Study on Metering of Solar Power Combined with Energy Storage System and Expanding Usage of Renewable Energy Metering Data

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1. Background

Energy Administration, Ministry of Economic Affairs, has shifted the renewable energy power to provide nighttime electricity demand to strengthen the overall stability of the power grid by encouraging the solar industry to install energy storage systems (hereinafter referred to as solar storage). On the other hand, the billing of solar storage energy requires flexible scheduling with the Department of System Operation, which needs to calculate the amount of electricity charged and discharged by the storage system and the amount of electricity generated by solar power using the 15-minute load profile, and different tariffs apply to the flexible charging and discharging time, and in conjunction with the simultaneous switching of supply by the solar storage operators, it is necessary to install multiple sets of meters in the same plants, which makes the billing pattern complicated. In the future, in response to the growth of renewable energy and the promotion of solar storage policy to increase the flexibility of system operation and scheduling, there is a need to analyze the relevant solar storage performance and conduct in-depth studies and research to facilitate the implementation of Taipower's policy and review the appropriateness of the adjustment of contracts and various regulations.

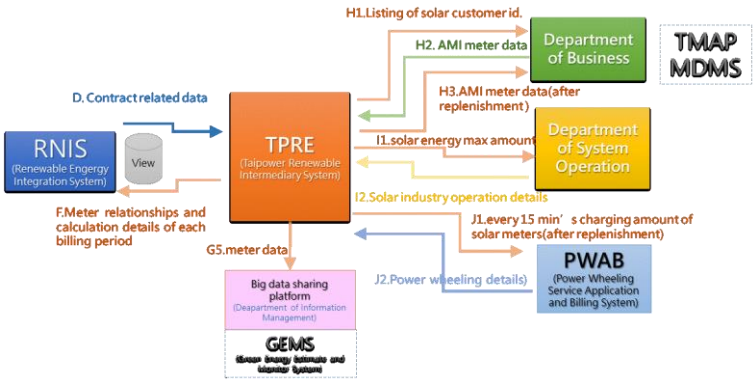
Therefore, based on the existing Taipower Renewable Intermediary System (TPRE) functions, in order to respond to the adjustment of the time zone of time-of-use pricing, billing of solar storage, multi-level meter merger pattern of shared booster station, dual loop meters of offshore wind power, the expansion and revision of the TPRE system functions are necessary. On the other hand, using the AMI of solar storage to conduct big data analysis on all the solar energy generating units and storage battery charging and discharging patterns will provide a feasible development direction of power energy and demand response policies in Taiwan.

2. Research Results

(1) Planning for expansion of interconnect systems and items

In response to the solar storage plants' billing needs, we have added new data exchange and interconnection items of the external systems, including AMI metering data, scheduling data after the dispatch date, power wheeling details, etc. We have planned and designed the data exchange and interconnection according to the specifications and frequency of the exchanged data and interconnection information to meet the future needs of TPRE's solar storage subsystem functions.

During the implementation of this research project, the RNBS (Renewable Energy Power Purchasing System) and the RNIS (Renewable Energy Power Purchasing Integration System) were put into operation. As a result, the interconnection items between TPRE and the external system were changed. Before the switchover, the interconnection items consisted of the existing and newly added solar-storage-related items. After the switchover, the existing interconnection items were replaced by the RNIS (Fig. 1), and the solar-storage-related interconnection items were retained in the TPRE.



Source: This study

Figure 1. Interconnection interface of TPRE(after RNIS launched)

(2) Monthly batch calculation operation

Monthly batch calculation operations include monthly operation before batch calculation, pre-operation of batch calculation, batch calculation (non-power wheeling plants), batch calculation (power wheeling plants), and manual calculation. The time sequence of each operation is described as follows (Fig. 2) .

(3) Relationship design of meters and generating units

For new solar plants, design the main table structures of solar storage meters and other meters, confirm the regulation rules for meter change, and provide setting and managing functions that align with the solar storage meter structure and associated generating units. In addition, considering various meter install types, we have designed a model structure that combines other customer IDs under one solar storage meter for cross-customer billing.

When a generating unit generates a large amount of electricity (e.g., offshore wind), technically, this generating unit may be connected to two circuits to transmit electricity, so the system needs to connect all generating units to both circuits to accurately measure the full amount of electricity (the billing logic is same as two or more main meters). The system extends the attributes recording the meter-generating unit interconnection info., provides the functions of query of interconnection among meters, and adjusts the calculations of power usage and power generated portion among generation units.

(4) Planning of TPRE service functions

The TPRE mainly provides Taipower with meter maintenance, meter-generating unit interconnection management, and billing calculation for customers with solar storage in every billing cycle. The service functions are divided into five functional modules: Service of purchasing management (general), Service of purchasing management (solar storage), Management of interconnection interface, Service of AMI analysis, and Service of system management (Fig. 3).

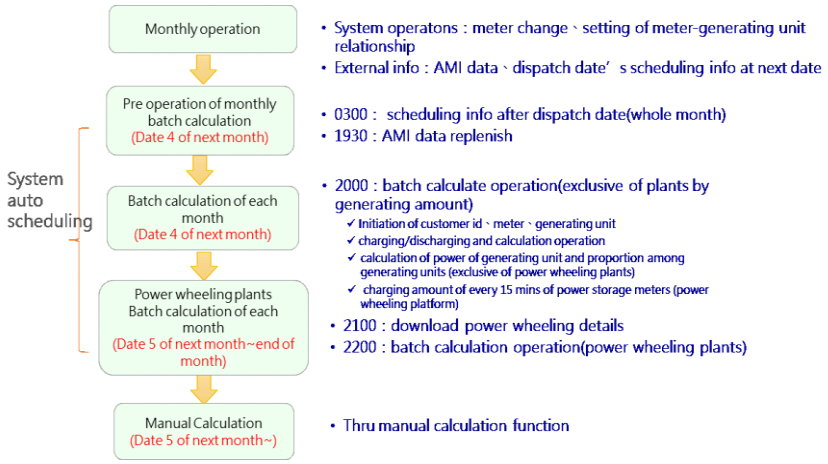


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Figure 2. Monthly batch calculation procedure

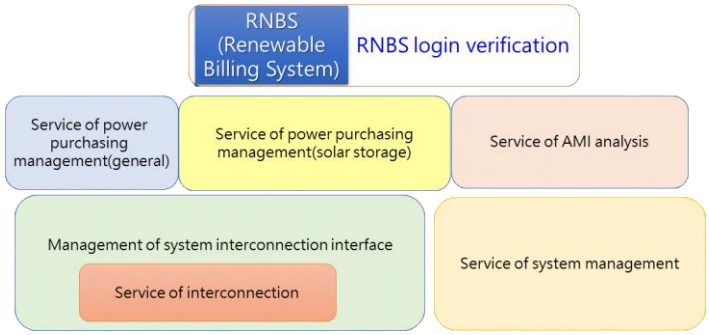

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Figure 3. Functional architecture of the TPRE system

(5) AMI analysis of TPRE

A. Big data application analysis on solar storage plant’s AMI meter information

The main data sources of AMI meter information of solar storage plants are:

(A) AMI meter reading info.: kWh of ch1, ch3 per 15 minutes of each meter.

(B) The Department of System Operation’s next day’s scheduling information, including the customer’s day-ahead scheduling amount and the dispatch office’s dispatch amount, for every 15 minutes.

(C) Contract information: Maximum purchase volume of storage, volume of generation unit, and guaranteed daily billing capacity.

Based on the charging/discharging patterns of generating units and storages based on the results of each period’s calculation of solar storages, the analysis includes the reasonableness of the scheduled dispatched amount, the result of the actual amount of discharging, and the guaranteed daily billing amount (the amount of electricity that is 2.61 times the nominal effective power).

B. Analysis of AMI data

In conjunction with the introduction of AMI meter data, the associated programs and the AMI analysis website are optimized to provide visualized information such as daily power generation analysis and storage charge and discharge analysis.