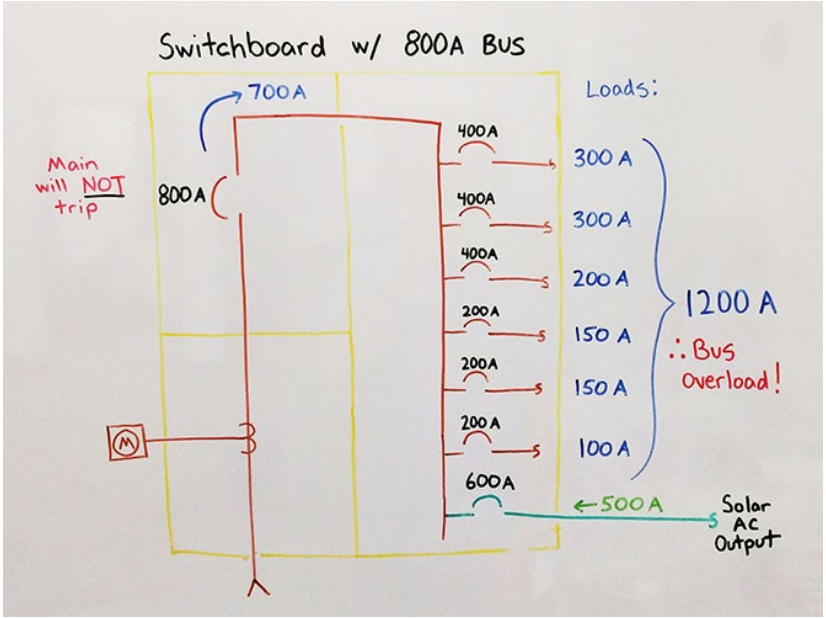
System under overload condition, with solar interconnected load-side

The load breakers are drawing more current than the main breaker's rating, **however the main is not tripping to protect the bus**.

The solar is acting like a "backdoor", allowing additional current to feed the loads. The loads are able to pull much more current than the bus is rated for, but the main breaker doesn't "see" it. **The bus will overload, overheat, and fail (possibly catastrophically).**

This is what the 120% rule is protecting against!



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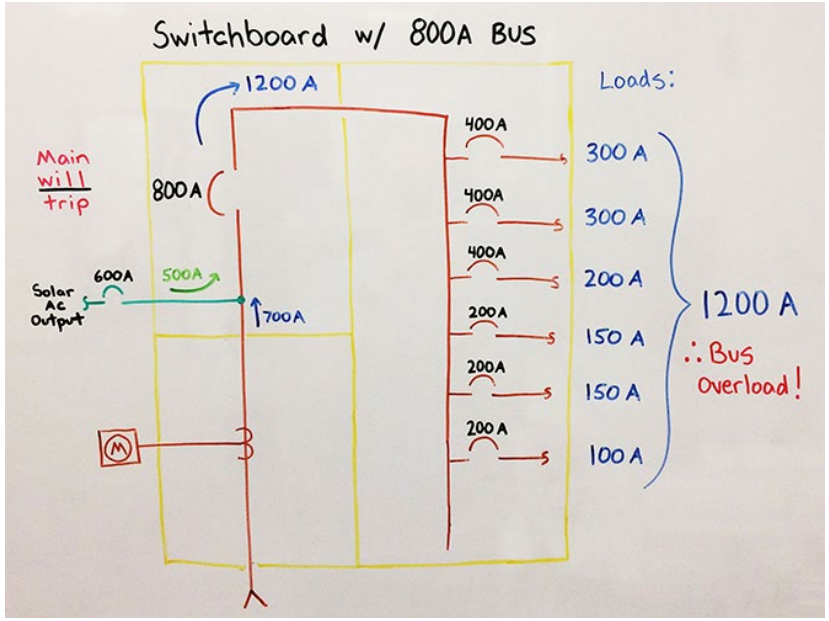
System under overload condition, with solar interconnected line-side

How does a line (supply) side interconnection affect the overload scenario?

Below is the example with the same load. Since the solar is on the line side of the main, it cant sneak anything past it to the distribution section. It doesn't matter if the current is coming from the PV or the Utility, if it exceeds 800A the main breaker will trip to protect the bus. The main circuit breaker will continue to protect the switchboard just as it always has, nothing to worry about.



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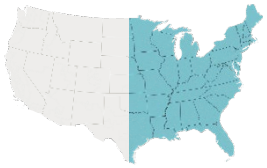
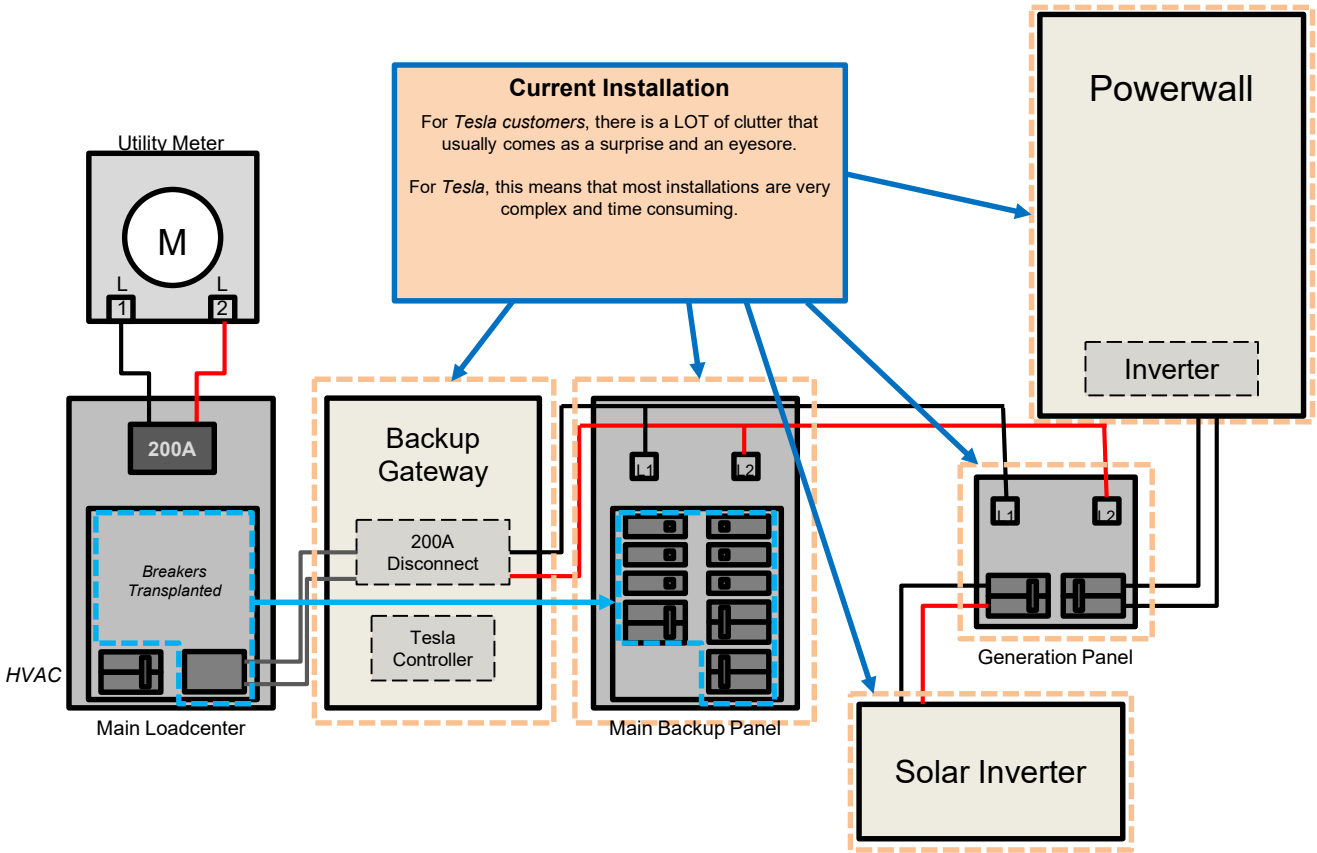
200A Partial Backup System [Current State]

1 Powerwall + Solar



East Coast



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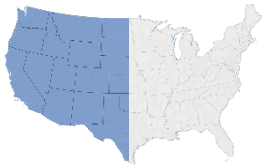
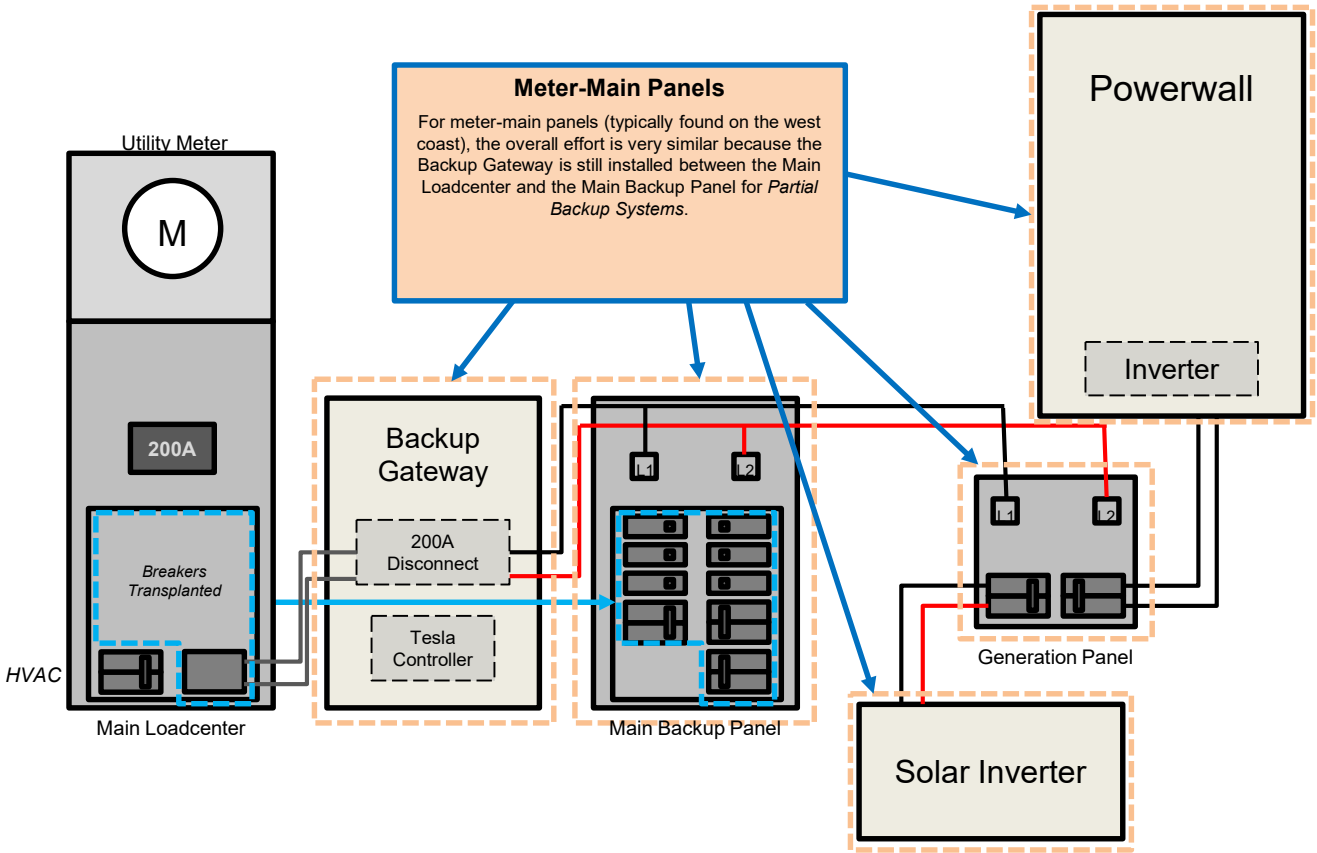
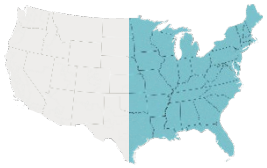


West Coast

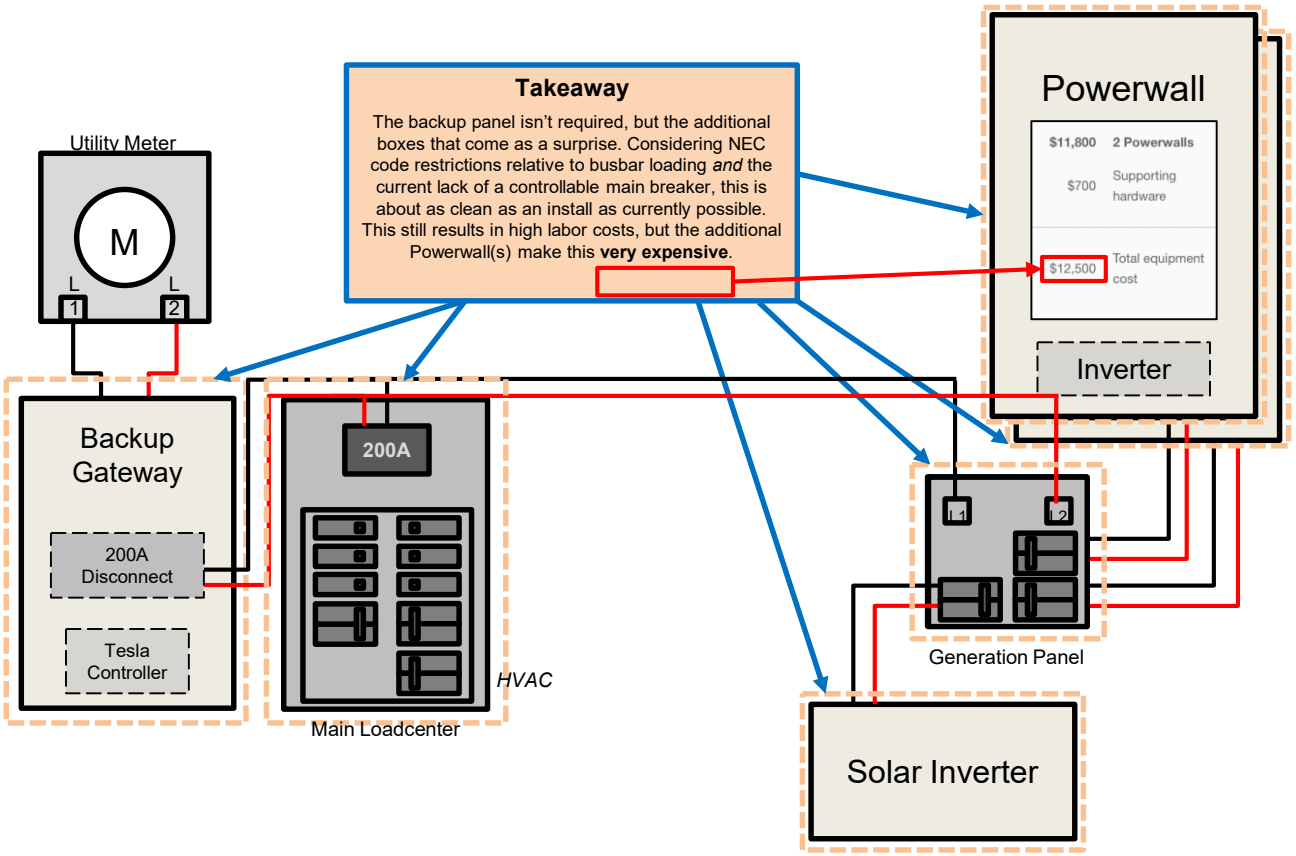


200A Whole Home Backup System [Current State]

2+ Powerwall & Solar



East Coast



200A Whole Home Backup System [Current State]

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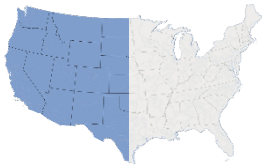

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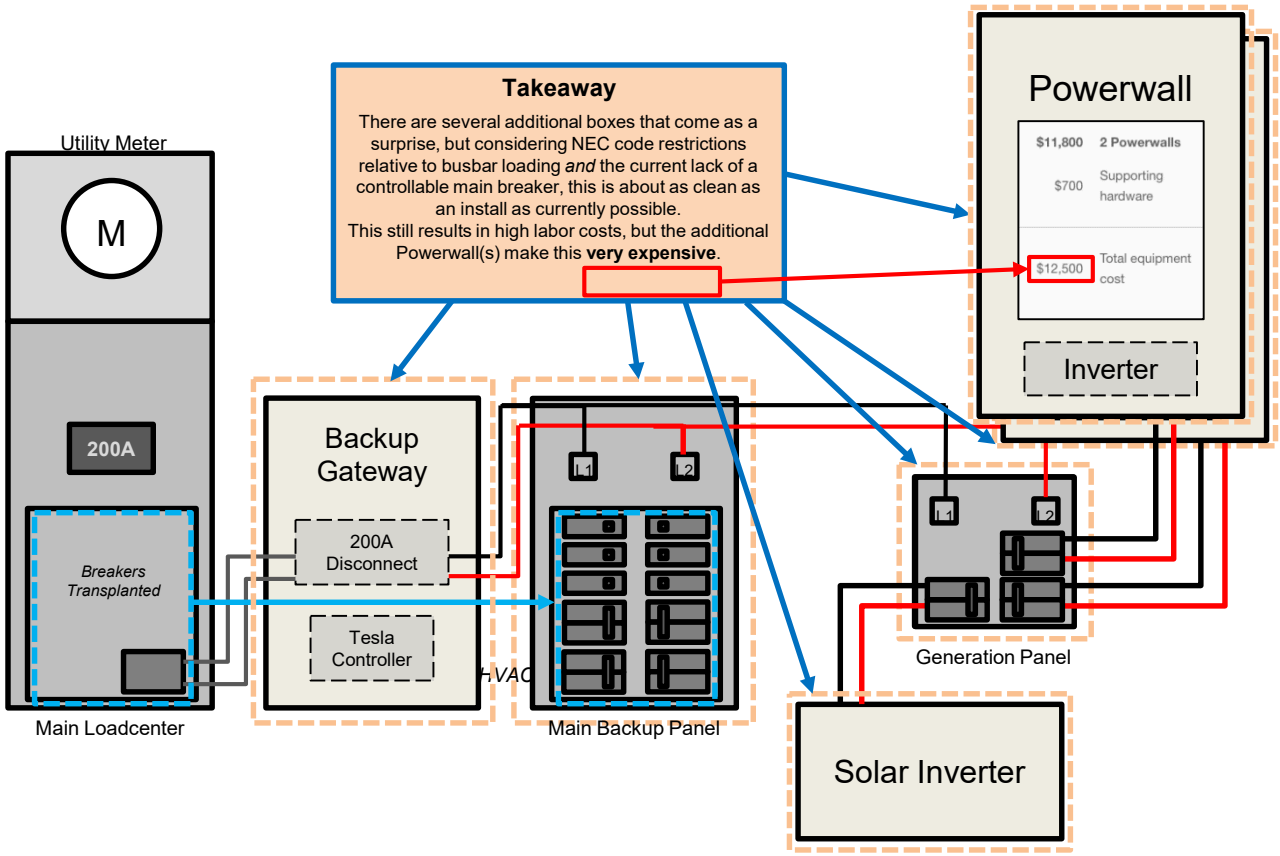
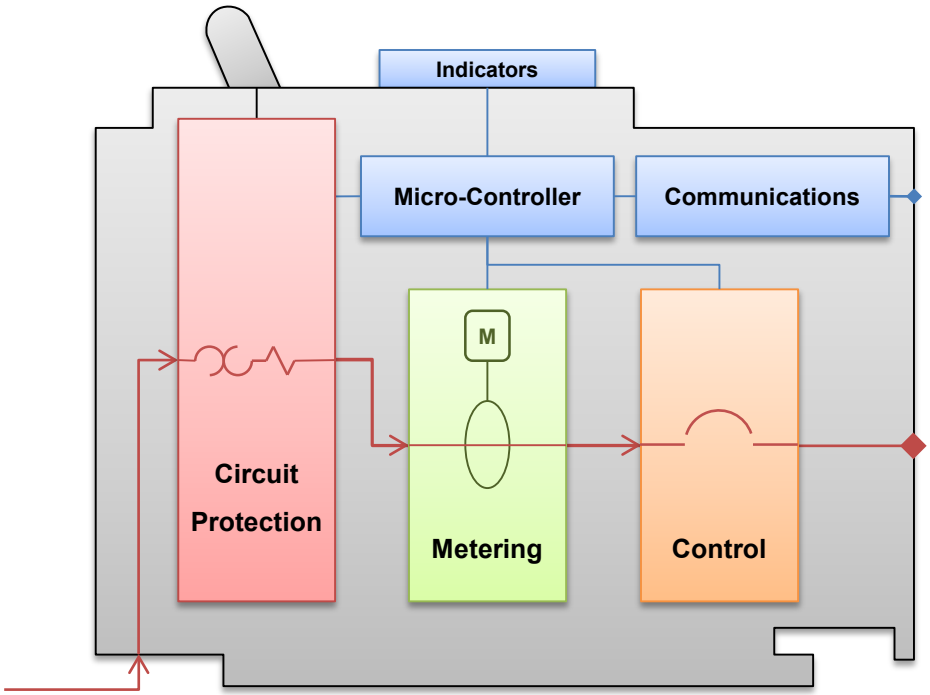


Energy Management Circuit Breaker (EMCB)



All done in a 1-in/pole Miniature Circuit Breaker

Circuit Protection

- Traditional Thermal-Magnetic
- Short Circuit, Overload Protection

Branch Circuit Metering

- Utility Grade Net Metering (ANSI C12.20 ±0.2%)
- Time Stamped Values

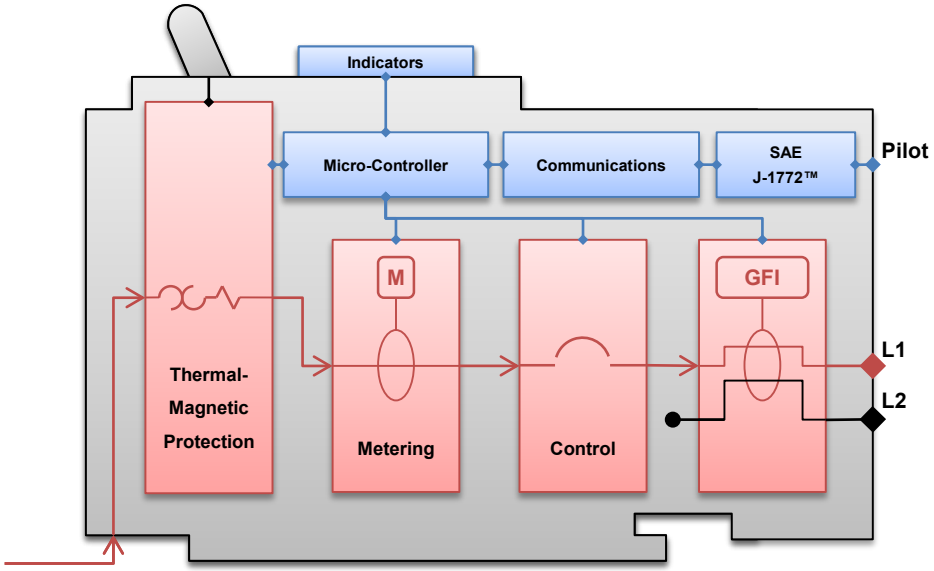
Remote Control

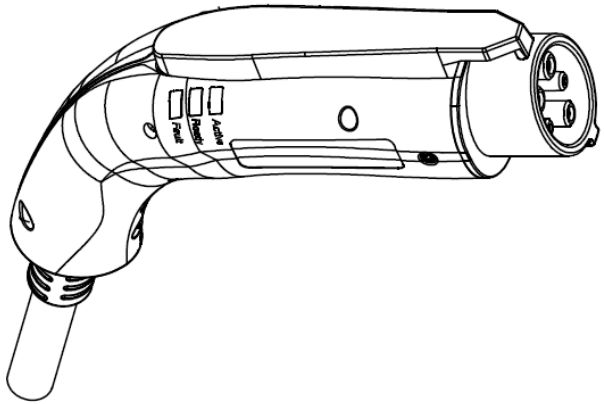
- On/Off Control Relay
- Independent from trip mechanism

Communications

- Status/Metering Info
- Outage/Tamper Notifications
- Load Specific Features

EV Breaker



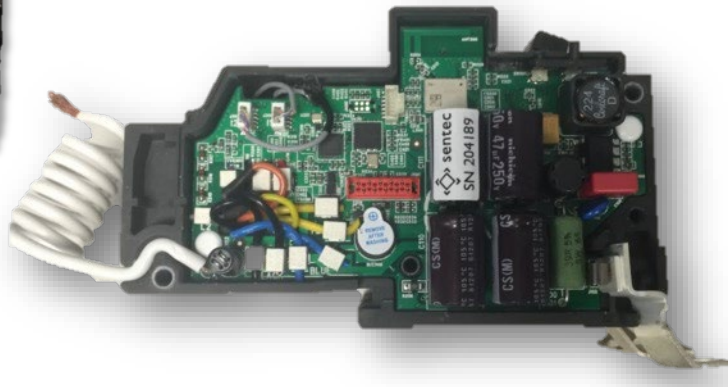


- Starts with a standard 208/240V 2-Pole PVM breaker
  - Thermal Magnetic Protection
  - Remote Control
  - ±0.2% Net Metering
- Adds additional features
  - Ground Fault Protection
  - SAE J-1772 Communication
  - Enhanced EV Connector with embedded UI

Enables lowest cost method for Level 2 AC Electric Vehicle Charging

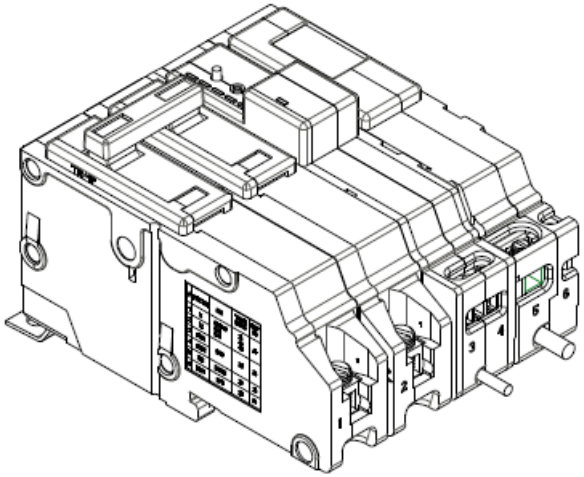
Standard EMCB

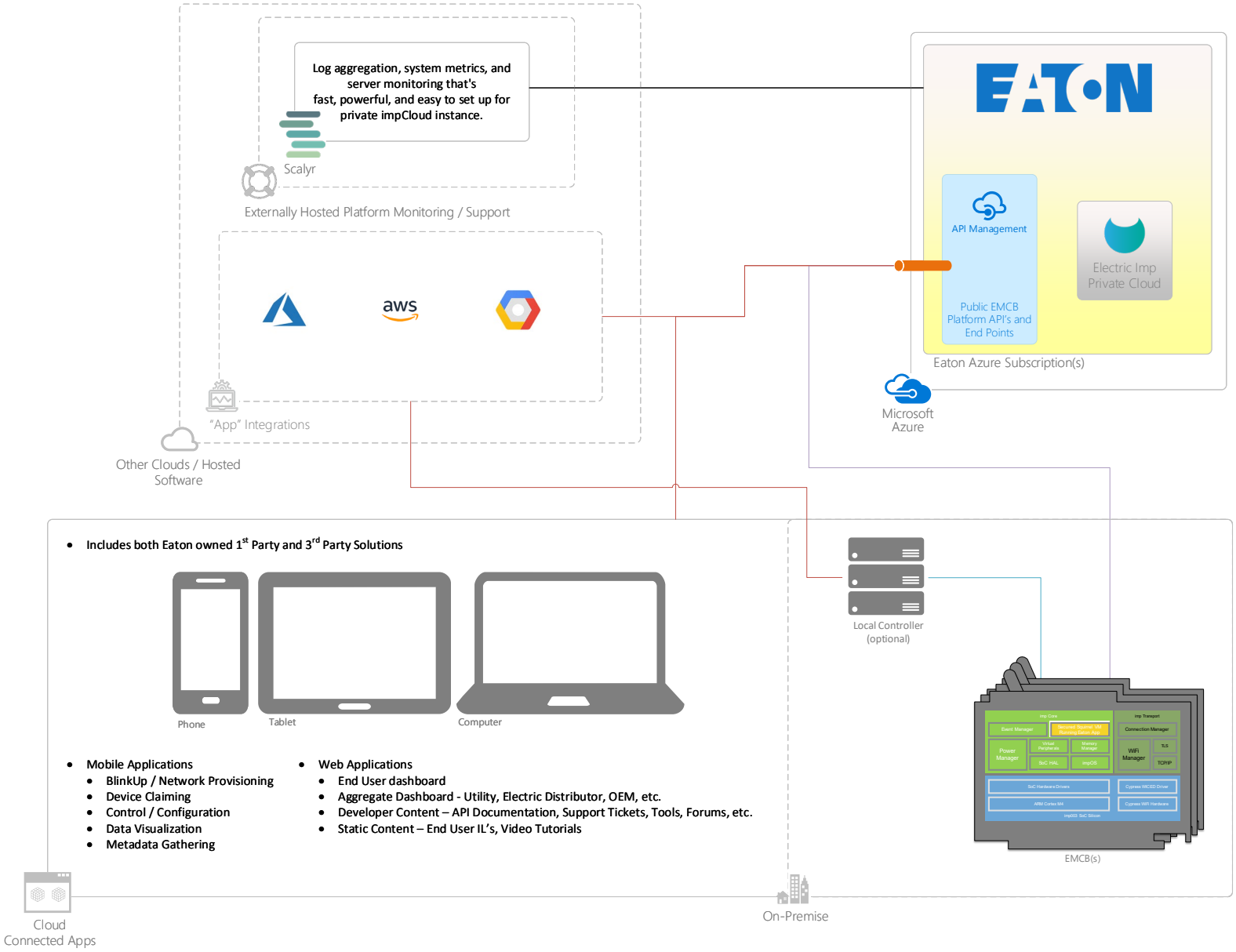
- 1 or 2 pole (plus electronics pole)
- 120/208/240VAC, 15-50A
- Plug-on (BR) or Bolt-on (BAB)
- Secure Cloud Connected Wi-Fi with Documented REST API
  - FW is OTA upgradable
- Remote On/Off Control
  - Typical network latency of sending a command and the breaker operating is under 100ms
  - Real Time Clock and scheduling of on/off events supported
- ANSI C12.20 0.2% Metering
  - 4-quadrant, bidirectional Energy, Power, Voltage, Current, Frequency, etc.
  - 200ms Waveform Capture @ 1,000 samples/sec for PQ events
- Nonvolatile Memory for storing interval data on loss of internet
- Individually Addressable RGB LED Status display
- Display Button
- Electronics Reset Button
- Piezoelectric Buzzer for Audible notifications
  - Loss of WiFi, Breaker Trip, etc.
- Temperature Sensor
- Accelerometer
- BlinkUp Sensor/Status
  - WiFi Commissioning & ambient light measurement
- Undervoltage Release for Cold Load Pickup



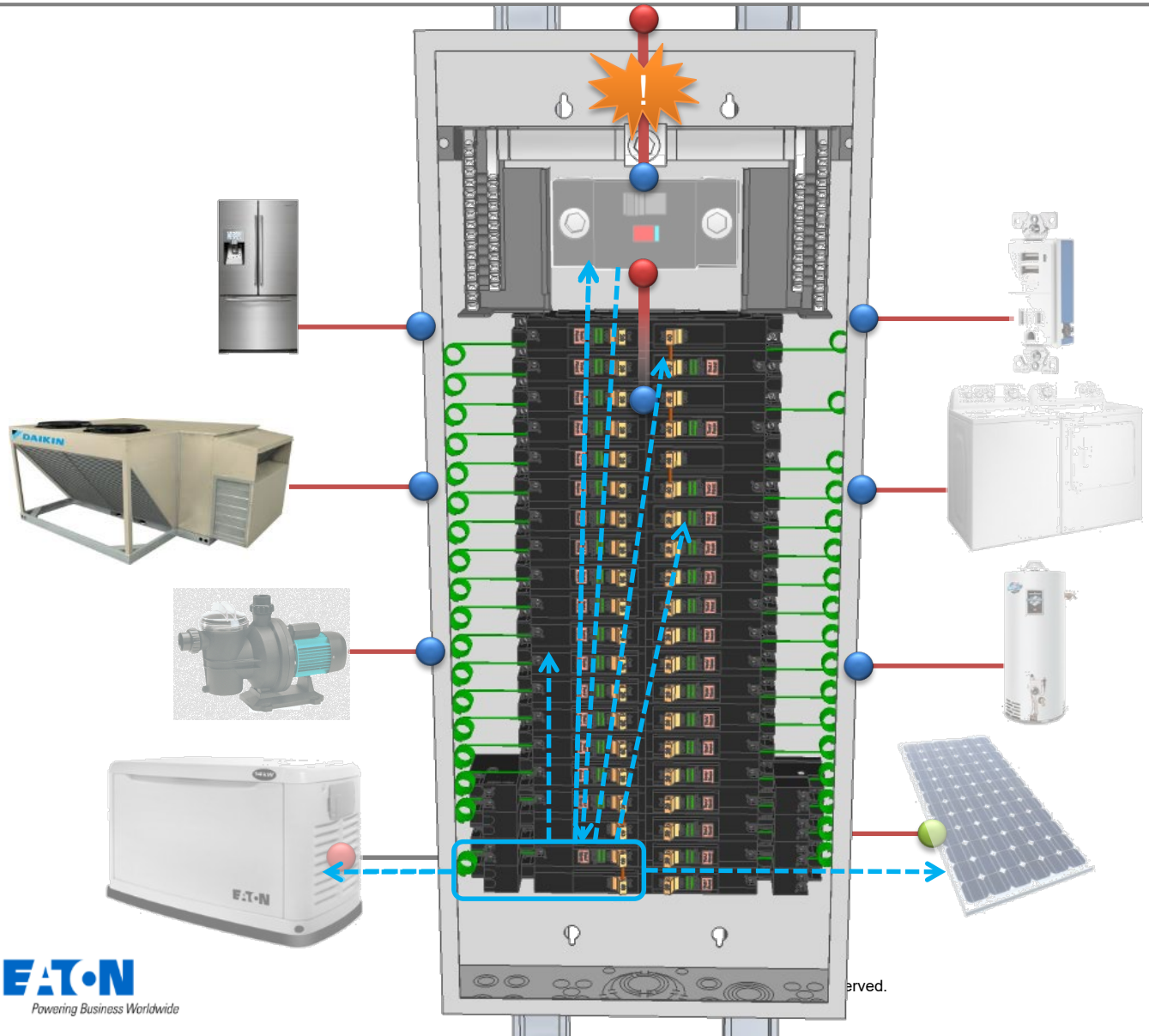
EV EMCB

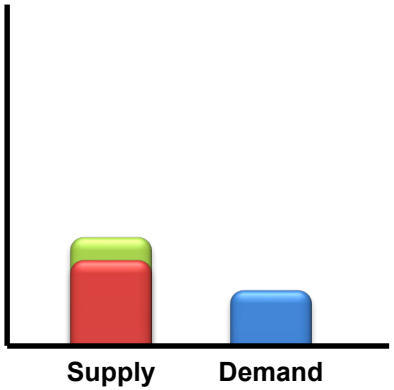
- Same features as Standard EMCB, plus the ability to directly charge an Electric Vehicle using SAE J-1772
  - Currently only supporting a single rating 208/240V, 40A protection, 30A charging
  - J-1772 provides analog control (in % / Amps) of the EV load in addition to binary on/off
- Requires 4th pole for EV Electronics
- Includes OLED display
- Eaton developed Enhanced EV connector with Status Annunciation also included





Power Router Example





Device	Peak Power Usage
EVSE (240V)	3.3 kW - 19.2 kW
Electric Dryer	>6 kW
Pool Pump	>4 kW
AC Compressor	~4 kW
Electric Oven	~3.5 kW
EVSE (120V)	~1.45 kW
Dishwasher	~1.8 kW
Air Handler (HVAC)	~0.8 kW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