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Developing Virtual Power Plant Applications for Managed EV Charging Platforms

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Coupled with renewables in other sectors, increasing EV deployment has put a strain on electricity grids, which will likely continue as the market grows. In response, utilities and grid operators are working with EV and charging OEMs to use EVs in virtual power plants (VPPs), as a grid resource instead of a grid strain. VPPs can help EV owners save money, and in some cases, profit from their distributed energy resource (DER). In a period of market evolution, companies are forming partnerships and pilots throughout the VPP and EV industry to develop this new business model.

Context

This report covers the following:

- Driven by multiple factors, EV adoption is increasing and having a significant impact on the grid.
- For grid stability, EVs must be integrated with other new energy technologies, in some cases complementing other DER and saving energy through VPPs.
- Stakeholders—including utilities, EV manufacturers, charging infrastructure suppliers, and VPP operators—must be proactive in preparing grids for EVs.

Recommendations

Guidehouse Insights recommends the following:

- Utilities must adjust their tariff structures to enable smart charging.
- EV manufacturers and charging infrastructure suppliers must form partnerships and open standards.
- VPP operators must engage with customers and other stakeholders.

Driven by Multiple Factors, EV Adoption Is Increasing Worldwide

EV market share is rapidly growing, in personal and in commercial and industrial fleets. Sales in 2022 exceeded 10 million, roughly 14% of vehicle sales—an increase from 9% in 2021 and 5% in 2020.[1] With even more incentives, regulations, and infrastructure deployed, the proportion of EVs is likely to increase over the next decade, which will lead to significantly higher electricity demands, new forms of energy management, and an opportunity to help solve issues from incorporating wind and solar energy into the grid. All of these factors will require the management of virtual power plants (VPPs).

A VPP, which for this report is synonymous with a distributed energy resource management system (DERMS), optimizes EV charging and in some cases supports EV battery discharge to support the grid. VPPs are becoming ever more popular in the energy transition.

Transportation Electrification Is Now a Common Strategy

Transportation is universally recognized as making up a significant portion of greenhouse gas emissions (GHG). In the US, transport is responsible for 29% of GHG emissions.[2] Worldwide, transportation follows a similar pattern. It is responsible for approximately one-quarter of energy related GHG.[3] Globally, governments are devising policies to lower transportation GHG. A common strategy is electrification.

The International Energy Agency (IEA) reports that 52% of road transport is covered by some form of fuel economy or vehicle efficiency standards—or both.[4] Examples of transportation policy include the new CO_2 standards aligned with the Fit-for-55 goal from the European Union (EU), and California's Advanced Clean Cars II Rule, which scales down emissions from light duty passenger cars, pickup trucks, and SUVs beginning with the 2026 model year and going through 2035. In 2035, all new cars sold in California must be zero emissions.[5] The Inflation Reduction Act and Bipartisan Infrastructure Law introduce hefty subsidies for the EV and EV charging markets. Even before these laws went into effect, the US had announced a goal of half of all vehicle sales in 2030 being EVs. In 2020, the UK announced that it was banning sales of all petrol and diesel internal combustion engine (ICE) vehicles by 2030.

Thailand's 30@30 policy sets a goal for 30% of all vehicles produced being electric by 2030. The Thai government has reduced import duties and excise taxes, allowed foreigners to own land as long as it is for EV projects, and introduced subsidies to reach this goal. China's most current Five Year Plan also prioritizes EV market development.

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[1] International Energy Agency, Global EV Outlook 2023 : Catching up with climate ambitions," April 2023, **https://www.iea.org/reports/global-ev-outlook-2023**.

[2] U.S. Environmental Protection Agency, "Carbon Pollution from Transportation," May 11, 2023, **https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation**.

[3] UN Environment Programme, "Transport," Accessed November 6, 2023, **https://www.unep.org/explore-topics/energy/what-we-do/transport**.

[4] International Energy Agency, "Transport," July 11, 2023, **https://www.iea.org/energy-system/transport**.

[5] California Air Resources Board, "Advanced Clean Cars II," Accessed November 6, 2023, **https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/advanced-clean-cars-ii**.

Companies with largescale fleets are also taking steps to electrify, sometimes with greater levels than policy demands.

- **Uber** announced the goal of having 50% of distance traveled in European cities be in EVs by 2025. The company will be a zero emission mobility platform by 2030 in the US, Canada, and European cities. Around the world, 100% of its rides and deliveries will be in zero emission vehicles, through public transit, or on foot.[6]
- **Lyft** has committed to 100% EVs across its platform by 2030.[7]
- **Amazon**, through a partnership with **Rivian**, has committed to using only EVs for its 100,000 delivery vehicles by 2030. It has already rolled out thousands of electric delivery vans in Europe and the US.[8]
- **FedEx** is adopting 500 **BrightDrop** (General Motors subsidiary) electric light commercial vehicles as part of its goal to be carbon neutral by 2040.[9]

Globally, transportation is recognized as contributing significantly to harmful emissions. Encouraging electrification is now a common strategy.

These incentives and mandates afford consumers more options for EVs, and more of them are now available for purchase. Not only is transportation electrification a strategy policy, it is a major strategy for fleet managers and OEMs.

- **GM** will offer 20 different models by 2025 and intends to move to all EVs by 2035.
- **Honda** and **GM** have partnered for a global production goal of millions of EVs starting in 2027, with emphasis on affordability and choice.
- **BMW** announced plans to bring a dozen new EV models to market in 2025.
- **Ford**, with its Model E division solely focused on EV development and production, plans to produce more than 2 million EVs annually, starting in 2025.

EVs Have a Significant Impact on the Grid

While parked and charging, EVs' high energy demands can threaten grid stability, especially during peak periods. This is where managed charging can come into play.

- VPPs can shift peaks to new times of day and move them seasonally.

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[6] Uber, "Your city, our commitment," Accessed November 6, 2023, **https://www.uber.com/us/en/about/sustainability/?uclick_id=c81d0071-16ae-42d7-a053-433d31471fa9**.

[7] Lyft Impact, "Our commitment to achieve 100% electric vehicles across the Lyft platform by 2030," Accessed November, 6, 2023, **https://www.lyft.com/impact/electric**.

[8] Amazon, "Everything you need to know about Amazon's electric delivery vans from Rivian," October 17, 2023, **https://www.aboutamazon.com/news/transportation/everything-you-need-to-know-about-amazons-electric-delivery-vans-from-rivian**.

[9] BrightDrop, "Moving things forward," Accessed November 6, 2023, **https://www.gobrightdrop.com/**.

- EVs can be charged during off-peak hours if drivers have enough charge available for the range they need.
- EV charging could create new peaks if EV charging takes place during the day—for example, at workplace charging stations, public charging stations, and, for remote workers, at home.
- If charging takes place at private charging stations, the residential peak will likely be in the late evening.
- Grid operators must plan for any and all of these scenarios, whether greater demand at current peaks or new peaks in the daytime or late evening.

These challenges could apply to more than transportation, but EVs are unique because of their movement. EV charging loads can move and their location strains can vary, leading to unpredictability about where and when strains might happen. As more EVs come into play, unpredictability increases. For example, anything from largescale events to seasonality could cause changes in EVs' movement patterns—and their corresponding charging. Even an event like a Taylor Swift concert, could cause a strain on the grid that would not usually occur in a certain area.

Energy Management Systems Are Evolving

As software platforms have developed and the world has become more digitized, energy management systems have advanced. Previously, utilities could not integrate distributed energy resources (DER), but with digitization, utility customers can engage with their charging use, billing, and more via a smartphone app. Utilities can employ software services from companies such as Bidgely, EnergyHub, and Eliq, which allow load disaggregation and analytics. With these software services, utilities can understand when consumers are using more or less energy, and determine what they are using it for. Utilities with specific software can also determine when a customer acquires an EV, what times of day it is being charged, and for how long—among other energy uses.

More EVs coming online and greater electricity demand have pushed the grid and corresponding energy management systems to improve their capabilities. Traditionally, grids have relied on a centralized generation model driven by fossil fuels. Grid operators could easily increase energy production when it was needed and decrease it when it was not. Now, grids are moving to distributed generation and incorporating backup power from DER. This supply model depends on multiple DER networked together, including solar, wind turbines, and energy storage systems—including EVs. Unlike their fossil fuel predecessors, DER are solutions to switch on and off , and supply is volatile. Many DER are not one-way solutions. Now, EVs, buildings, and other storage entities can receive power from the grid and serve as an energy source for it.

Energy management can take two forms: behind the meter (BTM) and in front of the meter (FTM). Many companies have begun with BTM integrations of managed charging.

Since EVs are a DER, vehicle-grid integration (VGI) is an important aspect of energy management. It can be separated into two sub-categories: unidirectional (V1G) and bidirectional (V2G) smart charging. Using V1G, EVs adjust their charging rates in response to grid operator's signals, but do not feed power back to the grid. Using V2G, EVs can adjust charging rates and feed power to the grid based on operator signals.

While vehicle to home (V2H) and vehicle-to-building (V2B) integrations do not supply power to the grid, they are an important aspect of bidirectional charging capable of providing energy storage and backup power.

Figure 1 V1G vs V2G

(Source: Guidehouse Insights)

Regulation drives FTM integrations. In the US, the Federal Energy Regulatory Commission (FERC) approved Order 2222, which requires regional transmission organizations and independent systems operators (ISOs) to allow DER access to wholesale energy markets. The legislation faced challenges, but has largely been accepted. Utilities have been submitting compliance plans with timelines of fully integrating DER into the wholesale energy market by 2026.

Europe has also embraced VPPs. The UK has incentives for home charging that are only available for smart charging, encouraging EV supply equipment (EVSE) that VPPs can utilize. The European Commission is mandating an “integrated energy system” as part of its European Green Deal. Countries in the EU have different levels of integration, but VPPs are integral to the Green Deal’s clean energy and sustainable mobility targets.

Asian markets including Australia, Japan, New Zealand, and South Korea are at the forefront of VPP integration. In Japan, supported by the Japanese Ministry of Economy, Trade, and Industry, Next Kraftwerke has collaborated with other entities in successful pilots of VPP integration. ASEAN countries have also begun exploring VPP opportunities.

This type of legislation is a major driver for investment in VPP technology and VGI. Companies such as Ford Motors have noted that they were already investing heavily in BTM technology for homeowners because of demand and their ability to do so. They see a use for power resiliency and managed charging. As noted, Ford’s pilot with PG&E was completely BTM.

EVs Must Be Integrated with Other New Technologies

EVs will be an important aspect of the DER available—wholesale, retail, and BTM. They must be effectively integrated with other clean power alternatives to prove an effective resource, which a VPP can do. VPP software, at a basic level, can provide data for utility knowledge about households that have an EV and their charging patterns. Utilities can use this knowledge to bill at different rates and provide incentives based on time of use (TOU). They can also provide managed charging services. With networked or smart managed charging, EVSE can adjust power levels based on TOU and energy needs.

Eventually, with proper hardware, VPP software can integrate bidirectional charging—aggregating EV energy storage as a grid resource. The following subsections review how EVs can be integrated into the power source and address grid challenges posed by the energy transition.

EVs Can Complement Other DER

Decentralization offers more flexible grids to incorporate EVs as energy sources. In most countries, a decentralized grid is a relatively new approach to providing power. These systems move from larger centralized power systems that transmit loads across long transmission and distribution lines so that, in decentralized systems, power producers can be located closer to end users because more of them can exist.

Previously, a major limitation to grids was that electricity could not be stored. It was generated when needed. Adding DER to the wholesale market can present difficulties in matching supply with demand in real time, but new DER, like EVs and other largescale batteries, can act as energy storage systems and complement other DER by feeding power back to the grid during peak hours.

EVs can be incorporated on-grid and off-grid. In on-grid programming, VPPs can be used to integrate DER—including EVs—at the retail and wholesale level. They can be connected at the wholesale level just as traditional power plants are, with system operators dispatching DER. They can also be integrated at the retail level, which is most common currently. These retail-level DER integrations are often community scale renewables, though they can go beyond the community level, with vehicles integrated from a wide range of locations. The power generated is connected to the grid through distribution lines. It is not used in the wholesale market; rather it is used FTM and transported from where it is generated. Off the grid, DER like EVs can provide backup power to homes and businesses in cases of storms or other grid issues.

Integrating Solar and Wind Energy Poses Challenges to the Grid

In theory, incorporating renewable energy should increase grid resiliency and power supply, and make generation cleaner, but an issue comes into play when renewable resources are not available 24/7, as is the case with solar and wind energy.

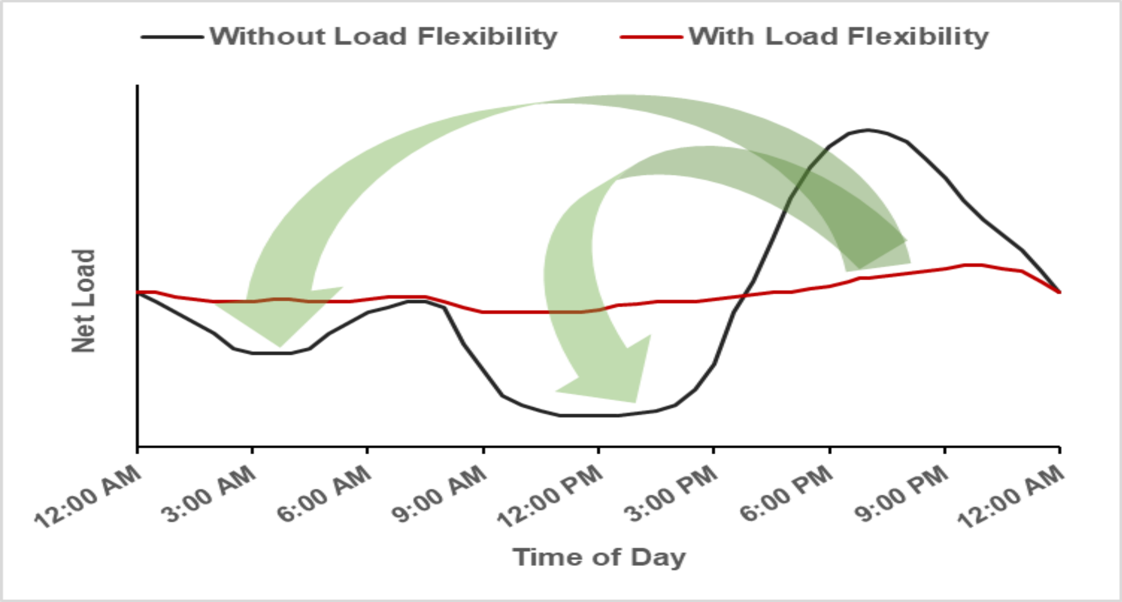
Case Study: CAISO Duck Curve

Time of availability is a major issue in California's solar energy. Traditionally, energy demand is low at night and higher from morning to evening—tapering off around 11 p.m. With the integration of solar power, renewable energy can be used to meet a portion of demand during sunny daylight hours, though how much demand it can meet depends on solar capacity. Unless solar energy is stored, after sundown, the jump in demand for fossil fuel-based power plants is much higher than it would otherwise be.

This poses two problems. The swing in demand is logistically difficult for traditional power plants and it could result in them not meeting power needs, and with less demand for power plants overall, dispatchable plants could go out of business. Then, the power needed would not be available for these hikes in demand.[10]

The duck curve illustrates the amount of power supplied by traditional power plants—not solar. California, with abundant sun, has seen a deepening **duck curve**. Figure 2 shows annual spring averages of net load—minus solar—each year from 2015 to 2023.

Figure 2 CAISO Duck Curve



(Source: Guidehouse)

Among the options for addressing this problem are limiting solar capacity and relying more heavily on fossil fuel-based power plants. This would be shortsighted, however, as EV adoption and the corresponding demand on the grid is increasing. Another option would be to integrate more DER and energy storage systems like EVs that could feed energy back into the grid during peak hours, and give customers an incentive not to charge their vehicles at peak hours.

[10] U.S. Energy Information Administration, "As solar capacity grows, duck curves are getting deeper in California," June 21, 2023, **https://www.eia.gov/todayinenergy/detail.php?id=56880**.

By integrating diverse types of renewable sources, rather than just one type like solar, the grid will experience less volatility. By integrating DER that act as energy storage systems, utilities can store energy during times of high solar generation and use it during times of low solar production, but high demand.

VPPs Present New Opportunities for EVs and EVs Present New Opportunities for VPPs

New wholesale opportunities for DER, with FERC 2222 driving integration in North America, present opportunities for EVs to serve as a grid resource, an integration they are driving beyond retail and BTM. VPPs provide a central entity where thousands of individual DER can be consolidated into entities that are dispatchable at the wholesale level. This technology moves energy storage systems beyond the backup and retail level. VPPs allow communication between utilities and EV owners for managing charging based on time of day—the minimum level—and allowing individual EV owners to serve as a small piece of the wholesale market, stabilizing the grid, and providing income for their owners.

VPPs strive to aggregate and optimize DER so that they can provide the same service as centralized fossil fuel plants operating 24/7—making them an advanced sort of DERMS that takes prices and what types of DER are available into account and then maximizes utility revenue, while maintaining grid functionality. An increased shift from traditional fossil fuel plants to DER, will keep VPPs integral to market optimization and locational determinations of which DER are best to use.

These VPPs present an opportunity for multiple stakeholders to use their supply and demand side resources in grid operations on a daily basis. They lower the barrier of entry to the marketplace by opening it to anyone who can engage in providing energy to the grid, not just specific power plants. Utilities and system operators use VPPs to manage the DER on their grid, while DER aggregators use them to participate in daily energy markets.

Because VPPs are virtual, they can be easily scaled up or down, as more or less DER is available. They can use all types of assets, including energy storage systems such as EVs. By using cloud-based technology, VPPs can use energy from renewable sources, like solar panels, in real time, or they can call on energy storage systems in times of high demand and low renewable output. Thus, VPPs can use optimization algorithms to ensure electricity comes from renewable sources at all hours of the day, regardless of weather conditions.

VPPs Provide Potential Energy and Dollar Savings

As cloud-based technology develops, FERC Order 2222 is implemented, and more DER come into play, VPPs will likely take the place of **peaker plants**, “low use, high-emitting power plants that grid operators call on at times of high demand.”[11] They are used during energy demand spikes that cannot be met by normally operating power plants.

Although peaker plants are dirtier and more expensive to operate than the usual power plants, concerns remain about meeting demand when they are **not** available, such as on a cloudy day or after the sun

[11] Enel, “What Is a Peaking Power Plant?” May 11, 2023, **https://www.enelnorthamerica.com/insights/blogs/what-is-a-peaking-power-plant.**

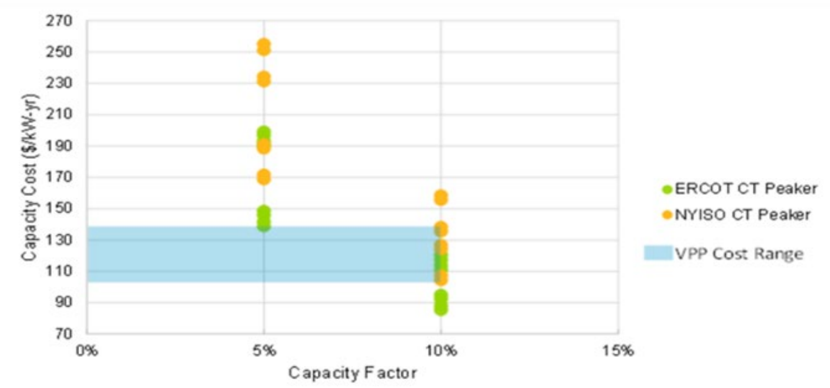
goes down. With more electricity demand and less predictability as EVs come online, the need for available capacity without significant warning will increase. Traditionally, peaker plants would have provided power on short notice, but VPPs can provide a cleaner, less expensive alternative. So peaker plants are perfect candidates for replacement by aggregated DER because of their short run times, aging to retirement, and infrequent use.

Currently, few hard numbers exist that demonstrate how costly peaker plants are compared to other fossil fuel-based power plants and DER. While they represent roughly 10% of grid resources, they provide power for only about 1% of the year, on average. In California, peak electricity demand is met in large part by peaker plants that operate at a capacity factor of under 15%—that is, they generate 15% or less of the electricity they would if they were running all year.[12] Additionally, peaker plants contribute 94% of nitrogen oxide emissions on hot, high ozone days, and cost ratepayers up to 1,300% more than the average electricity price.[13]

When comparing prices for units of electricity produced, of special note is that VPP-based energy has little to no variable cost, whereas conventional fossil fuel generation has higher variable cost for producing each unit of energy. Figure 3 illustrates the levelized cost of energy (LCOE) for the Electric Reliability Council of Texas (ERCOT) and the New York Independent System Operator Inc (NYISO). On average, VPPs are more cost-effective than peaker plants with extremely low capacity factors. Once capacity factors reach approximately 10%, they are at parity. As VPP technology develops and DER, like EVs, proliferate, **the VPP capacity cost range is likely to decrease**.

A VPP is typically valued on a capacity basis ($/kw) with zero variable cost, though total dispatchable hours are capped, while conventional generation is typically evaluated based on an energy basis ($/kwh), to account for the more significant variable cost associated with producing each kwh.

Figure 3 Peaker Plants and VPP LCOE During 2022



(Source: Guidehouse & AutoGrid)

[12] PSE Healthy Energy, "California Peaker Power Plants," May 2020, **https://www.psehealthyenergy.org/wp-content/uploads/2020/05/California.pdf**.

[13] AutoGrid-Guidehouse Insights, "How VPPs Can Replace Fossil Fuel Peaker Plants," 1Q 2022, **https://www.auto-grid.com/resources/white-papers/how-vpps-can-replace-fossil-fuel-peaker-plants-guidehouse-insights/**.

When using VPP to integrate EVs with other DER, utilities must strike a balance between meeting customer needs, such as X miles of range by Y time, and balancing the grid, while maximizing renewable usage. VPPs can help with this number of moving parts.

Although this analysis has focused on North America, Europe also must integrate EVs and other DER. Using variable renewable energy sources like wind and solar energy and other DER is crucial for achieving the EU's Fit-for-55 and 2050 climate neutrality goals. Flexibility is increasingly needed for maintaining a balance between demand and production on all time horizons, in the face of increasing scale and the frequency of fluctuations of the load net of variable renewable energy resources. Many European countries feature unregulated electricity markets that could effectively utilize EVs through VPPs as a wholesale power source. Smart metering is compulsery throughout the EU, which sets the region up for successful EV use.

Case Study: Bidgely Southeast US EV Managed Charging Pilot

In 2019, Bidgely partnered with a utility to conduct a 3-year pilot program that tested its AI peak load detection and estimation alerts for EV charging. The pilot also looked at how EV charging was affecting the grid, and what the charging habits of EV drivers were. The goal was to provide information for how widespread EV ownership is likely to have an impact on the grid, and to allow Bidgely to test further and improve its EV managed charging offerings.

Bidgely's UtilityAI Analytics Workbench helped the utility know which customers were charging EVs at home so it could recruit participants. Bidgely recruited customers with a welcome email and link to a personalized dashboard about EV charging and then, with the utility, designed a program with both incentives and strikes. Program participants received $500 for joining and earned strikes for charging during defined peak hours. If they received three strikes or fewer, they received another $20 per month.

Among program participants, peak charging was reduced by 75%, with 97% of charging occurring at off-peak hours **after** the program ended. Email open rates were above 75% and the AI solution was more than 90% successful at identifying EV households.

Part of the program's success in engaging customers and shifting charging load could have come from the study including an element of self-selection, because customers who opted in were already likely to be paying attention to energy use and utility billing. EV owners on average tend to be more concerned with energy savings than ICE owners. As EVs become more ubiquitous, that sentiment is likely to shift.

Even so, using AI technology to detect EV assets and manage charging times through incentives is a strong beginning for software solutions that manage charging and eventually utilize these assets as bidirectional grid resources.

Stakeholders Must Be Proactive in Preparing Grids For EVs

The grid will require greater capacity and resiliency as EVs become ubiquitous. In the transition from ICE vehicles to EVs, utilities must determine how to mitigate the greater strain EVs could put on the grid and how to use EVs as an effective asset. They must expand and adjust their business offerings; partner with EV manufacturers and charging infrastructure suppliers to utilize smart charging hardware and telematics; and use software enabled VPPs to engage with customers and other stakeholders. The following subsections delve deeper into what these recommendations entail.[14]

Utilities Must Adjust Their Tariff Structures to Enable Smart Charging

As EV adoption increases, drivers must pair buying an EV and enrolling in a managed charging program, but most often, consumers are not buying EVs for reasons related to grid stability or serving as a grid resource. They simply want transportation. Dynamic rates and passive and active managed charging are key offerings that assist in preparing the grid for managed charging. If introduced and marketed well, these offerings can engage a plethora of consumers and assist them in cost savings.

VPP enrollment must be simplified to reach this pairing of EV purchase and managed charging enrollment. Utilities can participate by offering consumer education, automatic enrollment with an option to opt out for budget payment plans, and wider VPP enablement of DER devices such as EVs.

Additionally, VPP deployment should prioritize equitable benefits for communities. Utility offerings such as low cost financing and rebates for EVs that can serve as DER can encourage consumers to shift from ICE vehicles to EVs, so communities can experience the benefits of switching to EV ownership and participating in cost savings and earnings from managed and bidirectional charging.

Utilities must use software that effectively aggregates DER and can balance electrical loads like a traditional power plant can. This will require engaging with regulators to understand tools and protocols used to scale up and rely on VPPs. Utilities can introduce new resources and workforce support for introducing new distribution system planning requirements, procurement processes, ratemaking, and customer programs that support introducing VPPs and their corresponding resources onto the grid.[15]

EV Manufacturers and Charging Infrastructure Suppliers Must Form Partnerships

EV manufacturers are already partnering with utilities to run pilots for V2G capabilities: examples include PG&E partnering with Ford, GM, and others, and Duke Energy partnering with GM, Ford, and BMW. These pilots typically involve the multiple stages of lab testing, small group testing, and large group testing.

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[14] Energy.gov, "DOE Releases New Report on Pathways to Commercial Liftoff for Virtual Power Plants," September 12, 2023, **https://www.energy.gov/lpo/articles/doe-releases-new-report-pathways-commercial-liftoff-virtual-power-plants**.

[15]U.S. Department of Energy, "Pathways to Commercial Liftoff: Virtual Power Plants," September 2023, **https://liftoff.energy.gov/wp-content/uploads/2023/09/20230911-Pathways-to-Commercial-Liftoff-Virtual-Power-Plants_update.pdf**.

As part of the Open Vehicle-Grid Integration Platform (OVGIP), the Duke Energy pilot will be a 12-month EV Complete Home Charging Plan. North Carolina customers will be allowed 800 kWh per month to charge their EVs at home for a fixed monthly fee, either $24.99 or $19.99 depending on the region. This allowance is nearly double what an average EV driver uses monthly. Customers can then identify their **desired state of charge** and **preferred departure times** on an OEM app that will identify and optimize EV charging times for each of them. The pilot's goal is to increase charging convenience while contributing to grid stability.

Besides partnerships, industry standards must be agreed to. OEMs, charging operators, aggregators, and utilities must agree to data sharing and more, which will improve industry efficiency, lead to effective data analysis, and create opportunities for more growth and partnerships. With proper security and privacy protocols, companies can still maintain their competitiveness.

VPP Operators Must Engage with Customers and Other Stakeholders

VPP services can include data and IT platforms, market interfaces, and DER platforms. Companies can include all of these, or one or two of them. Through these services, VPPs engage with utilities, ISOs/RTOs, and electricity consumers. Those developing VPPs must understand all stakeholders' needs and challenges as well as applicable regulatory frameworks and what technologies OEMs are developing.

- For VPPs to be successful, advocating and integrating with open charging standards is crucial for customer participation across different hardware vendors.
- Working with regulators to standardize service agreements across jurisdictions will improve efficiency and interoperability.
- Reducing the number of different interconnection standards, adapting common data policies, and creating cybersecurity baselines will improve the resiliency and usefulness of VPPs.

A VPP must have a significant volume of DER to be of use to the grid. Customers must be informed about grid management—how they can participate and benefit from it in the form of savings and eventually earnings. VPPs, with their ability to identify EV owners and provide software solutions that are easy to use, are the entities to do this. They can collaborate with utilities and utility customers to make sure appropriate customers are identified and focused on.

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