NEC Cloud Service for Energy Resource Aggregation Leveraging AI Technology

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Abstract

NEC has since 1951 been accumulating an abundant business experience with energy utility companies. Based on this experience, we have developed various energy management projects aimed at achieving an efficient and sustainable society. As one of these projects, we have developed and started providing an "NEC Cloud Service for Energy Resource Aggregation" (hereinafter referred to as the RA Cloud Service,) which is an energy management service employing AI technology. In 2016, the Ministry of Economy, Trade and Industry publicly offered the "Virtual Power Plant (VPP) Construction Demonstration Project". The RA Cloud Service is targeting companies that participate in this project in order to make VPP a practical business solution of the future.
RA Cloud Service supports the customers in enabling the best use of AI technologies to control and optimize the energy facilities owned by the consumer side in order to meet the Demand Response (DR) scheme.

Keywords
energy resource, aggregation, cloud computing, AI, VPP, DR, balancing market, RA, AC

1. Introduction

Recently in Japan, electricity is traded via the electricity market. The wholesale electricity market was launched to trade electricity (kWh value) and to complement the planned electricity generation amount. On top of the wholesale electricity market, another two markets will be launched in the near future; these are the capacity market and the balancing market. The capacity market trades the power supply capability (kW value) that is required nationwide, and the balancing market trades the balancing capacity (ΔkW value +kWh value) that is required to provide a supply and demand balance capability. It will also maintain the electric power system frequency (Hz). This balancing market will adopt a very important role in promoting renewable energy, which is an unstable power generation source at present, to become the main electricity power source of the future society.

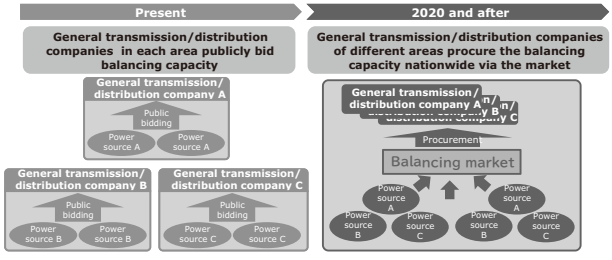


Fig. 1 Outline of balancing market.

The balancing market is scheduled to be launched by the year 2021. Once the market is launched, the balancing capacity, which is currently procured at the individual area level, will be procured nationwide via the balancing market (**Fig. 1**).

In the future, conventional companies and new entrants that have new energy facilities may join the balancing market, and the market will become more active. This will have the result that the balancing capacity can be procured and operated with a more reasonable price.

2. RA Cloud Service Initiated by Customer Requests

NEC participates in the "Virtual Power Plant (VPP) Construction Demonstration Project that Utilizes Demand-Side Energy Resources (VPP Aggregator Proj-

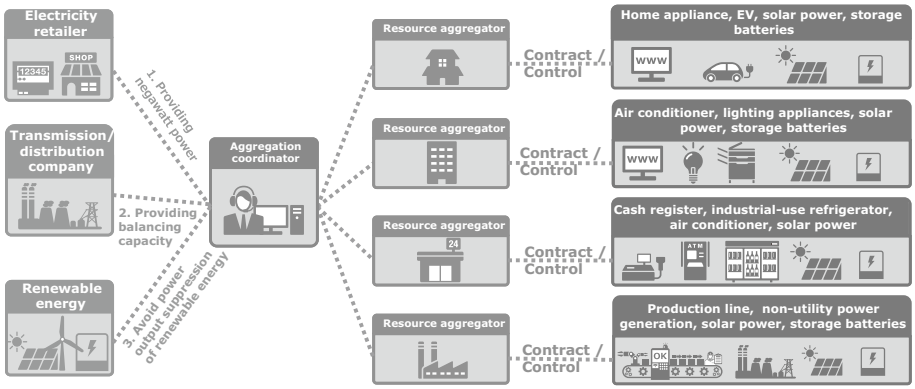


Fig. 2 VPP construction demonstration project.

ect)" for which a public offering has been made by the Ministry of Economy, Trade and Industry since FY 2016 (**Fig. 2**). This project started to create a supply-demand balancing capacity by utilizing the innovative energy management technologies that enable remote energy resource aggregations. These include storage battery generated supply at the consumer energy demand side such as for enterprises, homes, etc., and also the utilization of their power generation facilities. The project aims to demonstrate the electricity supply-demand adjustment capability by using the demand side's energy resources, making it function as if it were a single power station. As shown in Fig. 2, a resource aggregator (RA company) is an energy company that aggregates the energy demand-side electricity by concluding service contracts directly with suppliers. Therefore, the energy company will be a core company in the demonstration project. Aggregation coordinator (AC company) is in charge of trading electricity among the General Electricity Transmission and Distribution Utilities and Electricity Retailers while the RA company aggregates the electricity volume to be traded.

During the promotion of this construction demonstration project, NEC has received a great number of requests from RA companies. They requested to be provided services to aggregate the demand side electricity supply and create balanced capacity. Therefore, from November 2019, we will start to provide the NEC Cloud Service for Energy Resource Aggregation (RA Cloud Service). This is an energy service for utilizing the AI technology based on the systems that we have previously constructed for demonstration projects.

3. Service Providing Mechanism and Advantages of Cloud Computing Service

With the RA Cloud Service, the energy resources to be controlled are first of all registered to cloud computing and then a variety of information can be provided via the energy facility control systems owned by the RA companies. Based on this information, the optimum control commands for different energy resources can be determined via the cloud computing in order to create a balancing capacity (**Fig. 3**). Another feature of our service is to achieve accurate balancing capacity creation by employing AI technology to control energy resources with high precision.

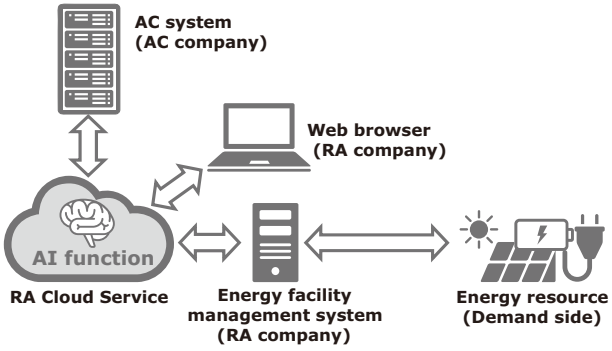


Fig. 3 Means of providing RA Cloud Service.

Requirement specifications for RA companies will be updated according to the progress of the institutional design of the balancing market, which is examined by the Organization Promoting Wide-Area Operations for electricity. The RA Cloud Service is continuously updated according to these requirements, therefore, RA companies may always access the latest RA Cloud Services by leveraging NEC's AI technologies.

4. Available Functions of the RA Cloud Service

This section describes the functions provided by the RA Cloud Service. The main functions of the service

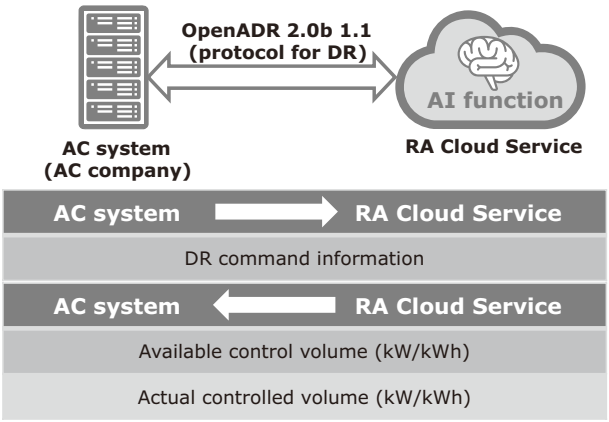
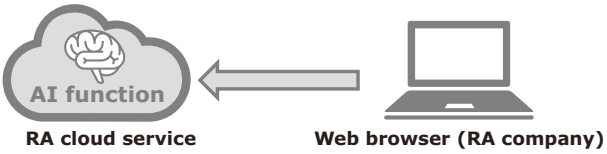
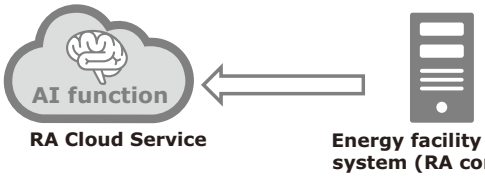


Fig. 4 External server linkage function.



Items	Description
Resource ID information	Code to identify individual resource
Area information	Resource installation place and relevant power grid area
Group information	Group to which the resource belongs
Resource type information	Resource types such as battery, generator, air conditioner, lighting, etc.
Resource property information	Property information including rated input/output electricity of resource, max. controllable electricity quantity, and reaction time

Fig. 5 Resource information to be registered to the cloud computing.



Items	Description
Setting value info.	Energy facility operation mode
Status info.	Checking whether or not there is an abnormal status in the energy facilities to control communications conditions, power supply/demand control , etc.
Input/output info.	Charge/discharge, power generation, etc. of the energy facility to be controlled.
Demand info.	Entire electricity demand at the demand side including actual load power consumption, which may not be the targeted load to be controlled.

Fig. 6 Resource information collected from the energy facility management system.

are:(1) linkage with external systems, (2) management of energy resources and (3) resource aggregation by leveraging AI technologies.

4.1 Linkage with external systems

For RA companies to start trading in the balancing market they must link with the system installed by the AC companies that are in charge of dealing in electricity trading with the General transmission/distribution company. **Fig. 4** shows the linkage between the RA Cloud Service and an external AC system installed by an AC company. The protocol for the linkage corresponds to OpenADR, which is compliant with the Cybersecurity Guidelines for Energy Resource Aggregation Business. Different types of information are available depending on the linked AC company. The RA Cloud Service prepares information as shown in Fig. 4 for the RA companies to transmit and receive.

4.2 Energy resource management function

With the RA Cloud Service, the energy resource information managed by the RA companies can be registered to the server in the cloud computing via the management screen. **Fig. 5** shows the resource registration information. By registering each resource by inputting items displayed on the administrator's screen, the status management control and the controlled results management may be performed.

Moreover, with this service, resource installation information can be registered. This makes it possible to manage resources per area so that linkages with multiple AC companies nationwide becomes possible.

4.3 The RA functions leveraging AI technology

By collecting various data from registered energy resources and examining their properties and their operation conditions, etc., RA functions control the energy resources according to the DR commands that the AC companies issue.

4.3.1 Understanding the resource status (data collecting)

In order to create a higher quality balancing capacity, it is necessary to understand the resource status pre-

cisely and quickly. To achieve this, information about the energy facility setting values and conditions, input/output electricity, and electricity demand should be acquired (**Fig.6**). Based on this information, the baseline and energy resource controllable amounts are calculated. The baseline is the predicted electricity demand amount when no control is given to the energy resource This is calculated beforehand based on the collected demand information.

4.3.2 Demand prediction and controllable amount calculations with AI technology

The Demand Response (DR) indicates how much of the demand is to be increased or decreased from the baseline. **Fig. 7** illustrates the resource control results. It is important to remember that there is some gap in the demand amount between the moment the resource control command is performed and the actual demand amount. Moreover, the control of exactly what DR indicates is not always performed and it varies depending on the properties and conditions of the resources. Therefore, in order to carry out the control as precisely as the DR command intends, it is necessary to give some allowance to the resource control to absorb errors.

AI technologies employed in the RA Cloud Service estimate the baseline prediction precision capability by studying the past control results. Based on the study results, it requests an appropriate corrective control amount for individual resources in order to complement the difference between the baseline and the actual demand and the control error derived from the resource property. Consequently, a more precise control can be achieved.

Besides such measures, an even more highly precise control will be achieved by adding information about the weather and other events that may impact electricity demand.

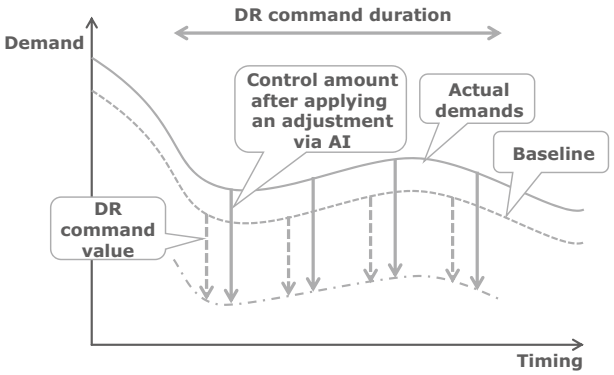


Fig. 7 Illustration of resource control.

INPUT	Control command function	OUTPUT
DR command info.	(1) Matching the DR command details, resource status information and the controllable resource amount.	Most optimal command value for each resource
	(2) Generating control command values for each resource	
	(3) Generating control command values with the AI adjustment provided	

Fig. 8 RA Cloud Service control command function.

4.3.3 Control indication function

Fig. 8 shows the control indication function. The control indication function manages the DR command sent by an AC company. It matches the DR command items and resource status and the controllable amounts that are calculated beforehand and then it distributes the optimal command values to individual resources. At this time, the RA Cloud Service adds the adjustment amounts to complement the control errors that are explained in Section 4.3.2.

5. Conclusion

The RA Cloud Service introduced in the present paper will contribute to achieving a highly precise balance capacity prediction by implementing various RA functions such as demand prediction, controllable amount calculation and control commands. It will achieve this by leveraging our proven AI technologies and accumulated expertise. Into the future, NEC will optimally use the advantages of our cloud computing services and will introduce more state-of-the-art AI technologies. We aim thereby to provide highly precise services for all of our customers. The technology to examine and control energy resources being spread over many places will be used for markets other than the energy markets. By exploiting such technologies, NEC will provide social value in various fields such as for those of energy, infrastructure and resource reuse.

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