Utilization of Demand Side Resources for Energy Efficiency and Demand Response in Japan

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Introduction

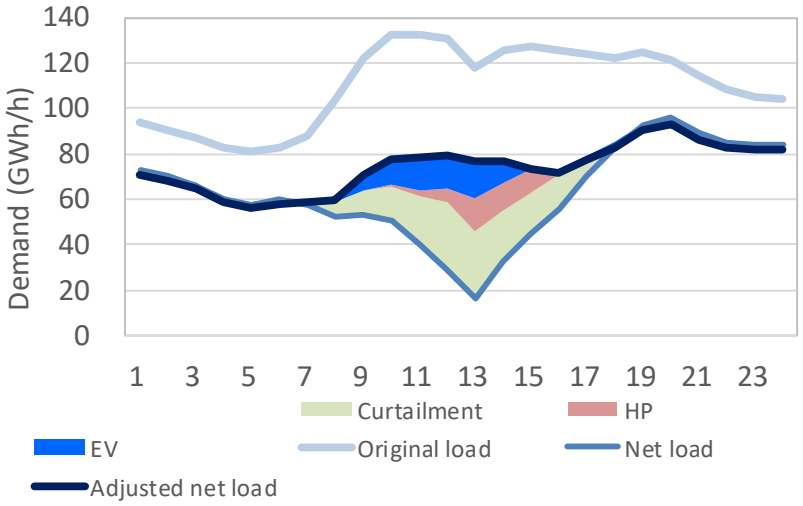
- Flexible distributed energy resources (DERs) on demand side will contribute to stable power system operation including massive renewable energy.
- Small DERs in Japan
  - Heat pump water heaters (HPWH) (1-1.5 kW)
  - Electric vehicle batteries (EV) (40-60kWh,3-6kW)
  - Residential stationary storage batteries (-10kWh,3-5kW)
- A number of VPP (virtual power plant) demonstration project to bundle these small resources are currently ongoing in various locations.

How many DERs are available in Japan?

- Heat pump water heaters (HPWH)
  - Cumulative sales were over 7 million units in 2018. (Government target in 2030 is 14 million units)
  - Existing equipment is operated during the late night and early morning hours when electricity rates are low and cannot be remotely controlled. Some of new products can be controlled.
- Residential stationary batteries (SB)
  - Cumulative sales were 360 thousand units in 2019.
  - They are increasing rapidly due to recent disasters such as typhoons.
  - Many are being operated independently, but are slowly beginning to be remotely controlled.
- Electric vehicles (EV)
  - Cumulative installation of pure battery EV (BEV) and plug-in EV (PHEV) was 240 thousand units (2018). (Government target in 2030 is 9 million units)
  - Hybrid vehicles are driving the sales of electric vehicles in Japan. Regarding BEVs and PHEVs, the number of sales has peaked because the number of types of vehicles is limited.
  - A demonstration on market price-linked charging was launched this year.
  - The use of charge and discharge control is limited due to the high price of V2X devices (bi-directional charging system).
- Household number in Japan : approx. 50 million

How much is the potential of DERs as a flexible resource?

- HPWHs and EVs could each provide about 15 GW of flexible power resources
- HPWH
  - Demand response effect of avoiding PV output curtailment are provided.
  - HPWH operates primarily during the day when solar radiation is high, which saves electricity consumption due to high outside temperatures and reduced tank loss.
- EV
  - The value of battery use is low if only charge control is used because of a short driving range in Japan
  - Charge and discharge control increases the value of batteries.



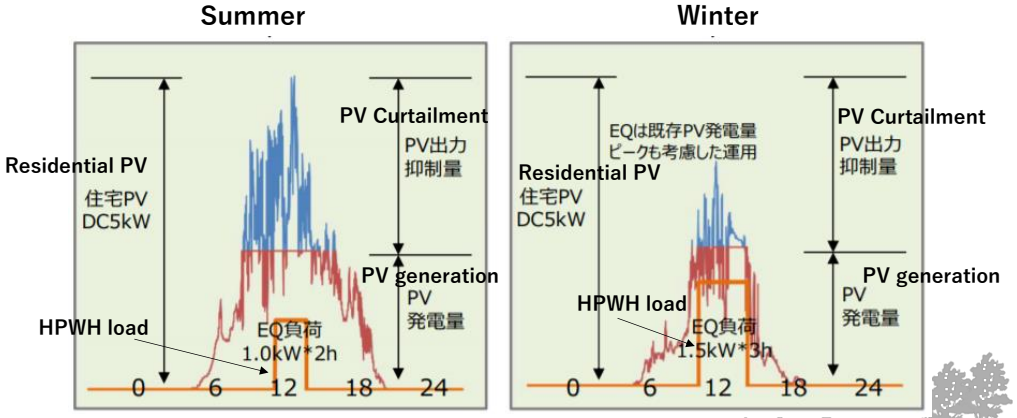
Supply and demand simulation on April 1, 2030
(PV 103GW, wind power 32GW installed)
DR effect of EV 9 million units and HPWH 14 million units in Japan

Iwafune et al.

Miyakojima Island Smart Community Demonstration Project

- Group control of controllable loads such as HPWHs and batteries to improve the load factor of the power system and absorb PV surplus under the limited conditions of an island.
- A business model based on a third-party ownership model for HPWHs and storage batteries.
- Construction of a cloud-based control system while avoiding increasing communication and management costs.

- FY 2018-19 PV+HPWH implementation results: 202 units in 40 municipal housing units, and 10 welfare facilities.



HPWH shifts boiling operation.

Expectations to DERs utilization are high…

- But the barriers are also high.
  - The small unit capacity of the resource makes it difficult to control them cost-effectively.
  - To break the barriers….
    - Spread of DER devices
    - Building an aggregation system using digital technologies
    - Further reduction of communication and control costs
    - Market design for the value of these resources to be realized
    - Construction of grid cord for DERs