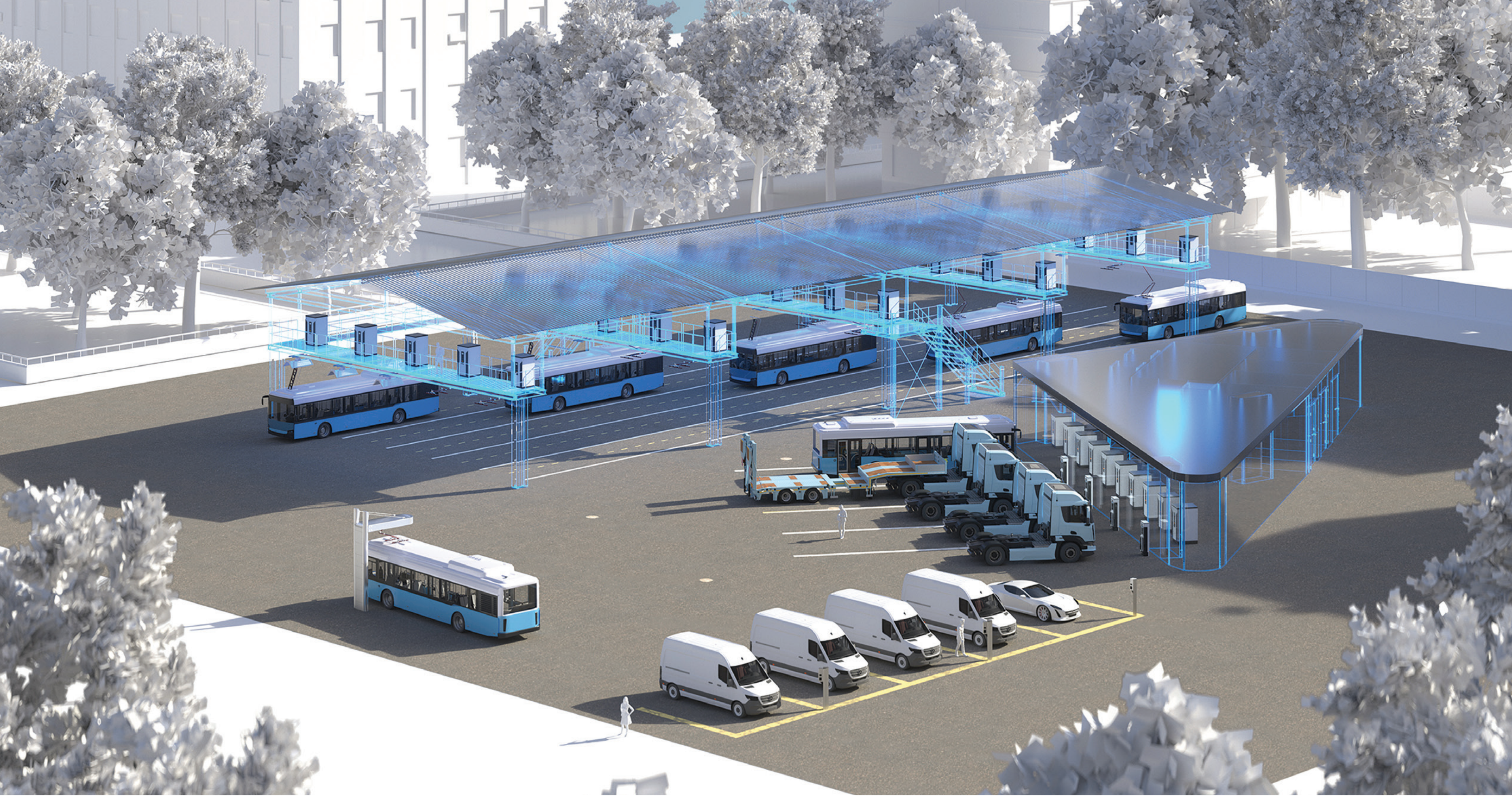

WHITE PAPER

Planning for Fleet Electrification – Determining what you really need

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Challenge

Fleet operators face a massive planning and analytical challenge as they electrify their vehicles. Companies need to know how to manage vehicle charging requirements, minimize costs, and rapidly deploy in the face of utility interconnection delays. Also, companies need to understand how to retain flexibility to meet evolving business needs and evolving technology.

Planning to help maximize the investment

Planning for your fleet electrification is critical to your success. Looking beyond the vehicle and considering the charging infrastructure, including power distribution requirements, will help you make the most cost-effective implementation decisions so you can best optimize your investment.

Siemens has developed an effective planning tool that models prospective electrification. This model can project cost comparisons between various charging strategies, power requirements, and number of chargers needed to optimize vehicle charging schedule/needs. It also identifies which chargers will result in the lowest possible cost while achieving the operational strategy and provides an assessment of the fleet/facility cost savings potential.

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The Siemens model was applied to an actual site in San Diego, California (model by Brian Basila, 2020) In this case the model evaluated three major cost drivers: electricity cost, utility interconnection cost, and capital cost.

Parameters evaluated were load management, load balancing, load shifting and also San Diego Gas & Electric's Time-of-Use tariffs, which include a Super Off-Peak rate from midnight to 6 A.M. Siemens selected the lowest-cost tariff available within the given charging constraints.

In this study, the following constraints were assumed:

- ✓ Vehicles to be fully charged by 6 am each day
- ✓ Charging to begin no earlier than 10 P.M. for overnight charging session
- ✓ Battery capacity of 125 kWh
- ✓ Minimum reserve of 25 kWh before return to depot
- ✓ 100 kWh average energy used per day
- ✓ Maximum charging speed of 50 kW

In the model, Siemens evaluated two scenarios: 1. Single daily shift operations; 2. 2-shift daily operations.

Of note: vehicle, charging, and delivery routes all place limits on charging that must be addressed in developing the optimal strategy. Further, the operation and vehicle constraints are key inputs into the charging technology selected. Two basic approaches are available: Level 2 AC charging and DC Fast Charging. The former can be delivered at up to 19 kW in the U.S., so a 100-kWh charge can be done in slightly over five hours. DCFC is typically 50 kW or higher. At 50 kW, the same 100 kWh is reached in approximately two hours.

Results of this model indicated that, in a single-shift environment, the client should utilize a basic approach, installing a Level 2 AC charger for each vehicle. However, DC fast chargers are the preferred approach if the company wishes to future-proof by retaining the option of having a second delivery shift each day. Under this option, the cost per shift is lower, and the number of delivery routes can be significantly increased.

Capital cost vs speed

AC chargers charge more slowly but are also less expensive. In our study, the AC charger cost assumption was $2,000 per vehicle (one charger per vehicle), with the DCFC cost assumption being $18,000 per plug (one charger per four vehicles). The DCFC advantage is the flexibility and charging speed needed to enable a second delivery shift per day, should that be needed.

Electricity costs

Electric delivery vans are expected to have the same duty cycles and package-carrying capacity as current, fossil-fuel vehicles. The element that establishes the fundamental operational and logistical change is the fueling/charging strategy in combination with on-board electric storage capacity.

While capital costs for chargers are substantial, electricity can make up over 90 percent of an EV's lifetime cost. A utility's peak-demand charges can make up 50 percent or more of the electric cost. Therefore, managing peak demand is essential in controlling the Total Cost of Ownership (TCO).

Big Picture All Level 2 AC Charging		Big Picture DC Charging w/2nd Shift	
Number of Shifts Taken by the EVs (10 years)	1,460,000	Number of Shifts Taken by the EVs (10 years)	2,920,000
Lifetime Cost of Siemens EVSE Solution	$42,664,000	Lifetime Cost of Siemens EVSE Solution	$77,364,000
Cost per Electric Vehicle Shift	$29.22	Cost per Electric Vehicle Shift	$26.49

Table 1. Single-Shift AC Charging versus Double-Shift DC Charging

Electricity rates, including demand charges, depend on the utility tariff available to the facility. Many utilities offer off-peak demand incentive options

Under the two basic scenarios in Table 1 – all Level 2 charging vs. all DCFC in a single shift – electricity costs are the same. This is because both the total kWh and peak demand are the same for both options. In the case where a second shift is added, total kWh goes up to support the added vehicle mileage each day. Demand charges are also higher, because an additional demand charge is assessed by SDG&E during the summer for peak demand during the peak afternoon hours. The demand during each hour is shown in the load profiles in Figures 1 and 2.

In Figure 1, the overnight charging assumption for all vehicles is that vehicles are charging between 10 P.M. and 6 A.M. The load profile assumption in Figure 2 includes a second daytime shift, charging vehicles between 4 P.M. and 7 P.M.

Utility interconnection cost

The last major cost driver in EV charging is utility interconnection. In this study, the peak demand is 5,000 kW, or 5 MW. Few existing utility sites have the capacity to interconnect such a large load without some utility investment in the local grid. The cost varies widely and can range from a few hundred thousand dollars for a service supply extension to the need to install a new substation bank with a potential price tag of tens of millions of dollars.

Siemens assumed a cost of

$264k per MW to add new conductors, a typical industry cost. The resulting interconnection cost of less than $1.5 million is a small percentage of the ten-year lifetime TCO. (Time is another key factor; it is not uncommon to see six-to-twelve-month delays resulting from permitting or utility construction schedules.)

Various funding options are available to mitigate the interconnection cost. First, utilities provide an interconnection funding allowance based on the forecast kW and kWh load over the next several years, the higher the load, the higher the utility revenues, and the higher the allowance. For a long-term, seven-to-ten-year commitment, the allowance could cover the entire cost, depending on the upgrade required.

Optional battery storage, or on-site generation, could be added as a non- wire's alternative. In this study, Siemens considered only the former.

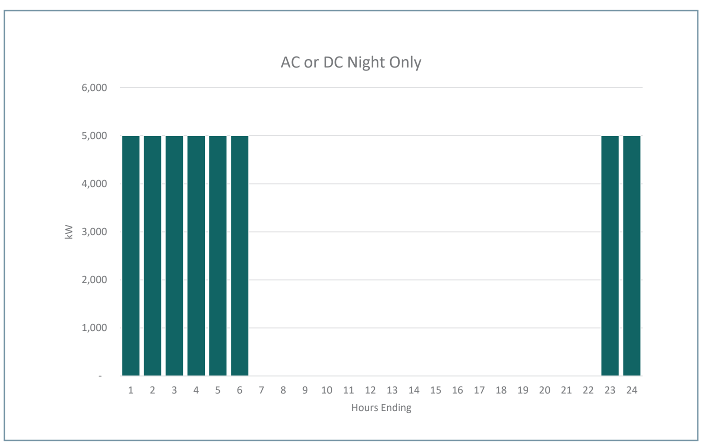

Figure 1. AC vs DC charging

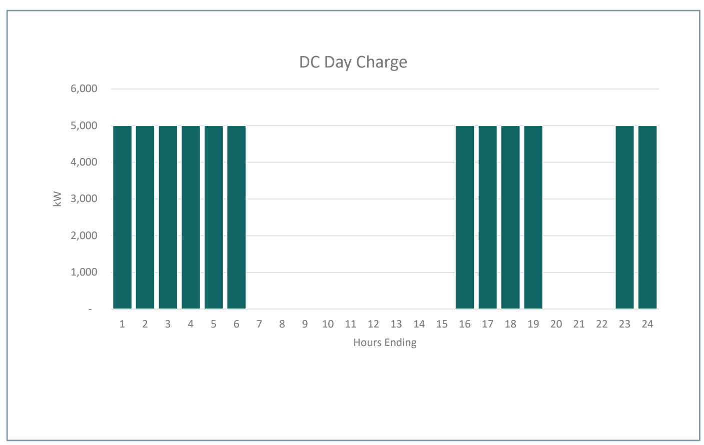

Figure 2. DC Daytime Charging

Battery storage

Battery storage is used by many utility customers to manage high peak demand charges, including in some EV charging use cases.

Here, Siemens analyzed storage and found it does not make economic sense. The main reason is that the load profile is flat. It was not economic, even in the two-shift case. Storage is most advantageous where there are very high peaks lasting only an hour or two.

Storage also could make sense as an alternative to a very expensive utility interconnection. Again, this situation was not the case here.

Best practices

The Siemens' model provides a rigorous analysis that achieves the lowest TCO. Siemens recommends fleet operators do the following:

- ✓ Assess a wide range of operating and technology scenarios
- ✓ Incorporate fully the implications of technology choices on future flexibility
- ✓ Account for the interactions between tariffs, business processes, utility interconnections, and available non- grid alternatives
- ✓ Be not only site specific, but also strategic in the context of the Company's overall objectives

Fleet electrification requires detailed planning. Using planning tools and modeling analysis can help simplify decision making, as well as better planning for capital and operating investments. Partner with Siemens to help make the transition smoother, so together we can build a cleaner, more electrified future.

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