Demand-Side Technologies of Electric Power Company

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TOKYO Electric Power Company

About TEPCO (as of March 2023)

Establish	May 1, 1951
Operating Revenue (consolidated)	7798.6 Billion YEN (FY2022) → approx. 54.75 Billion USD
Gross Assets (consolidated)	12,093.1 billion YEN (FY2020) → approx. 84.9 Billion USD
Electricity Sales (consolidated)	242.8 Billion kWh (FY2022)
Peak Demand	55 GW（2019）
Employees (consolidated)	27,898 (FY2021)

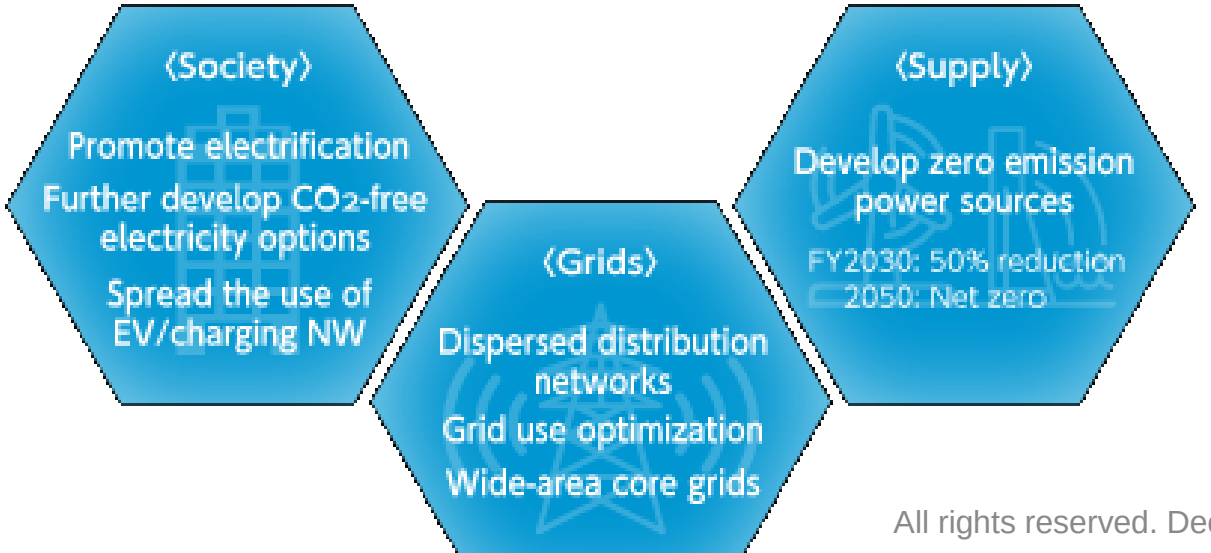
Targets and Initiatives for Carbon Neutrality

✓TEPCO has grasped the global trend of decarbonization and is boldly shifting to a business model based on carbon neutrality.

FY2030 target：
Reduce CO2 emissions of electricity delivered to customers by 50% in FY2030 compared to FY2013

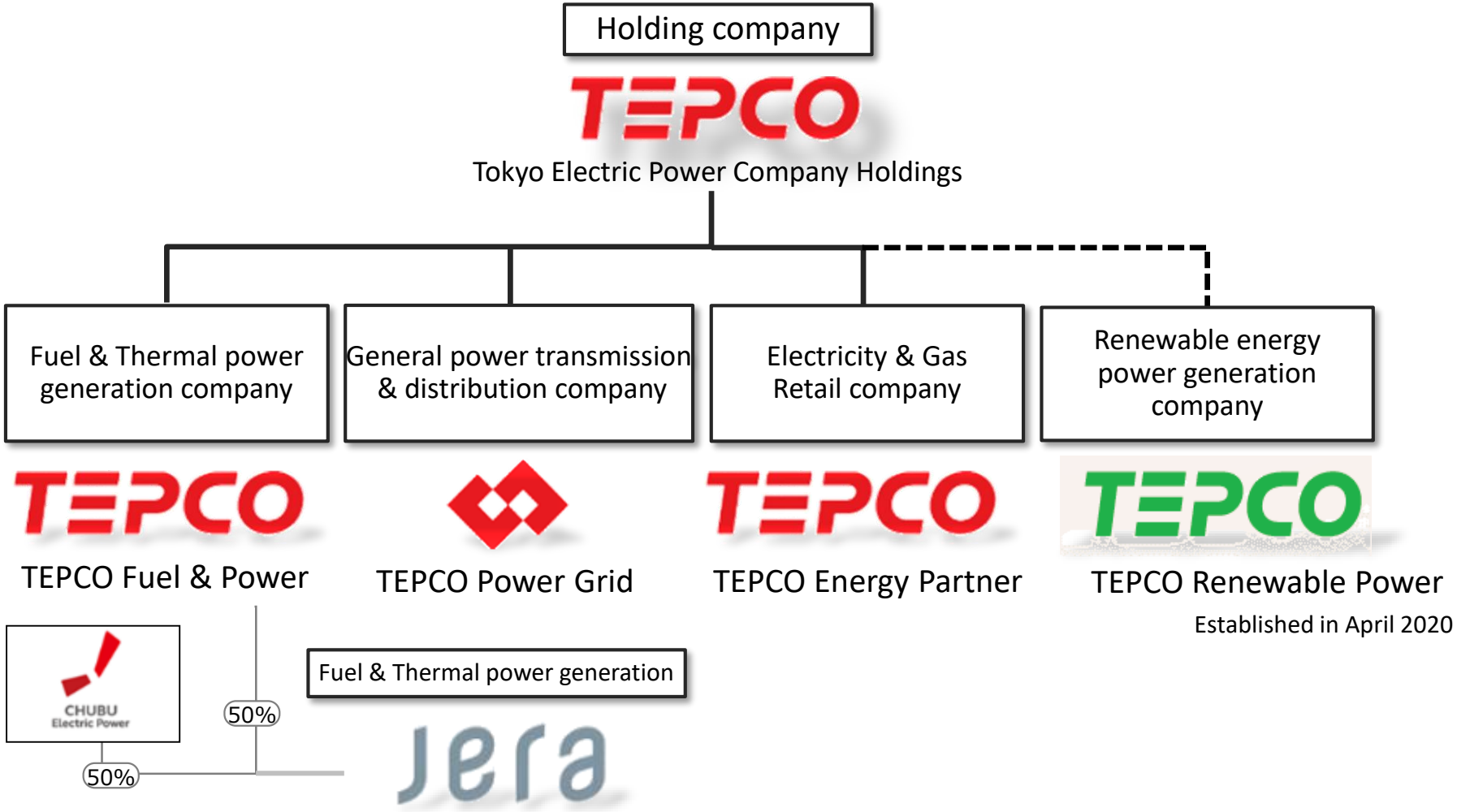
2050 challenge：
Reduce CO2 emissions from the supply of energy to net zero by 2050

With these objectives in mind the entire Group is engaged in initiatives to both develop zero-emission power sources and further promote the electrification of energy demand so that we can work with society to achieve carbon neutrality.

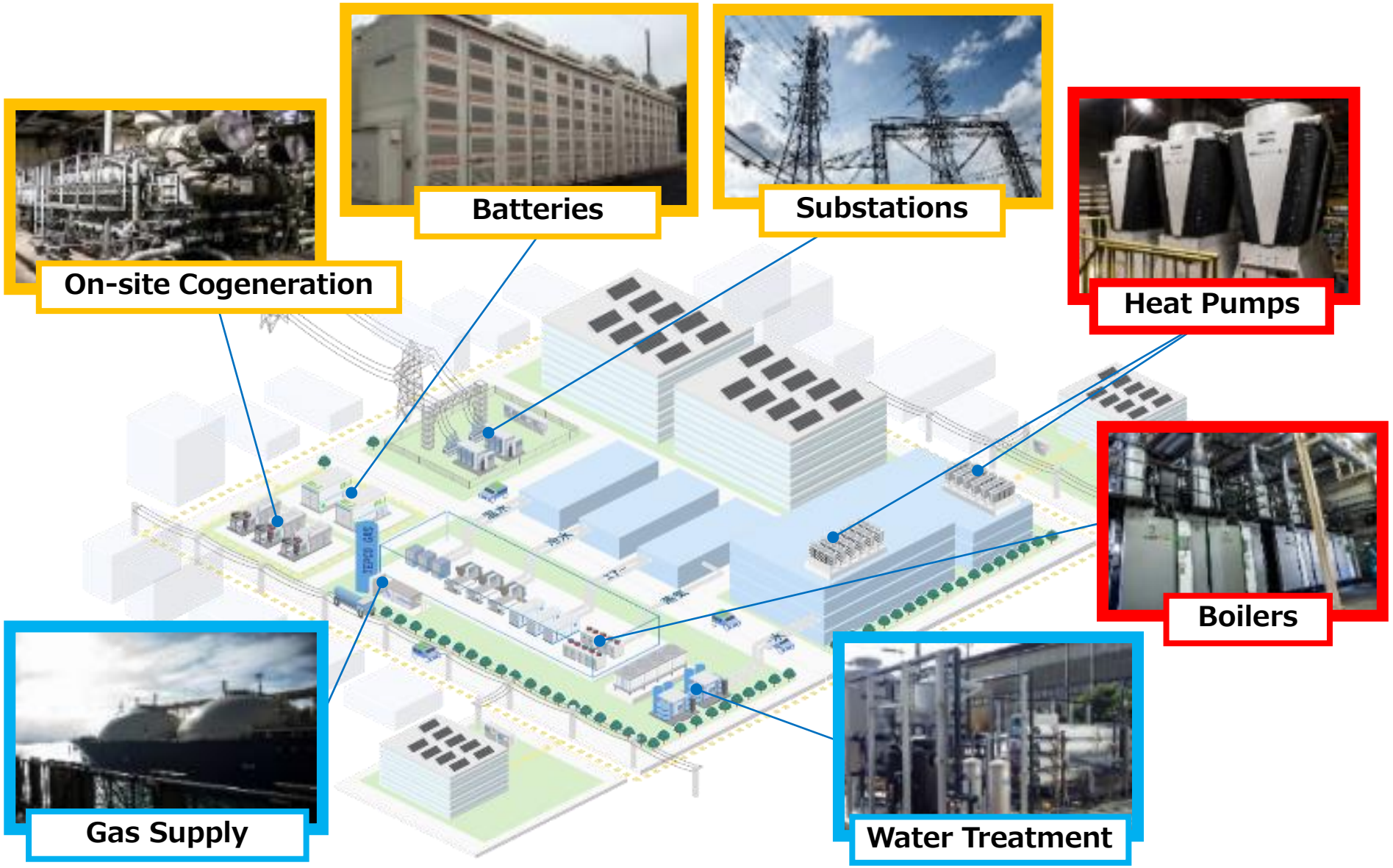


TEPCO holding company

■ TEPCO introduced a holding company system in 2016



Energy & Facility Solution Services by TEPCO Energy Partner



Case Studies of Energy Services by Japan facility solutions

■ More than 190 installation of Energy Services in Japan (ESCO, Energy Service Provider(ESP))

※ESPs include the supply and installation of energy-efficient equipment, energy supply, maintenance and operation, facility management, and more.

ESP

Hospital

Chemical Factory

Shopping Center

Food Factory

Electrical Equipment Factory

ESCO

Automobile Factory

University

Hospital

Museum

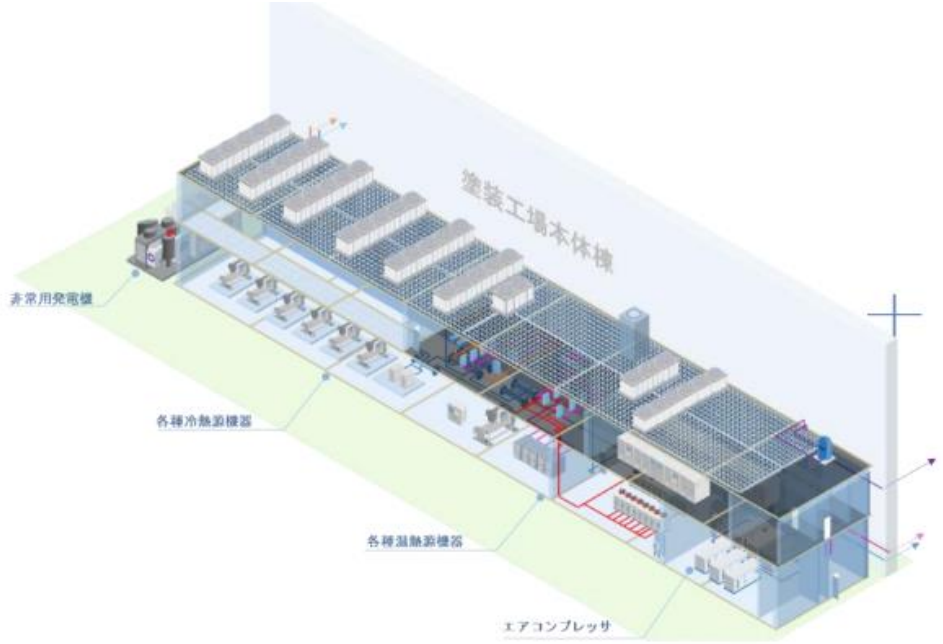
Other

Facility Design, Consultant

Shopping Center

Case Studies of Energy Services by Japan facility solutions

Provided energy facility services centered on high-efficiency heat pumps for the painting process at an automobile plant. The electrification of the plant from a fossil fuel-based facility resulted in improved energy efficiency and reduced CO2 emissions.
The reason for the high-efficiency system is the use of thermal waste heat as the heat source for the heat pumps' hot water supply. Specifically, the system utilizes hot waste heat from air compressor operation and cold water production.



Source: JFS Website

Expanding Demand-Side PV

- TEPCO announced a redevelopment plan for the TEPCO HD headquarters, "the world's first high-rise building to implement mega solar power generation using film-type perovskite solar cell (PSC) technology.

Film-type perovskite solar cell (PSC)

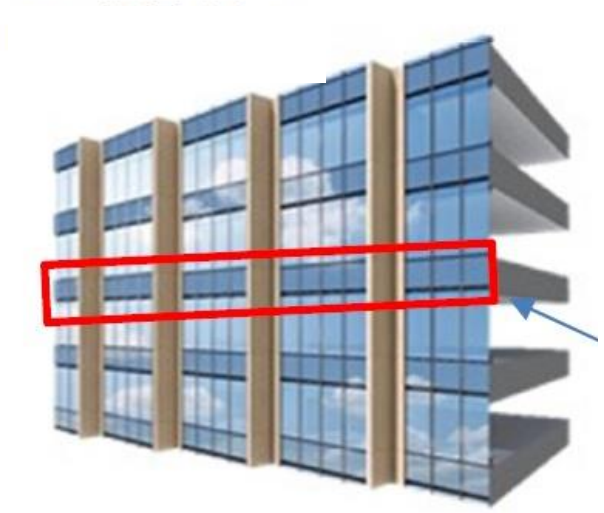


Image of PSC installation

Interior of outer wall of spandrel section

Impact by Expanded Introduction of Solar Power

In case more electric power is supplied than demanded while reducing thermal power output and utilizing interconnection lines and pumped storage, control renewable energy power output.

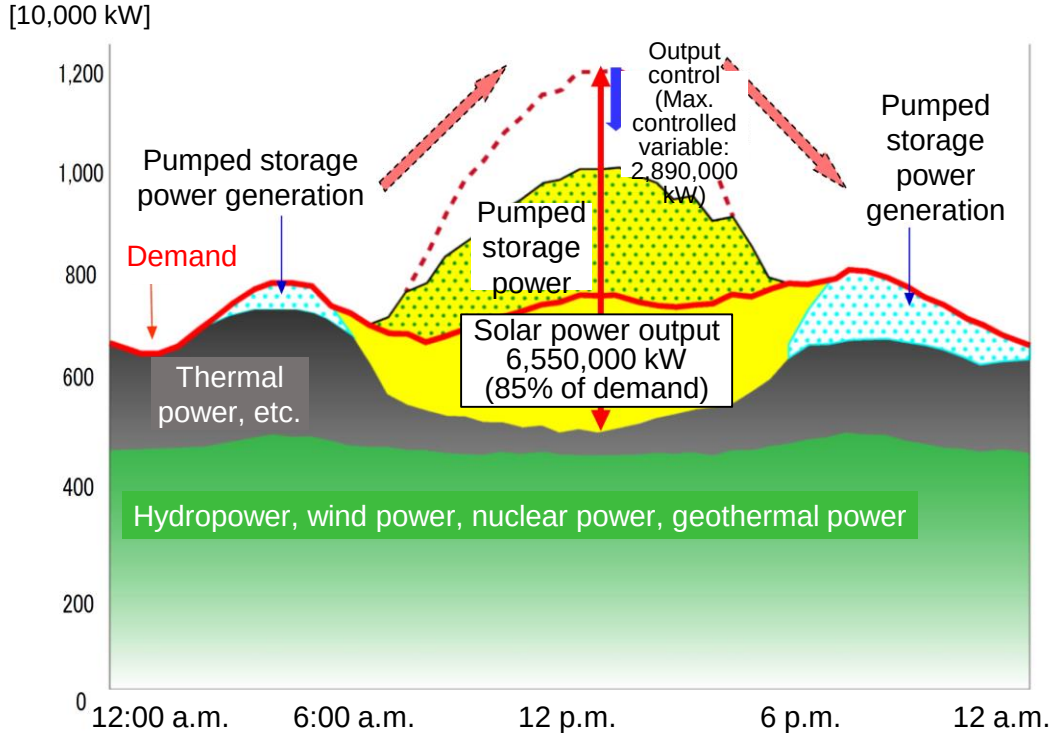
- In the FY 2019, the number of output control days in the Kyushu area was 74.
- Output control may be implemented more often due to expanded introduction of renewable energy.

Response based on preferential power feed rules

1. Output control of thermal power (petroleum, gas, coal) and utilization of pumping
2. Power transmission to other regions (utilization of interconnection lines)
3. Output control of biomass
4. Output control of solar and wind power
5. Output control of long-term stationary power* (hydropower, nuclear power, geothermal power)
   * Output control is technically difficult.

Source: Ministry of Economy, Trade and Industry, 33rd Strategic Policy Committee (Nov. 2020)

Supply-demand picture in Kyushu area (Mar. 8, 2020)



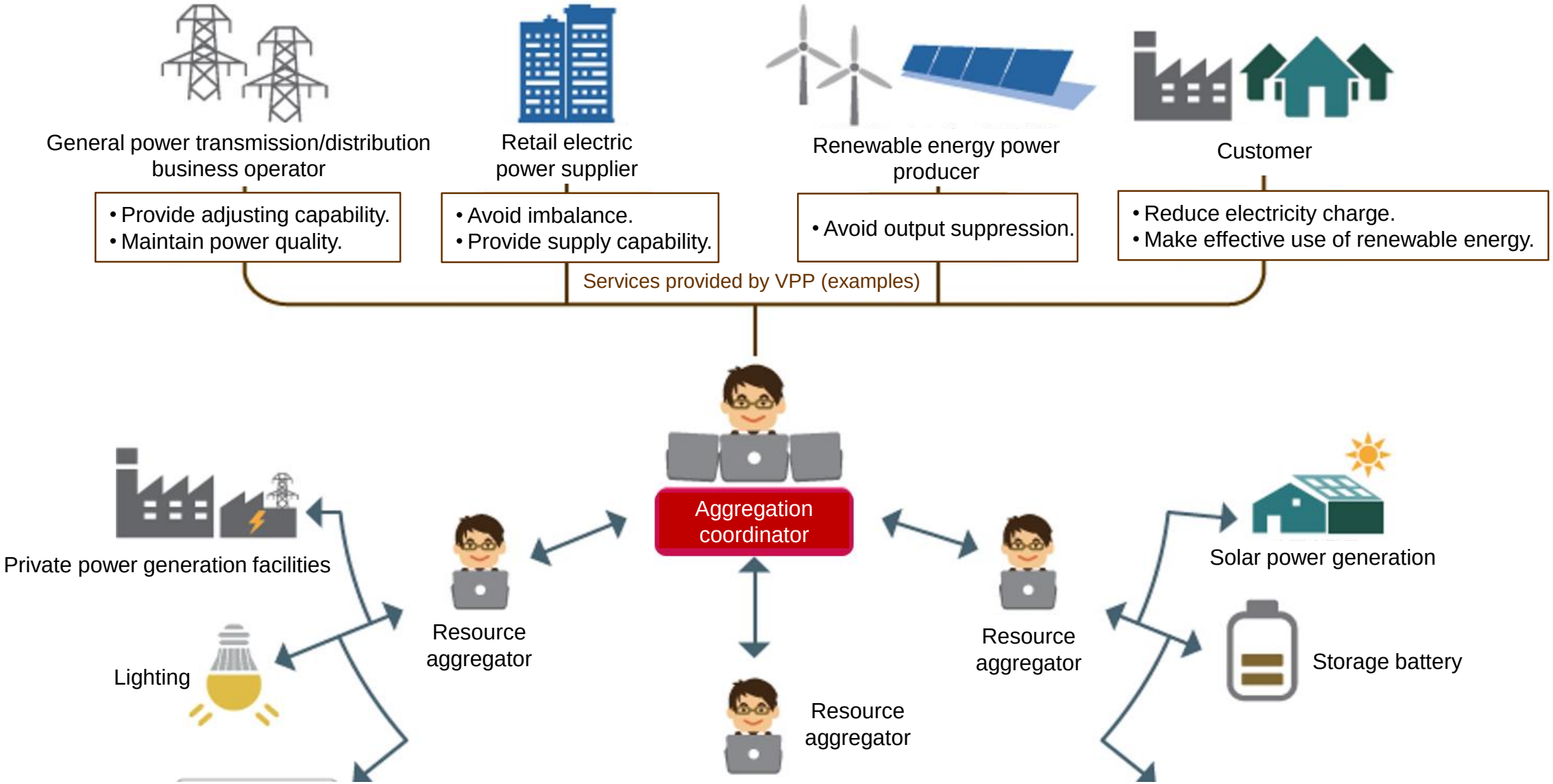
Supply/Demand adjustment capacity

When the share of variable renewable energy is large, a large supply/demand adjustment capacity is required to stabilize the grid electricity.

1)Suspension of variable renewable generation (We want to avoid as much as possible)
2)Very low operating thermal power plants
Examples: Generator for grid stabilization, which is expensive because it generates power for less than 100 hours a year
3)Pumped storage
4)Battery storage
Analysts forecast future price reductions. But this is not easy given the cost structure of battery storage systems. Examples: inverters costs, installation costs
5)Demand Response ready equipment
Add control functions to equipment that uses electricity on a daily basis, allowing the grid flexibility to use and stop electricity.
DR-ready equipment Examples: Demand response control of air conditioning, heating, storage water heaters, lighting, EV charging.

Among these options, DR-ready equipment is the most cost-effective.

Image of Virtual Power Plant (VPP)



Source: Website of Economy, Trade and Industry

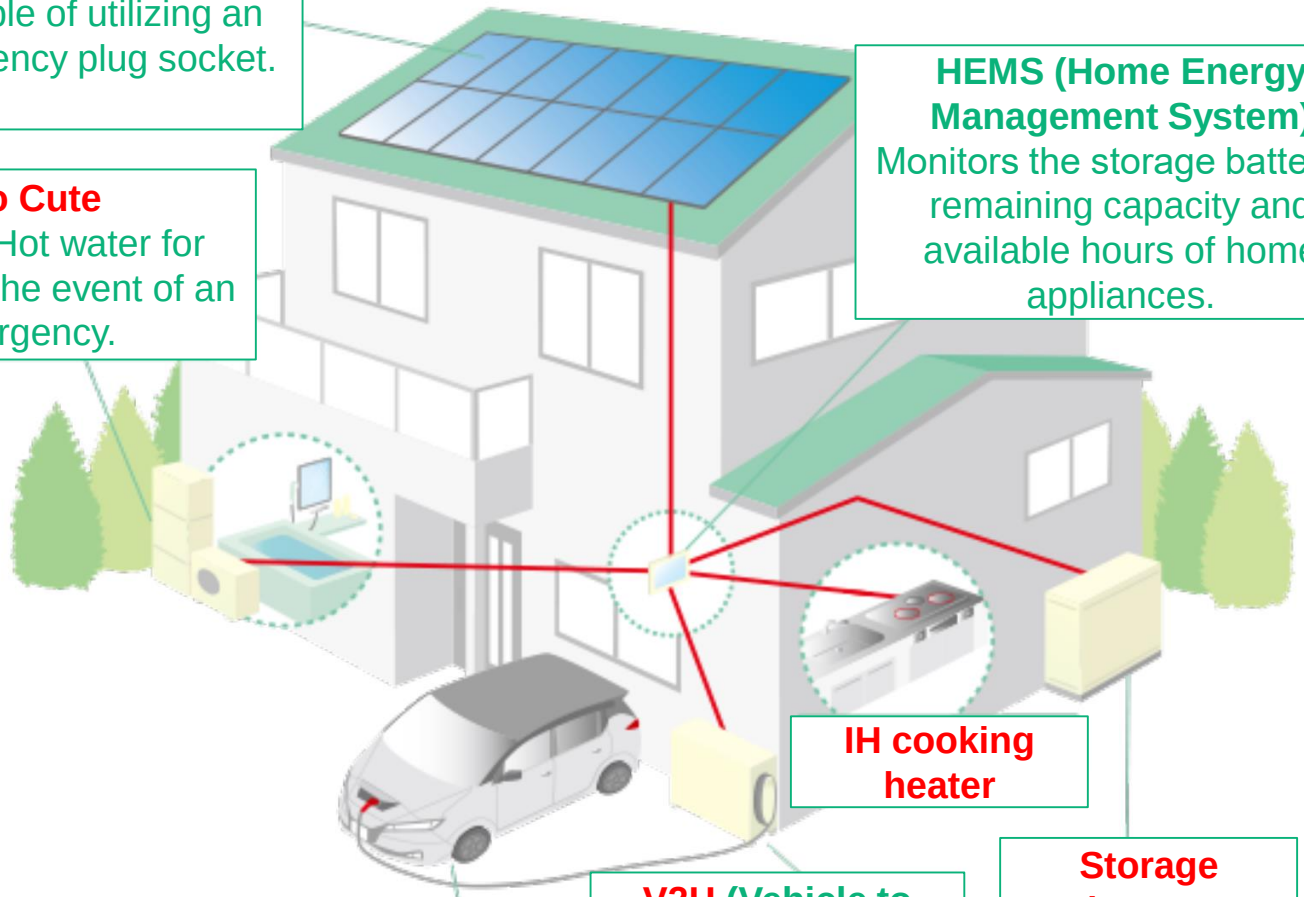
Resilient & Ecologically-friendly Houses

We offers expensive equipment as a subscription service.

Solar power generation
Capable of utilizing an emergency plug socket.

Eco Cute
Provides Hot water for daily life in the event of an emergency.

HEMS (Home Energy Management System)
Monitors the storage battery's remaining capacity and available hours of home appliances.



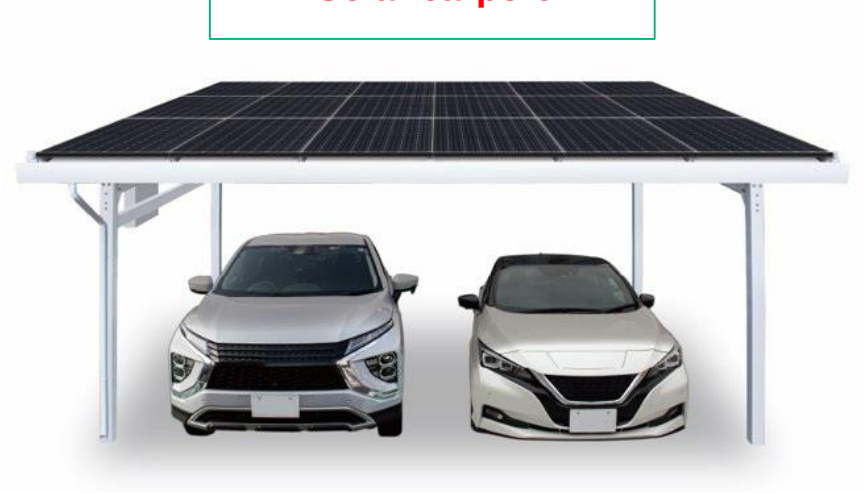
IH cooking heater

Storage battery
Functions as an emergency power source.

EV (Electric Vehicle)

V2H (Vehicle to Home)
Electricity charged to the EV can be used for the home.

Solar carport

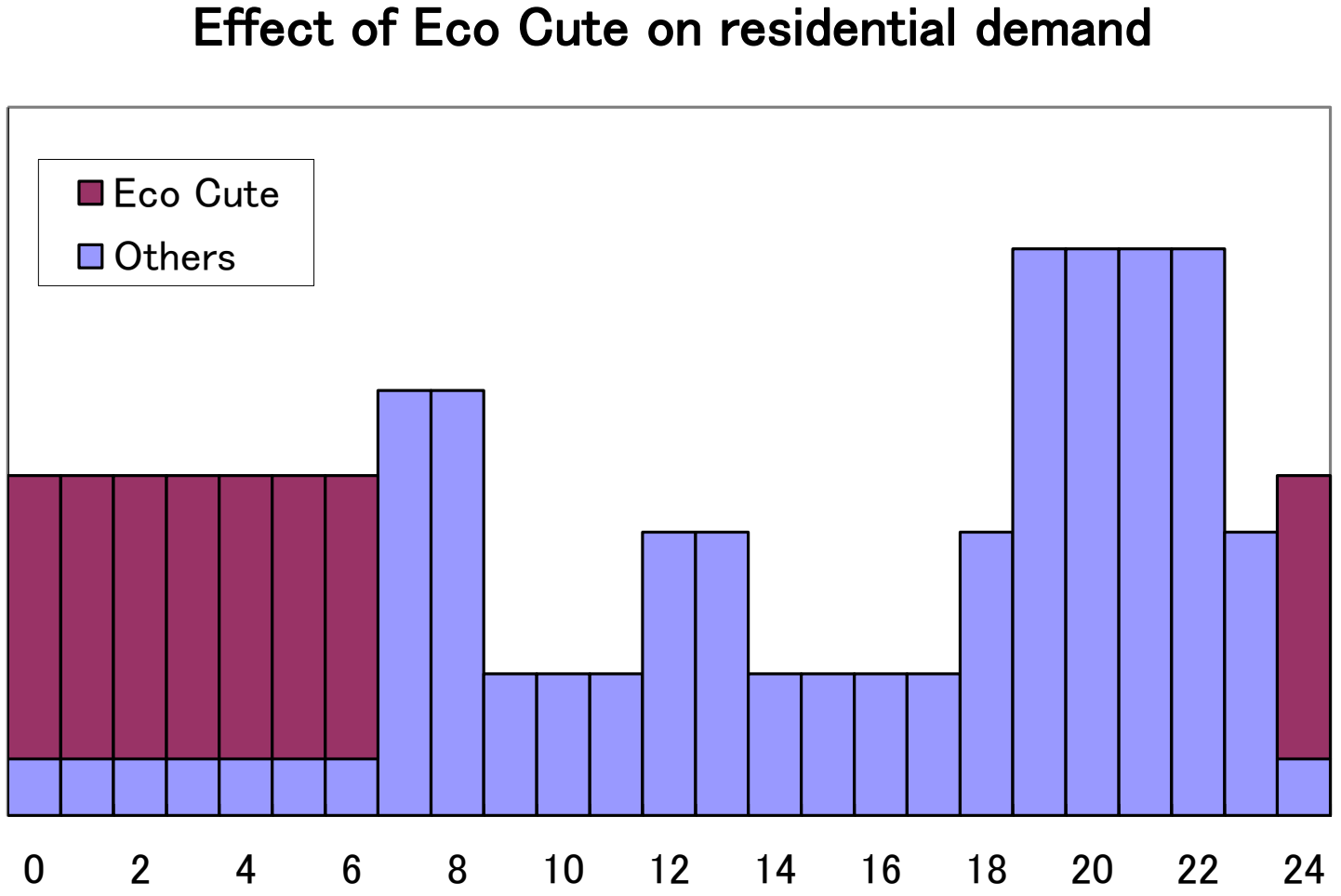


Source: TEPCO Energy Partner Website

Thermal Storage System (Residential①)

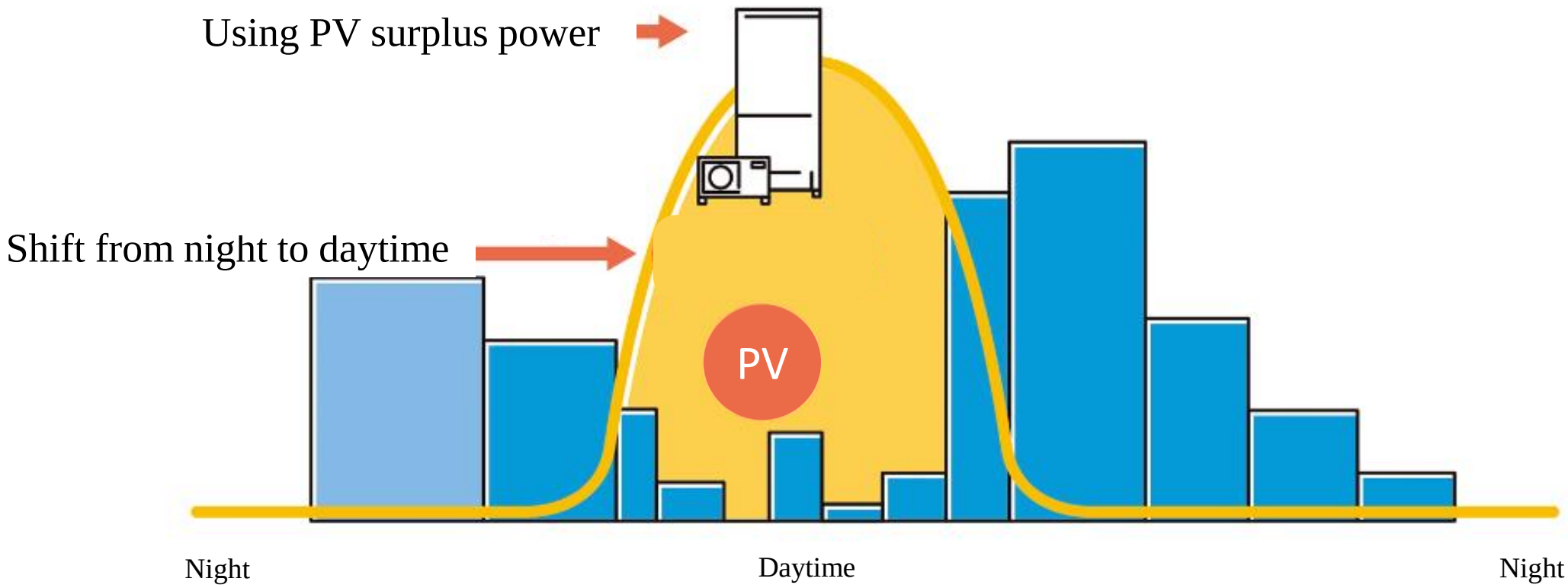
TEPCO developed Eco-Cute in 2001 to control the demand curve.

Eco Cute
(CO2 Refrigerant
Heat Pump Water Heater)



Thermal Storage System (Residential②)

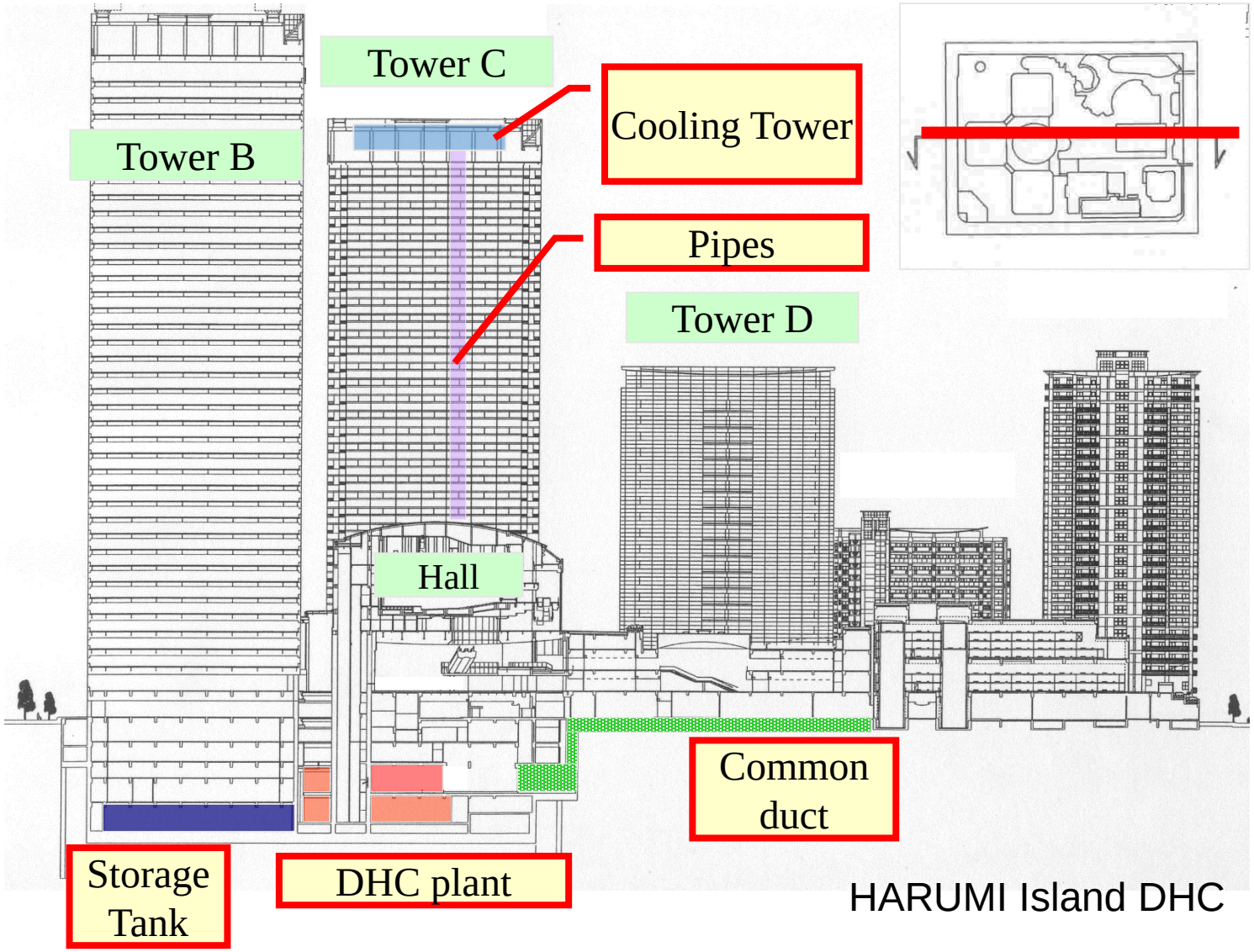
TEPCO EP developed PV-driven Eco-Cute in 2022.
This Eco-Cute uses two renewable energy sources, solar power and ambient heat, to produce hot water.



Thermal Storage System (DHC)

Harumi Island District Heating & Cooling System has a huge water thermal storage tank (19,060m3).

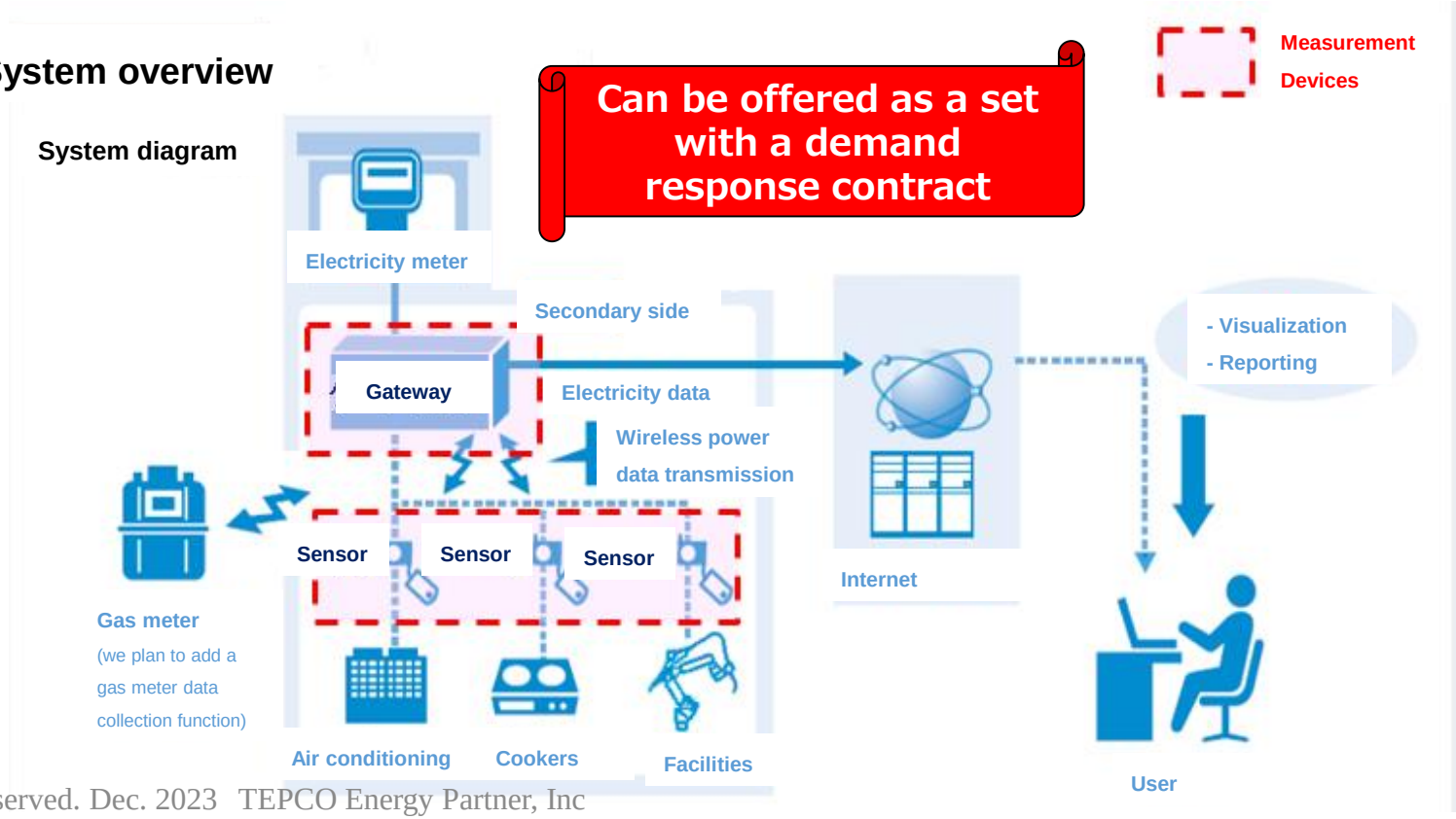
TEPCO EP is collaborating with the Tokyo Metropolitan Government on a demand response demonstration based on grid supply and demand conditions.

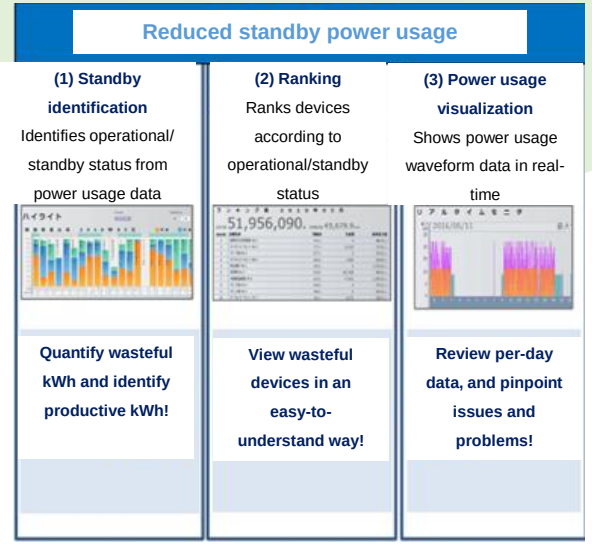


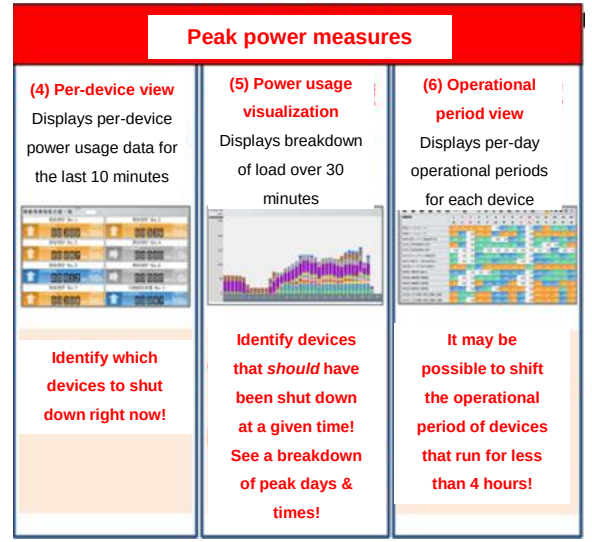
HARUMI Island DHC

TEPCO EP's proprietary visualization service

- We install and manage wireless sensors and data collection devices to help our customers visualize their electricity usage.
- This allows us to check the operational status of each device and identify previously-unnoticed wasteful activities.



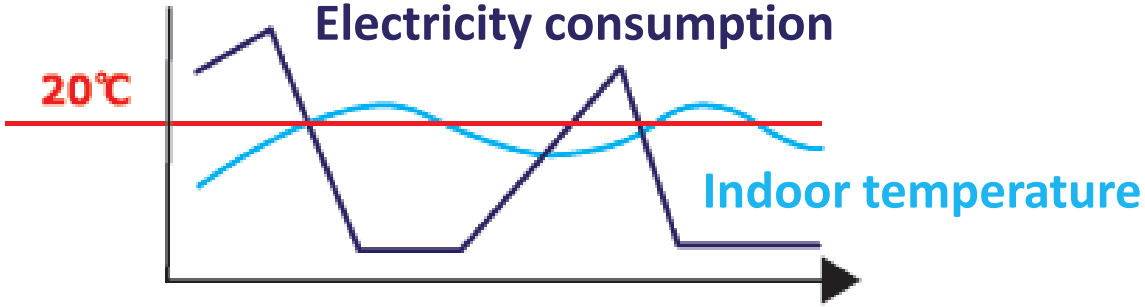




Packaged air conditioning control service by Japan facility solutions

Visualization and control service connected to a cloud system and call center to realize energy savings.

Indoor temperature suppression control

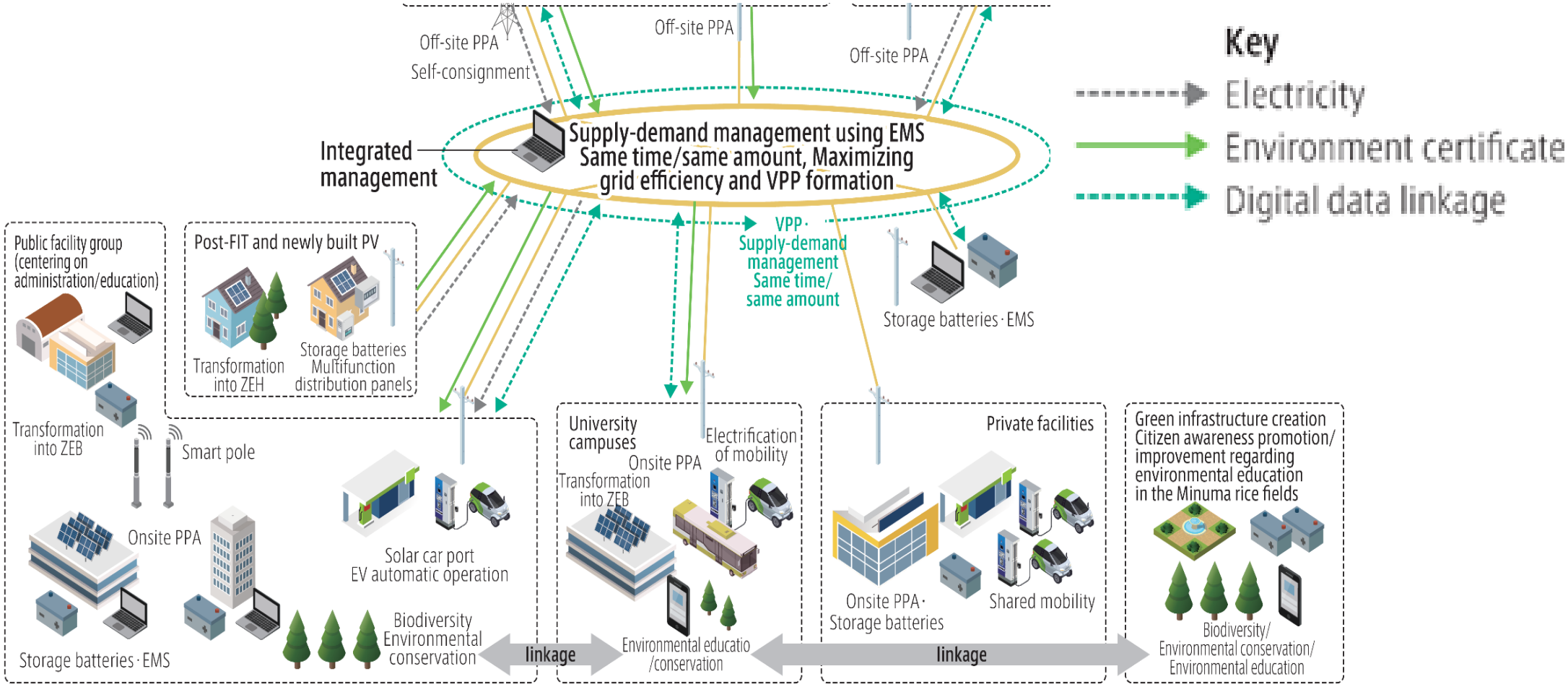


Air conditioning time control

Rotation between air blowing operation and air conditioning operation

Construction of urban energy model by EMS

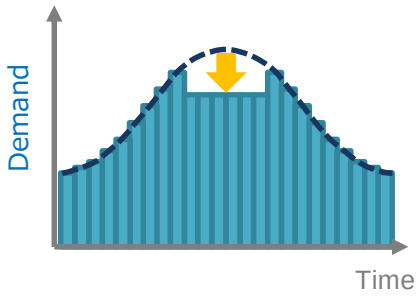
✓ The TEPCO Group will strengthen regional resilience and improve the quality of life by building urban energy models that match regional attributes as we contribute to the creation of a carbon neutral society.



Multi-faceted use of batteries

Peak cut/shift

✓ Demand leveling/ electricity charge reduction



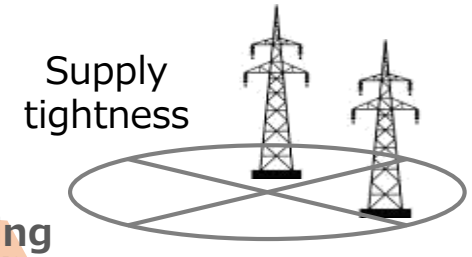
RE self-consumption

✓ Maximum use of RE surplus

Charge using surplus power

Demand Response

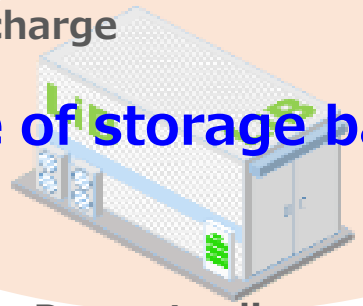
✓ DR implementation/compensation via storage batteries



Peak/off-peak charge & discharge

Balancing power

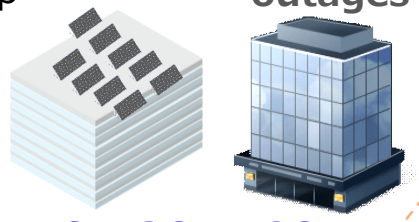
Multi-use of storage batteries



Power grid

Power outage/ instantaneous voltage drop

Back-up power source for grid outages



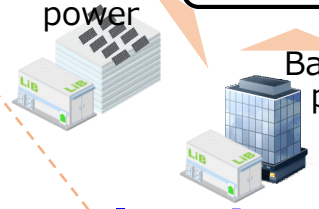
Power trading through charging/discharging

JEPX market

Balancing market

Balancing power

Aggregate



BCP power source

✓ Provides power supply during outages

✓ Guards against instantaneous voltage drop

Arbitrage

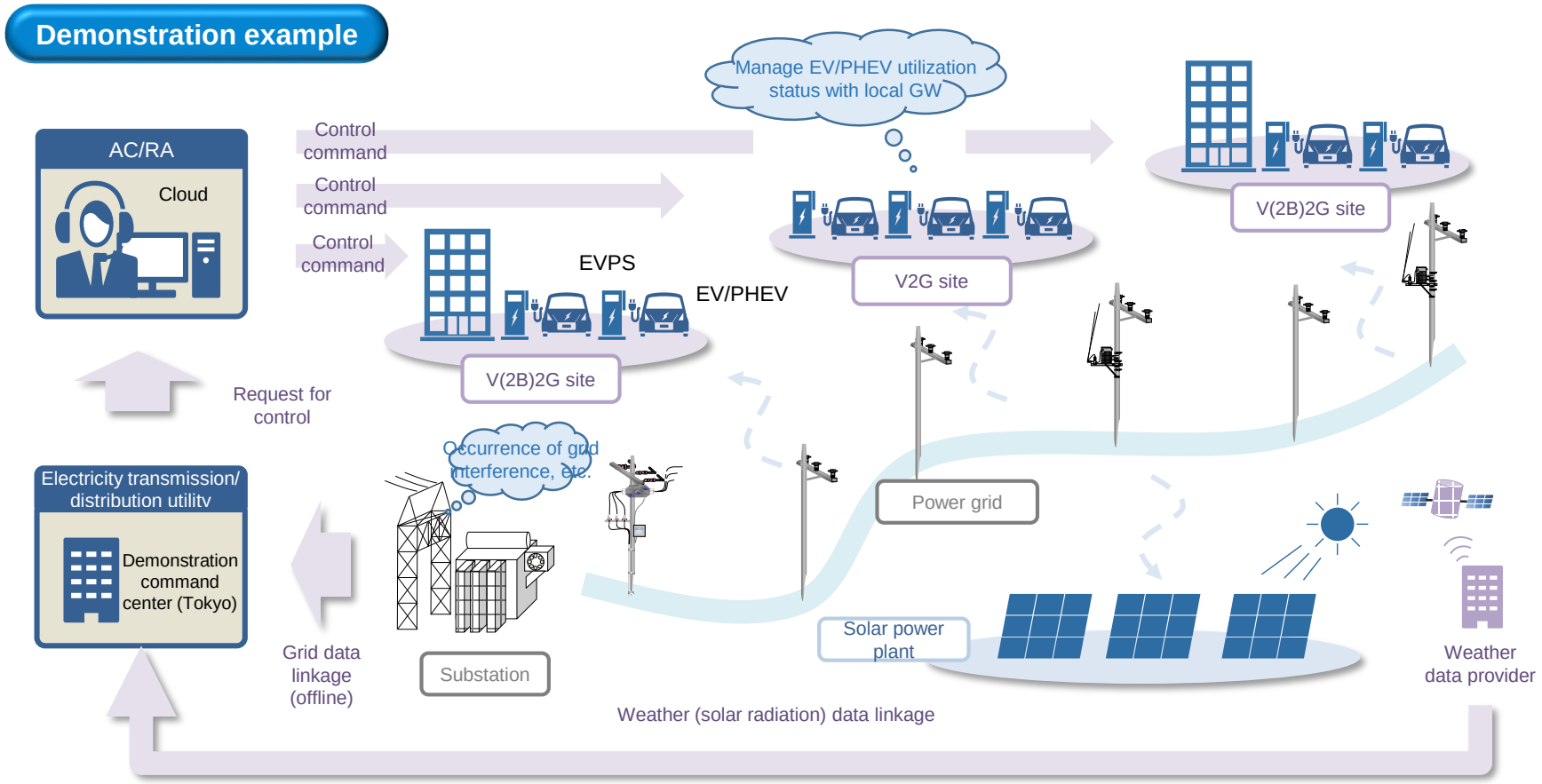
✓ Battery charge/discharge in line with market price

Balancing market operation

✓ Control storage batteries installed and contribute balancing power to market

EVs charging and discharging Demonstration

Starting the “demonstration business (VPP aggregation business) for building a virtual power plant utilizing an energy resource on the customer side”



*Provide control, assuming that all demonstration sites are connected to an identical commercial grid

Source: TEPCO EP Press (Jun. 8, 2020)

Demonstration (PV + Green Hydrogen Production)

Implementation structure

*Managing company in boldface

Yamanashi Prefecture (Bureau of Enterprises), TEPCO Holdings, Inc., TEPCO Energy Partner, Inc., Toray Industries, Inc., Hitachi Zosen Corporation, Siemens Energy AG, Miura Co., Ltd., Kaji Technology Corporation

Business period

FY2021 to FY2025 (5 years)

Business scale, etc.

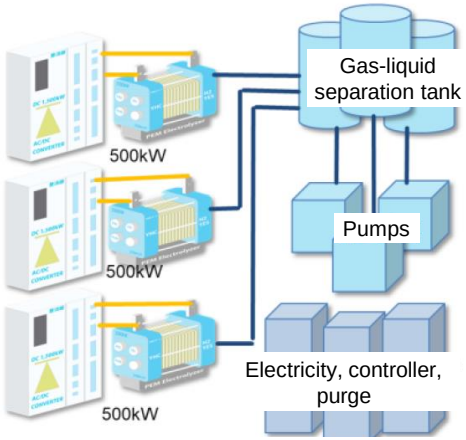
- Business scale: Approx. 14 billion JPY
- Support scale*: Approx. 10 billion JPY

* Incentive amount included. Expected to be rationalized per business progress, etc. using the phase-gate process, etc. in the future.

- Subsidy rate, etc.: 2/3 → 1/2 (incentive rate = 10%)

Business description

1.5 MW equipment at Yonekurayama



Source: Yamanashi Prefecture (Bureau of Enterprises)

Development description of fund business

Development of several-MW standard module

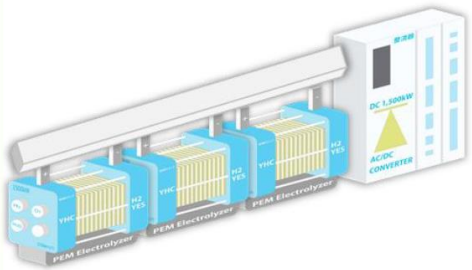


Illustration of standard module

Prototype manufacture and demonstration test of module coupling equipment

16-MW class

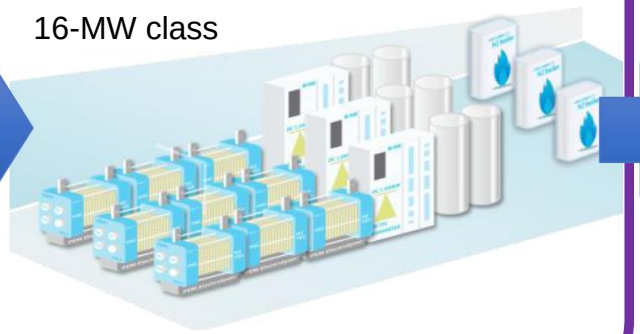


Illustration of module coupling system

100-MW class module coupling system

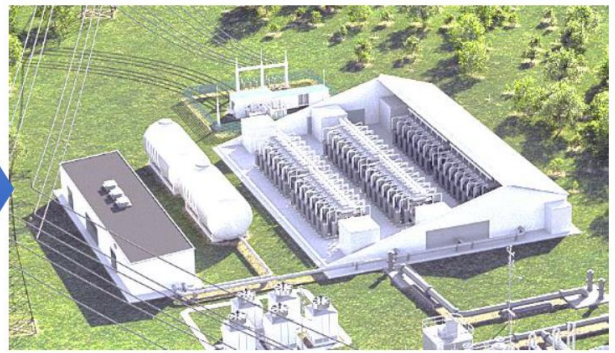


Illustration of large-scale module coupling system

Source: NEDO website

Development of demand-side hydrogen generator

TEPCO EP is developing a 500 kW-class hydrogen production system. The hydrogen production unit will be installed on the customer's site to supply green hydrogen using on-site PV and off-site renewable electricity.

Conclusion “Policy induced changes in demand-side activity”

- Demand-side activities are selected on the basis of cost efficiency.
- Heat pumps are effective for low-temperature heat below 100℃, while green hydrogen is more advantageous for high-temperature heat.
- Heat pumps can reduce CO2 emissions, but are more expensive than boilers with simple structures.
- Initial investment reductions through subscriptions and other means are effective in expanding the introduction of high-efficiency equipment with a long payback period.
- Subsidies for high-efficiency equipment and equipment manufacturers, bans on combustion equipment, and higher fossil fuel prices due to carbon taxes will also contribute to the increased adoption of heat pumps.

Conclusion “Demand Response ”

- Development of IT technology has made it possible to effectively use the thermal storage heat pumps and the Change temperature setting as the VPP.
- The VPP will contribute to the expansion of the ratio of renewable energy.
- It is cost-effective to add DR functions to demand-side equipment at the time of renewal due to aging. On the other hand, it takes more than 10 years, so early efforts are needed.
- It is also important to promote global standardization of communication protocols and DR functions.

END