Research on Promotion Strategy and Demonstration Model of Virtual Power Plant Integrating Distributed Energy

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I. Research Background and Objectives

Achieving an independent and diverse energy system and combining low-carbon and friendly environments have become the main target of our energy transition in Taiwan. Promoting energy creation, energy storage, energy conservation, and system integration has been the current trend of the energy transition. Along with new technology development in the energy industry, the distributed energy resource (DER) has been able to share some power supply responsibility of conventional power plants in the world. Virtual power plant (VPP) is one of the current trends in global power industries. However, new technology, business models, and regulation still need further exploration and clarification.

According to international VPP development experience, it is necessary to conduct demonstration experiments as early as possible to understand the VPP operation process, which involves interaction between Taipower and relevant stakeholders. With that, a long-term operation strategy can be built for gradual promotion. Our research objectives are VPP business model establishment, legality and supportive measures investigation, pilot study, and cost-benefit analysis.

II. VPP Business Model and Pilot Study

In VPP, we use advanced communication technology and software architecture to aggregate and coordinate geographically distributed energy resources. The basic business model is participating in the electricity market to provide services for the power grid. VPPs in electricity markets will greatly reveal distributed energy resources. In addition, optimizing the dispatch of the distributed energy resources we aggregate can alleviate the impact on the power grid of DERs.

According to well-known VPP business models in Germany, Australia, Japan, and other countries, the main resources are renewable energy and energy storage. Due to the various limitations of different markets, DERs mainly participate in markets through the aggregation of VPPs. Consequently, VPP operators have to know the feature parameters of DERs for aggregating DERs to an entity which satisfies thresholds of market participation. VPP operators must stand by and execute their duty after winning the bidding and being called for execution. VPP operators can dispatch distributed energy resources with notification or automatic control.

Business model category	Germany	Australia	Japan
Value Propositions	promote energy transformation	provide FCAS for demonstration to ensure energy security	VPP mechanism verification and future business model
Key Resources	PV, wind, hydro, CHP, biogas, storage	PV, storage	storage, V2G
Key Partners	VPP：Next Kraftwerke MO：50hertz, Amprion, Transnet BW, TenneT	VPP：Energy Locals、AGL、Simply Energy、Sonnen... MO：AEMO	VPP/MO：Tohoku Electric Power
Customer Segments	residential, business customer	residential customer	government resource, residential, business customer
Resource Qualification	single DER at least 100kW, aggregate at least 1MW	aggregate at least 1MW	use existing DER or demand response to participate
Value Propositions	create profit for DER , promote grid stability	reduce electricity cost, promote grid stability	balancing load, promote grid stability
Revenue Streams	participate in energy/ ancillary service market	self-use, participate in ancillary service market	participate in ancillary service market

Fig. 1 International Virtual Power Plants Business Model

We established a VPP trial platform server on the cloud, which aggregated some resource fields, including Taipower Research Institute in Shulin, Wenlin elementary school, Tatung company, etc. The VPP platform receives power consumption data every minute based on the Energy Trading Platform rules. In terms of trial execution, our testing resources include energy storage and controllable load. We simulated the market bidding according to the availability of our resources and followed the schedule of the energy trading platform. After executing auxiliary services, the resource owners can get rewards based on bidding prices.

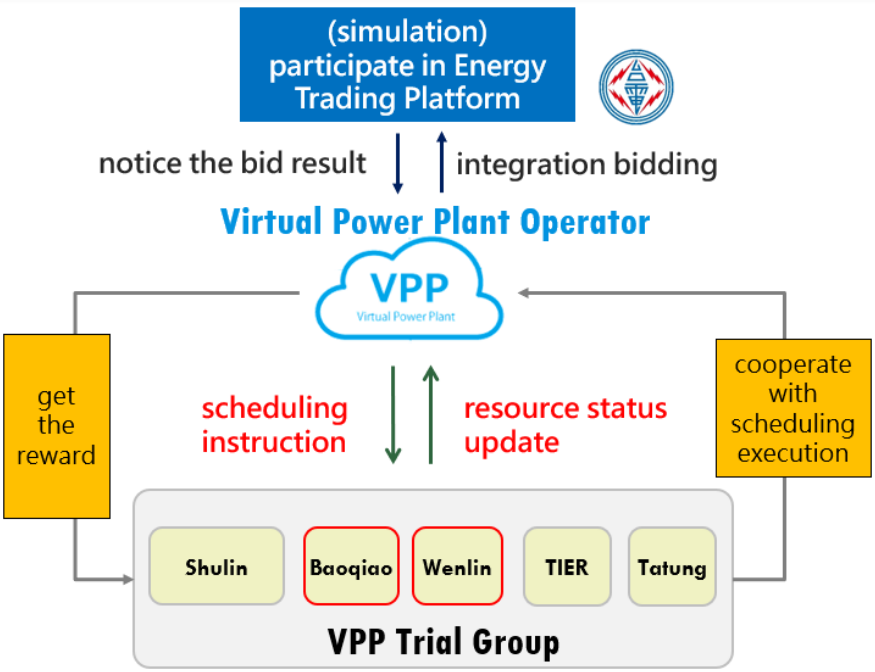

Fig. 2. Taipower Research Institute's Virtual Power Plant Trial Program

In this trial program, we tested our aggregation mode, data transmission methods, response capability of resources, and execution measurement of our virtual power plant. The testing period was from April to June 2022. We executed seven ancillary service events, and the energy storage implementation rate of Baoqiao and Wenlin elementary school is higher than 100%.

III. Conclusions and Suggestions

(1) Conclusions: We have developed a VPP trial platform with functions including data interface, resource aggregation, simulated bidding, scheduling notification, execution measurement, etc. In addition, we have aggregated a pilot group with 1.5MW controllable capacity and simulated participation on the Energy Trading Platform.

(2) Suggestions: For enhancing VPP aggregation, our trial platform needs to be improved, including aggregation mode adjustment, automatic control interface, bidding algorithm, etc.