

Electric Vehicle Charging Solution for Smart Cities

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OVERVIEW: Innovation based on the use of smart grids (next-generation electric power networks) is being pursued internationally in concert with the “Green New Deal” measures proposed by the Obama administration in the USA in 2009. In particular, smart cities are seen as representing a next generation of geographically localized energy and infrastructural systems. Smart cities are attracting attention for offering a new environmentally conscious form of urban living. Hitachi is pursuing a growth strategy for the global market based around its Social Innovation Business, and in April 2010 established the Smart City Business Management Division to create a range of solutions, starting with proposals for demonstration trials. EVs are an important element of the urban functions that make up a smart city. Hitachi has developed a solution for the management and operation of EV charging systems which it has already deployed commercially, and is working on the development of further new solutions.

INTRODUCTION

EVS (electric vehicles) fitted with lithium-ion batteries went on sale in 2009. With features that include being powered by electric motors that do not use fossil fuel and with longer range than past EVs fitted with lead-acid batteries, these EVs are expected to play an important role in the action being taking on global environmental problems.

EV charging systems are one of the requirements for the wider adoption of EVs. Fast charging systems and their associated products and solutions are becoming an active field of development at many companies, underpinned by the setting up of the CHAdeMO*¹ Association in March 2010 to establish a common standard for EV charging systems in Japan.

Because fast charging systems supply a large amount of electric power (up to 50 kW) to an EV battery in a short period of time (15 to 30 minutes), it is necessary to consider what effect their installation and operation will have on the electric power grid and associated electrical equipment.

There is also a need to put in place the charging infrastructure required for wider use of EVs in the future. Meanwhile, issues that are still to be resolved include network management of charging units installed by various operators around the country and the construction of systems for charging unit user identification, billing, and payment.

Hitachi’s EV charging solution has been developed in response to these requirements. The solution includes the development of a charging unit based on power electronics technology as well as the

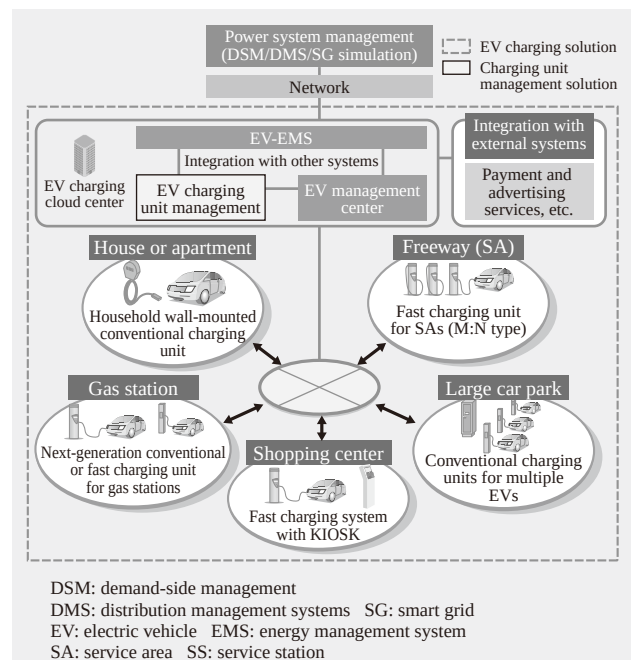


Fig. 1—Overview of EV Charging Solution.
Hitachi can offer a range of different charging units to suit different sites. Total business coordination is achieved through integration with external services (such as payment and advertising distribution) and a charging unit management solution.

*1 CHAdeMO is a trademark of the CHAdeMO Association.

management and operation of charging units based on control and information technology and a charging unit management solution that provides user services (see Fig. 1).

This article gives an overview of the charging unit management solution together with an example of an early commercial application and an update on current product development work being undertaken to create new solutions.

EARLY APPLICATIONS OF CHARGING UNIT MANAGEMENT SOLUTION

Overview of Project for Providing Extensive EV Infrastructure in Okinawa

The charging unit management solution is already in operation.

A rental car business using EVs was launched in Okinawa Prefecture, Japan, in February 2011. The plan is to have 50 charging sites operating in Okinawa within three years and 100 by 2020.

The charging infrastructure project is being run as the Advanced Energy Company, which was established with investment by 26 companies, including a number of local Okinawan companies. The company selected Hitachi's charging unit management solution as the management system for medium and fast charging units used in the project.

Business Model and Key Solution Functions

The charging unit management solution issues rental car users with identification (a smartcard identifying the holder as a rental car user), which is used to link in with user identification, billing, and payment.

The objectives of this business are industrial revitalization resulting from users driving their EVs to tourist and commercial destinations around the prefecture, and to achieve zero emissions on the island by eliminating the use of fossil fuels (see Fig. 2).

The main functions of the service in its current form are as follows.

- (1) A comprehensive integrated maintenance service with 24-hour/365-day monitoring of the charging units and a call center for help with breakdowns, recovery, and inquiries
- (2) A billing model which calculates fees based on the number of times the service is used
- (3) KIOSK (terminals used to access various services) for operating the charging units
- (4) Ability to perform remote operation (halting or restarting) of the charging units

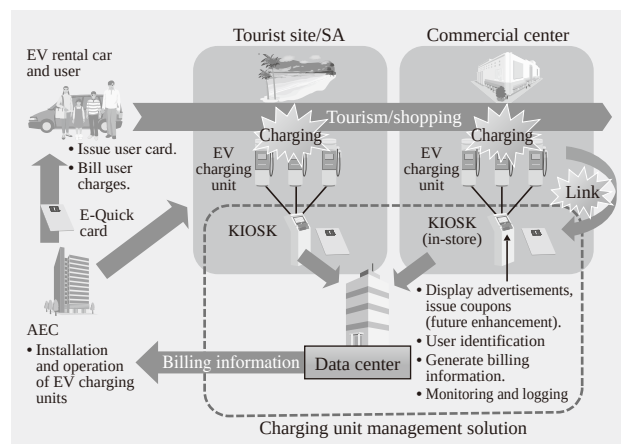


Fig. 2—Overview of EV Infrastructure Provision in Okinawa.

It will be possible in the future to implement models that incorporate a wide range of different services by linking the use of charging unit with the use of a KIOSK.



Fig. 3—KIOSK Operation.

The user holds the identification card over the smartcard reader in the KIOSK. Charging starts after the user's identity is verified and ends when the specified amount of charging has completed.

Based on these functions, the service's features include providing directions to retailers equipped with a KIOSK to create opportunities for users to go shopping while their vehicles are recharging. It also links in with information services for tourism and other information (see Fig. 3).

The aim is to further improve user convenience by linking to vehicle-mounted data terminals in the EVs to provide information, such as the location of charging units or where to find one that is not in use (trial service).

Future Challenges and Outlook

This model is an early example of a private-sector EV business.

A challenge for the future is to establish a model that encourages shopping or tourist activities through integration with other services, such as those for

issuing coupons or distributing advertisements to KIOSK when users use the charging units.

Moreover, the plan is to extend the model so that it creates new value as an environmentally conscious EV business by analyzing logs of user data, such as the status of the batteries in each EV, car parking availability information, and reservations, and then using this to provide feedback.

CHARGING UNIT MANAGEMENT SOLUTION

Objectives of Charging Unit Management Solution

The scope of the charging unit management solution extends beyond individual units, and its development is proceeding with the aim of creating a new business model that combines IT (information technology) with infrastructural systems through links to EMSs (energy management systems) as well as EV onboard information.

Features of Charging Unit Management Solution

The solution has the following features.

(1) A comprehensive set of basic functions for charging unit management

Basic functions include user identification, billing, and payment. The system can also be customized for other cards such as the “house cards” (store-issued credit cards) that users already hold or e-money smartcards that are widely used for ordinary transactions. Other capabilities include monitoring and logging, as well as calculating the time required for a full recharge (which in the case of a fast charge means charging to 80% of capacity) based on the SOC (state of charge) of the EV’s batteries.

(2) System is independent of charging unit supplier

Because the charging unit management system operates independently as a supervisory system, it can provide consistent operation and other functionality even if the network contains a mix of different charging unit models. This gives it the flexibility to cope with future expansion or other changes such as replacement of charging units.

(3) Service platform is designed for operational efficiency.

The system uses middleware that complies with the OSGi^{*2} (open services gateway initiative) framework for Java^{*3}-based service platforms, which

allows operations such as adding software functions to multiple KIOSK located remotely to be performed as a single operation.

(4) Integration with existing commercial systems

The introduction of charging units can be tied in with promotions through links to commercial systems such as service terminals (terminals used for functions such as loyalty points or the display of store information or advertising) installed in department stores, shopping centers and convenience stores.

(5) Integration and expandability for creating the next generation of smart cities

Plans include integration with centers used to manage systems such as EMSs or for on-board information on EVs, and with charging units that use photovoltaic cells or other forms of renewable energy.

PRODUCTS THAT SUPPORT FUTURE SOLUTIONS

In the future, Hitachi will work hard to reduce the cost to users of introducing the charging unit management solution as well as operating it as a cloud-based service to make it more reliable.

For its overall EV charging solution, Hitachi’s plan is to supply higher quality solutions by coordinating the overall charging infrastructure while also proceeding with development of its own charging units.

The following sections give an overview of fast and conventional charging systems that are currently under development.

Fast Charging System

To date, a total of 570 fast charging units have been installed in Japan (as of February 24, 2011, based on figures from the CHAdeMO Association).

Of those charging unit manufacturers that have led the market in releasing charging units, most offer units designed for use with one EV at a time. However, as EVs proliferate in the future, it is anticipated that there will be a growing demand for the ability to charge multiple vehicles at once.

To satisfy this requirement, Hitachi is currently developing a charging unit able to charge a number of EVs at a time, and an outline of its system structure is shown in Fig. 4.

Conventional Charging System

It is forecast that the proportion of EVs in the vehicle fleet will reach 5% (about 2.2 million vehicles) by 2020. While it is also expected that charging units will be installed in various locations as the use of

^{*2} OSGi is a trademark or a registered trademark of the OSGi Alliance in the United States, other countries, or both.

^{*3} Java is a registered trademark of Oracle and/or its affiliates.

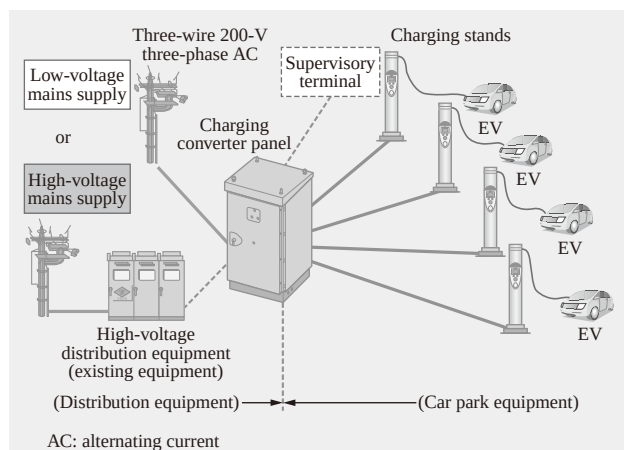


Fig. 4—Configuration of Fast Charging System for Multiple EVs. The converter panel and charging stands are separated to reduce the system size and make better use of space in the charging area. The system can select either fixed- or variable-capacity charging (outputs the charging capacity based on what the user requests).

EVs becomes more widespread, most of these will be conventional rather than fast chargers (2 million by 2020)⁽¹⁾.

The status of product development of conventional charging systems at Hitachi is as follows.

(1) Conventional charging systems for multiple EVs.

Currently, it takes approximately eight hours for a conventional charging unit operating at 200 V/15 A to charge a typical commercially available EV. For sites such as large apartment buildings or public car parks, and for commercial vehicles that are only used during the daytime, there is strong demand for the ability to charge multiple EVs simultaneously without exceeding the contracted level of power supply. To satisfy this demand, Hitachi is developing a charging unit that utilizes the CCIDs (charge circuit interrupt devices) fitted to charging cables to control the charging current supplied to each EV, and adjusts these so as to keep the total power within the contracted maximum (see Fig. 5).

(2) Slim conventional charging systems

If EVs are adopted more widely by ordinary consumers in the future, there will be a need to develop special-purpose charging units for home use.

Hitachi Cable, Ltd. released a conventional charging system with a slim design for home use in December 2011. To allow for interoperation with a household energy management system, Hitachi is also investigating a function for using an eco-mode switch (that performs charging at lower than the current requested by the EV) (see Fig. 6).

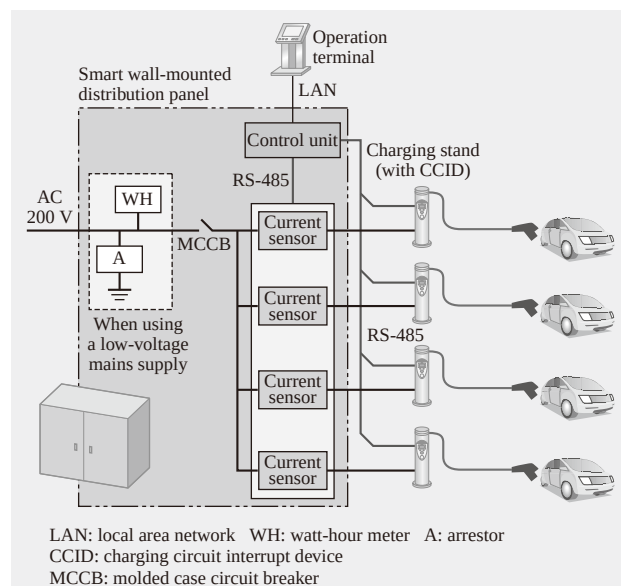


Fig. 5—Configuration of Conventional Charging System for Multiple EVs.

The system includes a function for efficiently controlling the current supplied to the EVs to keep it within the contracted level of power supply.



Fig. 6—Slim Conventional Charging Unit.

The charging cable is designed for general consumer use and is made of lead-free materials (polyvinyl chloride). The conductor design and internal structure use proprietary technologies to provide flexibility with ease-of-use.

Meanwhile, Hitachi Consumer Marketing, Inc. handles the sale of charging units, installation of 200-V power supplies, servicing, and maintenance. Through its nationwide channels, the company has retained the services of many electricians with the proper qualifications for installing power supplies and it is calling on the overall capabilities of Hitachi to support the establishment of charging infrastructure.

CONCLUSIONS

This article has given an overview of Hitachi's charging unit management solution together with an example of an early commercial application, and an update on current product development work being undertaken to create new solutions.

Hitachi's EV charging solutions are currently building a solid track record, having been chosen for use in the Yokohama Smart City Project and a smart community project in Spain [New Energy and Industrial Technology Development Organization (NEDO)].

Through these projects, Hitachi aims to deploy advanced solutions such as integration with DSM (demand-side management) of the power system and the use of smart grid simulations for preliminary study and analysis work including analyzing the

impact on the electric power grid when considering sites for installing charging units as part of the urban planning process.

In conducting urban planning in the future, the provision of infrastructure for charging EVs will have an increasingly important role as a new type of social infrastructure platform.

Hitachi views EV charging solutions as being an important part of support for smart cities and aims to create new value in the future.

REFERENCE

- (1) The Study Group on Next-Generation Vehicle Strategy, Ministry of Economy, Trade and Industry, "Next-Generation Vehicle Strategy 2010," http://www.meti.go.jp/english/press/data/20100412_02.html

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