driivz sparkion

Meeting the Need for Energy with Smart Energy Management for EV Charging Networks

Optimizing the grid, renewables, and local battery storage to scale and meet demand for EV charging while reducing costs.

August 2024

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01 Introduction

EV adoption is continuing its upward trajectory, closely meeting forecasts of the 2023 Global EV Outlook. By the end of 2023, there were about 40 million EVs on the roads globally with the lion's share of that (95%) in China, Europe, and the US. About 70% of those were battery electric vehicles (BEVs).

EV sales in Q1, 2024 suggest that growth will continue throughout the year and that total EV sales will surpass 2023 figures by more than 20%. This expected growth in EV adoption, and the corresponded growth needed in charging infrastructure to meet net zero emissions goals for 2035 will increase the need for electricity for EV charging by up to 35x compared to 2023 values.

Meeting the need for energy is a growing challenge

The need to charge all those EVs rolling off the assembly lines will increase the demand for energy. A study by the National Academy of Sciences indicates that in California, this increased demand will require more than two-thirds of electricity distribution circuits to upgrade capacity at a cost of between $6 billion and $20 billion. California state agencies responsible for providing electricity claim they will be able to meet the growing demand, but those claims are based on a set of assumptions that may not hold water. While power grids in the US can supply enough electricity to meet demand for EV charging in general, they can't meet the demand at peak charging hours. To meet those mid-morning peaks when people get to work, and the early evening peaks when they get back home, grid expansion is not only needed, but it must also be accelerated. And to maintain emissions reductions to reach ESG goals, those upgrades would need to favor renewable energy to be as low-carbon as possible.

Countries in Europe are facing a similar problem. There's no question that the demand for EV charging infrastructure is there, and some studies show that infrastructure will spawn a 40x increase in demand for energy for EV charging by 2040. But, while there are ambitious plans to improve and expand the charging infrastructure, across the EU, thousands of public charging stations are lying dormant because they can't get a power connection. While some of the reasons are logistical, environmental, or regulatory, in many cases, it's simply because the grid would not be able to handle the extra load, significantly lengthening the deployment time of a new public charging site from six months to two years.

This situation begs the question, "What if we could accommodate EV charging without upgrading the underlying electrical infrastructure of the local grid?" Moreover, what if EV charging could even be seen as a solution to grid limitations rather than an extra burden?

Optimizing energy management for EV charging is the solution

According to Eurelectric's 2023 e-mobility report, by 2030, electricity demand for EV charging will make up to 10% of total demand in the US and 5% in Europe.To meet this increased demand while minimizing the impact on the grid and consequent need for grid upgrades, a variety of technologies and practices are essential to continue driving e-mobility, including (amongst others):

- **Procurement of distributed flexibility**
- **Network tariffs including Timof Use incentives**
- **Demand-response capabilities**
- **Renewable energy and energy storage systems**
- **Bi-directional charging technologies**

This white paper explores how smart energy management, that optimizes EV charging using the grid, renewables, and local battery storage can increase the capacity for EV charging at any site, postponing or even eliminating the need for costly infrastructure upgrades, while reducing costs, increasing energy resilience, and generating new revenue streams for network operators.

02
What is Smart Energy Management for EV Charging

Smart energy management must be an integral part of any EV charging solution from day one. Allowing unmanaged consumption of energy is a sure way to trip breakers, blow fuses, and incur costs such as utility demand charges. Theoretically, increasing capacity could be a solution, however, an extremely expensive one. A local grid upgrade to accommodate 4 DC fast charging stations can cost more than $150,000, and in any case, you may wait months or years for it to happen. A Charge Point Management System (CPMS), together with a smart Energy Management System (EMS), can open the door to EV charging without upgrading electrical infrastructure, but what exactly does that mean?

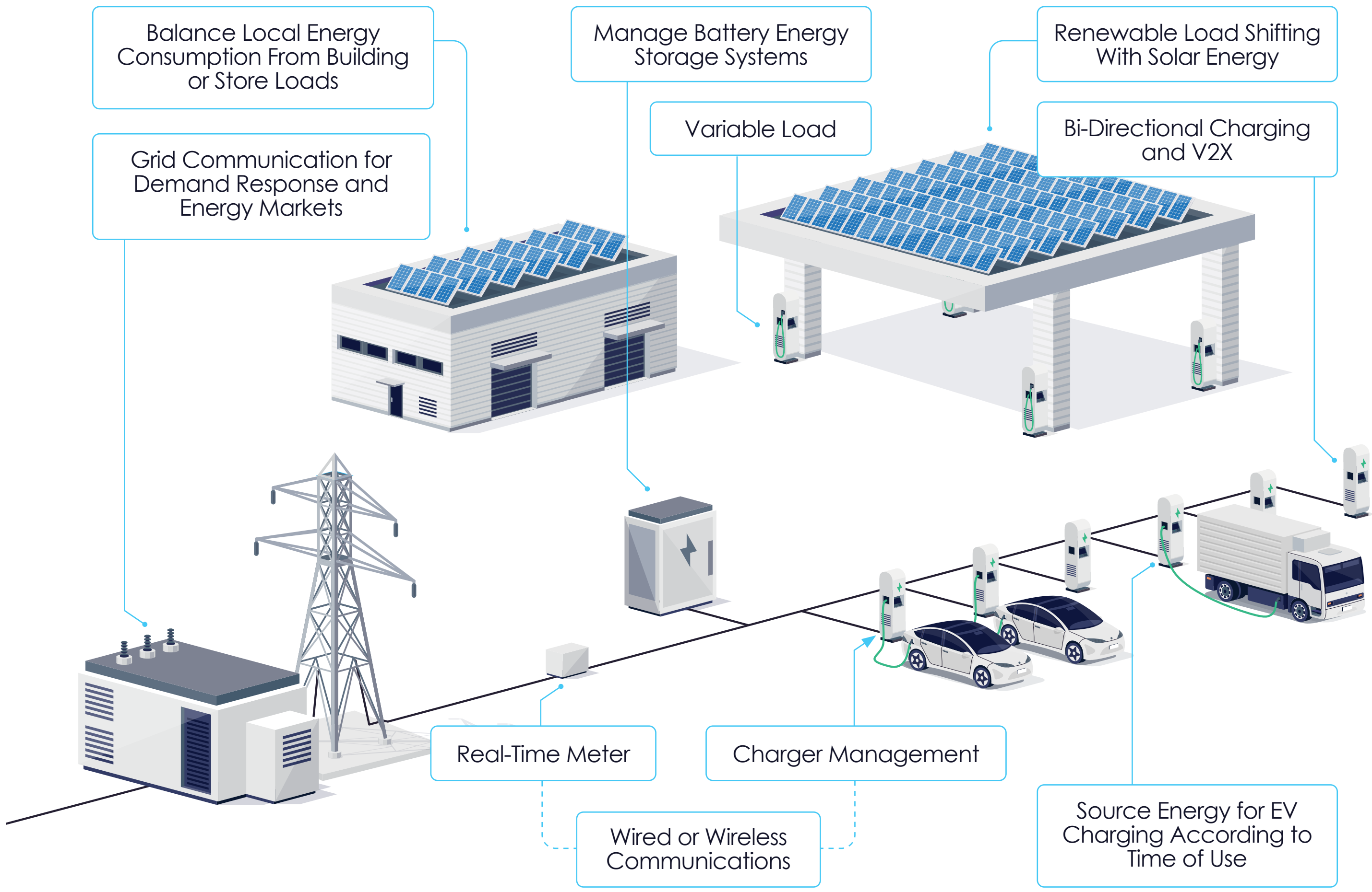
Smart Energy Management

Smart energy management optimizes how all energy sources at a site (the grid, renewables, and local battery storage) are used to accommodate EV charging, while considering unmanaged loads, and the varying cost of energy from the grid.

02 What is Smart Energy Management for EV Charging

EV charging is a prime candidate for smart energy management because it offers enormous flexibility in terms of the amount of energy required from the grid at any given time. An EV charging and energy management platform controls and optimizes the flow of energy at a site, and determines how much is delivered for EV charging as a function of several factors:

- **Demand:** how many EVs are charging concurrently?
- **Business needs and priorities:** can charging of a particular EV be reduced, or put on hold for any period of time, or should one EV be prioritized over another?
- **Supply:** how much energy is available from the different sources at the site? Typically, these are a combination of the grid, renewable energy (usually photovoltaic - PV cells), and battery energy storage systems (BESS).
- **Constraints:** what is the capacity of the site's electrical infrastructure to deliver energy, and how much energy is needed for unmanaged loads?
- **Cost:** the cost of consuming energy from the grid, and then compensation for selling it back, both of which may vary at different times. Also, the cost of storing energy for later use.
- **Contractual obligations:** is the site bound by demand response obligations to the utility, or has it bid on energy flexibility markets.
- **Advanced capabilities:** do the currently charging vehicles and EV chargers support V2X?



The factors at play in smart energy management scenarios.

02 What is Smart Energy Management for EV Charging

Balancing local energy consumption

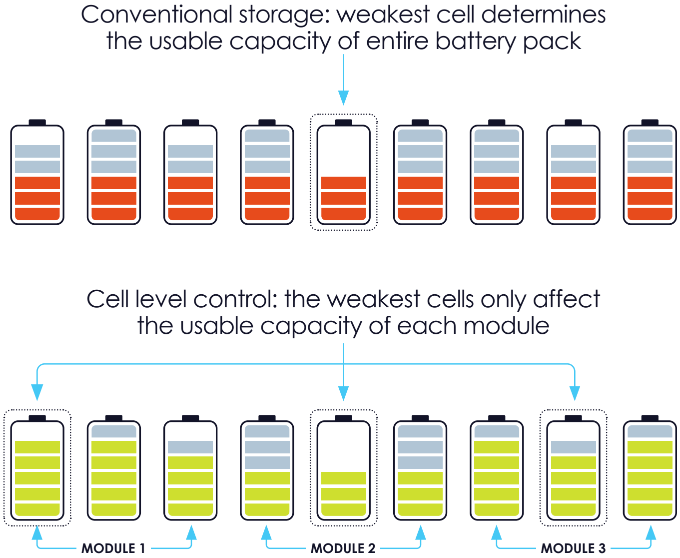
As the controlling mediator between energy sources and energy consumers, a smart EV charging, and energy management system balances the supply of energy with its consumption. However, while there is granular control over energy delivered for EV charging, there is no control over unmanaged loads. Consumers of power like air-conditioning and heating systems, a car wash, in-store appliances etc. simply draw the power they need to function. And while renewables and battery storage can supplement the grid during periods of peak demand, they are also limited in their capacity and are not always available.

When demand exceeds available supply, things can start going wrong. Circuit breakers may trip causing EV chargers or other systems to go down. Electrical infrastructure may be damaged, and in more serious cases, a transformer serving the local micro-grid can even burn out taking the whole site down and incurring heavy penalties for the site owner. A smart energy management system mitigates these risks through peak shaving. Energy delivered for EV charging is reduced as needed, to accommodate unmanaged loads as they come into play, ensuring that the site never exceeds its capacity. This granular control may be applied at any level, from a single charger to a site, a campus, and even a whole city.

Load shifting with renewables and battery energy storage systems (BESS)

Renewables are an important factor in the EV ecosystem and are a great supplement for the grid. By co-locating localized renewable energy sources with EV charging points, CPOs can reduce energy costs while alleviating strain on the grid. When renewable energy is available, it may be used to meet current demand, and any excess can be diverted to a local BESS for later use. However, since renewable energy depends on weather conditions, its availability is unpredictable.

A BESS is a cost-effective and resilient source of energy. Smart energy management systems utilize a BESS as a low-cost and a readily available energy source for a site by controlling the charge and discharge behavior of the batteries. The BESS can be charged when there is an abundance of renewable energy, and discharged when demand peaks, grid energy costs are high and renewable energy is scarce. Smart BESSs will also provide cell-level battery control to optimize the battery packs by bypassing weak cells that reduce the usable capacity, enabling the BESS to generate more energy while reducing the cost per kWh.



Cell-level battery control optimizes BESSs

Load Shifting

During times of peak demand, or in response to demand response events, smart energy management can shift loads to renewables and BESSs to reduce costs and alleviate strain on the grid. When renewable energy is abundant and exceeds demand, it can be used to recharge the BESS.

02 What is Smart Energy Management for EV Charging

Dynamic cost optimization by time of use (TOU)

Different types of sites will have different peak hours for charging. An office building may peak on weekday mornings, while a shopping mall will peak on weekends. Through direct integration with the utility supplying electricity to the site, the network operator may have visibility into how the cost of electricity varies during the day. Depending on the services the utility provides, these may be static day-ahead tables, or real-time hour-by-hour spot pricing. A smart energy management system can use this data, and combine current electricity costs with other factors, such as the driver plan being invoked, the amount of energy stored in a local BESS, expected availability of renewable energy, historical hourly demand patterns, and more, to decide which source to use for EV charging. When energy costs are high, the ROI on renewables and BESSs is clear. Energy drawn from the grid for EV charging can be reduced to a minimum (or even zero) and replaced with renewable energy (if available) and energy stored in the local BESS. The BESS can be recharged later, when grid energy costs are low, and/or when there is an excess of renewable energy available.

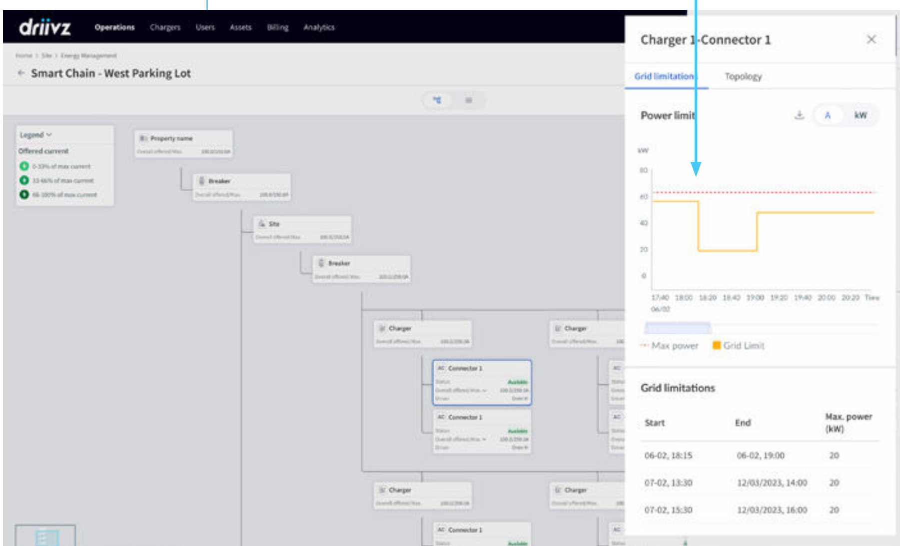
Time Of Use

When energy costs are high, the ROI on renewables and BESS is clear. Energy drawn from the grid can be reduced to a minimum and replaced with renewable energy and energy stored in the local BESS.

Leveraging grid communication to support demand response

By communicating with the Distribution System Operator (DSO)(the local grid operator), a smart energy management system can respond to real time signals and leverage its control over the energy flow between renewables, battery storage and EV charging to accommodate demand response events. Through OpenADR, the system can respond to a request to reduce the power drawn from the grid by either replacing some of the grid power currently in use for EV charging with renewables or a BESS, or by simply reducing the power being used for EV charging.

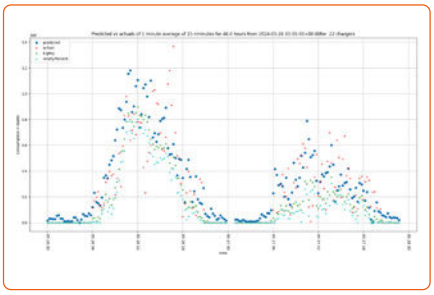
openADR event



Using EV charging sites as virtual power plants (VPP) to participate in ancillary services

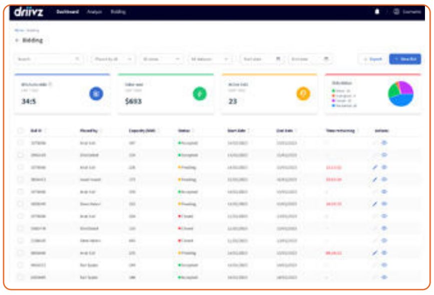
A virtual power plant is a network of distributed energy resources (DER) that can be centrally controlled. With the exponential growth in EV adoption in recent years, and the ensuing proliferation of EV charging stations, it has become clear that EV charging sites are primed to be VPPs. What is needed is central control over the energy flow at the sites, which is exactly what a CPMS with smart energy management does. Here's how it works.

Day T-2: Prediction



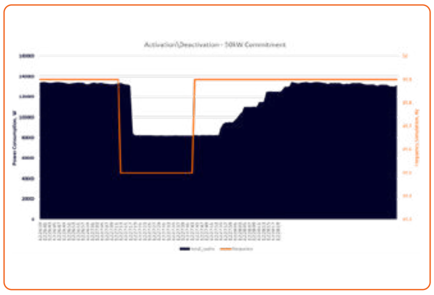
The CPMS analyses historical data (usage, weather, special events etc.) for all EV charging sites to predict demand for the following days.

Day T-1: Bidding



Based on its predictions for demand, the CPMS calculates how by how much (and how quickly) it can reduce its consumption from the grid for EV charging at each site and enables CPOs to bid on ancillary services in energy markets.

Day T: Activation



If there is a deviation in grid frequency and the bid is activated, the CPMS reduces consumption from the grid for EV charging and may then use renewables or BESS to provide supplemental power if needed.

As an early stage, maturing market which is struggling to make profits, the EV charging business can look to energy flexibility as a vehicle to profitability by generating new revenue streams. With the ability to ring up hundreds of thousands of Dollars/Euros per year, ancillary services can be a game changer that improves margins and increases profits for EV charging sites, validating them as a sound business proposition.

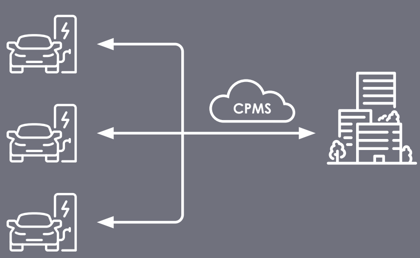
Looking to a future in which V2X technology becomes commonplace, a network operator could use smart energy management through its CPMS to participate in ancillary services not only by reducing the consumption from the grid for EV charging, but also by utilizing energy stored in EV batteries to provide power back to the grid.

Smart Energy Management is Central to V2X

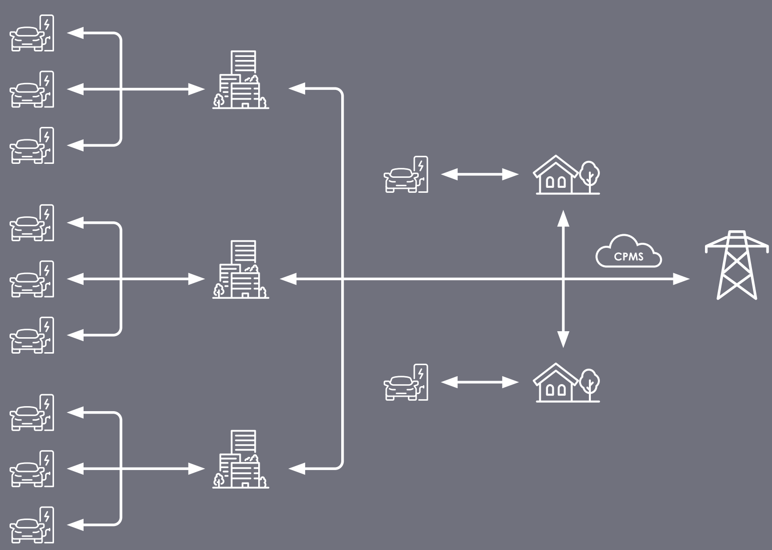
While V2X is still nascent technology that is not widely used, EVs show great promise to be a significant source of energy that can mitigate exponentially growing demand. In the summer of 2022, an extreme heat wave that hit California threatened to cause rolling blackouts across the state. A pilot project in San Diego showed that seven electric school busses were able to supply enough power back to the grid to power 452 homes each day of the heat wave.

To make use of V2X you need a smart EV charging and energy management platform that can add the energy stored in EV batteries to the mix of sources it uses to manage the flow of energy. At the level of a site, such as a gas station or a commercial location, through smart energy management, a building can utilize EVs to provide emergency power during an outage (V2B – Vehicle to Building), or to reduce the site's electricity bill in much the same way that on site battery storage is used.

Scaling up to the level of a campus or even a city, smart energy management can utilize the energy in multiple EVs to bid in energy flexibility markets and help balance the grid, and even supply additional power as in the San Diego school bus pilot.



V2G for a site



V2G for a campus/city

While support for V2G adds significant expense to EVs, a study by McKinsey estimated that each school bus providing energy back to the grid can generate up to $16,000 annually, showing that V2X is a win-win proposition all around.

03 Smart Energy Management Scenarios

There are several elements that can take part in smart energy management for EV charging scenarios.

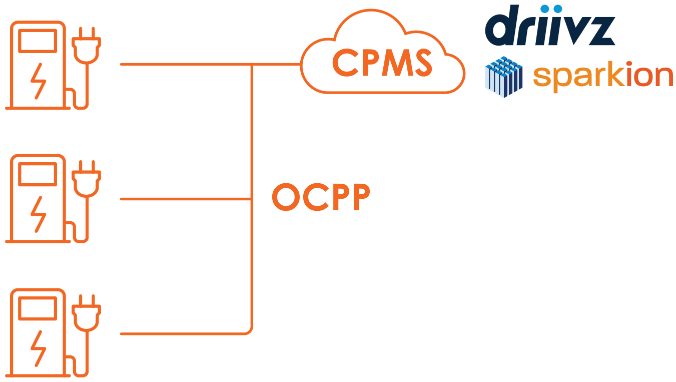
- **EV Chargers**
- **Charge Point Management System (CPMS)**
- **Onsite battery storage**
- **Onsite controller to manage a site's assets**
- **Smart meters**
- **Renewable energy sources (PV)**
- **Unmanaged loads**

While there are many ways to construct a site using different combinations of these elements, let's examine four common scenarios for smart energy management in increasing levels of complexity.

Scenario 1: Managed EV chargers

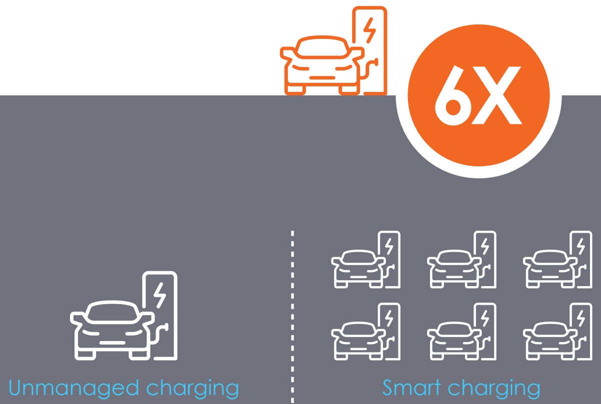
In this simple (and most common) scenario, the EV chargers are controlled from the cloud over OCPP by the CPMS. There are no additional consumers to control.

The CPMS controls how much energy is delivered by setting charging profiles for each active charger. The amount of energy delivered to each charger depends on factors like available capacity, vehicle priority, and more. As EVs connect and disconnect from chargers, the CPMS applies real-time dynamic load balancing by updating the charging profiles for the active chargers to share available capacity between them. The CPMS also applies peak shaving to ensure that the site's capacity is never exceeded, no matter how many chargers are active concurrently. Even in this simple scenario, the EV chargers can act as a virtual power plant (VPP), whether comprised of several chargers at a single site, or of tens of thousands of chargers aggregated from multiple sites.



The granular control over EV charging that the CPMS provides means that the network operator can participate in energy flexibility markets by reducing the amount of energy allocated for EV charging when a bid is activated. Smart energy management also reduces a site's CapEx (and increases its ROI) since it can accommodate up to 6X as many EVs compared to unmanaged charging, without requiring any upgrades to electrical infrastructure.

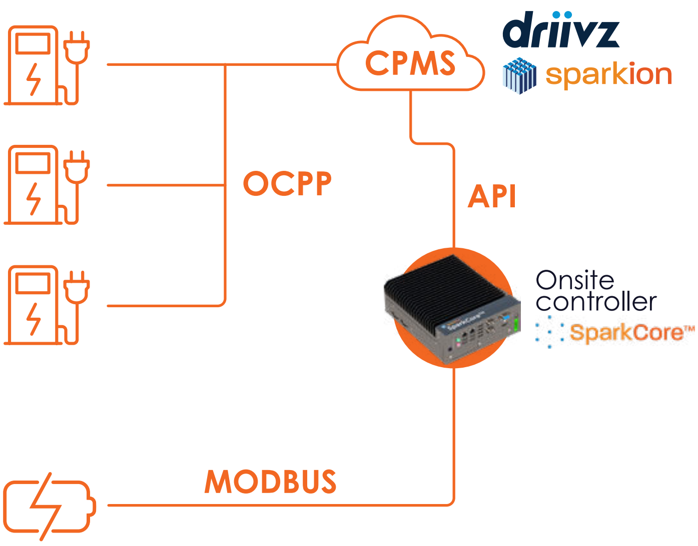
Accommodate up to 6X as many EVs compared to unmanaged charging without upgrading electrical infrastructure.



Scenario 2: Managing EV chargers and on-site battery storage

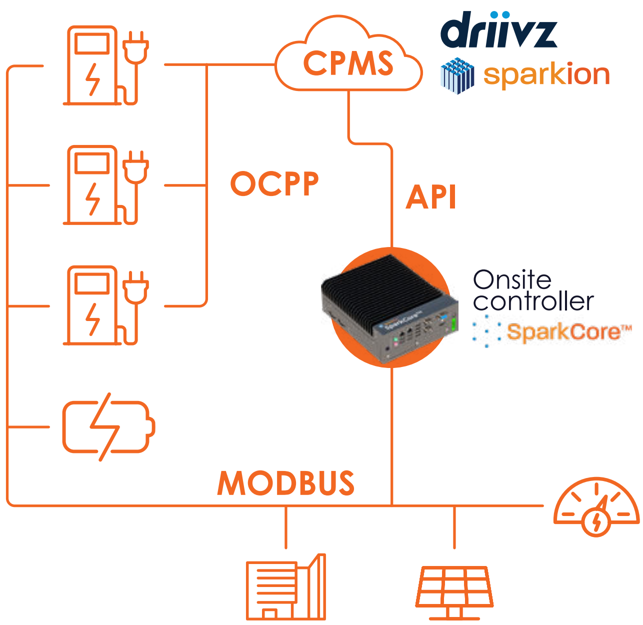
In this scenario, onsite battery storage adds another dimension to the site's energy management. Energy delivered to EV chargers is still controlled by the CPMS over OCPP, while an onsite controller manages charging and discharging of the onsite BESS.

The controller communicates with the CPMS via API to obtain hourly energy prices and demand for EV charging and uses those to determine the optimal times to charge or discharge the onsite battery. The onsite BESS can discharge the battery to replace grid power, or even feed energy back to the grid.



Scenario 3: Managing complex sites

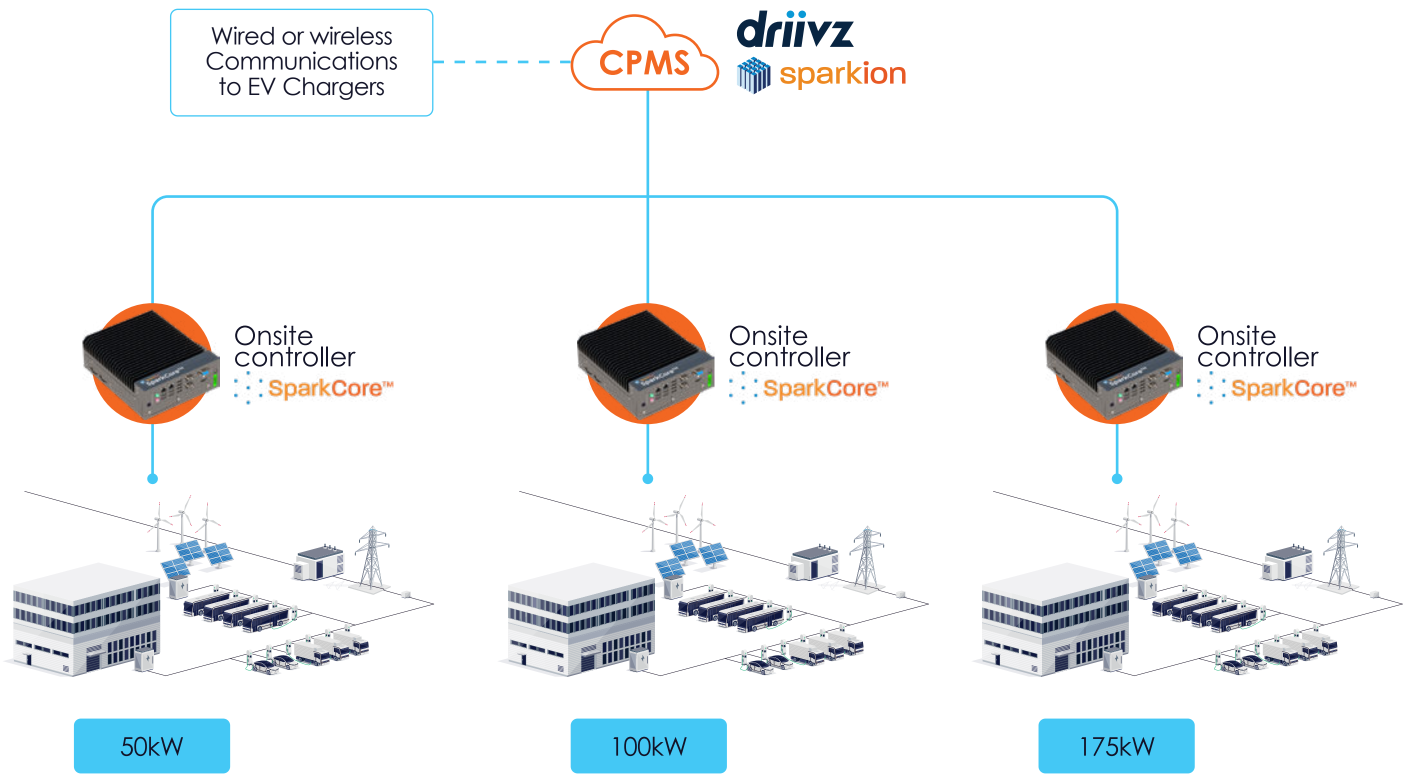
In this more complex scenario, the onsite controller takes primary control over all the onsite assets that include EV chargers, BESS, renewables (PV), smart meters, and unmanaged loads. The onsite controller connects to EV chargers via MODBUS to manage energy for EV charging while the CPMS handles other aspects of charger management via OCPP. The onsite controller is also connected to all the other site assets, either directly or via smart meters enabling it to take those into consideration when allocating energy for EV charging. While this scenario is more complex, it also offers more opportunities to participate in energy flexibility markets. The onsite controller (as opposed to a cloud based CPMS) offers much faster response times to local spikes in demand for energy and notifications from the grid enabling bids on flexibility that requires near-immediate response times.



Scenario 4:
Automated multi-site aggregation

In this scenario we have scaled up to a multi-site campus and could continue this process to the level of a city or even a whole country. There are multiple sites of varying complexity, each of which may be constructed according to any of the scenarios previously described. Energy management for each site is optimized independently according to the characteristics of the site and the elements it contains. But, in addition, all the sites are centrally controlled by the CPMS giving the whole network all the characteristics of a virtual power plant.

The CPO can bid on energy markets with the assets of all the sites it controls at its disposal. Given historical data and predictive analytics, the platform can anticipate the balance of energy at any of the sites in order to place bids. When those bids are activated, the platform has the energy assets of all the sites under its control to work with to make an optimal decision on how to manage the energy flow and fulfil its commitment on the bid.



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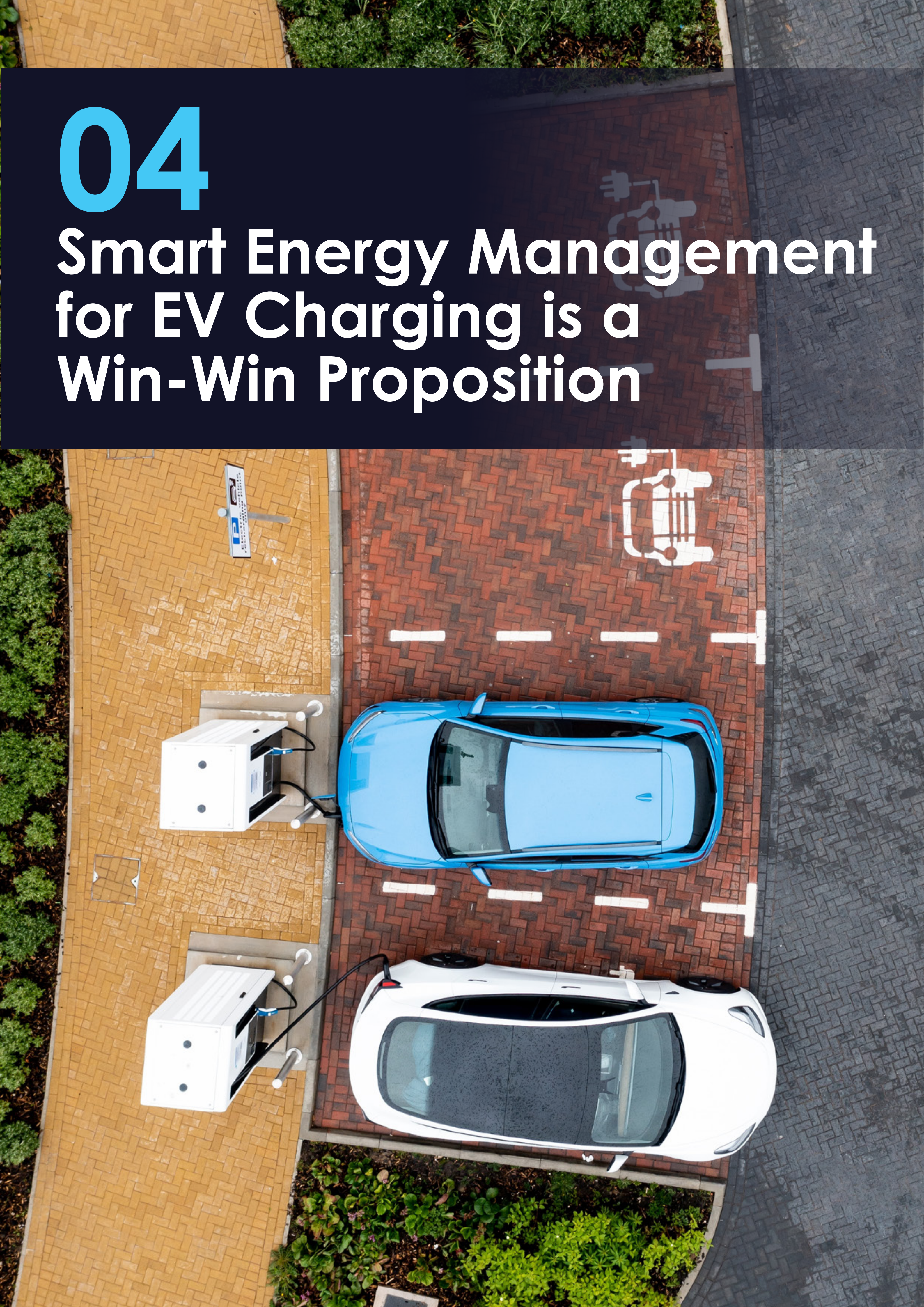
Smart Energy Management for EV Charging is a Win-Win Proposition



04 Smart Energy Management for EV Charging is a Win-Win Proposition

Smart energy management is a win-win proposition in which everybody benefits – site owners, network operators, drivers, and even the utilities.

Service Continuity And User Experience

Preventing outages with breaker trip protection

Since providing maximum power concurrently to multiple chargers at a site would most likely trip a breaker switch, the smart energy management platform uses peak shaving to limit the power allocated for EV charging ensuring the site's capacity is never exceeded, while load balancing that power to all connected vehicles. The net effect is that the network operator can provide a better charging experience to more vehicles at a time without risking power outages that would interrupt service.

Reduced Costs

Demand charge mitigation

Sites that exceed their contracted electrical capacity may be heavily penalized by the servicing utility in the form of demand charges. Smart energy management lowers peak consumption rates that determine demand charges, thus lowering overall cost for an EV charging site.

Energy shifting and automated TOU scheduling

By considering TOU tariffs, a CPMS with smart energy management can perform automated cost optimization for the network operator. When grid energy is most expensive, the platform can shift to draw power from onsite renewables if available, or from a local BESS. When grid energy costs are at their lowest, the CPMS can prefer the grid as a source both for EV charging, and to take advantage of the low rates to recharge a depleted local BESS.

Improved Energy Efficiency

Maximized energy storage throughput

Cell level control over the batteries in a BESS bypasses weak cells that reduce the system's usable power, increasing the BESS's energy throughput while reducing costs.

Effective Distribution Of Energy

Real-time decisions based on EVSE load

EVSE load can vary from zero when the site is empty, to demand for hundreds of kW at peak hours when all chargers may be occupied concurrently. A CPMS with smart energy management offers granular control over power to accommodate vehicles connecting and disconnecting to chargers while considering constraints of the site's electrical capacity and unmanaged loads limiting the power available for EV charging.

Increased Profits

Value stacking

Since smart energy management that optimizes energy flow at a site offers different opportunities to provide value, network operators can offer each type of capability as a separate service to increase profits. In all cases, drivers benefit from smart energy management since they get a stable, reliable and seamless charging experience at sites that are properly managed – and can benefit from lower TOU rates when available.

05 Meeting Demand for Energy with Smart Energy Management

EV charging places huge demand for power. One way to meet that demand is to upgrade electrical infrastructure, but in many cases that is not a viable option, either because of the high cost, or simply because utilities cannot keep up with the demand.

Smart energy management offers a viable alternative to expand EV charging networks and support the growth of EV adoption by optimizing EV charging while taking full advantage of stored energy in BESSs, and renewable energy from PV installations. With granular control over EV charging, a smart EV Charging platform together with an Energy Management System can accommodate unmanaged loads, dynamically load balance available energy between currently active charging stations, shift loads between the grid, batteries and renewables to capitalize on dynamic energy costs, and protect the local microgrid from damage that could bring the site down. Beyond accelerating EV adoption, smart energy management also enables millisecond response times to signals from the grid, enabling network operators to participate in demand response schemes and ancillary services that generate new revenue streams.

As demand grows and the EV charging market becomes more sophisticated, smart EV charging and energy management improves energy resilience for network operators enabling them to scale up and increase the ROI on their EV charging infrastructure. And while there is still much to be done to support EV adoption and reach net zero emissions goals, there is much we can already do with smart energy management for EV charging.

About Driivz

Driivz, a Vontier (NYSE: VNT) company and part of its EVolve™ e-mobility portfolio, is a leading global software supplier to EV charging operators and service providers, accelerating the plug-in EV industry's dynamic and continuous transformation. The company's intelligent, cloud-based platform spans EV charging operations, energy management, advanced billing capabilities and driver self-service tools.

Driivz's team of EV experts serves customers in more than 30 countries, including global industry players such as EVgo, Shell, Circle K, Volvo Group, Recharge, St1, ElaadNL, ESB, Mer, Francis Energy, Ennet Corporation and eMobility Power. The Driivz platform currently manages 100,000 public chargers (hundreds of thousands in roaming) and hundreds of millions of events for millions of EV drivers in North America, Europe and APAC.

About Sparkion

Sparkion, a Vontier (NYSE: VNT) company and part of its EVolve™ e-mobility portfolio, is an engineering-led provider of cost-effective, reliable energy management solutions for the behind-the-meter industry with a focus on electric vehicle charging infrastructure (EVSE). Sparkion's proprietary AI-driven software platform helps CPOs, fleet operators, and EV site owners orchestrate and optimize energy use and consumption and achieve a net-zero transportation future.

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