

# Cloud-Based EV/PHV Charging Infrastructure Service

HIRANO Takahisa, KOYAMA Toshimitsu, YASUDA Toru, SHIGEMATSU Daisuke, KONDO Yasuaki

## Abstract

Use of both the electric vehicle (EV) and the plug-in hybrid vehicle (PHV) is expected to increase as clean vehicles become more desirable. However, in order to sustain the expected growth in the market the preparation of suitable charging infrastructures will be an essential requirement. Deployment of EV charging infrastructure services in a commercial context and a reduced labor input by business operators will be required to effectively operate the systems after installation. To deal with this issue, NEC has developed an EV charging infrastructure system that is equipped with remote operation & maintenance/energy control, member authentication and E-money payment functions so that the business operators can install and operate it efficiently and securely. The system also provides cloud-based services for the EV/PHV users, such as a charging station map and a charging completion mailing function. In the future, NEC is also planning to study the application of cloud-based services for other environment-friendly vehicles, such as the fuel cell vehicle (FCV).

### Keywords



oil wholesale, AEON, Nippon Charge Service (NCS), AEON<->NCS collaboration, CEATEC Award 2013 Grand Prix, E-money (WAON) billing

## 1. Introduction

Global warming measures and the enhancement of the competitive power of the Japanese automobile industry herald a massive dissemination of electric vehicles (EV) and plug-in hybrid vehicles (PHV). This trend will feature the introduction of highly environmentally

friendly systems and energy efficiencies. The preparation of suitable infrastructures for recharging the vehicles has also become an essential need. Since FY2012 the Japanese Ministry of Economy, Trade and Industry (METI) has been encouraging business operators to introduce charging equipment by subsidizing the development of charging infrastructures. It is now urgently required to create a service that takes user convenience into consideration, as well as providing an environment that facilitates installation of new models enabling the deployment of effective commercial charging solutions. In this paper, the authors introduce the "cloud-based EV/PHV infrastructure charging service" (**Fig. 1**). This is a service deployed by NEC with the aim of creating new values.

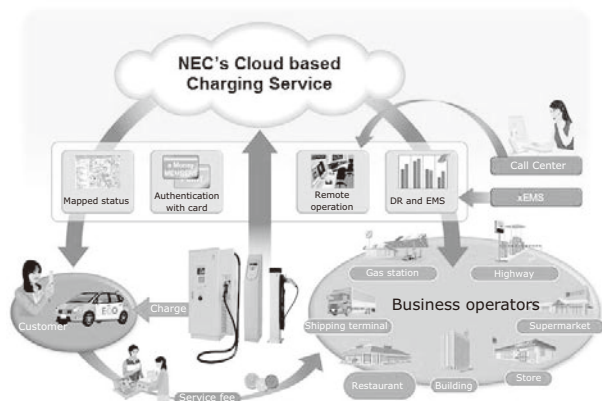


Fig. 1 Cloud-based EV/PHV charging infrastructure service.

## 2. History of Cloud-Based EV/PHV Charging Infrastructure Service Business

### 2.1 The Start of a Commercial Service

NEC started commercialization of the cloud-based EV/PHV charging infrastructure service in October 2011.

However, as many of the business operators at that time did not recognize the need for the automation of the charging equipment administration or for authentication and billing, they tended to introduce the charging equipment only as a standalone system.

### 2.2 Joint Demonstration Experiment by Oil Wholesalers

In 2012, a joint demonstration experiment was begun by oil wholesalers as a project subsidized by the Resources and Energy Agency, METI. It tested the possibility initiating the billing of services by mutually linking the gas user membership cards of the wholesaler companies.

In this experiment, NEC's cloud-based EV/PHV charging infrastructure service was located in a focal position and was linked to the cloud-based centers of other companies (Fig. 2). This arrangement permitted a personal authentication service by using the gas user membership cards on the chargers installed at the service stations (SS) of the wholesalers. The experiment was completed with a highly satisfactory evaluation.

Moreover, it also succeeded in exerting a significant influence on the business operators that had installed chargers with regard to how easily the administration including billing was performed and on how user convenience might be improved.

### 2.3 Demonstration Experiment at Hakone, Kanagawa Prefecture

NEC has tested the billing of the EV charging service by carrying out a demonstration experiment from January 2013 at the town of Hakone, Kanagawa Prefecture.

Changeover to the paid service involves the following issues:

- Collection of data for use as an index of tariff settings capable of recovering the cost of a paid service operation, including data for the introduction

of authentication and billing equipment and that for their operations.

- Administration of unattended charging equipment (maintenance, tamper prevention, etc.)

To resolve these issues, we installed NEC's charging controller in each of the existing chargers made by other manufacturers in order to act as the interface for the cloud-based authentication/billing services. By connecting the controllers to the EV cloud charging, we were able to introduce unattended charging spots based on card authentication as well as to collect data for use as a tariff setting index (charge quantity, charge count, etc.) for the administration center (Fig. 3).

Remote maintenance and remote surveillance from the cloud system enabled us to counteract failures and to prevent tampering related to card authentications.

The Hakone Municipality approved the installation of the cloud-based charging infrastructure because it contributed to a significant reduction in human labor by automating the charging spot operation. This function had previously required the attendance of municipal workers when charging vehicles.

In the future, we will promote networking of standalone charging equipment in order to deploy a highly convenient cloud-based infrastructure charging service. This will be based on the technology and expertise that has been cultivated through the development of service platforms that make use of the EV cloud-based charging systems.

This demonstration experiment was conducted as part of the "FY2012 entrusted project for study and a survey of the introduction of an authentication/billing system of rapid chargers for electric vehicles". It was entrusted by Kanagawa Prefectural Government to be performed by NEC.

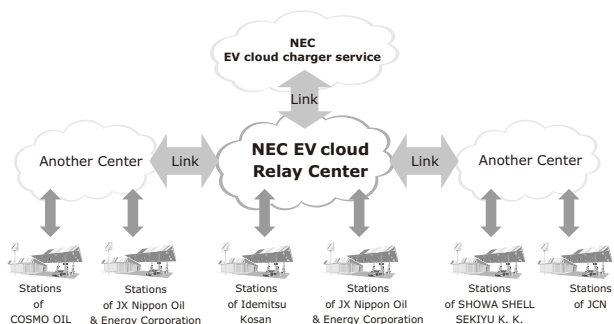


Fig. 2 Linkage between cloud-based centers in the demonstration experiment.

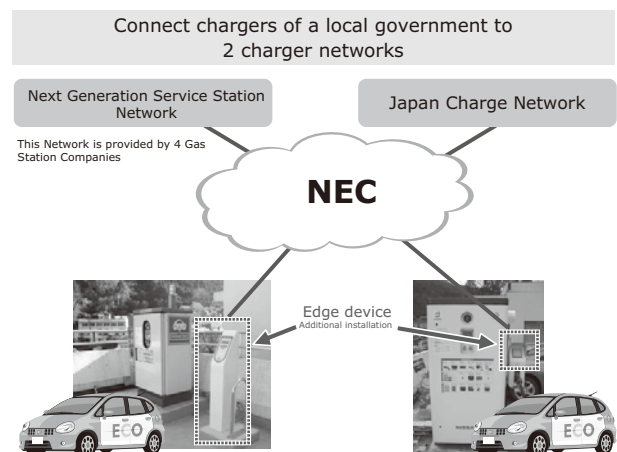


Fig. 3 Outline of the demonstration system.

## 2.4 Collaboration with Japan's Biggest Distribution Company AEON

In parallel with the demonstration experiment at Hakone, we also had a collaboration with AEON Co., Ltd., the biggest distribution company in Japan. This consisted of a demonstration experiment of the E-money billing of charging equipment based on authentication using AEON's E-money card called the WAON Card. It was conducted at the AEON Mall Koshigaya Lake Town, one of the largest malls in Japan, from November 2012.

In the demonstration experiment collaborated with AEON, we provided a cloud-based administration charging service, a cloud-based authentication/billing service and a call center service and examined the following operational issues in the framework of the AEON EV Expanded Project initiated by major AEON Group companies,

- Unification of operation methods that varied between charger manufacturers.
- Measures to be adopted in the case of WAON card authentication errors.
- Vehicle moving method after charge completion.
- Measures in the case of an E-money (WAON) billing mistake.

From the operational aspect, the disaster prevention center of each mall plays the main role by supporting users face to face.

We analyzed and visualized the data accumulated in the cloud-based infrastructure charging service collaborated with AEON and have analyzed the potential for new services through the CRM (Customer Relationship Management) technique. We are particularly aiming at new services that ride on the strength offered by the use of the WAON card and which can offer various advantages to both the user and the business operator, AEON.

## 2.5 The Establishment of Nippon Charge Services (NCS), and Its Service Provision

In May 2014, Nippon Charge Services LLC (NCS) was established under the leadership of four Japanese automobile manufacturers (Toyota Motor Corp., Nissan Motor Corp., Honda Motor Company and Mitsubishi Motors Corp.) This event triggered a new challenge aiming at expanding charging infrastructures for electric type vehicles (EV, PHV, PHEV).

It was NEC's cloud-based EV/PHV charging infrastructure system that was adopted to realize the unprecedented attempt to install networking chargers all over Japan and to create a unified mechanism for charging services and billing.

The establishment of the NCS has begun to operate the charging equipment nationwide for NCS-affiliated members and for collaborating chargers, thereby bringing about a significant change in the previous business model of charging infrastructures.

This service makes use of the administration technology, the inter-cloud linkage technology and the authentication/billing technology that NEC has cultivated through past experience in operating the cloud-based infrastructure charging service.

The NCS network offers an open environment in which various businesses may participate. Any charging equipment can be connected to their network as long as it has been manufactured according to certain common specifications. Real-time information from the networked ordinary and rapid charging equipment is subjected to integrated management by the cloud system. This procedure provides charging services such as personal authentication, billing and monitoring of charger running information that are highly convenient both for the users and for the business operators.

## 2.6 AEON <-> NCS Collaboration

In FY2014, the NCS went further than simply using the installed charging equipment based on the in-store dissemination project. It decided to promote positive collaboration with enterprises running services by using independent cards such as AEON's WAON card. Their charging equipment was thereby categorized as affiliated equipment.

NEC has built a system for enabling authentication and billing at the charging equipment installed in each AEON mall. This arrangement results from applying NEC's proprietary cloud linkage technology and expertise.

In this way, NEC supports the implementation of a service that permits EV/PHV charging anywhere in Japan via card access.

## 3. CEATEC Award 2013 Grand Prix

At CEATEC JAPAN 2013, NEC's innovative cloud-based EV/PHV charging infrastructure service (**Fig. 4**) received high evaluation and won the Grand Prix of the Network & Service Category of CEATEC AWARD 2013 with a comment stating that "This service is required to function as a system hub and its availability is highly significant for society. The multi-payment facility assures its dissemination, for example by capitalizing a company based EV charging". This award encourages us to propose further enhancement of the service model in the future.

#### 4. Future Perspectives

NEC's cloud-based EV/PHV charging infrastructure service is expected to achieve further development by connecting to various other services. As our next target, we are planning to create a service model that allows EV/PHV users to ride their vehicles with secure minds and for the charging business operators to operate their charging equipment smoothly, supported by the information collected at large NCS centers. This service is to be developed in collaboration with the NCS as well as with the Japan Charge Network Co., Ltd. who are currently deploying a similar service to that of NEC.

The service is not simply an attempt to provide charging infrastructures but it is also expected to provide a foundation for various other traffic-related

businesses. We anticipate that it will contribute to the promotion of an increase in the use of EVs and PHVs in Japan by collaborating with parties deploying activities over a wider range of fields (Fig. 5).

Considering the role of EV in working as a "mobile battery" in the case of a disaster, we would also like to emphasize its value as a social solution by strengthening the central service by incorporating disaster countermeasures. In addition, the mechanism of the NEC charging cloud service is also applicable to the hydrogen stations for the FCV (Fuel Cell Vehicles), the next-generation environmental vehicle that is expected to be increasingly available in the future.

In the future NEC will not function merely as an installer of charging equipment, we will actively support the dissemination of the service as a core information transmission facility. We intend thereby to create advanced urban areas that can meet the needs of various groups of people, and to support the implementation of a society that will be resistant to adverse environmental conditions and disaster events.

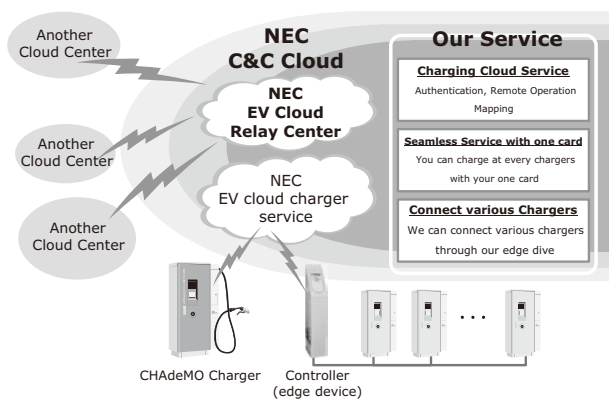


Fig. 4 Multi-vendor charging infrastructure service.

\* WAON is a registered trademark of AEON Co., Ltd.

#### Our Solution for EV/PHEV

We provide total solutions based on NEC's asset for customers and market of EV/PHEV.

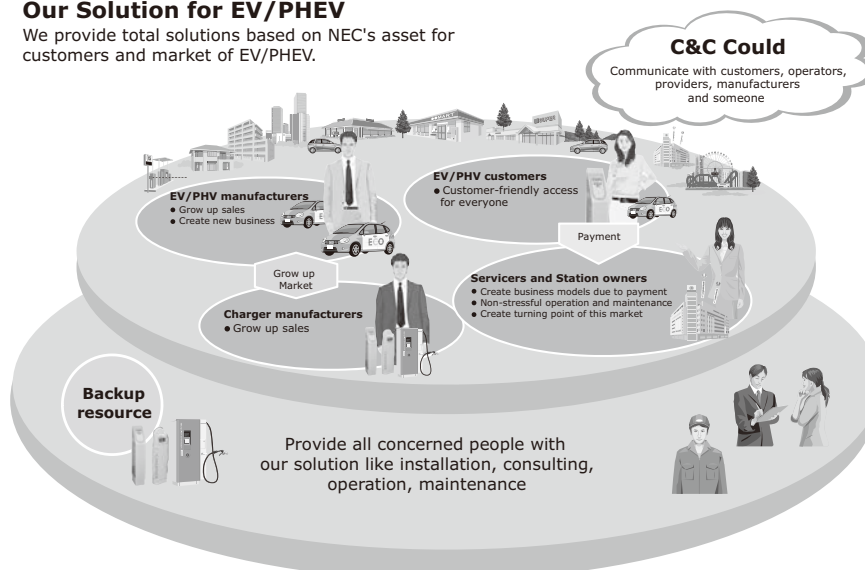


Fig. 5 A world made real by NEC's cloud-based EV/PHV charging infrastructure service.

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Vol.10 No.2  
April 2016

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