Evaluation and Implementation of the Integration of Supply and Demand Resources: Taking the Livestock and Electricity Symbiosis as an Example

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I. Research Background

With the new energy transition vision, Taiwan has actively increased the proportion of renewable energy in the power generation system and promoted the establishment of a smart grid in order to pave the way for the future, increasing the need for grid connection. With growing distributed energy resources, energy management for prosumers with renewable energy generation equipment has become an important issue. The transformation process can help traditional animal husbandry to increase its operating efficiency by lowering its electricity expenses and develop into a virtual power plant. Since livestock farms, fishing grounds, and other agricultural sites have spacious land, the potentials to develop renewable energy in these places are also higher. With the VPP, the residual renewable energy could be transmitted to the demander through the grid, forming a new business mode.

II. Research Content

To understand the global trend, our project studied global DER development, including cases from Japan, the USA, and Australia. From the study, we concluded some key factors needed for the success of DER development. (Fig.1) The pilot site of this project is set in the off-campus farm of the Department of Animal Science in National Chung Hsing University, utilizing the existing and newly installed energy management equipment (electricity generation, electricity storage, electricity usage monitor, AI energy management system, etc.) to collect energy data, conduct energy control experiments and to develop VPP business plan. We expected to develop an operating model that may be commercially feasible and in accord with the Taiwanese regulations on “sustainable renewable energy farms.”

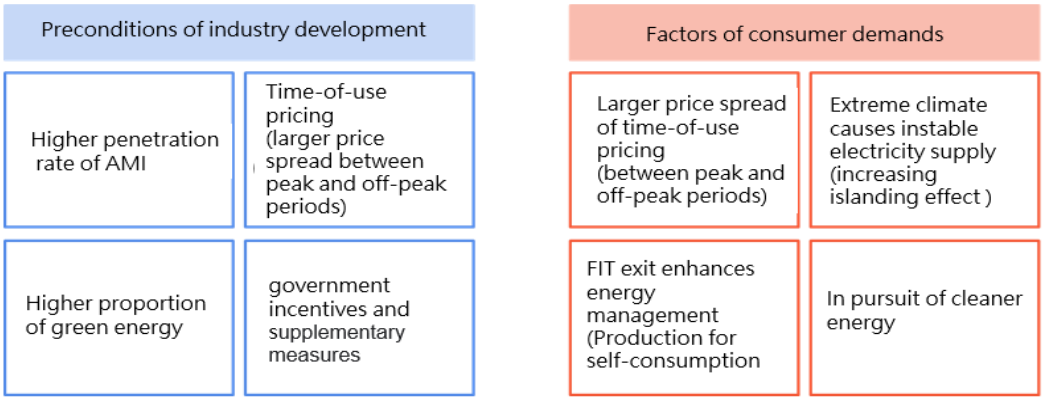

Fig.1 Conditions of developing HEMS

III. Research Result

To prove the business model of DER, we cooperated with National Chung Hsing University by installing solar power (for self-consumption), an energy storage system, demand response equipment, and an AI-embedded energy management system of NextDrive. To diversify the energy generation system, this project also utilises the hydrogen fuel equipment established by Prof. Jun-Yen Uan from National Chung Hsing University (Fig.2). Through the installation of the equipment mentioned above, load management could effectively enhance energy efficiency in the pilot site. Moreover, it could also provide environmental benefits by reducing carbon emissions by up to 37 tons annually. However, as the wireline at the pilot site is complex, the planned energy management system from the project has not reached its optimal use in energy control. Therefore, it is suggested that in the future, when working on a site similar to this, it is important to check the wirelines first in order to ensure energy efficiency.

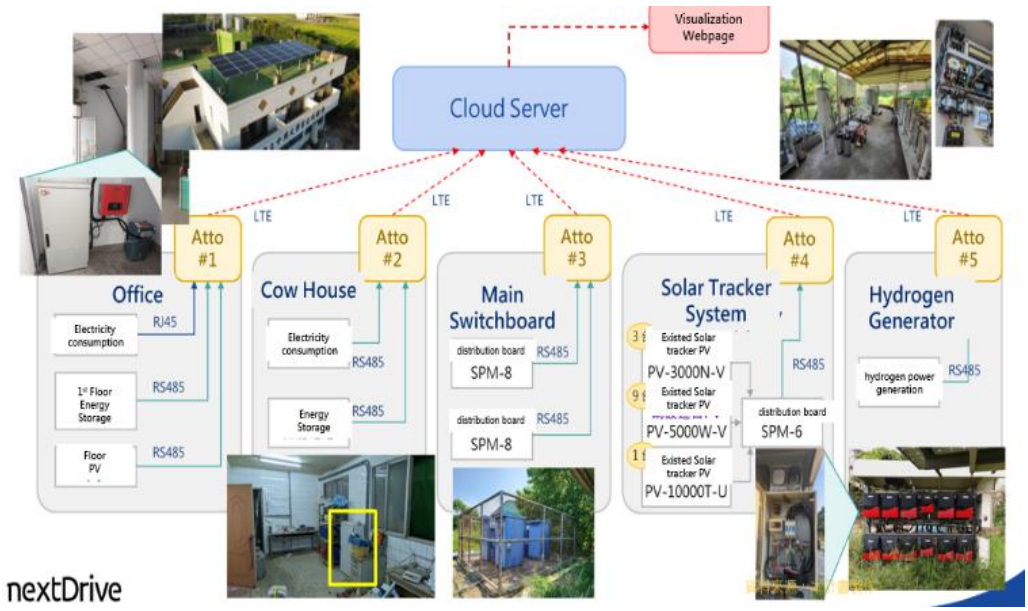

Fig.2 The system framework

In addition, from the simulated data of the pilot site, this project evaluates the economic benefits of different system capacities under an energy management system-controlled mode. It concludes that the pilot site will achieve better economic benefits with a higher percentage of solar power (for self-consumption) (Fig.3, Fig.4).

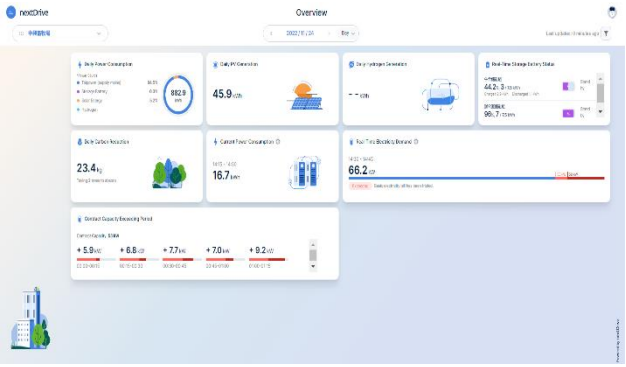

Fig.3 System interface

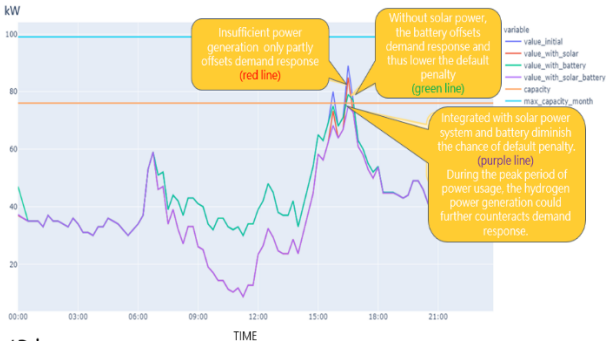

Fig.4 The operation mechanism

With the highest feasible solar PV capacity installed in the pilot site, the profit and internal rate of return from the direct sale of all solar power reach their peaks, followed by excess energy injected to the grid with feed-in-tariff. Selling all solar power to Taipower with feed-in-tariff produces the lowest profit and internal rate of return.

This project suggests that agricultural sites should first increase their energy efficiency and then aggregate with different resources in the vicinity, to form a complete DER, reduce the dependency on the central grid, and create additional profits by participating in the electricity trading platform (Fig.5). As most low voltage electricity users in Taiwan have no incentives for implementing energy generation and storage equipment yet, we could focus on the agricultural sites with energy management potential to establish a successful business model of energy efficiency and sustainability of agricultural farms.

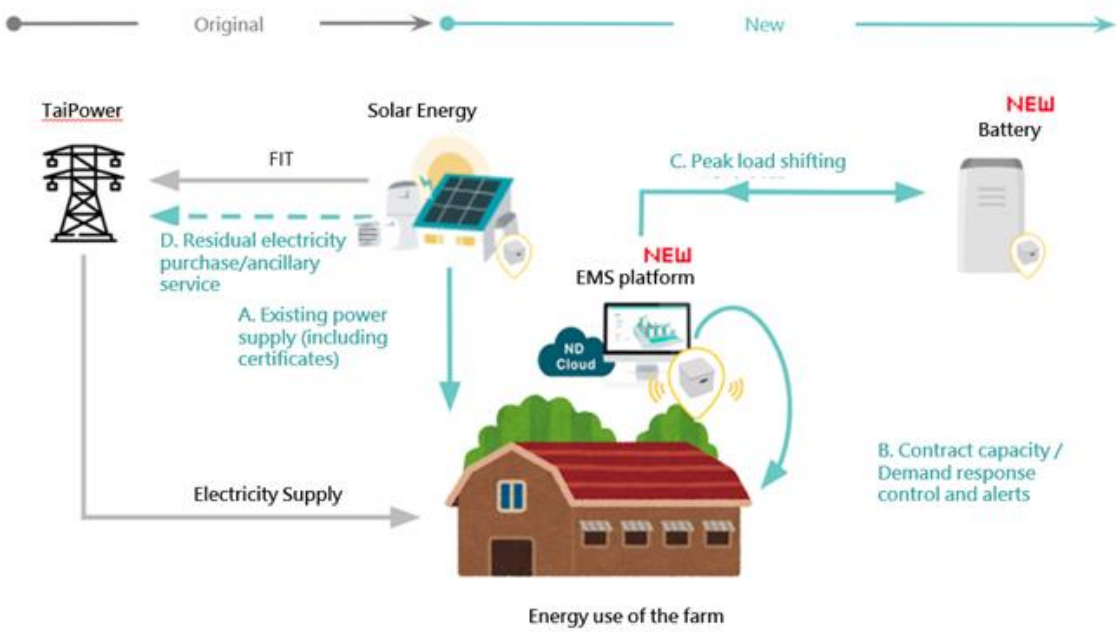

Fig.5 New business mode