EV Charging Infrastructure System That Facilitates Commercialization of EV Charging

ABE Tsuyoshi

Abstract

One aspect of the commitment to achieving a sustainable society involves the promotion of electric vehicles (EVs) worldwide. However, encouraging the uses of EVs requires the construction and expansion of an electric vehicle charging infrastructure - which will lay the groundwork for further popularization. Having developed an EV charging controller that helped drive the development of EV charging infrastructure from tentative experiment to the level of practical application, NEC has now built a complete commercial EV charging infrastructure system featuring IC card user authentication/billing and electronic money billing functions, as well as remote operation monitoring and electric charging control. This paper describes the system developed by NEC and looks at a case where the system has been introduced.

Keywords

sustainable society, electric vehicle, charging, billing, cloud

1. Introduction

Electric vehicles (EVs) are expected to play an important role in global efforts to help offset global warming and particulate matter (PM2.5) pollution and their use is being promoted worldwide. However, in order for EVs to truly succeed in the mass market, it is essential to build a qualitative mechanism that can be maintained and managed for years to come, as well as to dramatically expand available EV charging infrastructure by installing chargers in as many locations as possible. To meet this challenge, NEC has built a commercial EV charging infrastructure system designed to facilitate operation of EV chargers as a business.

More specifically, we have developed an EV charging controller that connects existing EV chargers to the network. By linking this with NEC's cloud server systems, we can offer IC card user authentication/billing and electronic money billing functions, as well as remote operation monitoring and control, supporting flexible payment options and uninterrupted, continuous operation 24 hours a day, 365 days a year.

We have also developed a system that is capable of distribution, cooperation, and management of a few hundred chargers using multiple EV charging controllers. This makes it possible to install large numbers of chargers in the parking lots of large commercial facilities. This gives EV drivers the convenience of being able to park anywhere and charge their vehicle, while providing the facility managers with improved control, such as being able to set limits on the amount of electric power that can be used simultaneously.

So far, our efforts in this area have been rewarded with high evaluations. For example, in January 2015, our system was installed on the 2nd floor basement parking level (with 125 chargers) of the Tokyo Midtown commercial complex and has been operating successfully ever since.

This paper discusses the deployment of NEC's EV charging infrastructure business and describes our commercial EV charging infrastructure system, which is now being deployed by NEC to help promote commercialization of the EV charging infrastructure.

2. Deployment of EV Charging Infrastructure

Now past the launch phase, the installation of EV charging infrastructure is now experiencing rapid expansion (**Fig. 1**). Japan's Ministry of Economy, Trade and Industry has set a target for installation of 5,000 quick chargers and 2 million standard chargers by 2020. This goal is being supported by government

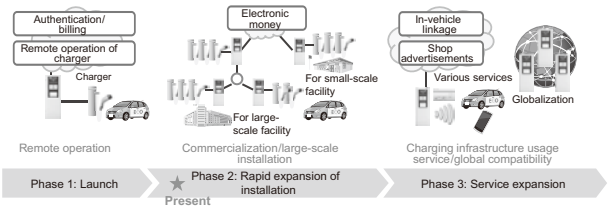

Fig. 1 Deployment of the EV charging infrastructure.

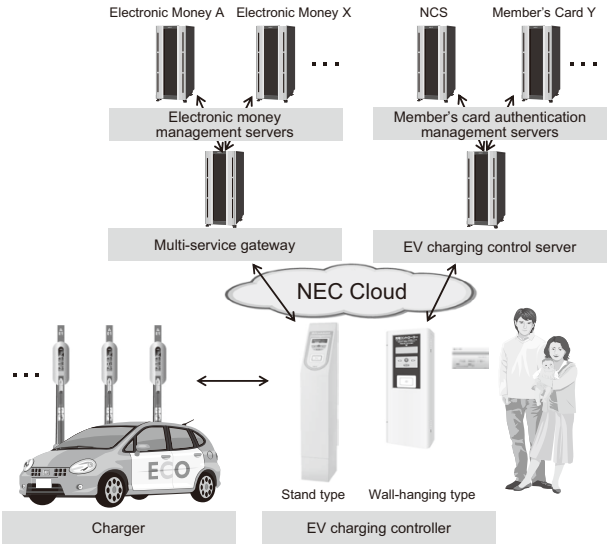

Fig. 2 Overview of the EV charging infrastructure system.

subsidies and cooperation between the state and major automakers. As a result of this effort, we are now witnessing gradual establishment of large-scale installation projects on highways, at convenience stores, and in large commercial facilities.

As an industry-leader right from the very beginning of the launch phase, NEC is paving the way for widespread installation of EV chargers by using its experience and technological expertise to commercialize the EV charging infrastructure and develop systems suitable for use in large-scale facilities. Looking farther into the future, NEC is getting ready to deploy these systems on a global level, while leveraging its experience in comprehensive communications technology and social infrastructure to create new services that support and transcend EV charging by adding new value to the deployed charging infrastructure.

3. Commercial EV Charging Infrastructure System

The overall configuration of NEC's EV charging infrastructure system and the functions that it offers are described below (**Fig. 2**).

(1) Charger

A device to transmit electricity in an EV, the charger comes in two types - standard charger and quick charger. Those two types have different charging connector configurations and charging speeds. They are already available from various manufacturers.

(2) EV charging controller

This device offers the following four functions.

1) Controlling the charger

Comprehensive management of charging operation is possible when all chargers are connected to the network. Connection of the chargers is possible when they are set to conform to a simple communication protocol (charging start/stop, suspension/restart, status notification, etc.) defined by NEC. This system allows the chargers listed in the **Table** to be controlled remotely from the EV charging controller. One controller can directly control up to 30 chargers.

2) User interface

An interface is provided to enable customers to start and stop charging (**Fig. 3**).

All operations - from controlling the connected chargers to reading user cards and handling electronic money - which are for charging payment - are integrated in this interface to assure smooth operation.

Table List of compatible chargers.

	Manufacturers of compatible chargers
Quick chargers	JFE Engineering Takaoka Toko Nichicon Nissan Nippon Steel & Sumikin Texeng Hasetec Fuji Electric
Standard chargers	NEC Toyota Industries Naigai Engineering Panasonic

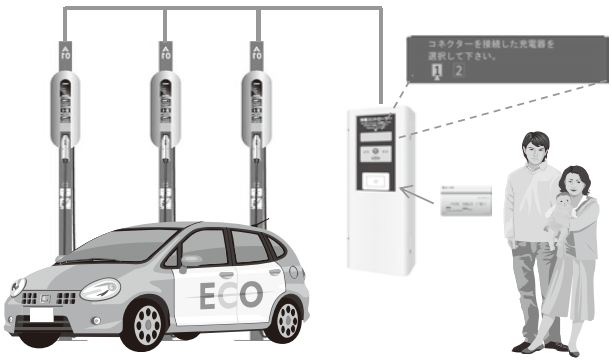

Fig. 3 EV charging controller and chargers.

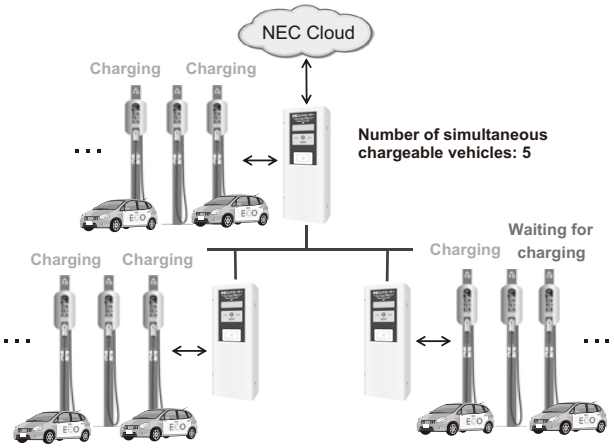

Fig. 4 Controlling the number of chargers that can simultaneously perform charging by inter-controller linkage.

3) Communication between controllers

The system incorporates the communication capability necessary to support the construction of a large-scale charging system with more than 30 chargers. By connecting the controllers via LAN, the controlling of up to 780 chargers is possible.

To assure the safety and reliability of commercial systems incorporating hundreds of chargers, this communication capability also features a simultaneous charging limitation function that prevents power capacity from being exceeded by simultaneous use of a large number of chargers. Additional functions include a function to limit the display and operation of distant chargers, and a function to enable operation to continue even if there is a failure in one part of the system (**Fig. 4**).

4) NEC inter-cloud communication

A function to link the controller with various servers in NEC's cloud using 3G communication capability is provided. This facilitates various functions essential to commercialization such as user authentication, billing, and continuous monitoring.

(3) EV charger control server

This server offers two primary functions.

1) Remote monitoring and maintenance

When linked to the EV charging controller, this function provides remote access to controller status information to facilitate remote management and operation of controllers and chargers. A web interface is provided for easy management of controllers enabling real-time monitoring 24 hours a day, 365 days a year, as well as immediate operation and adjustment.

2) User authentication (user card authentication and password authentication)

The server is equipped with a user card authentication function and can approve or reject cards by comparing the card data read by the controller with the verified data on the server. It is also provided with an interface that makes it possible to farm out the authentication process, facilitating cooperation with other card management/administration companies.

When a user card is not available - because the customer has accessed the system via a telephone automatic response service or their smartphone - the system can use the customer's credit card to issue and authenticate a password allowing the customer to use the charger.

(4) Membership authentication management server

This server offers a membership authentication function - which is usually managed by card management/administration companies - for cards that can be used for charging, such as the Nippon Charge Service (NCS) card. Data - such as authentication card information and membership usage results - is exchanged via the externally linked interface with the EV charging control server. This data can be used to generate a monthly report on usage and operating conditions.

(5) Multi-service gateway

A function that enables safe, integrated management of multiple electronic money services is provided. Processing of electronic money is distributed to individual electronic money management servers via this server, regardless of the type of processing. The systems applied to the EV charging system are based on NEC's experience in vending machines.

A remote software update function is also provided.

(6) Electronic money management server

Transaction log data and invalid card or payment data is handled by servers belonging to the respective electronic money payment companies.

All of these functions are executed on NEC's cloud network, providing a reliable foundation for our commercial EV charging infrastructure system.

4. Case Study: The Introduction of NEC's EV Charging System to the Tokyo Midtown Commercial Complex

Using this system, in January 2015, we accomplished large-scale installation - unprecedented of its kind - amounting to 125 vehicles spaces which are about 80 percent of the hourly flat-floor-type 157 vehicle spaces in the Tokyo Midtown commercial complex (**Photo 1**).

(1) Installation in almost all parking spaces

Because it was necessary to install chargers in almost all the existing parking spaces, we developed a new standard charger and an installation appliance that would make it possible for either gasoline or electric vehicles to use the same parking space (**Photo 2**).

Photo 1 Testing the charging system in Tokyo Midtown.

Photo 2 View of the completed charger installation.

Photo 3 EV charging controller.

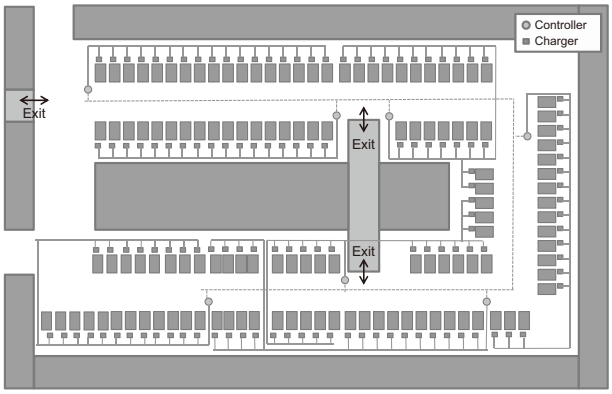

Fig. 5 Layout of the EV charging controllers and chargers in the parking.

(2) Large-scale installation of more than 100 units

The installation was designed so that each of the 125 chargers could be controlled by any one of the 7 controllers set up along the various customer flow paths, making it possible for customers to operate the chargers from any controller. In addition, as the total number of installed chargers would exceed the actual power supply capacity if all were used simultaneously, we included a simultaneous charging management function (**Photo 3**, **Fig. 5**).

This system was installed and tested from November to December 2014, and introduced to the public in January 2015. Although this was the first time an EV charging system designed for use in a large facility had been installed and made available to the public, the system experienced no significant problems and is currently operating smoothly.

5. Conclusion

In this paper, we have examined the elements and functions of NEC's commercial EV charging infrastructure system and seen how the system has been successfully introduced in a large commercial facility. The success of this commercial EV charging infrastructure was made possible by NEC's extensive experience and expertise in development and construction technologies, including our cloud service, electronic money services, and embedded systems. Thanks to our comprehensive technological capability, NEC is ideally positioned to promote widespread construction of EV infrastructure and thereby to contribute to the achievement of a more sustainable society.

Authors' Profiles

ABE Tsuyoshi
Manager
Embedded System Solutions Business Center
Global Products and Services Development Division

Information about the NEC Technical Journal

Thank you for reading the paper.
If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Japanese

English

Vol.10 No.1 Special Issue on Enterprise Solutions to Support a Safe, Secure and Comfortable Life
- Value Chain Innovation Linking "MAKE," "CARRY" and "SELL" -

Vol.10 No.1
December, 2015

Special Issue TOP