33rd Electric Vehicle Symposium (EVS33)
Portland OR, USA, June 14 - 17, 2020

Achieving 'Electric Car Charging in Every Parking Spot' with Modular Cabling System: Case Studies

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Summary

We discuss a novel approach to provide electric vehicle charging in every parking place using a modular cabling system and plug-in smart chargers. This solution addresses pain points of property owners and offers tenants convenient and affordable service options. Case studies in a variety of building types and regions demonstrate increases in electric vehicle adoption, property values and client satisfaction.

case-study, smart charging, electric vehicle (EV), electric vehicle supply equipment (EVSE), load management

1 Introduction

While most EV charging efforts have lately centered around long distance driving, 90% of daily use is actually less than 30 miles (Pasaoglu 2012). These are trips to work, shopping, in the city: everyday living. For this we do not need superchargers where it is necessary to drive to the charging stations. Instead, a more practical approach is to have large numbers of low-cost, relatively slow chargers wherever cars are normally parked, at work, at home, in commuter parking, or the mall. When done right it is quite convenient to the EV driver. Just plug in when normally parking--no need to spend time to go to a high power charging station.

EV charging then becomes the next utility, like high speed internet or plumbing. It is not hard to imagine that EV readiness will be a requirement in the near future. When charging is available in an everyday context, people are then more likely to switch to an electric car, as its usage costs are lower and the ride is quieter and cleaner. This consequently adds to the demand for more parking with charge access.

The biggest challenge to property owners has been the high cost of charging and associated cabling systems. Large expenses for equipment, installation, maintenance and expansion mean less is spent on fewer charging points. This tends to make the cost and convenience to EV drivers unfavorable, and results will be inadequate even after best attempts by the real estate owner.

The Parking Energy solution is a modular system that separates cabling from the smart charging and contains enough intelligence to work with existing infrastructure. It is the ideal solution for the life cycle of both

retrofit and new construction. A standardized approach has allowed Parking Energy to run the same systems, both hardware and software backends in multiple locations worldwide, with minimal modifications in the backend for regulation and language differences.

In this paper we examine a large office building and public parking garage in Finland, a parking lot and an EV manufacturing lot in Germany, an office / research building in Japan, and a planned condominium complex in California. We also present the Parking Energy business ecosystem that allows partners and contractors to benefit from the work done so far.

2 System Design

The Parking Energy approach separates cable installation, which is relatively simple and long-lasting, from charging hardware, which is complex, expensive and quickly obsolete. Property owners make an initial, one-time investment to bring electricity to each parking place in their garage. Chargers are then easily added with a quick connection system as tenant demand grows, and service fees are paid by consumers. Additional layers round out the service offering - web and mobile apps, billing and monitoring, building integration, metering and load management.

Table 1: Rationale for separating cabling from charging stations

	Cabling	EV Charging station
Lifespan	30-50 years	5 years
Technology complexity	Low	High
Cost structure	Large overhead, low cost per parking space	Cost is mostly linear to the number of parking spaces equipped
Who should pay for the investment	Property	EV Driver
Fits into the real estate owners' mindset	Yes	No
Cost	300-700 EUR/parking space, inversely proportional to the number of parking spaces	To buy - a few hundred euros To service - 15-40 EUR/month

Figure 1: Cable network vs. Charging service

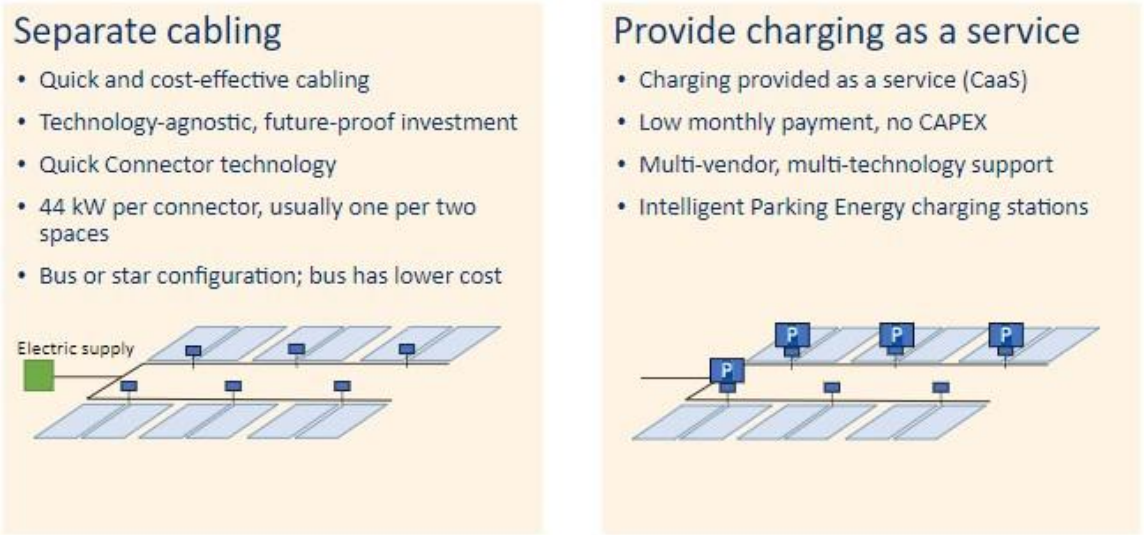

Figure 2: Plug and play charging station

3 Case Studies

3.1 Office Building in Finland

EV charging readiness was implemented in 238 parking spots. The cost of the installation was $415 per spot. Even though this was a new building, EV charging was not included in the original electrical plan. For this reason, the electrical main board had to be extended. This extension was about one third of the cost, with the rest split between equipment and installation. A small number of charging units were installed initially. Once the few office workers with electric vehicles began charging with them, interest grew among colleagues and the collective experience inspired further EV ownership. Because of this experience, company car policies were changed to favor electric vehicles. In the next two years the real estate owner also ordered the system for nine other buildings and now plans to add two more.

3.2 Public Parking Garage in Finland [EuroPark]

In this case a large underground parking facility operator wanted to serve their customers with EV charging. They initially ordered a few chargers from multiple charging providers to discover what people prefer. The facility is in the Helsinki city center and is used by office workers during the day, shoppers in the evening and residents at night. The Parking Energy (PE) system stood out in ease of use and low price. While the PE system was expanded three times due to demand, there were also differences in usage. Chargers were installed with three capacities: 3.7 kW unit, 7.4 kW and 22 kW. The electricity price was the same between the units at 20% above cost (lower than competition), but the 22 kW unit incurred an additional $0.02/minute charge, while the lower end units had no time charge. Even if the time charge was low, clients overwhelmingly opted for the lower power units, presumably due to a psychological price barrier. This is understandable, as most users leave their cars charging for more than six hours, so the speed is largely irrelevant. EuroPark now has Parking Energy system in all seven Helsinki city center garages, and there is a constant pressure to add more stations.

3.3 Outdoor Parking Lot in Germany

In this case a small office park installed quick connectors and chargers in their parking lot. German and Finnish electrical systems operate at the same 240V 3-phase levels. The phases are alternated in the quick connectors to even out the load during single-phase charging. Other issues included a different VAT base, localization of client software app, configuring a reliable data connection, and limitations in electricity-based charging with complex national ‘weights and measures’ regulation.

3.4 EV Manufacturing Lot in Germany

This case is a long-term storage lot for new electrical vehicles waiting for delivery. Cars should be delivered fully charged, so a continuous electrical supply with monitoring was desired. The PE 3.7 kW unit seemed appropriate, and after lengthy field testing the client confirmed this solution. The major benefit is

the ability to charge a very large number of vehicles at low speeds with a relatively low-powered electrical system. It precludes installation of a new and costly electrical feed to the storage lot.

3.5 Office / Research Building in Japan

In the Japanese pilot site, the available electricity was split-phase 200V 50A, yielding 10 kW. The connector used was a standard Japanese 'dryer' plug. Parking Energy Quick Connector can be used both in Delta and Star connected electrical systems as well as split-phase systems. The only difference between them is the wiring configuration inside the charging station and the location of a notch key in the connector plug, which varies according to the local system. This allows same connector product to be used in mixed electrical system countries such as United States, where both 3 phase and 1/split phase are commonly used. The Japanese translation of the app and minor issues with reliable network connectivity were the only issues. The pilot project was not used for electricity billing so the Japanese tax accounting rules are, as of this writing, unclear to us.

3.6 Condominium Complex in California (planned)

A condominium complex under construction in California was evaluated for potential pilot installation; this is still pending. The contractor plans to bring 208V 3-phase cabling to all parking spaces in the garage. In this case we proposed using quick connectors in Delta configuration, with 208V per phase and a maximum of 63 amps per phase. The regulatory and liability environment is more complex in the US than internationally, but can be solved with some effort. There is a large and growing demand for flexible and affordable EV charging solutions in the US, driven by both market demand and changes in building codes.

4 Cost Comparison on EV-readiness investment costs

The Parking Energy modular cabling solution provides EV-readiness. Once the charging unit is installed on top of the quick connector the parking spot can be used for charging. This contrasts with other solutions: (a) chargers are installed without prior preparation (direct charger installation), (b) cabling is installed but not connected to anything (make-ready), or (c) a single vendor is contracted to install chargers on demand (charger-ready).

Whereas purchase cost data for charging stations, especially so-called wall boxes, is widely and publicly available, data on concrete investment costs for equipping parking bays with cabling is rather elusive. In Table 1 we present a brief overview based on three sources (see footnotes). This covers both wide variety of equipped parking bays (1-243 per parking lot) as well as all four readiness levels. The EV-ready column is representative of the cases studied in this paper.

Table 1. Average investment costs per parking bay for major EV readiness approaches

Cost type	**Direct charger installation***		**make-ready***	**charger-ready****	**EV-ready*****	
Preparation	$0	$0	$1 750	$3 850	$920	$415
Charger installation	$3 525	$2 180	$1 830	$0	$0	$0
Subtotal	**$3 525**	**$2 180**	**$3 580**	**$3 850**	**$923**	**$415**
Charger (7.4-22kW)	$2 000	$2 000	$2 200	$2 200	$1 485	$1 485
Total	$5 525	$4 180	$5 580	$6 050	$2 408	$1 900
Number of bays	1	5	5	243	28	238

* Agenbroad, 2014 / ** Soller, 2019 1€=1.1US$) / *** Suonsivu et al., 2017; charger costs maximum for 22kW outlet

Both direct charger installation and make-ready schemes plan for 7.4kW charging stations (Agenbroad, 2014). The charger-ready scheme aim for 22kW charging station (though less powerful wallboxes are possible). In contrast, the EV-ready approach covers all charging stations from 2.3kW up to 44kW. The investment cost values in EV-ready cases (Table 1) are based on the more expensive 22kW charging stations offered by Parking Energy.

Interestingly, the EV-ready solution has the lowest total costs while keeping initial readiness costs highly competitive.

5 Conclusions

Several key selection factors drove decisions to deploy the Parking Energy design: low cabling and investment cost, flexibility and choice of chargers, future-proof hardware options, intelligent energy management, and “hands off” support from the vendor after installation.

At a Finnish office garage, the quick connector enabled accelerated EV adoption (>15% in June 2019) and improved acceptance in the market, becoming the preferred choice of early adopters.

It is early in the evolution of EV lifestyles, so there is not much data yet on market value of EV-ready parking places. We predict these will become a desirable feature in the near future, commanding a premium price. Many people want to enjoy the benefits of electric mobility and will choose to own one when conditions are favorable.

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Author

Johannes Helander has 30 years experience in real-time, embedded, and operating systems software design and research. He has over 30 each of patents, peer reviewed publications, public demos, and invited talks. He has worked as a researcher at Aalto University, Microsoft Research Redmond and Germany. Recently he has been involved in multiple startups, working on solving real-world problems in intelligent energy use with software and entrepreneurship. Johannes serves as the Director of Research for Parking Energy Ltd., and is helping establish US operations.