Upgrade Avoidance

White Paper

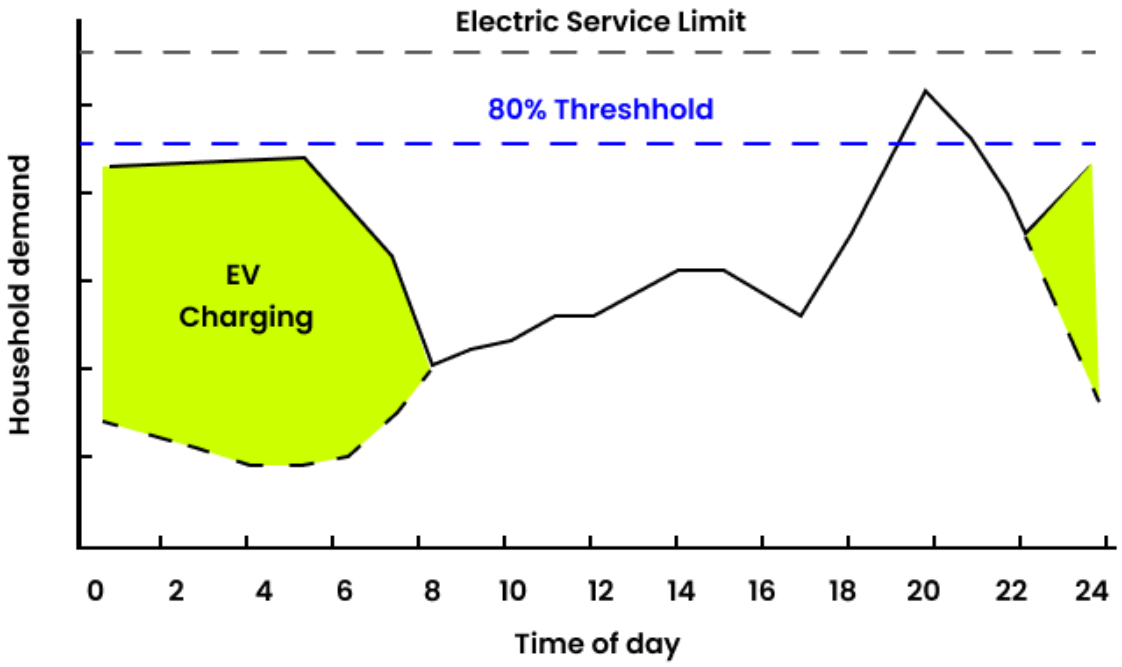
Avoiding Electric Service Upgrades

There are strong incentives for owners of electric vehicles (EVs) to install Level 2 chargers at their homes. Charging at higher power is faster and more efficient, and there are often rebate programs that make the purchase of a Level 2 charger very affordable. However, a Level 2 charger can add 30-60 amps to the electrical load for a residence, which may exceed their existing electric service capacity. This can create problems for the homeowner and the utility.

To expand the electrical capacity of their house, a homeowner can request a service upgrade from the utility. This can be a very costly undertaking – many times greater than the cost of the Level 2 charger itself. If the service is underground, a new trench may need to be dug to lay upgraded wiring and conduit, which can result in costs that run into the tens of thousands of dollars. In neighborhoods with high EV penetration and no remaining distribution capacity, providing a service upgrade to a single home may require significant upgrades to the neighborhood infrastructure, such as a transformer replacement.

A better alternative

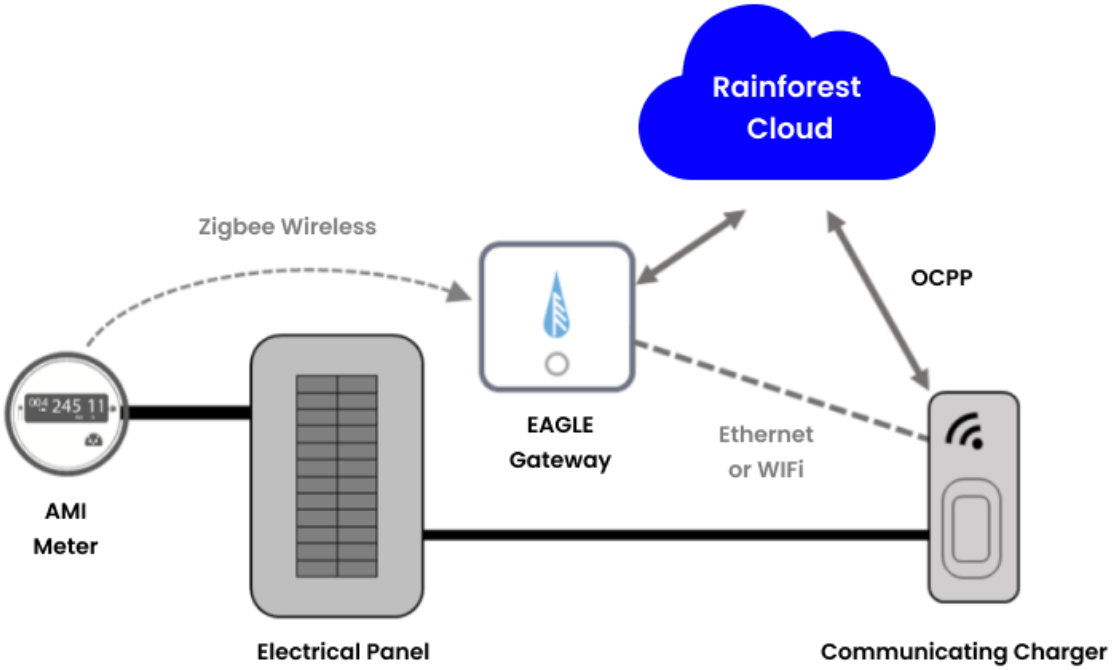
Fortunately, there is an alternative that saves the customer considerable expense and allows the utility to accommodate higher EV penetration without having to upgrade infrastructure. The National Electrical Code allows the total potential loads of the home to exceed the service to the panel if there is an Energy Management System (EMS) to limit simultaneous loads such that the service limit is not exceeded. By using an EMS, the homeowner can install a Level 2 EV charger – even if the maximum load of the charger exceeds the available capacity – without having to upgrade the electrical service to the home.



The EMS regulates the Level 2 charger output so that it stays within the available capacity of the electrical service. If a number of large electric loads (air conditioning, clothes dryer, oven) are turned on, then the EMS limits the EV charger to keep the total load of the house within its service limit. Conversely, when not many electric loads are turned on, then the EMS will allow maximum charge to the EV.

Our solution

The Rainforest EAGLE is an EMS that can control and manage communicating EV chargers. By leveraging standard charger protocols such as OCPP (Open Charge Point Protocol) or local protocols like Modbus TCP or IEEE 2030.5, the EAGLE can manage the rate of charge so that it doesn't exceed the electric service limit.



The EAGLE communicates directly with the utility Advanced Metering Infrastructure (AMI) meter using the meter's internal Zigbee radio. The EAGLE gets real-time demand (kW) readings from the meter and can determine how much capacity is available for EV charging. Commands are then sent to the EV charger to control the rate of charge to match the available capacity.

In the event of an internet outage, the EAGLE can switch from the OCPP connection to local control, if available. The EV charger is programmed with a default mode that limits the output to 12A if it loses connection.

Many benefits

This system allows a homeowner to install a Level 2 EV charger without having to worry about upgrading the electrical service to the home, making home charging technology more affordable – especially for older homes, particularly those in disadvantaged communities.

It also provides the utility with a non-wires alternative (NWA), preserving the capacity of the distribution transformer, and allowing additional EV chargers to be installed without having to upgrade the distribution infrastructure.

In addition to monitoring local demand reads from the meter, the EAGLE is also part of Rainforest's integrated managed charging platform, which enables charging using EV-specific TOU (time of use) rates, response to demand response (DR) events, and can even implement fully optimized charging that takes customer, home, distribution, and supply needs into the equation. This gives the utility a full range of options to achieve peak load reduction, even as EV adoption is accelerating.

NEC Compliance

In 2014, the National Electrical Code (NEC) introduced article 750, which deals with Energy Management Systems (EMS). NEC 750.2 (2014, 2017, 2020) defines an EMS as "*A system consisting of any of the following: a monitor(s), communications equipment, a controller(s), a timer(s), or other device(s) that monitors and/or controls an electrical load or a power production or storage source*" (this definition was moved to NEC 100 Definitions in 2023). Our system meets this definition, as the EAGLE gateway is a piece of communications equipment that works in conjunction with the utility meter to monitor the home's electrical panel. It also works with our cloud, which controls the EV charger, which in turn affects the load at the electrical panel.

NEC 750.30 sets out the conditions under which an EMS is permitted to monitor and control electrical loads. Specifically, NEC 750.30(C) has four conditions:

1. There will be a Current Setpoint that defines the maximum source current permitted by the EMS.
2. The EMS will automatically turn off current flow upon failure or malfunction.
3. Software to adjust settings must be password protected and only accessible to qualified personnel.
4. The electrical panel will be marked to indicate the presence and function of the EMS.

Our system adheres to all of these conditions. The Current Setpoint is determined by the electrical service and can be set only by password-protected software accessible only to administrators authorized by Rainforest. Included with the EAGLE gateway is a sticker that the homeowner must attach to their electrical panel and send a photo to the administrator to initiate the service.

Article 220 of the NEC dictates how the Service Load for a home should be calculated. NEC 220.70 (2023) states: "*If an energy management system (EMS) is used to limit the current to a feeder or service in accordance with*

750.30, a single value equal to the maximum ampere setpoint of the EMS shall be permitted to be used in load calculations for the feeder or service." This means that the contribution of the EV charger does not need to be considered in the calculation of the home's service load, since the total load is limited to the EMS Current Setpoint.

NEC 220.70 (2023) also states: "*The setpoint value of the EMS shall be considered a continuous load for the purposes of load calculations.*" Since the main breaker for most homes is only rated at 80% of its current rating for continuous loads, then the Current Setpoint must be set at 80% of the home's electrical service limit. Therefore, our system is set to this value.

Article 625 of the NEC deals with Electric Vehicle Supply Equipment (EVSE), i.e., EV chargers. NEC 625.42(B) (2023) explicitly permits control using an EMS: "*EVSE with restricted access to an ampere adjusting means complying with 750.30(C) shall be permitted.*" Since our system uses the password-protected Open Charge Point Protocol (OCPP) to control the charger, then it fits this description.

Earlier versions of the NEC are less explicit. In 2020, section 625.42 makes the same statement as above without making reference to Article 750. NEC 625.42 (2017) refers to "automatic load management systems" without providing a definition but implies that they can be used.

In short, the National Electrical Code allows the use of the Rainforest Upgrade Avoidance service to act as an EMS and limit a household's service load by controlling the EV charger.