Aggregate Smart Public Housings to Develop
the First Virtual Power Plant in Chinese Taipei

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NEP
National Energy Program II

OUTLINE

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- Public Promotion

- Vision for the Development of VPP

Background

Current Status of Energy Supply, Demand and Energy Policy of Taiwan

Energy Demand Characteristic

- Power demand is concentrated both regionally and seasonally
- The development of high value-added industries and the enhancement of living standards cause power demand to increase

Energy Supply limitations

- Isolated power grid
- Mainly based on thermal power generation
- Power facilities cannot be expanded due to lack of space, right-of-way and the opposition from local residents
- Power quality affected by the lack of management of small scale distributed energy resources (DERs)

Energy Policy for 2025

- Non-nuclear homeland
- Increase the proportion of green energy capacity to 20%

Background

Challenges In Energy Supply and Opportunities to Promote VPP in Taipei City

challenges

1) Taipei City has the highest electricity consumption per capita in the territory

2) Commercial and residential are the most demanding sector of electricity in Taipei City

3) Potential for increasing the renewable energy capacity is low (lack of space and less hours of sunlight)

4) A blackout would have a great impact on economic activities and citizens' lives

opportunities

1) Smart Grid technology implementation is driven by the Smart Taipei vision

2) Taipei City Government has a strong financial position

3) Citizens have high awareness towards energy saving and carbon reduction

4) Taiwan's High-voltage Demand Response has been gradually saturated, whereas Low-voltage users represent 51.6% peak demand

5) Public housing policy is clear and its property right belongs to the city, which is suitable for Demonstration site

Taipei centralize all the challenges and opportunities

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Strategy

Develop a VPP in Taipei City, Starting in the Public Housing with Pilot Projects

- On account of the challenges mentioned previously, Taiwan thus must be cautious about its energy transition and take care to keep a consistent spinning reserve to prevent power outage events

- In 2018, 325, under Smart Grid and VPP Project Phase 0 and Phase 1, out of 7,141 households have been completed and participated in the Low-voltage Demand Response Bidding Program by the use of the Aggregator Platform
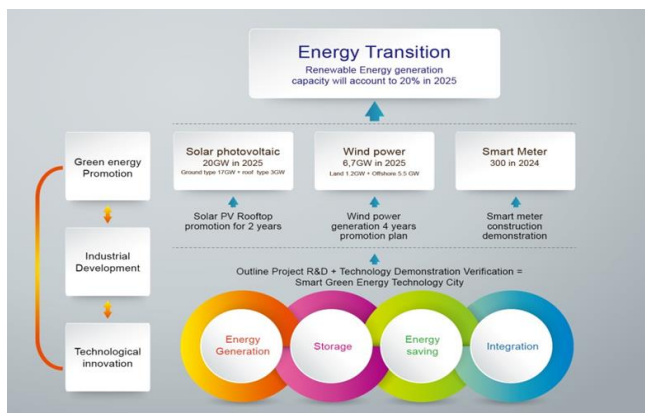
Strategy

Synergies Between Central Government, Local Government, and NGOs

- **Project Planning**
  - The second phase of the National Energy Program
  - Taipei City Government Urban Development Bureau
  - Taiwan Institute of Economic Research
- **Technology Implementation**
  - Chung-Hsin Electric and Machinery Manufacturing Corp.
  - National Cheng Kung University
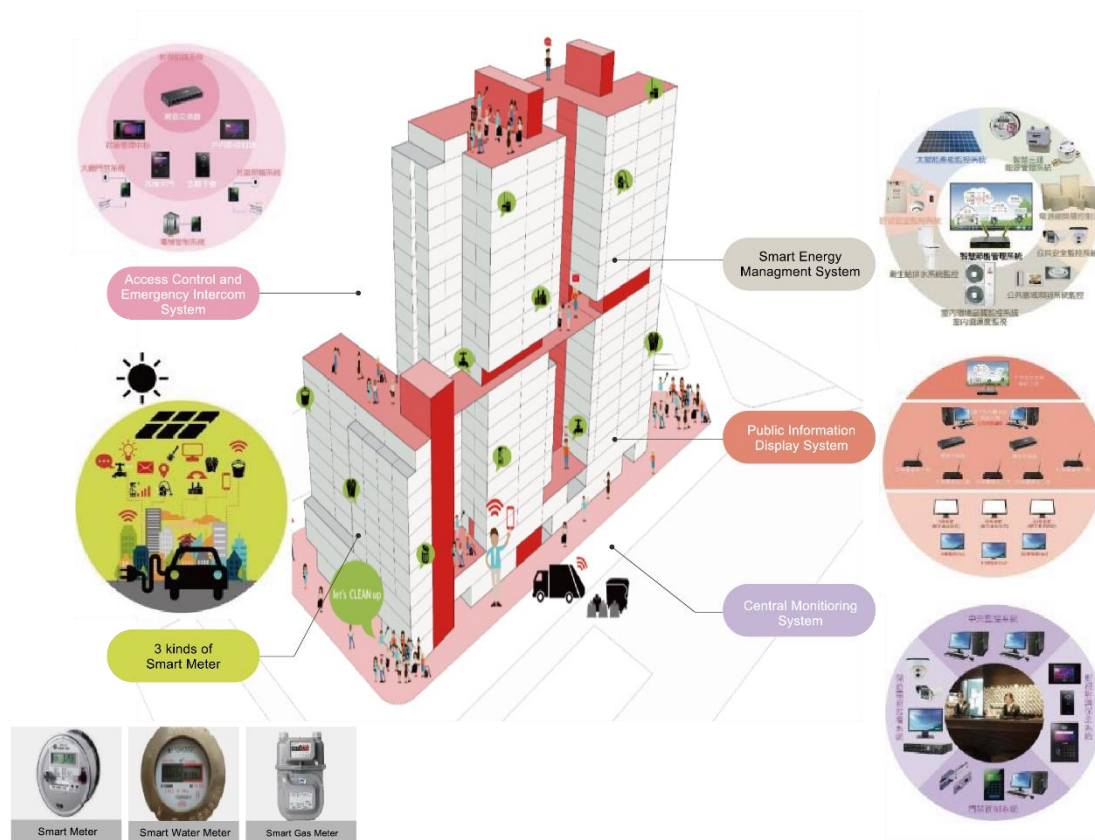- **Demand Response Bidding Platform Establishment**
  - Taiwan Power Company

Conceptual Design

VPP Demonstration in Xinglong Public Housing Area 2

A total of 301 households are equipped with smart grid technology in the house (HEMS), while a smart energy management system (BEMS) have been implemented in the buildings

Solution 1

Hardware Construction of Public Facilities in Building

The smart public housing building includes DERs that are integrated with an EMS to establish a microgrid which can smoothly and ideally switch the building's consumption to integrate the electricity from renewable energy, ESS or the power grid in different situations.
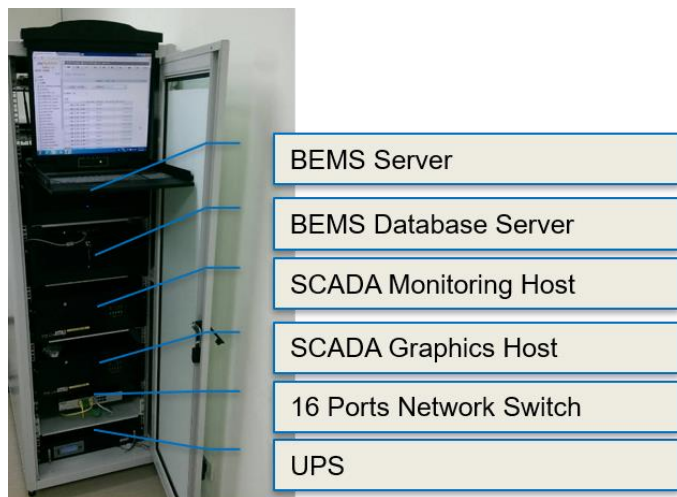
- **Solar PV System:** Provides a certain percentage of total power consumption of public electric facilities
- **Energy storage system:** Stores both green energy from PV and the grid, can be remotely controlled to participate in Demand Response
- **Diesel generator:** Provides backup power
- **Smart EV charger:** Can be remotely controlled to react to Demand Response
- **AMI:** Monitors electricity consumption and communicates real-time data to Taipower for billing or participating in Demand Response
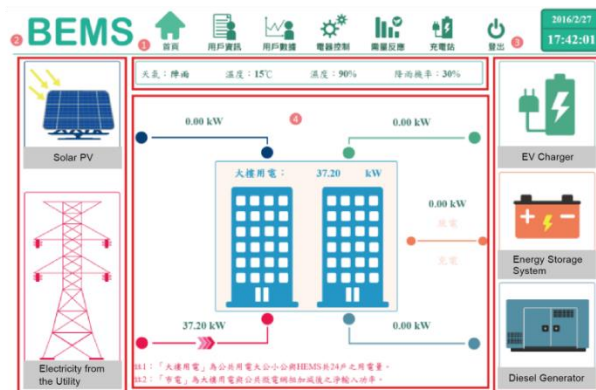
Solution 2

BEMS Hardware/Software Construction

BEMS Server

BEMS Database Server

SCADA Monitoring Host

SCADA Graphics Host

16 Ports Network Switch

UPS

- The **Building Energy Management System (BEMS)** adopts IoT technology and smart meters to monitor and control Supervisory Control and Data Acquisition (SCADA) System, which integrates the electricity consumption behaviors of the public facilities in the building and **the HEMSs**

- From the **monitoring room**, information concerning the building energy consumption can be displayed and analysed


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Solution 3

Hardware Construction in Households

To verify possible benefits from implementing smart grid technology, several households have been equipped with **smart appliances** and **sensors** to perform intelligent **energy-saving** control. During peak demand, these appliances can also be controlled to react to **Demand Response** request.

- **LED Lighting**: Adjust and turn on/off depending on the need and preference
- **Air Conditioner**: Automatically adjusted corresponding to the comfort level sensing by the room temperature sensor, the thermometer and hygrometer
- **Smart Meter:** Residents can get real data of their electricity consumption and decide their future consumption behavior
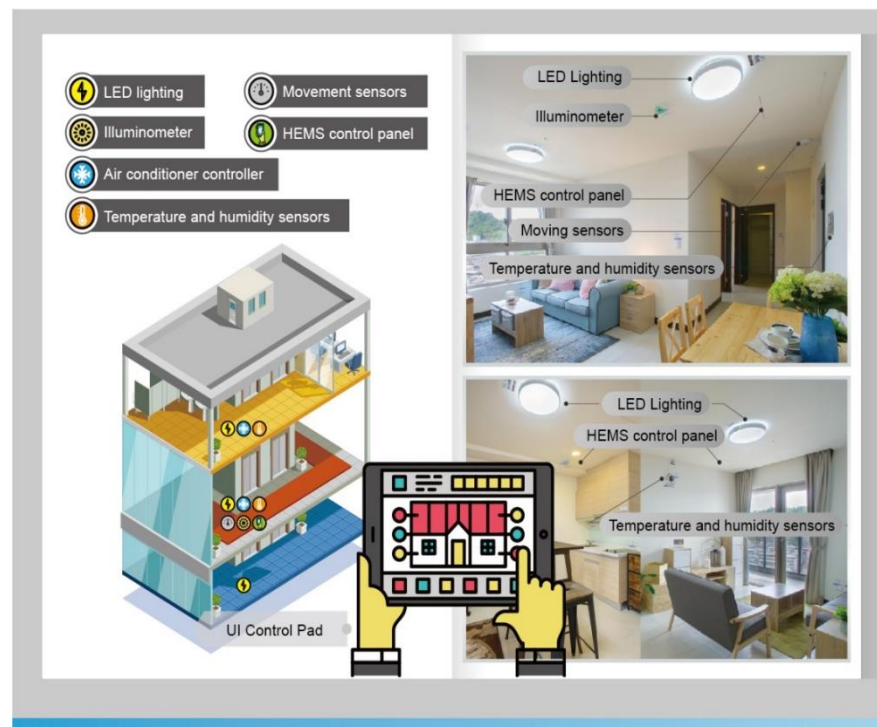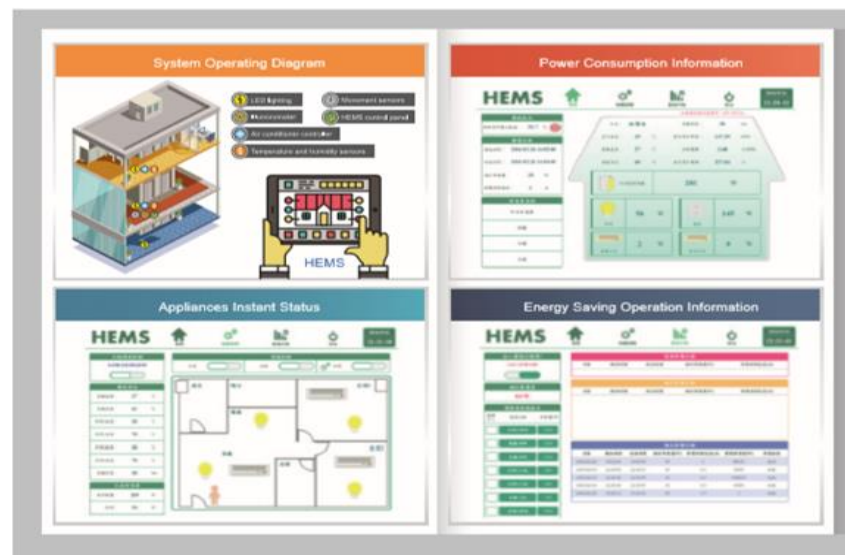
Solution 4

HEMS Hardware/Software Construction

Smart Appliances can be integrated by the **House Energy Management System (HEMS)**, and the HEMS will further be connected to the BEMS. The HEMS will collect real-time data and display processed information to its users, such as electricity consumption status, pricing information, emission reduction result, energy and money saving strategies and suggestions.

UI Control Pad: Smart appliances can be automated and remotely controlled by residents via an APP on the control pad
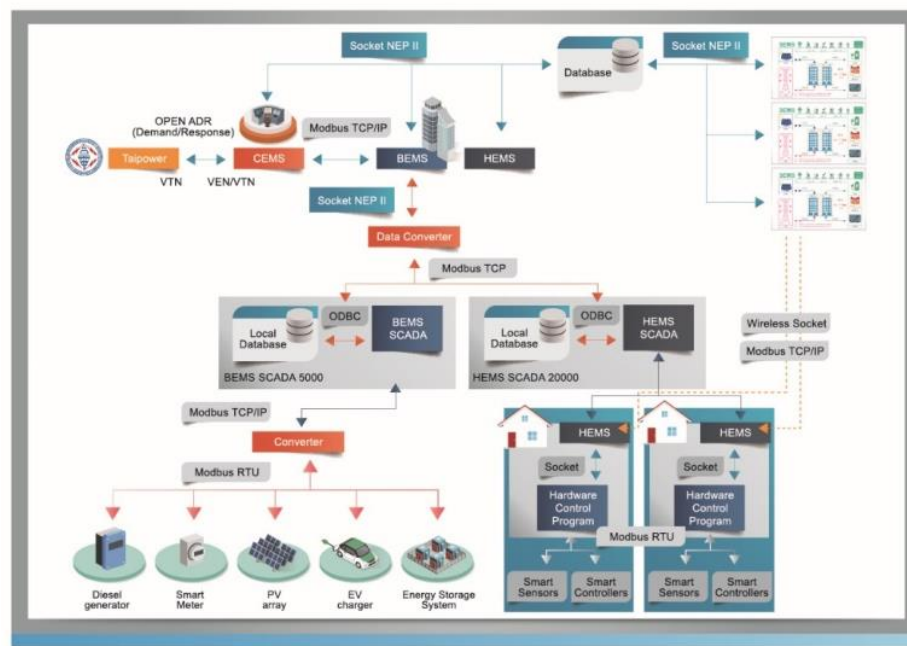
Solution 5

Establishment of a Regional Energy Cloud Information Center
that Provide Household Electricity Cloud Services

The consumption data of **various types of households** in Xinglong Public Housing Area 1 & 2 will be aggregated and controlled by the **Community Energy Managment System** (CEMS) and send to the Cloud Platform, to characterize the electricity consumption pattern in Xinglong Smart Community.

➜ In case of power outage or emergency situation, **the CEMS can operate as a VPP**, from one building of the community to another, dispatching the energy resources.

Solution 6

Establishment of Aggregator Platform
to Participate in the Demand Response Bidding Program

- A user group representative, an aggregator, can make use of the OpenADR 2.0 protocol to submit a bid with expected price to Taipower and compete with other aggregators according to the mechanism established by Taipower

- Taipower takes Demand Response as a method to enhance spinning reserve, as well as an energy resource of the Economic Dispatch to reduce its overall power supply cost. It will then calculate an equivalent price from high voltage demand response bidding program as a reference of accepting a bid from low voltage demand response bidding program

- Once the bid is accepted, the users will be notified that the HEMS will turn off specified devices during the agreed period, and then receive the reward from Taipower

Overall Solution

Xinglong Smart Community as a User Group Representative in the Aggregator System

Xinglong Public Housing Area 1 and 2, through their HEMS and BEMS, will be integrated into Xinglong Smart Community. With the use of CEMS, Xinglong Smart Community can participate in the Demand Response Bidding Program to assist the operation of the power grid to get rewards.
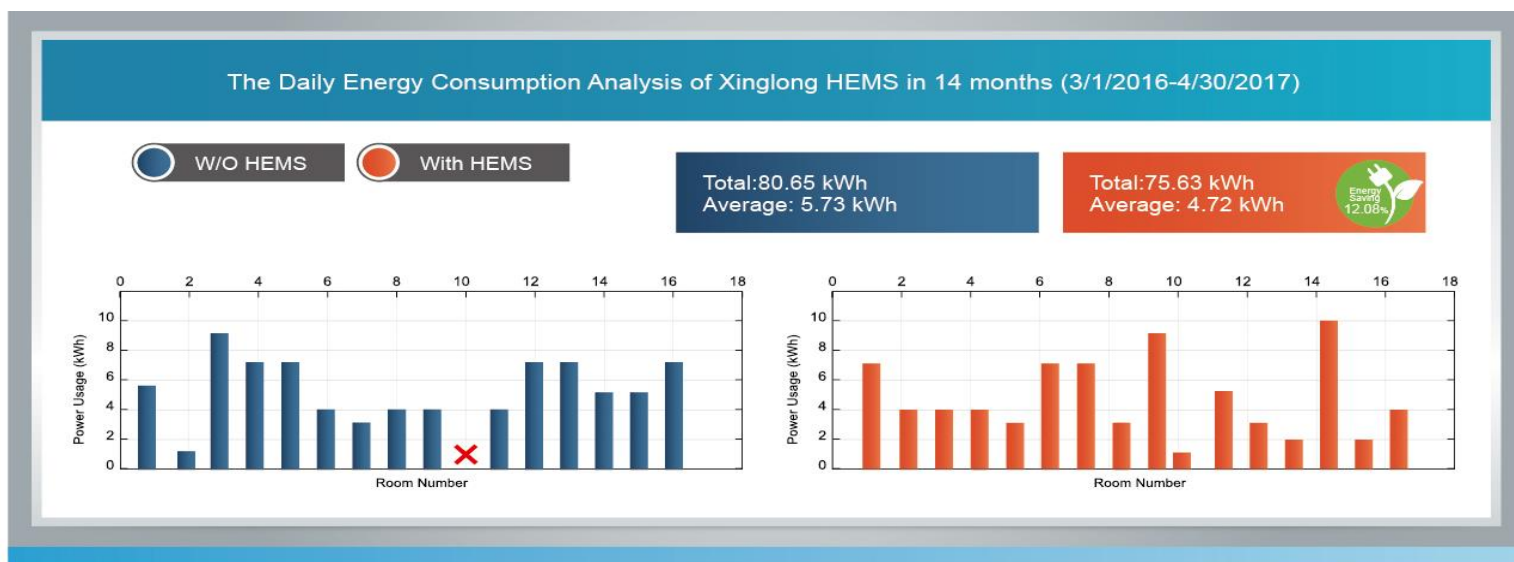
Current Results and Performance

Energy Saving

- HEMS has been introduced to citizens living in the Smart Public Housing with different ages and living patterns: senior residents, young couples, housewives (husbands), students, small offices/home offices (SOHOs), office workers

- For verifying the function of HEMS, a 14 month energy consumption analysis of the building have shown that the utilization the HEMS can allow more awareness and control over the home loads, and result to **12% to 13% of energy saving** in average

The Daily Energy Consumption Analysis of Xinglong HEMS in 14 months (3/1/2016-4/30/2017)

W/O HEMS	With HEMS
Total:80.65 kWh Average: 5.73 kWh	Total:75.63 kWh Average: 4.72 kWh Energy Saved 12.08%

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Current Results and Performance

Demand Response Bidding Program Effectiveness

In order to relieve risk of power shortage and avoid the use of power plants with higher fuel cost, Taipower will seek for **Demand Side Management** to reduce the energy consumption at specific period of time.

- Xinglong Public Housing Area 1 and 2 has been combined to participate in the Low-voltage Demand Response Bidding Program in order to verify the mechanism of Aggregator Platform

- The first experiment for the Demand Response Bidding Program was executed January 10th, 2019, where households with HEMS and public facilities with BEMS were accepted and gathered to participate to the bidding program. It achieved the reduction of 3.112kW during a period of 2 hours

Execusion date	Execusion time period	Contract Capacity (kW)	electricity rate of the day (NTD/kWh)	Customer baseline load (CBL) (kW)	Actual electricity capacity (highest demand during that period in kW)	Actual reduction capacity (kW)	Rate of execusion (%)	Reward (NTD)
2019-01-10	17:00~19:00	50.000	6.0	115.838	112.726	3.112	6.2	37.344
2019-04-09	16:45~18:45	50.000	3.9	132.127	124.214	7.913	15.8	61.721
2019-04-26	17:15~19:15	50.000	6.0	95.905	82.568	13.337	26.7	160.039

**January 10th: It achieved the reduction of 3.112 kW during a period of 2 hours
April 26th: It reached to 13.337 kW reduction!**

Potential impacts

Energy Saving

It has been estimated that for six exemplary smart communities, accounting for a total of about 6,000 public housings on a total building estimated area of about 593,500 m^2, it could save 20% of energy, which equals **NT\$ 322,860,000 electricity cost reduction, or 44,720 tons of CO$_2$ emission reduction for 20 years.**

**Demand Response Bidding Program Effectiveness**

In 2025 it is estimated that the VPP concept could be further expanded to achieve the development of three Low voltage Aggregators in all urban area of Chinese Taipei, with one million households included. Assuming that each household could reduce 0.5kW during the Demand Response period, it could result in a **500 MW increase of the spinning reserve** in the whole country.

Public Promotion

Transparent Channel of Public Communication to Promote the Concept

- Taipei City Government compiled and published the "**Taipei Public Housing Smart Community Construction Reference Manual**" to share its experience to other city governments and the public, both domestic and overseas to assist in the implementation of smart grid technology into life and the development of relative standards

- The smart buildings are open to public during **visit events**

- Every year Taipei City organize the "**Smart City Exhibition**" for Taiwanese citizens and City international leaders to promote further collaboration
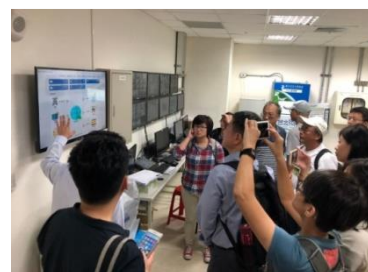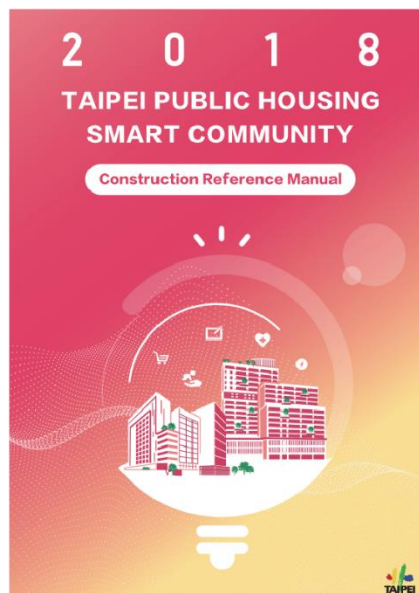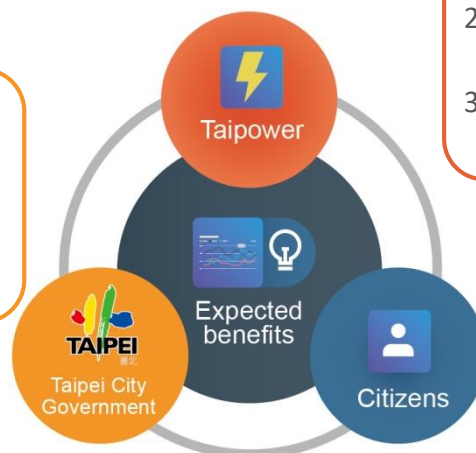
Advantage of Developing VPP in Taipei

A Win-Win-Win Situation for Taipower, Taipei City Government and Its Citizens

The development of the Aggregator System along with the liberalization of the electricity market will contribute to achieve the Virtual Power Plant concept, a dispatchable and large VPP within Taipei City.

- The **Demand Response Bidding Mechanism** will improve through the experiments from the city

- **Smart Grid Technology implementation will expand** to other edifice with different types of energy consumption in a faster and more efficient way

- Citizens, gaining more awareness toward energy saving, will establish **more aggregators**, and those Aggregators will then **participate in different kind of energy services markets**

1. Relieve risk of power shortage
2. Reduce transmission and distribution pressure in power system during peak hours
3. Create an energy resource of the Economic Dispatch to reduce its overall power supply cost

1. Stabilize and secure power supply in the city
2. Create an aggregator business model to gain revenue and raise energy efficiency
3. Stabilize various economic activities in the metropolitan area

Taipower

Expected benefits

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Citizens

1. Access to more reliable electricity supply
2. Lower electricity cost from energy saving
3. Be rewarded for energy conservation in Demand Response Program

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Vision for the Development of VPP

The VPP concept is expected to extend to all urban area in Chinese Taipei, and to partially solve the overall challenges mentioned before, especially in the enhancement of spinning reserve.
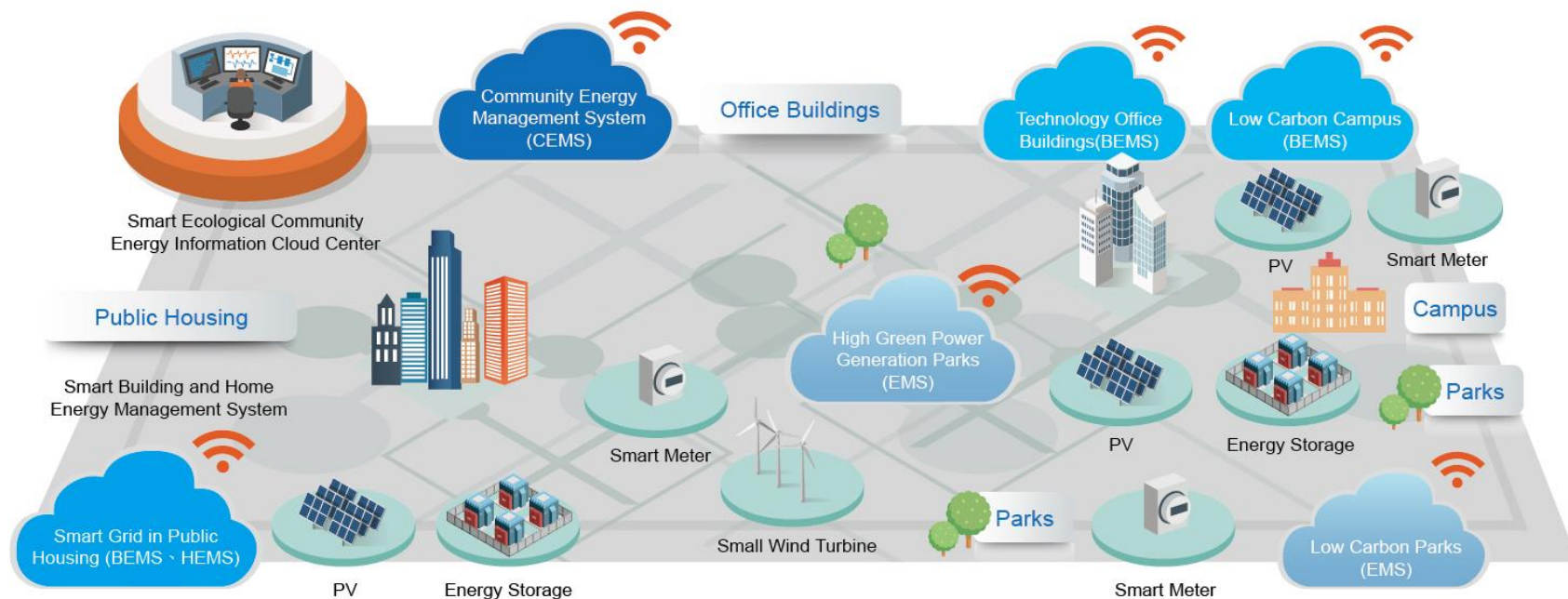
It is expected to increase the spinning resere, stabilize the power supply, increase the integration of DERs and RE, dispatch the load and finally, increase the citizen's awarness.

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Thank you

For your attention!