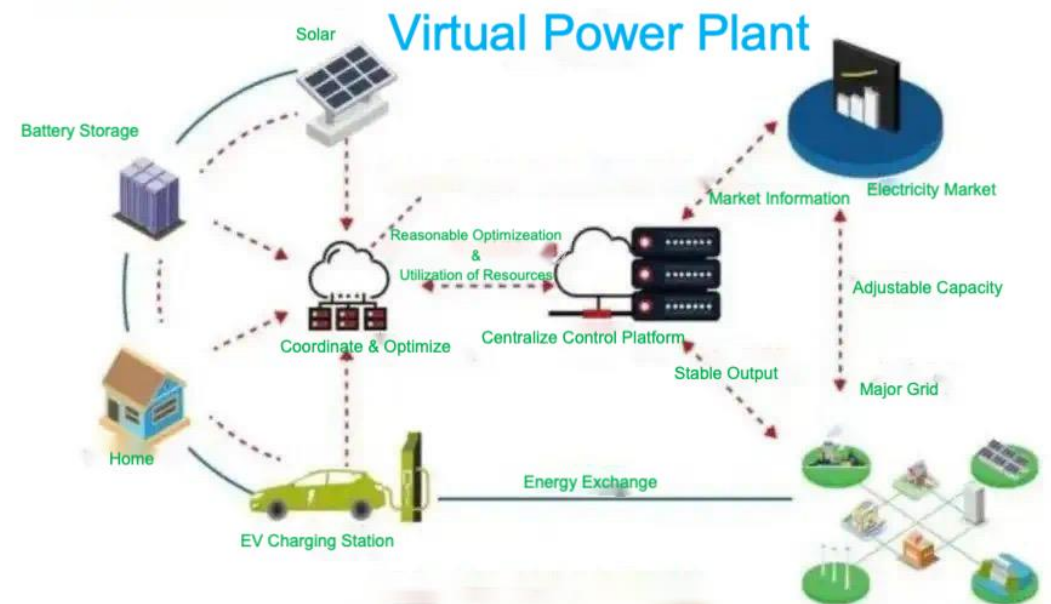
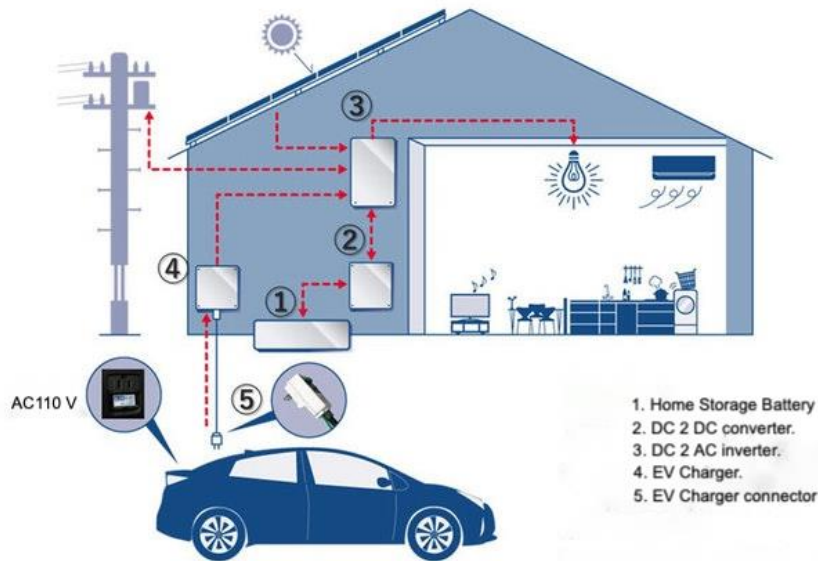


# Virtual Power Plant

Cloud is the Power Plant, Data is the Fuel

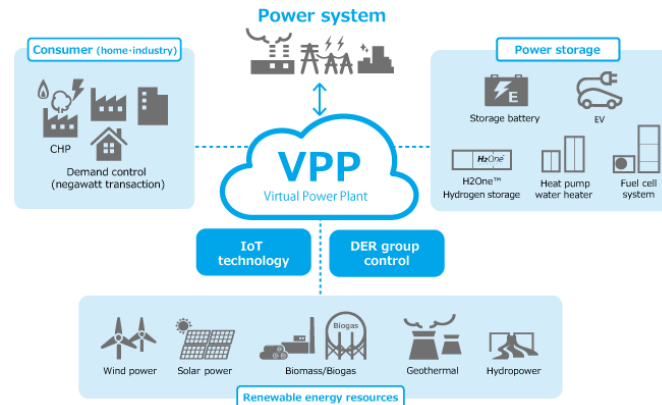


# Introduce renewable energy by stabilizing the electricity supply

- Aiming to become a cyber physical system (CPS) technology company in the energy industry by fusing the know-how accumulated through the supply of products such as power generation equipment and power transmission and transformation equipment with prediction, analysis, and optimization technologies utilizing IoT and AI , PEP will contribute to the realization of smart and sustainable society. Following this, PEP is developing a negawatt aggregator business and storage battery aggregator business.



# What is a Virtual Power Plant?

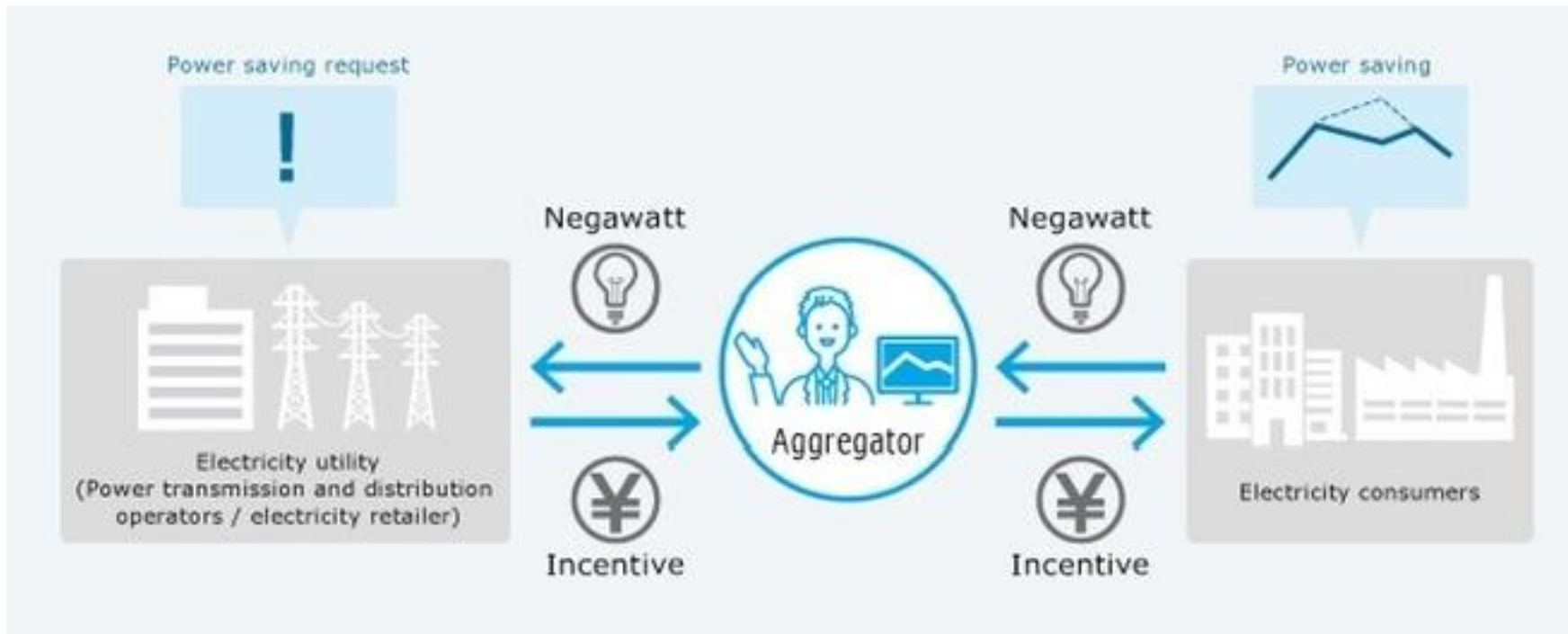


- Since the La Niña causes mostly the opposite effects of El Niño: above-average precipitation across the northern Midwest, the northern Rockies, Northern California, and the Pacific Northwest's southern and eastern regions. Meanwhile, precipitation in the southwestern and southeastern states, as well as southern California, is below average. This also allows for the development of many stronger-than-average hurricanes in the Atlantic and fewer in the Pacific.
- Electric car grid charging station also cause the balckout, need to be replaced by DC charging station.
- Conventional energy supply systems that depended on large-scale power plants have been challenged, and the spread of distributed power sources such as renewable energy, including solar power and wind power, has been increasing. As the amount of renewable energy generated greatly depends on the weather, the energy supply will become unstable as its use spreads. The new concept of energy service comes as a solution to maintain the stability of the power supply. This means, for example, that scattered energy sources, such as distributed power sources and storage batteries, can be remotely controlled by IoT equipment and function as if they were one power plant.
- Therefore, it is necessary to control many geographically spread power generation and storage facilities in real time, according to the ever-changing supply and demand situation. For that purpose, it is necessary to have excellent technology for remotely controlling dispersed devices and technology for more accurately predicting electricity demand and solar power generation. By adjusting the balance between supply and demand with VPP, renewable energy power can be used stably. VPP is expected to promote the introduction and expansion of renewable energy and contribute to a decarbonized society.

# Negawatt aggregator business

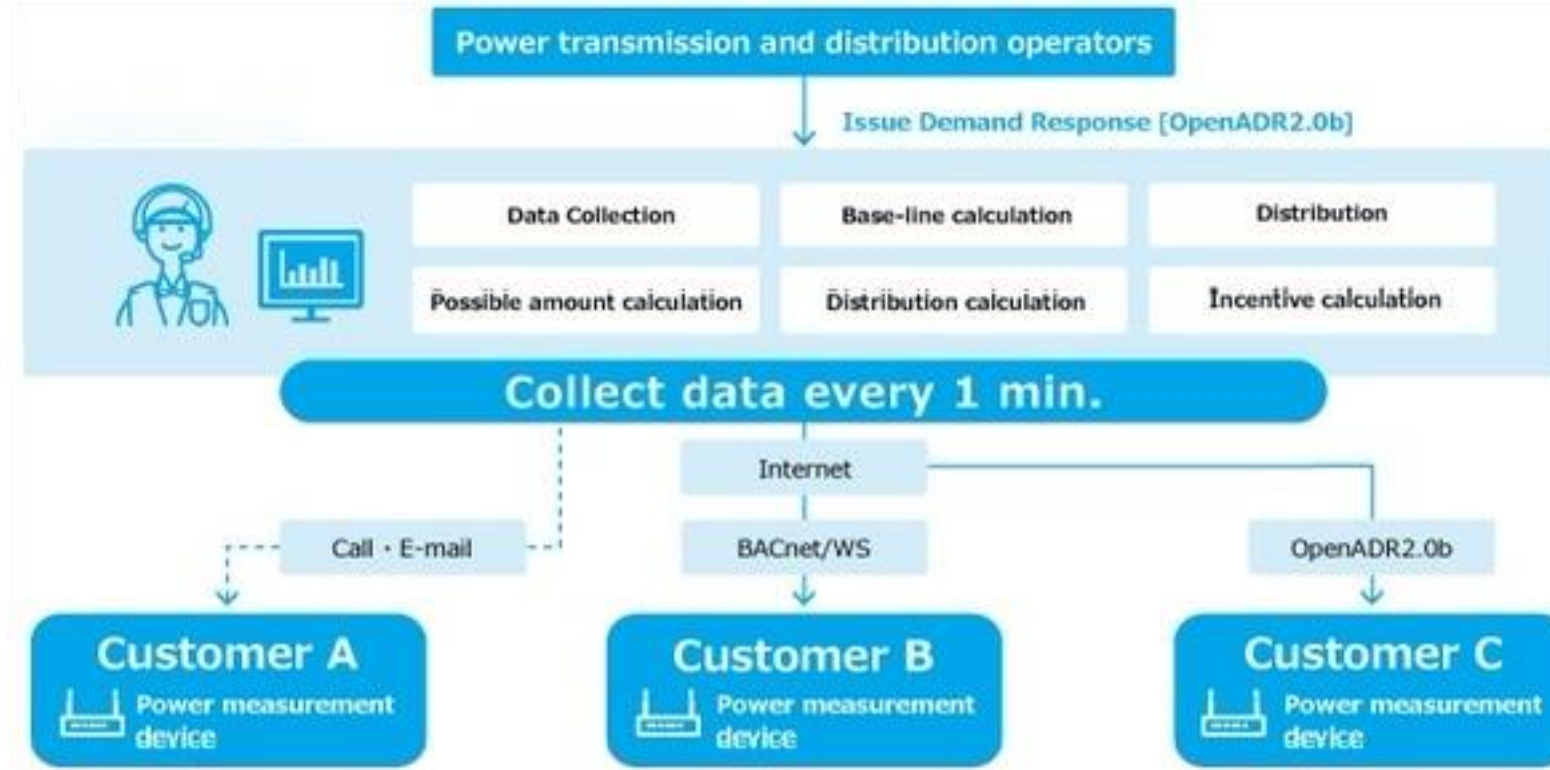
Provide service for mediating between electricity utilities and electricity consumers to support negawatt trading.

- We provide services that support negawatt trading by mediating between electricity utilities and electricity consumers.
- To achieve accurate power savings, PEP has developed an aggregation system that has been certified by OpenADR and is working to enhance customer portfolio technology using data. In addition to assisting power-saving consulting with customers in cooperation with electricity retailers, we also handle power saving requests to electricity consumers on behalf of electricity utilities.



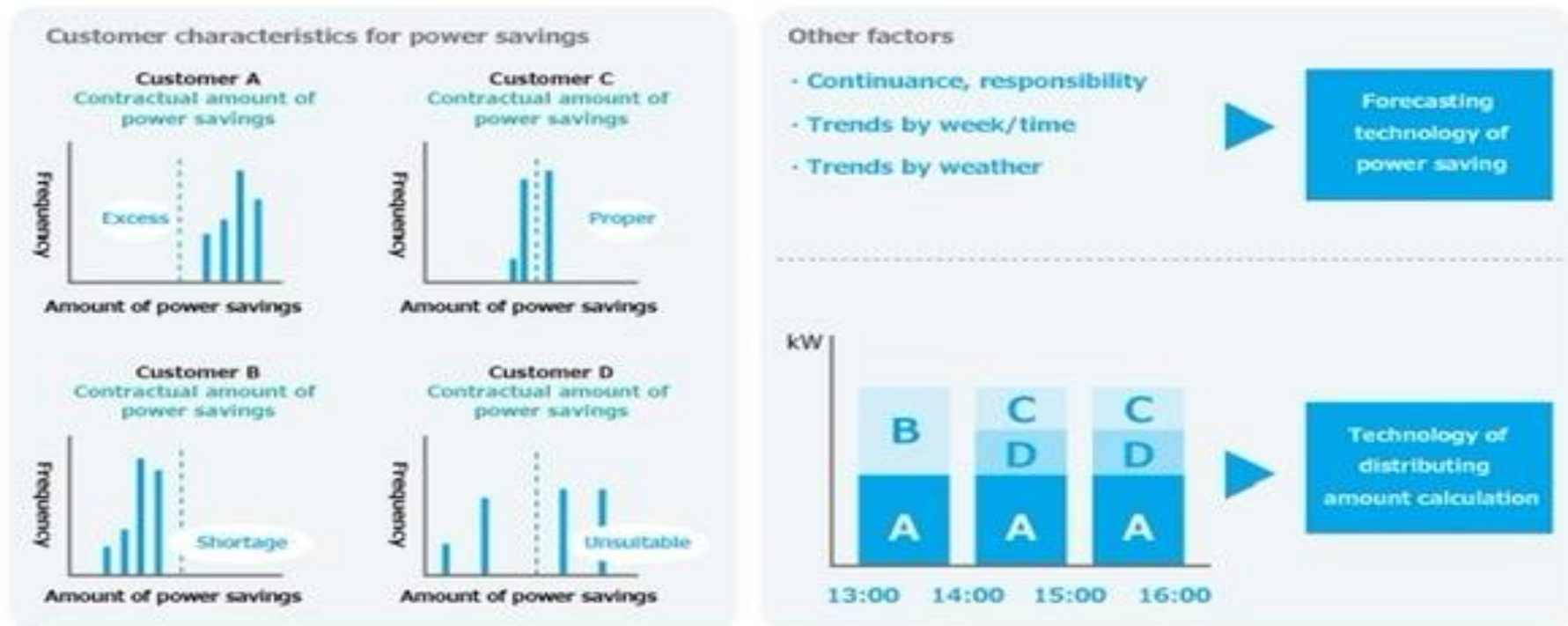
# Negawatt aggregation system that realizes accurate response to power saving request

- For each customer, we generate and collect data and develop a system for issuing power saving requests. PEP's negawatt aggregation system is OpenADR 2.0b certified. Electricity retailers and resource aggregators subsequently offer individual functionalities as cloud services.



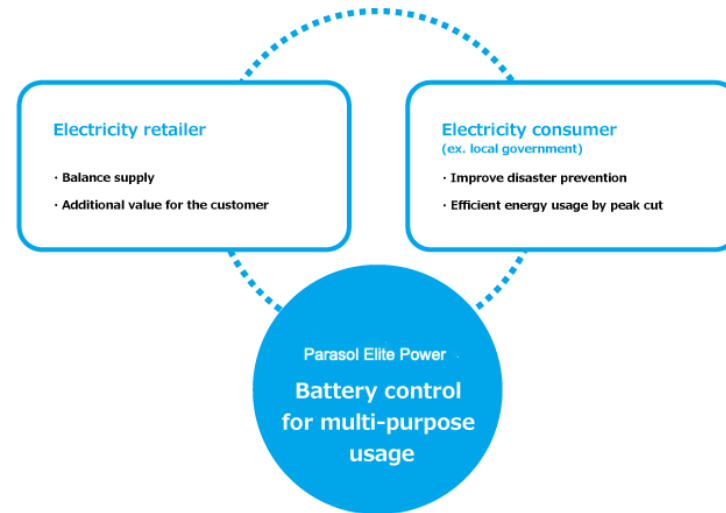
# Electricity consumer portfolio technology to increase the power saving success rate

- We start by understanding the characteristics of individual customers based on the data collected and consulting with customers. Through the portfolio technology combining multiple customers, the success rate of power saving requests from power transmission and distribution operators has steadily increased.



# Storage battery aggregator business

Multiple storage batteries can be grouped and controlled for multiple purposes.

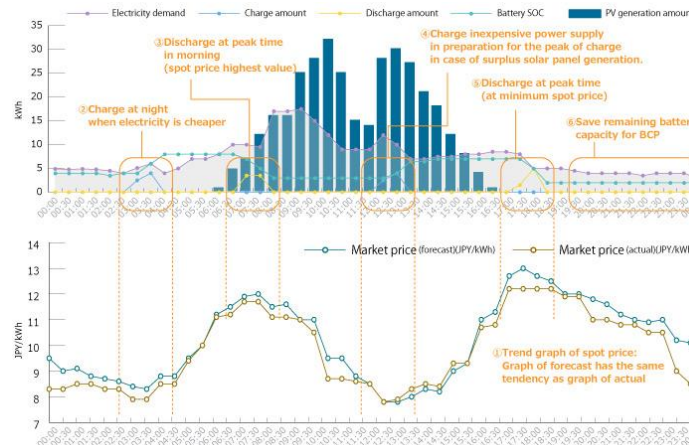


- Since 2020, PEP has been operating a demonstration project to develop an intelligence VPP system of storage battery control technology. PEP developed a control technology for groups of multiple storage batteries. Then, PEP will start commercial service of VPP operation from January 2023.
- As an example, we control groups of multiple batteries to enable efficient operation of peak cut and demand response according to the status of the power systems and storage batteries, while securing the necessary power in case of emergency for the storage batteries installed at disaster prevention facilities. As a result, while providing emergency power to improve disaster prevention, storage batteries are also used for balancing to help optimize the balance of supply and demand.

# Group control technology for multiple storage batteries

- We have the technology to schedule and control (multi-use) storage batteries according to the users' multiple uses based on our prediction technology. For electricity consumers, Business Continuity Plans BCP is used as a backup power supply in the event of a crisis, such as during a disaster, and can also be used for peak-shift. For electricity retailers, this can be used to improve the power procurement cost by avoiding imbalances and the market value. For power transmission and distribution operators, it can be used as a resource for balancing power tenders. By using these differently according to the situation, storage batteries can be used more efficiently. Multi-purpose usage and individual functions are provided as cloud services.

- 1.Trend graph of spot price: Graph of forecast has the same tendency as graph of actual
- 2.Charge at night when electricity is cheaper
- 3.Discharge at peak time in morning (spot price highest value)
- 4.Charge inexpensive power supply in preparation for the peak of charge in case of surplus solar panel generation.
- 5.Discharge at peak time (at minimum spot price)
- 6.Save remaining battery capacity for BCP



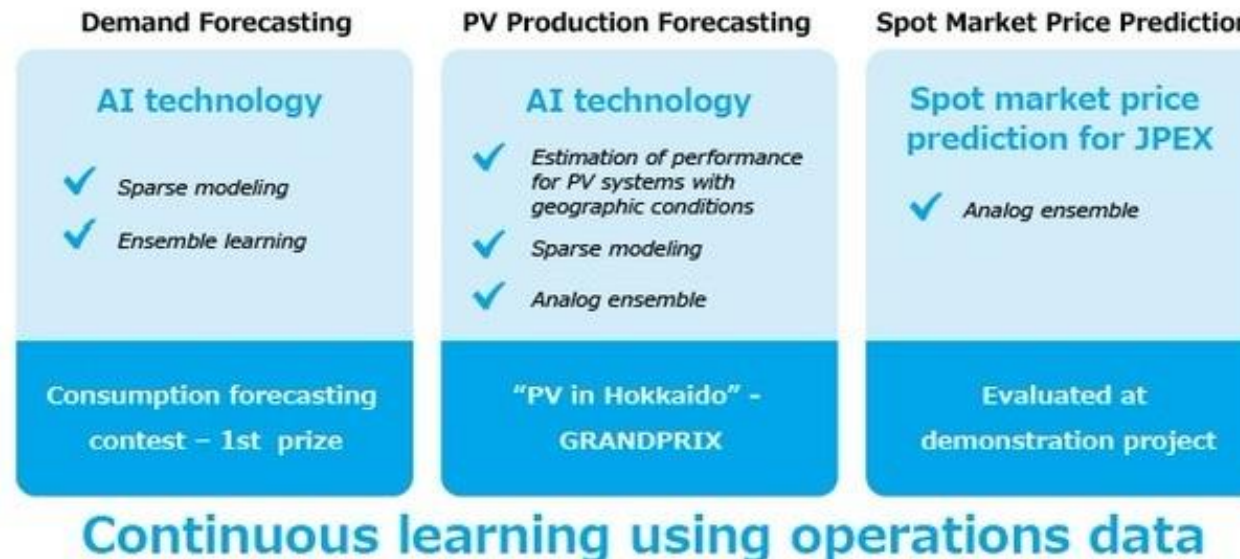
Example of multi-purpose usage of batteries

| Example of multi-purpose usage of batteries |  | Merit taker                                   |
|---|--|---|
| 1   | BCP application  | Electricity consumers                         |
| 2   | Store excess power from PV   | Electricity consumers                         |
| 3   | Peak-cut/peak-shift  | Electricity consumers                         |
| 4   | Use JPEX market price  | Electricity retailer                          |
| 5   | Imbalance prevention   | Electricity retailer                          |
| 6   | Balancing power tender<br>(Capacity market/balancing market at future) | Power transmission and distribution operators |



# Prediction technology utilizing AI

- By utilizing AI, we improve the accuracy of the prediction technology cultivated in our other power system businesses.
- For electricity demand forecasting, weather forecasting is performed at multiple time steps, and demand forecasting uses sparse modeling and ensemble learning to efficiently learn the relationship between weather information and actual power demand values. Using AI to optimally combine forecast results enables us to produce accurate demand forecasts.
- For PV generation forecasting, various data collected from an independent weather forecasting system are combined. Even when the performance and installation conditions of the solar power generation equipment are unknown, AI is used to make estimates based on the past power generation performance of the equipment. This technology has a track record of accurately predicting power generation.
- For electricity market price forecasting, we developed a technology to make accurate predictions based on various data obtained from our own weather forecasting system and past actual data, using analog ensemble (similarity search method).
- These are applied to the VPP system and individual functions are provided as cloud services.



# Glossary

- **VPP (Virtual Power Plant):**
  - Remotely control scattered energy sources such as distributed power sources and storage batteries with IoT devices to make them function as if they were one power plant.
- **IoT (internet of things):**
  - The concept of connecting whole range of devices and components to the internet.
- **CPS (cyber physical system):**
  - Digitalize the events that occur in the real world using IoT, etc., and utilize AI in the digital world.
- **Negawatt Trading:**
  - Consolidate the power saving of electricity consumers and trade as electricity demand adjustment.
- **DR (demand response):**
  - Adjusting electricity demand by controlling energy resources on the electricity consumers side.

# Glossary

- **OpenADR:**
  - International standard protocol for automatic demand response (ADR) that automatically controls energy equipment.
- **Resource aggregator:**
  - An operator that collects electricity consumer side energy resources and decentralized energy resources and controls them to provide energy services.
- **BCP:**
  - Business continuity plans are plans to continue important operations even in crisis situations, such as disasters.
- **Imbalance:**
  - Difference between power generation plan and actual demand.
  - Balancing power tender:
    - A system in which power transmission and distribution operators (operators that maintain and operate transmission lines and substations) procure adjustments through public offerings.