Enterprise Electric Vehicle Charging Stations

Using

Photovoltaics & Energy Storage

A Whitepaper

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Introduction

Environmentally responsible companies provide their employees the opportunity to charge their electric vehicles while at work. Clearly, this is a significant step for an employer to show their commitment to their employees and to the environment. However, the resulting increase in the electrical bills could also quickly become a significant financial burden. Fortunately, sound financial steps are available to mitigate these expenses and further demonstrate the employer's commitment to the environment.

In what follows we discuss the problem in further details and consider possible solutions. You will find that using renewable energy in conjunction with advanced energy storage technology provides an intelligent, cost effective and environmentally friendly solution for this growing industry. We call this *Enterprise EV Charging* .

Background

As electric vehicles gain in popularity, many electric vehicle owners still struggle transitioning from the convenience of making a quick stop at a gas station to having to charge their electric vehicles at a stationary charger that renders the vehicle unusable while it is being charged.

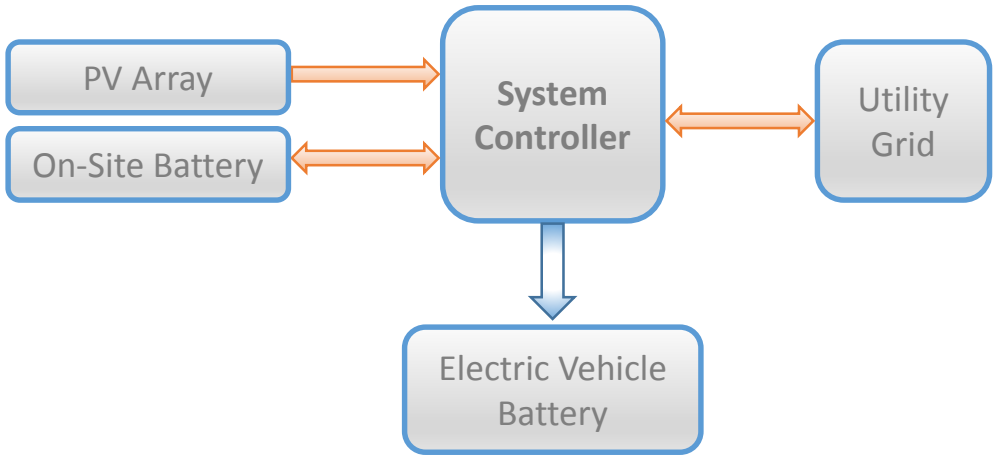
Daytime charging, while at work, is a clear solution to this problem. However, the impact of daytime charging on a facility's utility bill and the overall grid infrastructure is significant. In particular, charging during on-peak hours, when the utility grid is most impacted, is an expensive proposition for electric vehicle owners and their employers.

Adding a 100-car EV charging system to a typical commercial building with 1,000 occupants could increase the facility's power bill by as much as 60%. This increase is partially due to higher energy usage. However, it is the increase in demand charges that is the main driver of the increase in costs. This is a direct consequence of employees arriving at work at the same time as when energy and demand costs are both priced at a premium.

At JLM, we design systems that combine the energy production capabilities of PV solar with the demand reduction capabilities of advanced energy storage (AES) systems to neutralize the cost impact of *Enterprise EV Charging*.

System Components

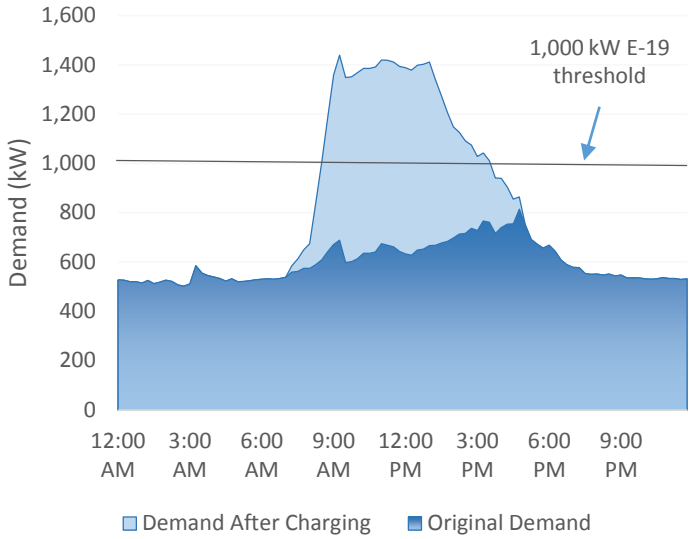
Enterprise EV Charging systems are configured as shown below. The system takes energy generated from the PV solar system and uses it to charge the on-site energy storage system. When solar energy is not available the system uses the energy from the grid instead but avoids expensive, on-peak energy.



EV Charging for Employees

Charging stations most commonly operate in one of two modes: Level 1 charging or Level 2 charging. Level 1 charging is most practical for residential use because it can run from a conventional 120 Volt outlet. Level 1 charging is commonly referred to as "trickle charging" and can take up to 9 hours to charge a hybrid vehicle or up to 17 hours to charge a fully electric vehicle. Level 2 chargers require a 240 Volt circuit, but can run at 5-10 kW and cut charging time in half. [1]

Idaho National Laboratory conducted a study of 35 charging ports at the Facebook headquarters in Menlo Park, CA. This study analyzed the use of charging stations with connections for Level 1 and Level 2 charging which were available to drivers at no cost. One of the findings of this study was that when given the option between equally available Level 1 or Level 2 charging ports, drivers opted for Level 2 charging on 98% of occasions.[2] The study concluded that Level 1 charging ports were primarily used when Level 2 charging ports were all occupied.



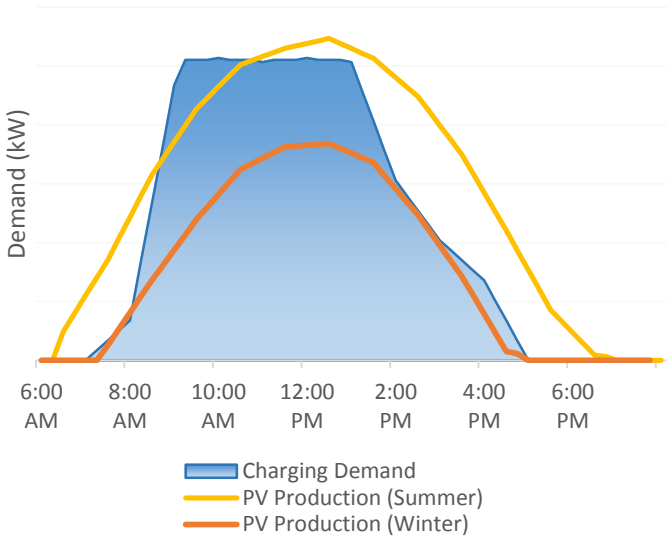
While Level 2 charging is the faster and more preferred method, it is also more expensive for the commercial building operator. A single charging port can add up to 10 kW of demand charges to the utility bill. Installing 100 EV Chargers in a typical commercial building, could mean a two-fold increase in the building's demand costs. Additionally, up to 3,000 kWh of energy per day is consumed by such a system mostly during expensive on-peak hours. The graph above may be used to visualize the impact of adding 100 Level 2 chargers on an existing demand profile. In some cases the building's electrical system has to be redesigned to be able to handle the higher loads.

First Pass Solution: PV Solar

A PV solar system, installed in the form of carports could be a simple solution to this problem. Assuming that we could guarantee that the sun would shine everyday, a PV system could fully charge the vehicles with minimal required use of on-site energy storage.

However, such a system would not be able to compensate for the additional demand charges. This Is due to the fact that in the early hours of the day, the PV system does not produce a significant amount of energy. The increase in demand charges is more pronounced during winter months as both capacity and timing of PV solar production is adversely affected by the low winter sun.

The demand profile of a building is often impacted so significantly that the utility company deems it necessary to change the utility rate plan to a more expensive tariff. In one study in the PG&E territory, after the installation of 100 EV charging stations, the demand level for the building was increased from 800 kW to 1,400 kW causing PG&E to change the rate plan from E-19 to the more expensive E-20 rate plan.



1. http://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-diego/fact-sheets/ResComm%20EVSE%20Permit%20Guidelines%20v3_Final_attach.pdf
2. http://evworkplace.org/wp-content/uploads/2014/07/INL-Workplace-EVSE-Utilization-AtFacebook-Jun-2014.pdf

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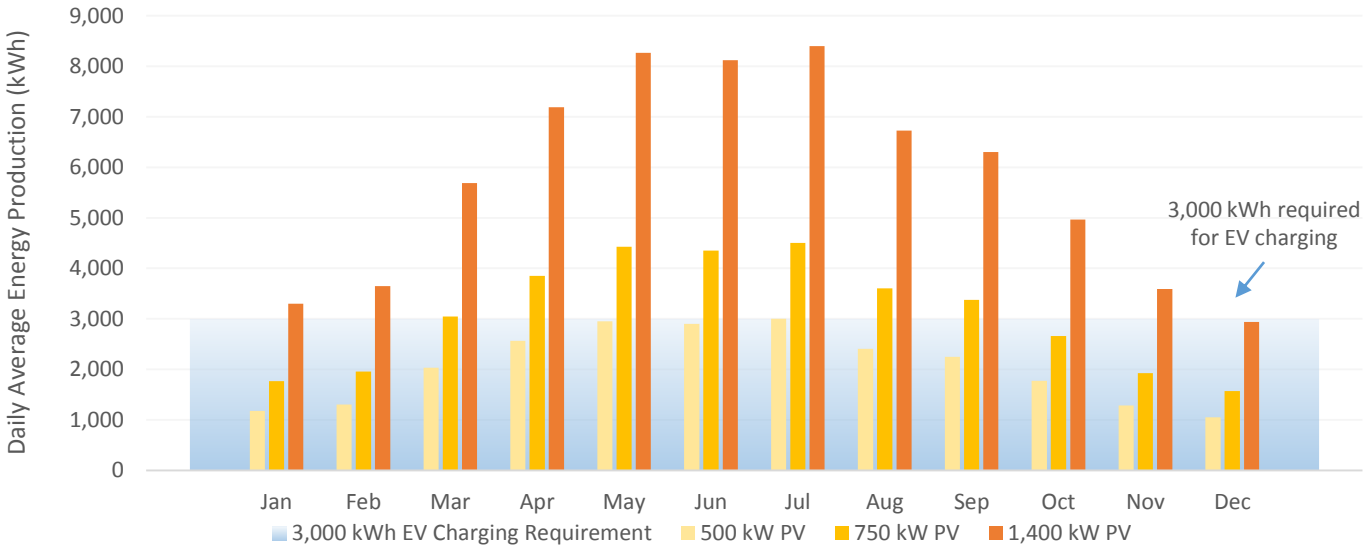
Enterprise EV Charging: PV Solar Combined with Advanced Energy Storage

Using a combination of PV and advanced energy storage can help the system owner to curtail the demand increases as well as the energy costs. The PV Solar system offsets or eliminates the kWh portion of the utility expenses brought on by the addition of the EV Chargers. The AES system, on the other hand, reduces or eliminates the kW portion of the utility expenses. The size of the PV Solar system and the AES system must be optimized to fulfill the specific business objectives of the utility payer.

PV System Sizing and the Parking Lot Space Requirements

EV Charging systems can be sized in a variety of ways depending on the goals of the end user. Consider an electric car battery that uses 30 kWh of energy for a daily charge . Installing 100 EV charging stations would require 3,000 kWh daily. This energy is depicted in blue on the graph below along with average daily production by month for three different PV system sizes in the San Francisco Bay Area.



Notice that the 500 kW PV system produces enough energy to balance the energy requirements only in the summer months. Such a system would require 2 to 3 parking lot spaces for every electric vehicle. A 750 kW PV system overproduces in summer months and yields a shortage during winter. However, when viewed over a one-year period, it produces enough energy to balance the energy requirements for the proposed EV charging system. A 1,400 kW system would produce 3,000 kWh daily even in the winter months. Available lot area could be a limitation for systems this size as they would require 5-10 spaces worth of coverage per electric vehicle.

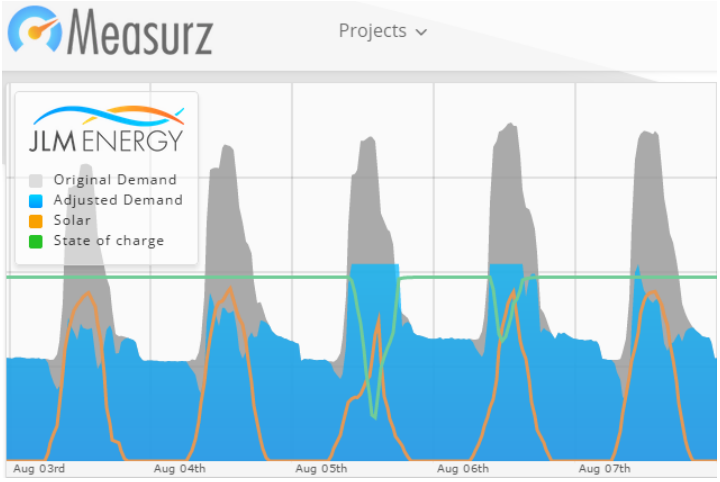
Enterprise EV Charging System Optimization

When sizing the PV solar and AES system for Enterprise EV Charging applications, several factors must be considered:

1. Total savings resulting from system installation
2. Return on Investment
3. Initial Investment
4. The size of the PV Solar system
5. The number of parking lot spaces taken up by the PV system
6. Incentives and Rebates
7. The relative cost of Energy and Demand
8. The cost and space requirement for the AES system

System Sizing and Benefits

To illustrate these factors, we use a sample building with a certain demand profile. A portion of the demand profile is shown in the diagram below. We used a typical value of $20/kW for demand charges and $0.10/kWh for energy charges. Originally, the facility had $612,110 of electric costs. The costs increased to $957,956 after the added demand and energy consumption from installing 100 EV charging stations; a more than 56% increase.



Using JLM's Measurz software platform, we compared the resulting electric costs after adding only a PV solar system and PV systems coupled with AES. The PV system reduces the net energy consumption, but on days with high cloud cover the PV Solar system cannot lower the monthly maximum demand. The AES system is then used to minimize the monthly peak demand and further lower costs. The payback periods were calculated after considering the SGIP Rebate of $1.75/Watt for the AES system, Federal Tax Credit of 30% for the PV system, and an additional 35% from MACRS depreciation.

In the case of our subject building , the smaller PV (500 kW) and AES (100 kW/200 kWh) systems reached faster returns on investment of 5.6 years, but could not fully eliminate the added electricity costs. For the same subject building, the largest system (1.4 MW PV + 800 kW/1600 kWh AES) eliminated 111% of the added cost, but had a slower return on investment of 6.35 years. The most financially attractive solution might be the solution combining 1400 kW of PV with a 400 kW/800 kWh AES system. This combination eliminated 101% of the added electric costs and would reach a return on investment in under 6 years.

PV Size (kW)	AES Size (kW/kWh)	Current Electric Costs	Electric costs after 100 EV Chargers	Electric cost with PV	Electric cost with PV and AES	% Savings	Total System Cost	ROI
500	100/200	$612,110	$957,956	$856,198	$832,438	36%	$2,103,500	5.59
750	100/200	$612,110	$957,956	$807,209	$782,949	51%	$2,978,500	5.68
1400	100/200	$612,110	$957,956	$684,699	$659,399	86%	$5,253,500	5.84
500	200/400	$612,110	$957,956	$856,198	$812,818	42%	$2,448,500	5.54
750	200/400	$612,110	$957,956	$807,209	$762,749	56%	$3,323,500	5.62
1400	200/400	$612,110	$957,956	$684,699	$638,199	92%	$5,598,500	5.78
500	400/800	$612,110	$957,956	$856,198	$790,858	48%	$3,138,500	5.80
750	400/800	$612,110	$957,956	$807,209	$739,309	63%	$4,013,500	5.79
1400	400/800	$612,110	$957,956	$684,699	$608,819	101%	$6,288,500	5.81
500	500/1600	$612,110	$957,956	$856,198	$758,798	58%	$4,153,500	6.96
750	800/1600	$612,110	$957,956	$807,209	$701,849	74%	$5,593,500	6.58
1400	800/1600	$612,110	$957,956	$684,699	$573,099	111%	$7,868,500	6.35

At JLM Energy, using our portfolio of renewable energy products, in addition to our sophisticated energy flow and modeling, hardware and software platforms (Gridz and Measurz), we look for optimized energy solutions to complex problems like Enterprise EV Charging.

Conclusion

Public electric vehicle charging stations are becoming faster and more commonly available, but these improvements also translate into added stress onto the utility grid and significant increases in the system owner's utility bill. Daytime workplace charging in particular creates demand when the utility grid is most impacted and when energy costs are highest to the system owner. Using renewable energy in conjunction with advanced energy storage provides an intelligent, cost effective and environmentally friendly solution for these complications. The PV panels produce energy to offset the consumption from charging the electric vehicles and the advanced energy storage can supply power to minimize the increase in instantaneous demand seen by the utility. This allows the owner of the charging station to provide this service at minimal added cost.

In an example case study of a 100 vehicle charging system, a compelling option was a 1,400 kW PV system paired with a 400 kW/800 kWh AES system which eliminated 100% of the added electric cost while reaching a return on investment in under 6 years. Most facilities will require an in-depth analysis to find a unique system to best fit it's profile. JLM Energy specializes in developing hardware and software products like Gridz and Measurz to find the optimal solution to any energy problem.

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