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A Vehicle-to-Load Playbook

Turn Your Customer's EV Into a Home Power Source

The Future of Home Energy Storage

Starting up

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Ford unveiled the F-150 Lightning in May of 2021 with a fundamentally new pitch: This is not just an electric vehicle (EV), this is a battery on wheels. There were both AC and DC power outputs to the home. This jumpstarted the bidirectional EV era by allowing EV owners to use the large battery bank sitting in their garage to power more than the drivetrain.

It also drove a lot of customer conversations with few good answers. Until now.

Modern EV battery technology opens up multiple pathways:

- **On-grid:** EVs sending stored energy to the electric grid to perform grid services when called upon by the utility. This is vehicle-to-grid (V2G).
- **Off-grid:** Homeowners utilizing their EV battery bank for themselves, to power their home in outages or as needed. This is vehicle-to-load (V2L).
- **Either:** Both charging EV batteries from home and using the EV as a power source for home load. This is vehicle-to-home (V2H)

V2G is an intriguing concept, and some utilities are piloting virtual power plant (VPP) programs with customer EVs right now. However, V2G is in its very early days because interoperability and communications standards are still in development.

V2H is bidirectional power flow between the home and an EV. While some solutions, such as the FranklinWH System, provide it through separate devices, the goal is to have a simple connection, and the industry is still working on that.

Meanwhile, V2L is available for your customers right now to power a home during a grid outage or natural disaster. More importantly, the equipment you install today to utilize V2L can help seamlessly enable V2H and V2G capabilities when those standards and technology catch up.

In this V2L Playbook, we'll explain ...

- The equipment needed for V2L
- V2L vs. home batteries
- The importance of EMS and AC coupling
- How to be V2G ready

Setting up V2L

To utilize the EV as a generator:

- Turn EV on (often, the EV must stay on)
- Put the EV in generator mode
- Connect to the generator port on an ESS or EMS gateway

There are three distinct pathways:

- You could take the DC out of the car to a dedicated inverter. This will be the approach of the EV manufacturers. But that also means your customer is stuck with a new ecosystem of products tied to the EV manufacturer.
- You could DC couple with a multi-purpose hybrid inverter.
- You could take the AC directly out of the car. **This is the simplest pathway**, which also allows for more intelligent control, depending on the EMS gateway.

Amarhanow: "Portability of AC power from the EV is a positive benefit when the inverter is in the car."

Amarhanow: "The 'handshake' between the EMS and EV confirms the MID is engaged to prevent anti-islanding protections keeping utility workers safe."

V2L requires the following equipment:

- **Power Output Port on EV:** Provides AC power directly from the vehicle's battery, usually via a standard 120 V or 240 V outlet. This setup does not require a separate bidirectional charger, as the power is delivered as usable AC from the vehicle itself.
- **Mechanical Transfer Switch:** Isolates the home from the grid to prevent power back feed from the EV battery to the grid and then switches to EV power once the EV is connected and set to supply power to the home during an outage.
- **Basic Energy Management System (EMS) with generator port:** Controls energy transfer but lacks advanced energy optimization capabilities. Responsible for maintaining safe operation of the local power system with the utility grid.

V2L Case Study

Example of a V2L hook-up using the FranklinWH aGate

In this video, a FranklinWH Certified Installer explains the new Vehicle-to-Load solution available through the FranklinWH System's aGate intelligent energy management controller. By plugging his EV into the FranklinWH aGate, he backs up his entire home when solar isn't enough. Learn more about this feature at franklinwh.com.

Special thanks to Solar Pro Energy Systems for their partnership in developing this case study.

Example of powering a home the old fashioned way with a standby generator, using the same aGate port.

"A V2L solution, in my opinion, is a much better solution than having a gas-powered generator backup."

V2L or Battery Backup?

Will a customer still need an energy storage system (ESS) if using an EV for home backup? **Yes and no.** An EV is a cost-effective purchase for temporary backup power. On a dollar per kWh basis, an EV is roughly $400 per kWh vs. a home battery in the ~$500 or $600 kWh range, not including installation price. So, they *could* forego the ESS.

But there is more to consider.

> **Amarhanow:** "Adding an EV likely moves that home to a time of use (TOU) utility rate tariff. At that point, you'll want to go a step further and maximize those TOU benefits by adding a home battery to do peak shaving."

Moreover, standalone V2L operates as a single energy source without the ability to intelligently control energy. V2L on its own cannot manage home power and loads efficiently during an outage and is unsuitable for advanced energy saving strategies such as TOU control, load shedding and shifting.

By contrast, a dedicated home ESS is purpose-built for continued cycling and is capable of coordinating multiple power sources and home loads to maximize energy efficiency and reliability.

The intelligent controls include the charging of the EV, which maximizes the total cost of ownership of the EV.

> **Amarhanow:** "The highest quality battery systems or EMS are going to manage both power sources in an intelligent manner. While on grid, you're going to make the most of the energy storage or energy sources in your home to reduce bills, and then also perform self-consumption or backup if you need it to.
>
> "The EV is typically the largest load in the home, especially with a Level 2 EV charger that's potentially up to 80 amps output. You may set an intelligent schedule for the charger to ensure you're not charging during on-peak periods and also make sure that it's not destabilizing the microgrid if you go off grid."

Battery Considerations

EV Batteries vs. ESS Batteries

EV Batteries: According to the Lawrence Berkley National Lab, an average American home uses about 30 kWh of electricity per day. The Ford F-150 Lightning comes with a standard battery capacity of 98 kWh. In an outage, assuming the home is not doing any power rationing, the Lightning could power the home for nearly 3 days. This outage ride through capacity can easily hit 7 days with moderate power rationing in the home while off grid.

But EV batteries are designed for transportation. EV batteries typically endure around 3,000 charge cycles, translating to approximately 6-10 years of use. This lifespan aligns with high output automotive expectations but may not withstand the frequent and rigorous daily cycling demands of home energy management. This means using standalone V2L as a daily home energy management solution, such as addressing a TOU tariff to reduce energy costs, can compromise your EV battery's longevity.

ESS Batteries: ESS batteries are engineered for longevity, often supporting over 6,000 cycles. Some advanced battery solutions, such as FranklinWH aPower 2, guarantee 60 MW output in 15 years without cycle limitation. This durability can handle continuous charge and discharge cycles without significant battery wear or degradation.

Does V2L impact the EV warranty?

Most EV warranties are based on time and mileage, not on energy throughput (kWh cycled through the battery), which is the standard metric for home ESS warranties. While V2L functionality is increasingly supported by manufacturers, using your EV as a home backup source may raise warranty questions depending on how the energy is used and how often.

It's important to recognize that EV batteries and their inverters are designed for a very different use case: propelling a 3-ton vehicle with rapid acceleration—often supported by a 100 kW (or greater) inverter. This high-power, short-duration use is unlike the sustained, low-power output profile expected in a home backup scenario.

While occasional V2L use for backup is unlikely to violate warranty terms (especially when the feature is officially supported by the automaker), frequent or prolonged use could raise concerns if the warranty doesn't explicitly cover such applications. Owners should consult their specific vehicle's warranty terms and any manufacturer statements about V2L or home backup usage.

V2L Limitations

When utilizing V2L technology to power a home, be sure to consider the following factors:

Power Output Limits: V2L systems have maximum power output capacities, which may restrict the number of appliances that can be powered simultaneously. For instance, the Ford F-150 Lightning can provide up to 9.6 kW output power. It is essential to realize that an EV battery may not simultaneously support multiple energy-intensive appliances.

Duration of Power Supply: The EV's battery capacity and the total load determine how long it can supply power. As a general guideline, 1 kWh of energy consumption corresponds to approximately a 2% drop in the state of charge (SOC) of your EV battery. For example, if you consume 12 kWh in a day, accounting for a 10% to 20% energy loss during power transfer, the actual energy used is about 9.8 kWh, resulting in a 5% to 6% SOC reduction.

Take another example, with a 77.5 kWh battery set to a discharge limit of 20%, the EV provides 62.5 kWh of usable capacity. If you have a total backup load of 500 W, the EV could supply power for approximately 125 hours, or about 5.2 days.

Manual Connection Requirement: V2L operation typically requires manual intervention—connecting the vehicle to the home and enabling the EV's power output. Because of this, V2L is better suited for planned or extended outages where homeowners can actively manage the connection. It can be especially valuable when a home's ESS is low on charge and grid power is unavailable for an extended period.

Importance of EMS

Why EMS Matters

Picking the right ESS is crucial for maximizing a bidirectional EV for V2L and, eventually, V2G.

- The ESS should include an energy management system (EMS) with a power control system (PCS). The EMS can dynamically manage EV charging in conjunction with other home loads as it does the ESS.
- The EMS should have a generator port to simplify V2L backup.

Virtues of AC Coupling

The simplest way to use an EV as a rolling generator is by AC coupling with an EMS gateway, such as the FranklinWH aGate.

Amarhanow: "The EMS stabilizes your microgrid. You have a bunch of different power sources, and the EMS will balance power sources in a grid following or grid forming mode, and that's also known as your voltage source, or your current source. A generator or an EV acts as a voltage source. With an EV, we're currently limited to the EV inverter output. The primary inverter has both surge and reactive power.

"We recommend an AC-coupled EMS because it keeps things simple. A DC power connection would likely require communications over potentially proprietary standards with the EV's BMS or other on-board systems to get it to discharge. A DC power connection to the EV also potentially gets into warranty issues with the EV.

"AC coupling keeps it simple. If using the AC port on the EV, the AC-coupled system operates within the defined parameters of the EV's warranty. The home loads are all AC (although most modern electronics have their own DC converters). AC coupling enables you to have different power sources for the different preferences of regions across the country."

Future Outlook: V2L today, V2G ready

In addition to enabling V2L today, the FranklinWH aGate and aPower are positioned to enable V2G when that day arrives. FranklinWH already cooperates with several utilities and Distributed Energy Resource Management System (DERMS) providers for virtual power plant (VPP) dispatch programs.

Currently supported programs include:

- California: DSGS
- Connecticut: Energy Storage Solutions
- Idaho /Utah/Wyoming: Wattsmart through Rocky Mountain Power
- Massachusetts/New Hampshire/Rhode Island: ConnectedSolutions
- North Carolina: PowerPair/Duke Energy Battery Program
- Oregon/Washington: Wattsmart through Pacific Power
- Vermont: Bring Your Own Device

Amarhanow: "We are watching for the upcoming IEEE 1547 standard, 2026 edition. This 2026 standard was last updated in 2018, so this edition will likely set the rules for the next decade. But we have the tools today. The inverter grid interactive standard, UL 1741 SA, is available and fully adopted across all the utilities. The hope is we continue to build on that as we go forward."

Bottom Line

Is your customer looking for a resilient, off-grid-capable system that integrates seamlessly with V2L? Or are they more focused on managing TOU rates today and preparing for V2G capabilities in the future?

Installing an AC-coupled ESS paired with FranklinWH's intelligent EMS and power control system (PCS) provides the ideal foundation for both paths. AC coupling ensures flexibility and simplicity, supporting a wide range of power sources—including EVs, generators, and even small wind turbines. With FranklinWH's aGate at the center, power flow and load management are handled safely and intelligently.

Becoming a FranklinWH Installer

1. Submit the application form on the FranklinWH portal.
2. Take the FranklinWH installer training courses and pass the exams (2 hours!).
3. You're certified!