

Japanese Energy Market

- Optimum Use of Distributed Energy Resources for Demand- side Response -

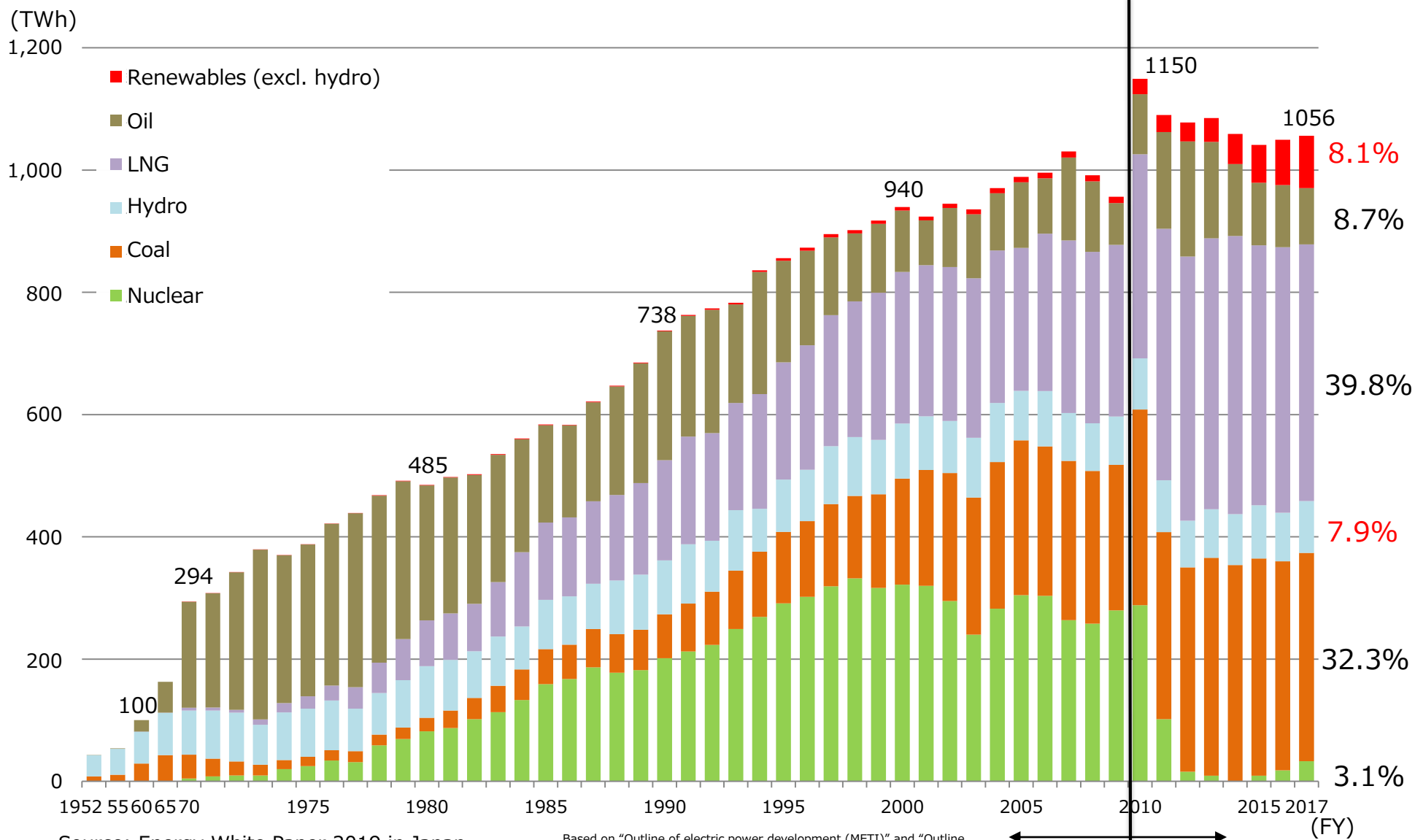
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Ministry of Economy, Trade and Industry, Japan**

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Power generation and supply

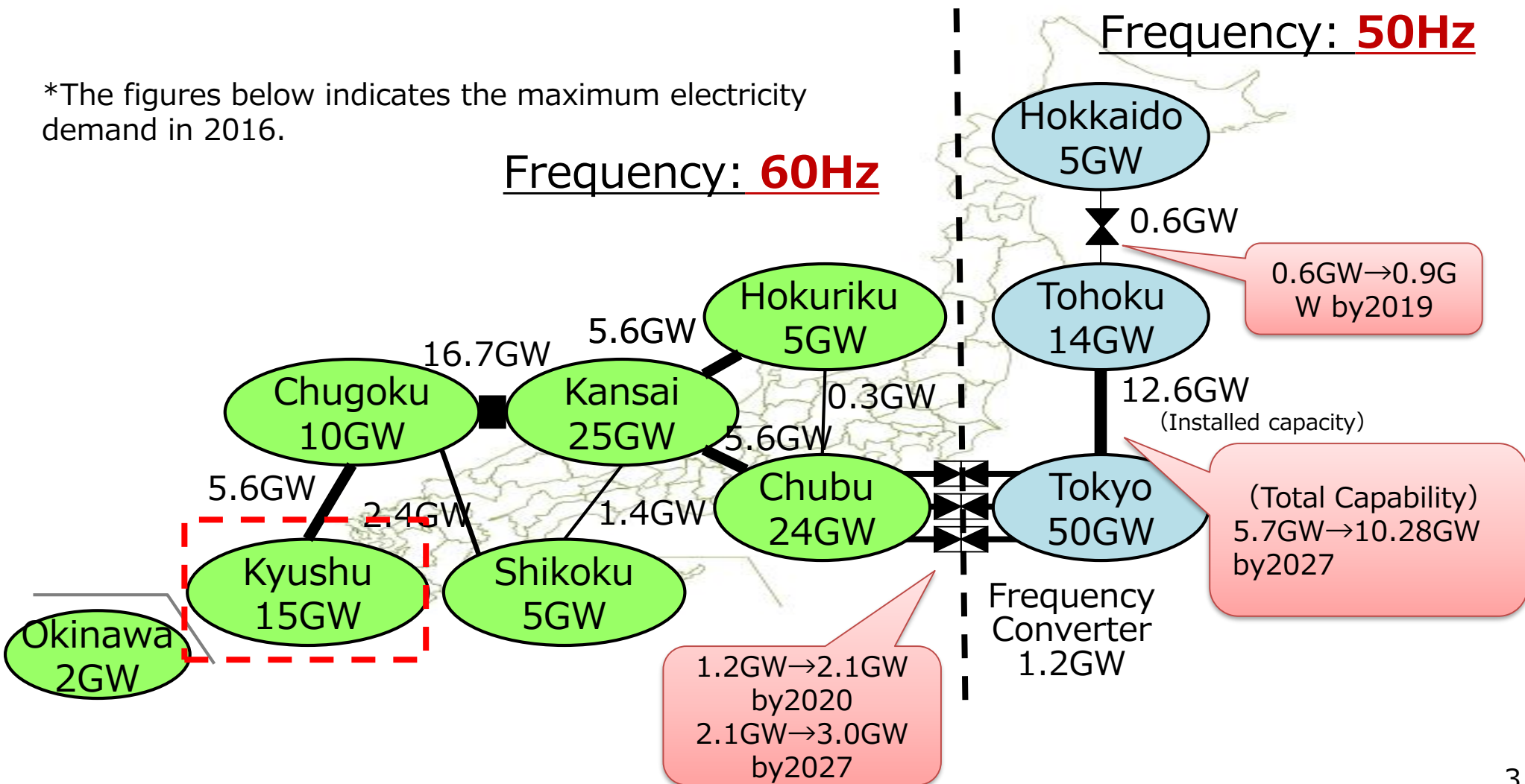
● 80% Thermal power, 8% Hydro, 8% RE and 3% Nuc.



Power Grid

- 10 TSOs/DSOs manage grid stabilization.
- Two frequency areas exist

*The figures below indicates the maximum electricity demand in 2016.



Mission/ Background

● Japan's Responsibility for Energy Transition

Energy trilemma

- ✓ **E**nergy security
- ✓ **E**nvironment (Sustainability)
- ✓ **E**conomic affordability (Cost)

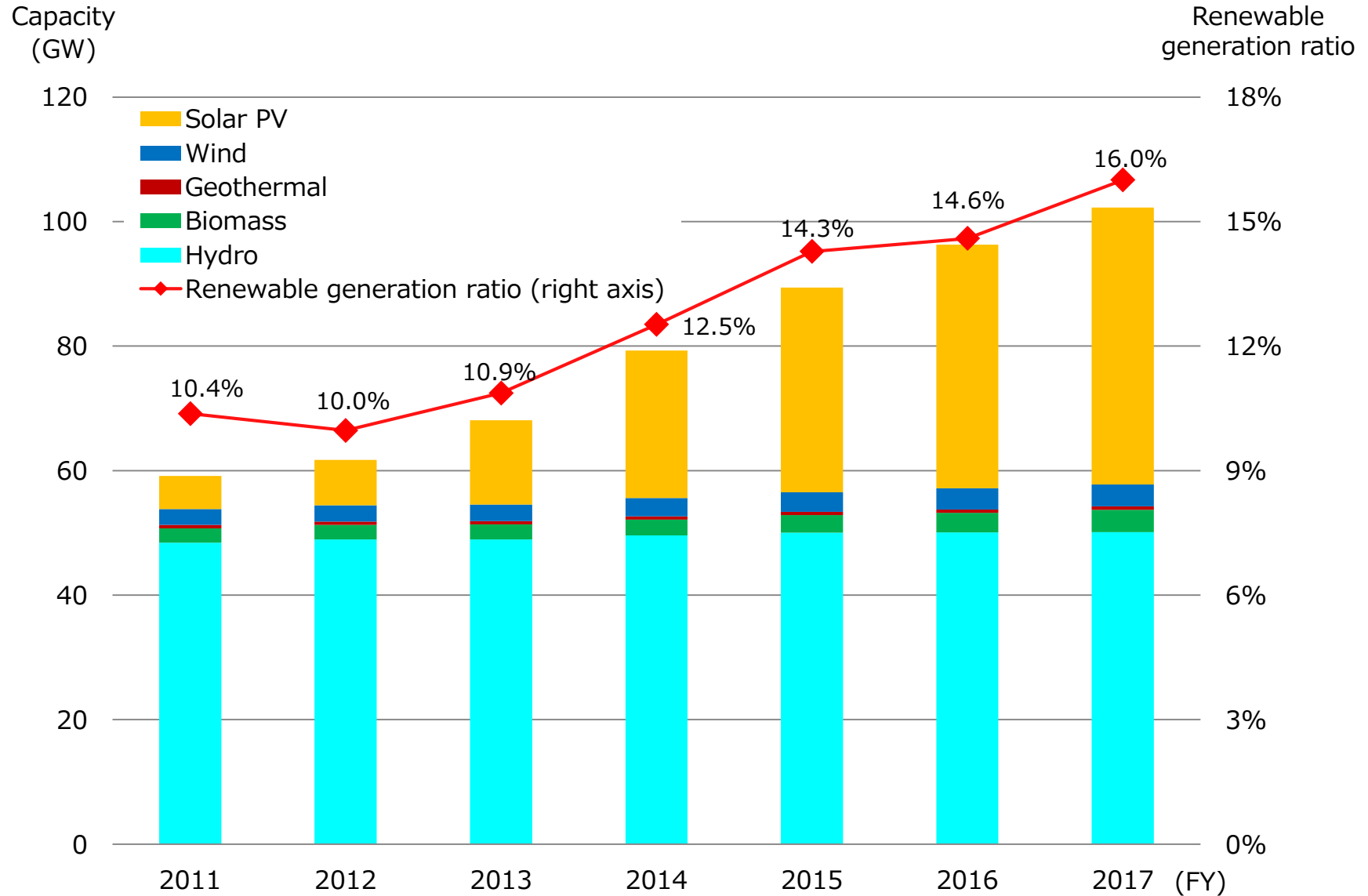
} **3"Es"** + **Safety**

● Measures;

- ✓ Energy Efficiency
- ✓ Renewable energy
- ✓ Nuclear energy
- ✓ CCS + Fossil fuels
- ✓ Hydrogen

More Renewable requires 3 key actions

- 1. Lower Cost, 2. Strengthen Grid, 3. Flexibility system



Energy system reform

Past

Non-interactive supply system

based on bulk electricity resources (BER) and large-scale transmission

<Electricity>

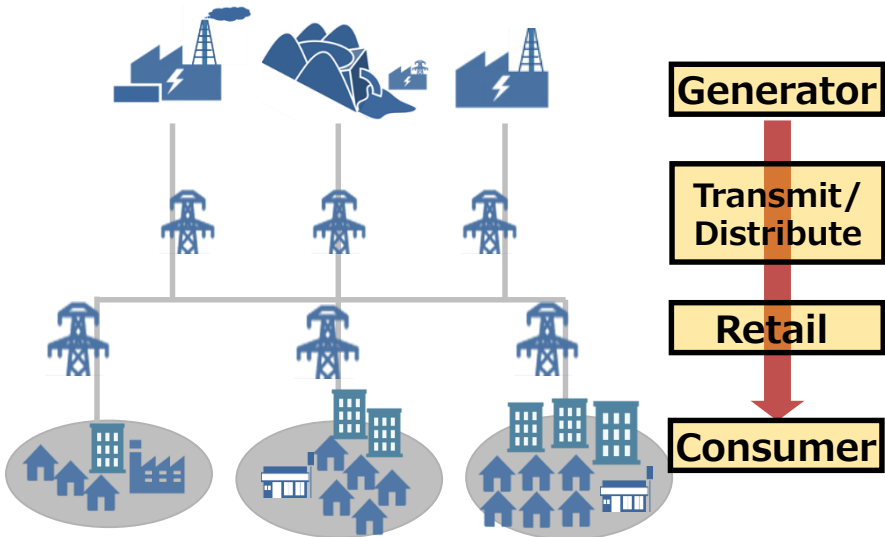
One-way supply by thermal power generation, varied with demand

<Heat>

Not consumed enough

<Players>

Vertically integrated companies



Current and Future

Interactive supply system based on both BERs and DERs

<Electricity>

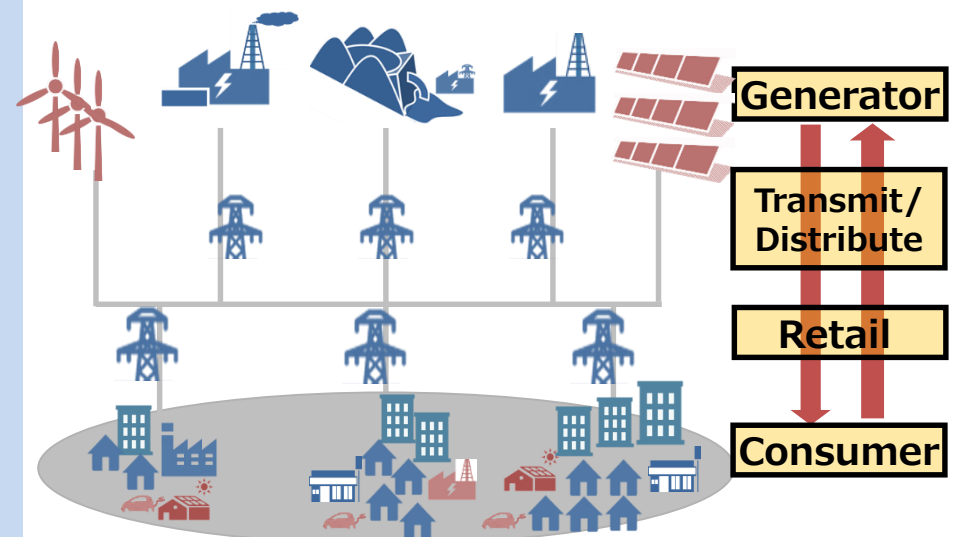
Interactive supply by DERs, using IoT technology

<Heat>

Flex. and sharing energy consumption

<Players>

Liberalization encouraging various companies to enter the market

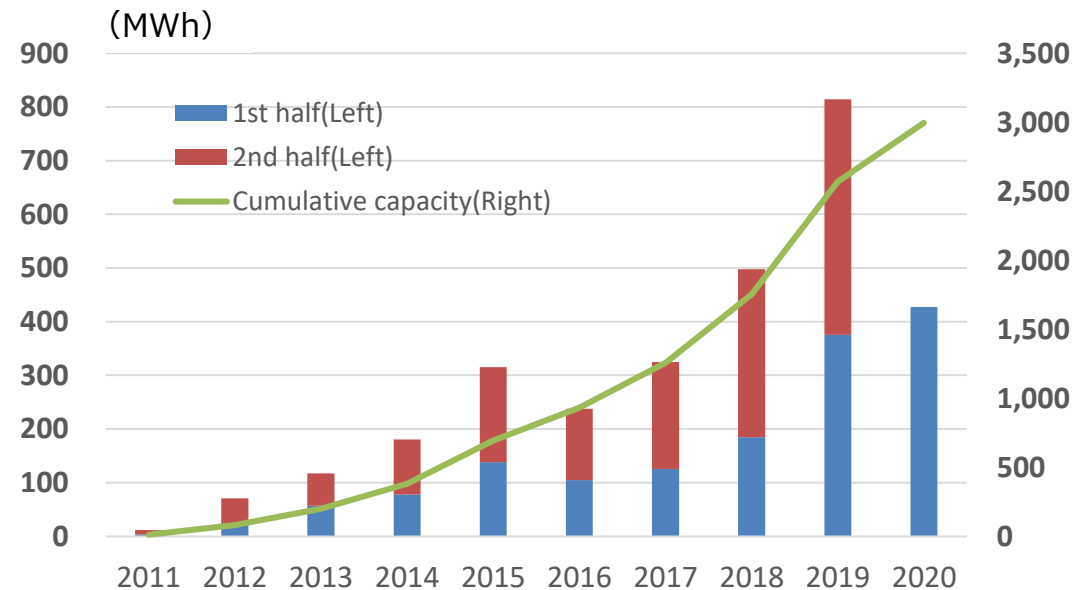
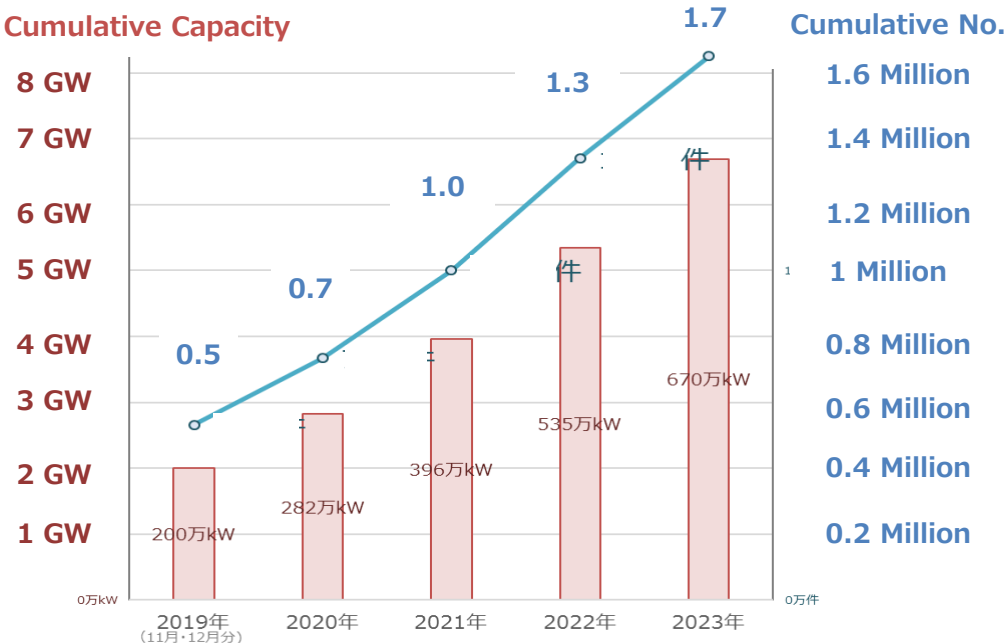


Steady growth of DER's market in Japan

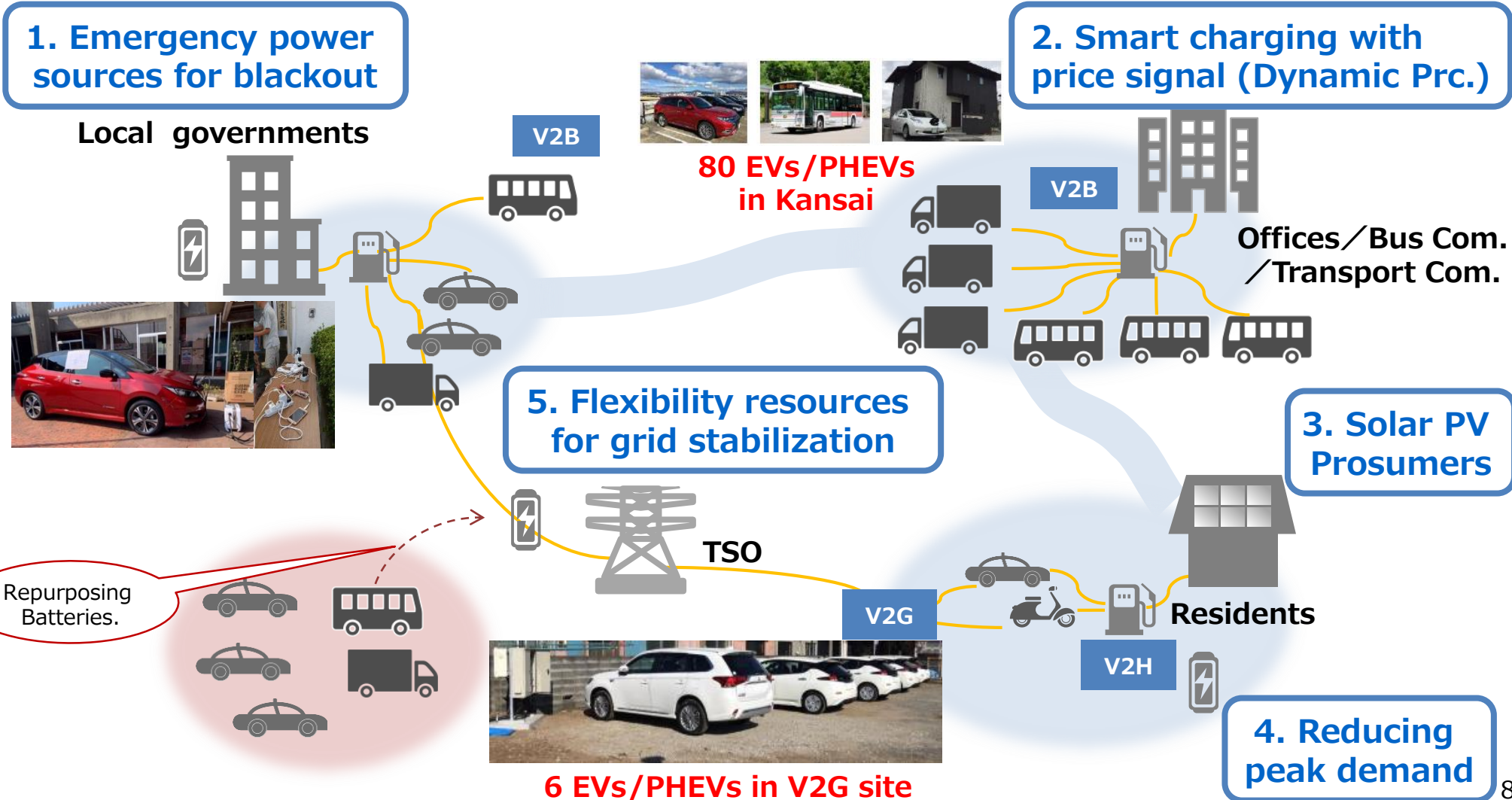
- Existence of post FIT solar PV in 2019 happened. **2GW solar PV** in household graduated from FIT **in 2019**. Residential PV in Post-FIT will reach **7GW in 2023**.
- **Lithium-Ion battery storage in behind the meter** marked market record of annual additions, **800MWh in 2019**. Cumulative battery storage-BTM reached **3GWh at the end of 2020**.

Household Solar PV (Post FIT)

LiB market (Behind the Meter BS)



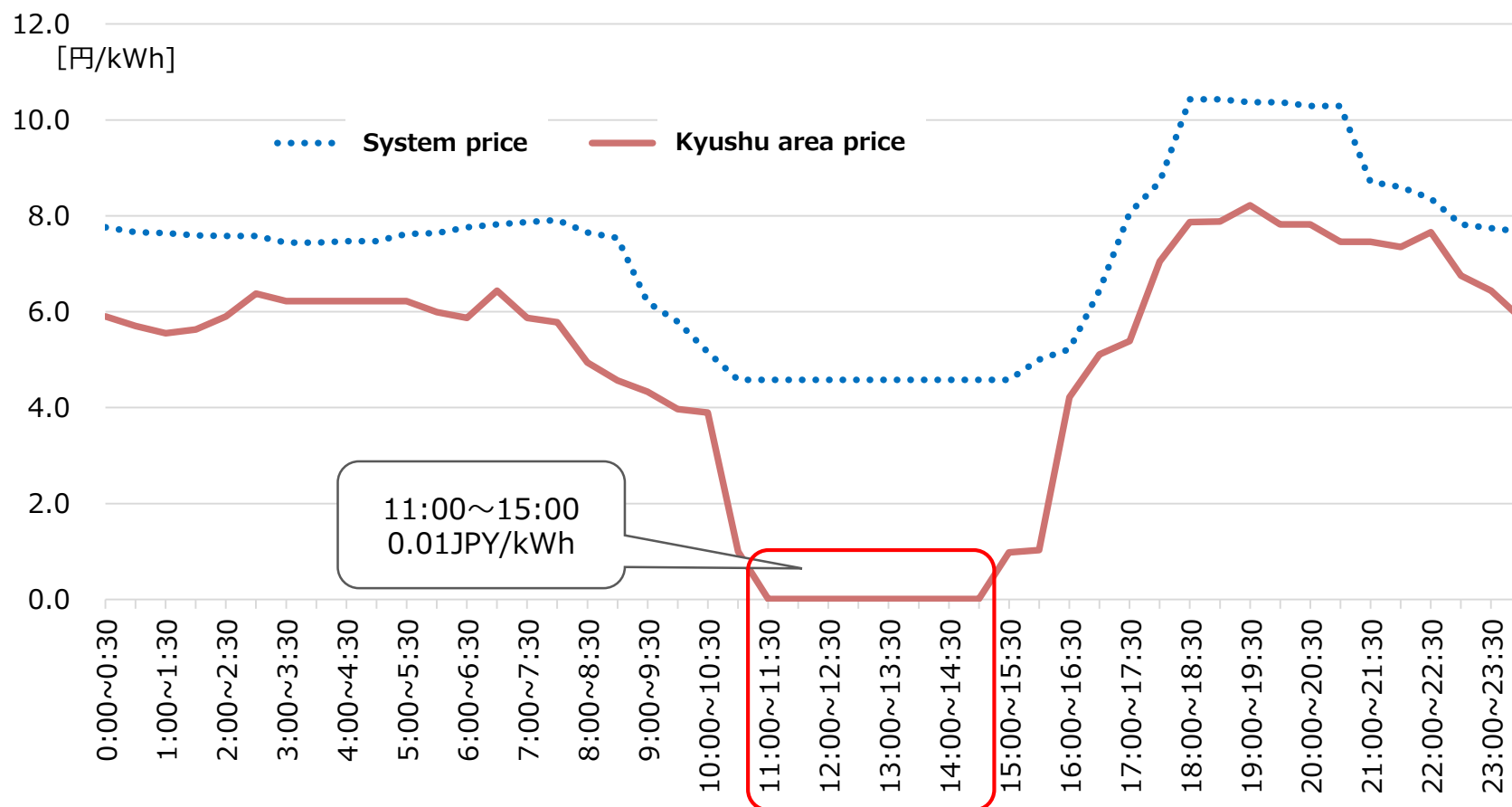
- Combination of EV and V2X enhances their values. 1. Emergency power sources, 2. Smart charging, 3. Solar prosumer, 4. Reducing demand, 5. Grid stabilization. Key element is EV Aggregation business.



Recent transaction prices in Kyushu area METI Ministry of Economy, Trade and Industry

- Renewables are installing rapidly in Kyushu, traded by lowest prices. Need to use lower electricity.

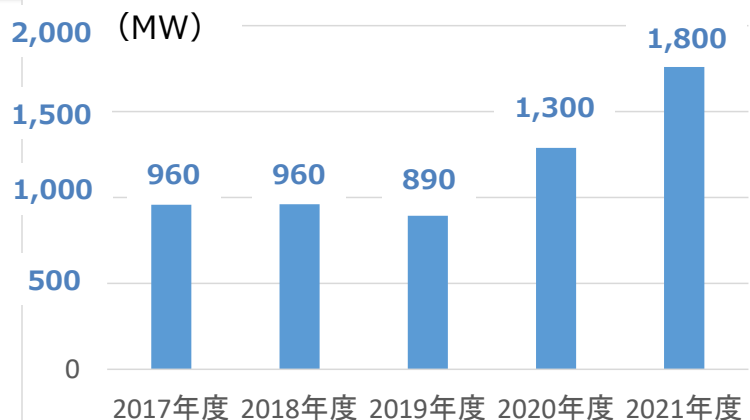
System price and area price in Kyushu, as of 24 Feb. 2019



Source: JEPX

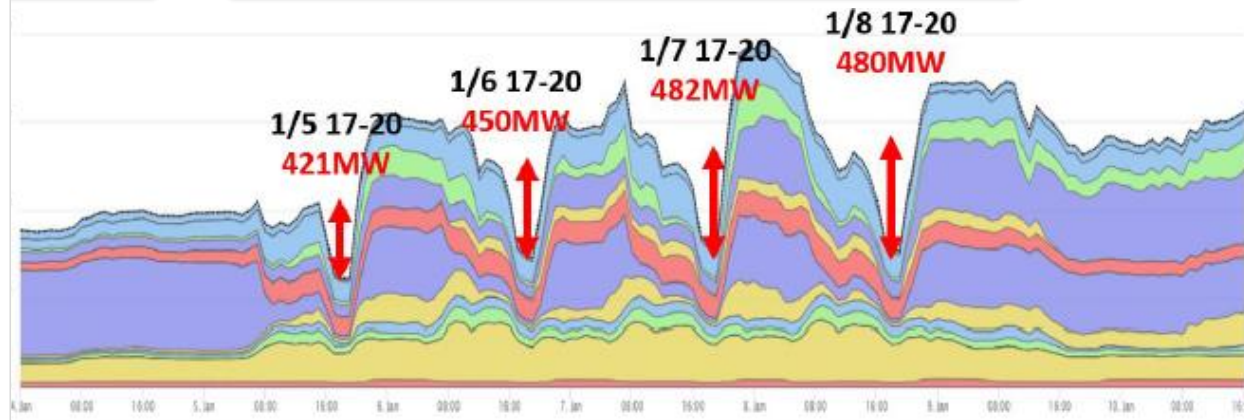
- **1.8 GW Demand-side Response (DR)** was awarded in TSO's auction of reserve power.
- Major resources: **Large-scale loads of factories** in industry sector. Requirement: **3 hours duration, 3 hour response, 12 times/year**.
- DR (Load curtailment) provided huge contributions in severe peak period in January 2021. Energy Market welcomes more active participants of DR. **Challenges are how to encourage large-scale loads in industry sector to DR businesses.**
- **4GW DR** won auction in **Capacity Market**, which will deliver **in 2024**.

Total DR Capacity in TSO's auction



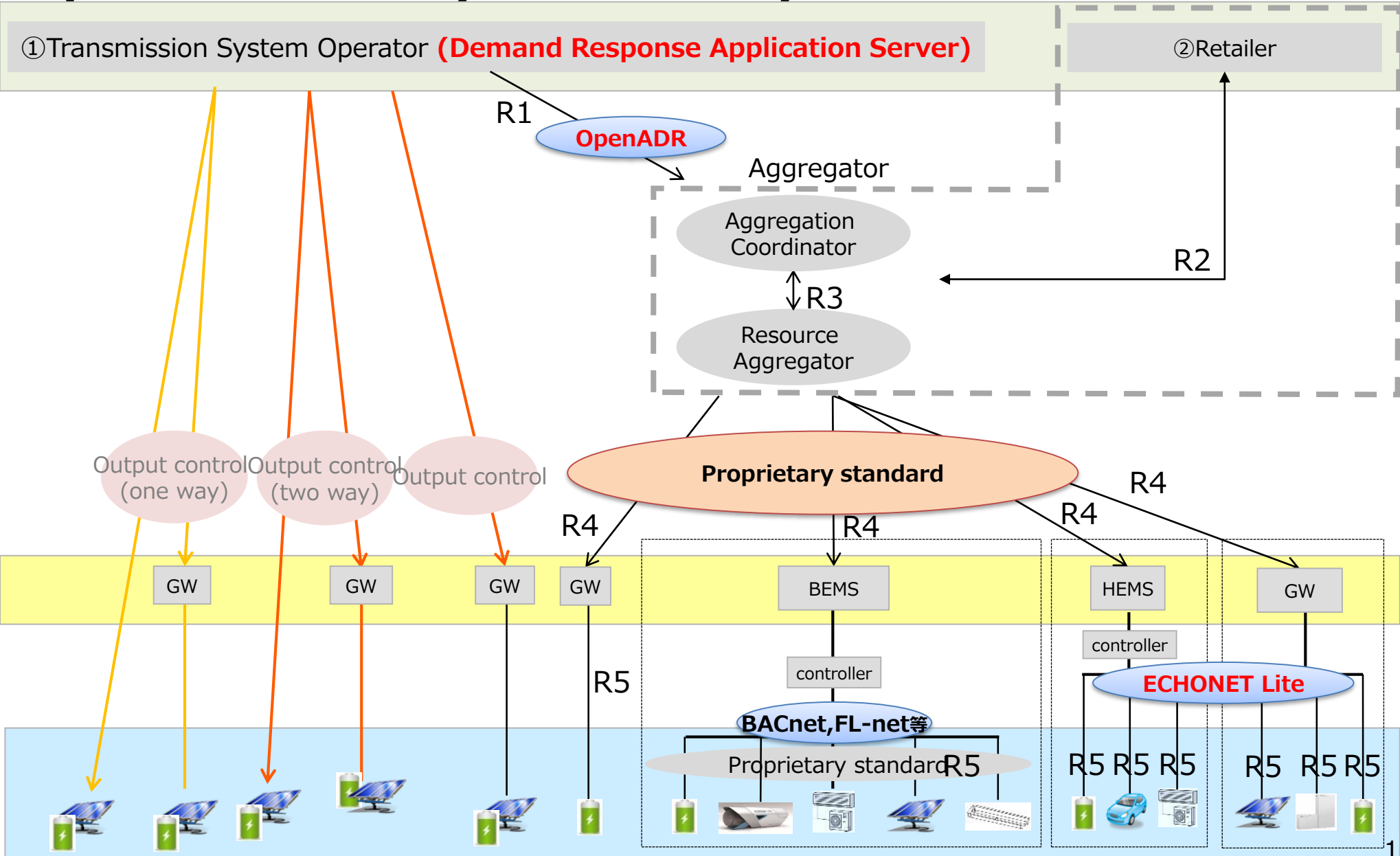
Source: EGC

DR dispatched in Jan. 2021



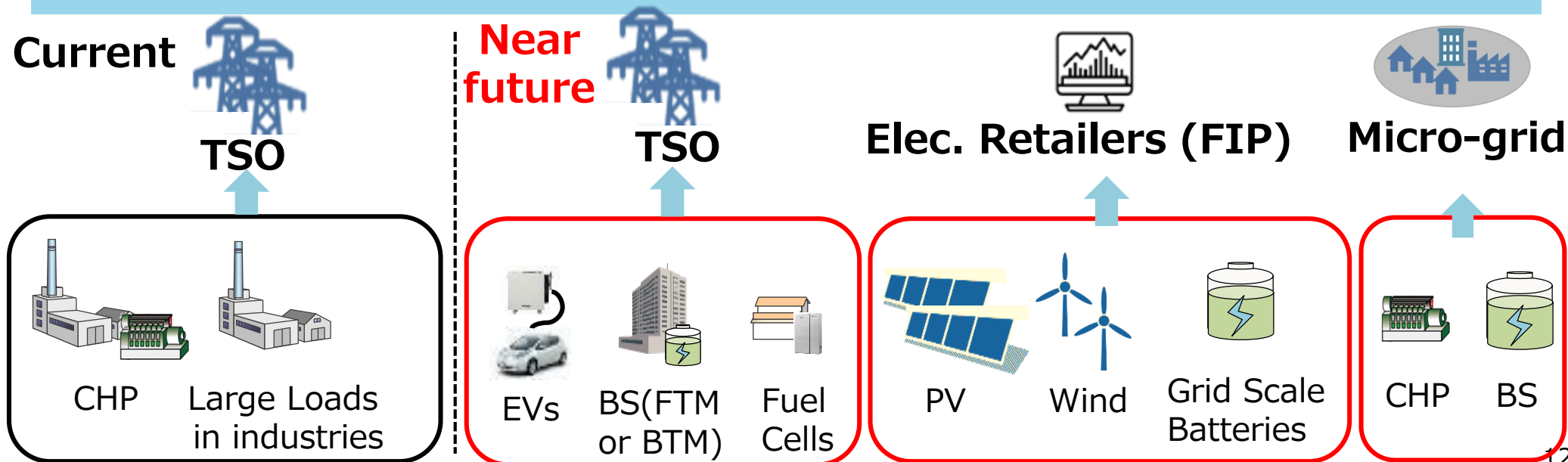
Source: Energy Pool Japan

Aggregation Communication Structure - protocol and cyber security -



Third Party Aggregators enhancing DERs values METI Ministry of Economy, Trade and Industry

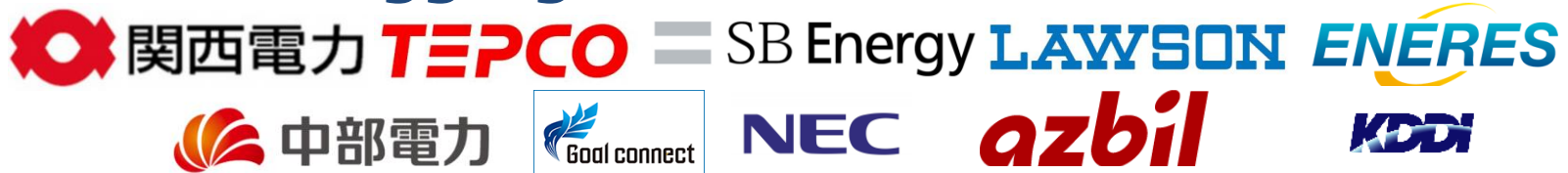
- **Current business model** in Japan
 - Major resources: **Large-scale loads** in industry sectors
 - Major business area: **Demand response in sever peak time**
- **New business models** in Japan
 - New resources: **Small-scale DERs** (EVs, Battery Storages, Fuel Cells in Households), **Solar PV**, **Wind**, **Grid-scale Battery Storages**. DERs need to be **cost down** and **market entrance**.
 - New business area: **Balancing Market**, **Capacity Market**, **JEPX (FIP Scheme for REs)**, and **Local Residents in Micro-Grid**



VPP national demonstration project (2016-20)

- About **100 participants** joined.
- Major Resources: **BTM Battery, CHP, EV, HP**. Total Capacity: **60MW**
- Outcomes: **Demand response for Replacement Reserves for FIT, Demand shift by dynamic pricing, EV aggregation (V2H or V2G)**

Aggregation Coordinators



Resource Aggregators



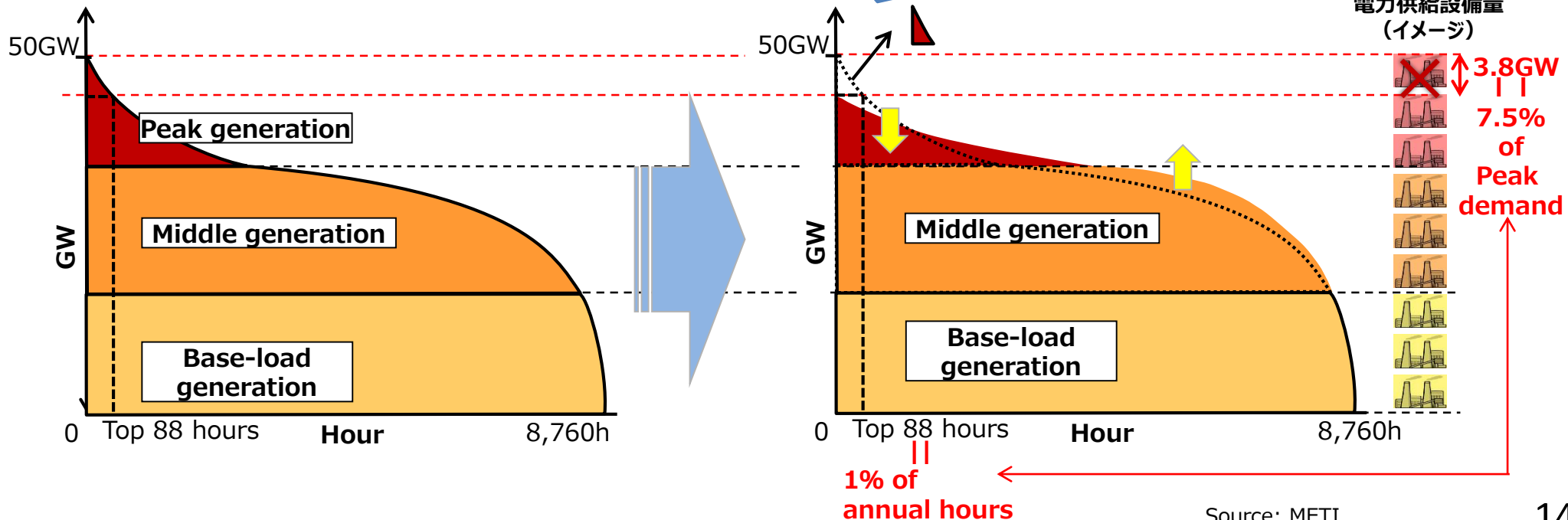
VPP flattening demand load

- VPP can reduce use during peak generation (kWh) (which is costly) and reduce the need for investment in peak operating capacity (kW) by reshaping the demand load flat.

Flattening duration curves

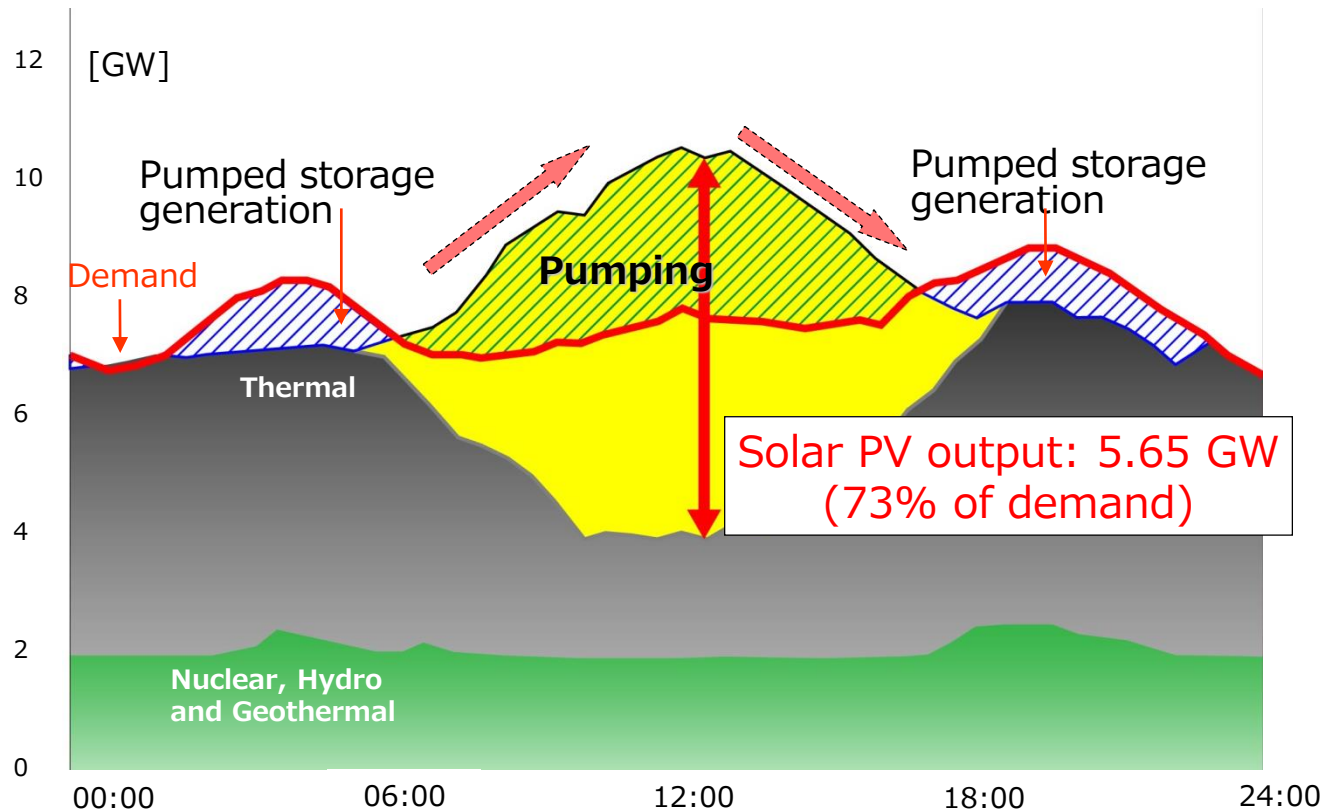
Reduction of peak generating time (kWh value)

Reduce investment in peak capacity (kW value)



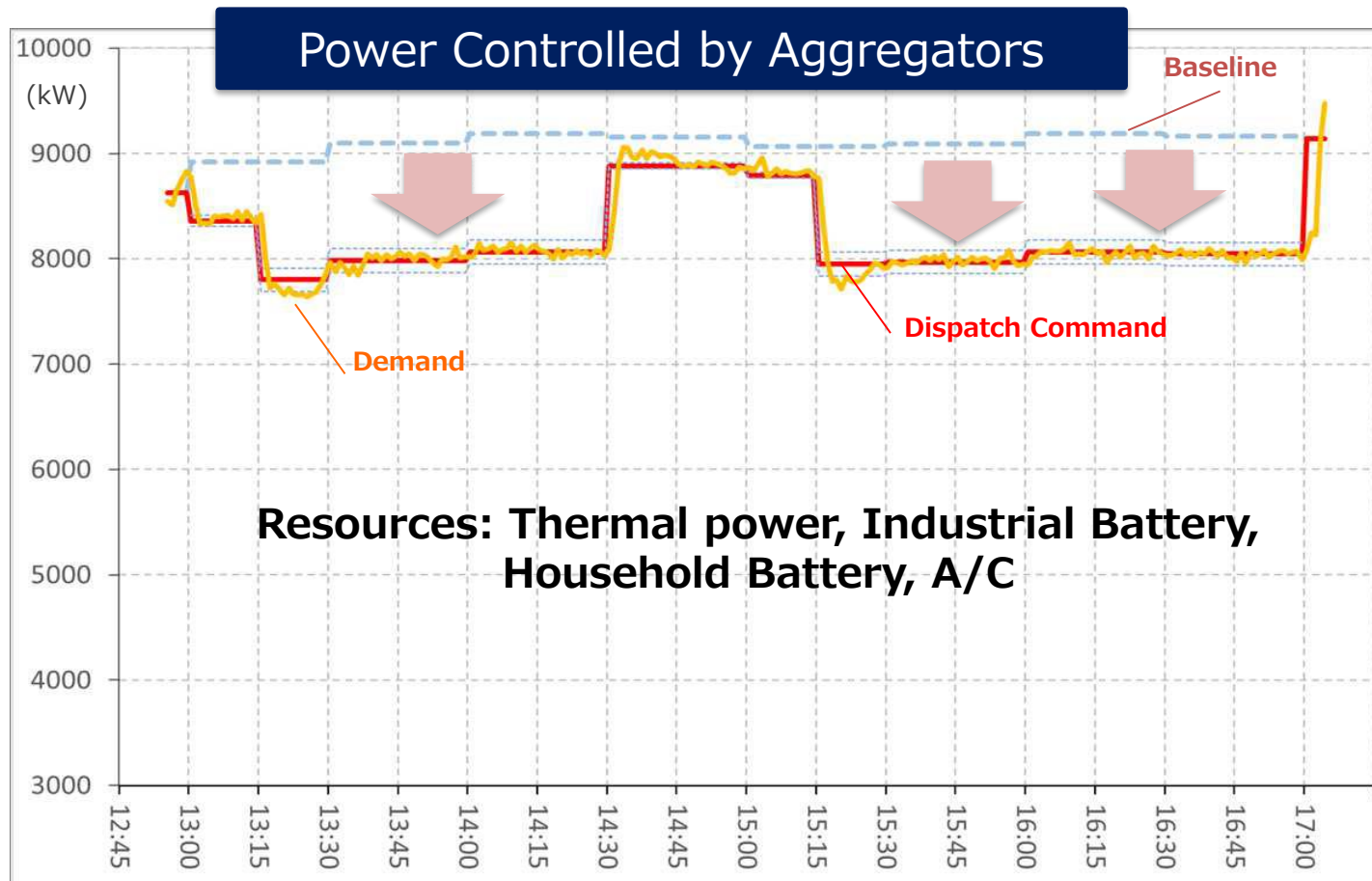
VPP helping PV to generate power in low-demand period

- Solar PV output produced 73% of demand in Kyushu.
- VPP can help solar PV to generate electricity by shifting demand to necessary times, similarly pumped hydro storage



VPP provides new reserve power sources METI Ministry of Economy, Trade and Industry

- Aggregators provide reserve power by controlling multiple distributed energy resources.
- VPP shifts electric power to necessary time for grid stabilization.



Market Reform Schedule

- Energy market reform has been progressed. **Replacement Reserves for FIT** in Balancing market has opened **in April 2021.**
- **FIP scheme, new business license of Aggregators or Distributed Network Operators** and **new imbalance price** based on JEPX price will be in force **in April 2022.**
- **FIP scheme** requires aggregators to support VREs to enter JEPX.

	2020FY	2021FY	2022FY	2023FY	2024FY	2025FY~
	TSO's auctions for reserve power					
Capacity Market (C.M.)	Main auction in C.M. for 2024			Additional auction in C.M. for 2024	Delivering in C.M.	→
Balancing Market (B.M.)		R.R.-FIT in B.M.	R.R. in B.M.		F.F.R. and F.C.R. in B.M.	→
FIP scheme			In force			
License of Aggregators, DNOs			In force			

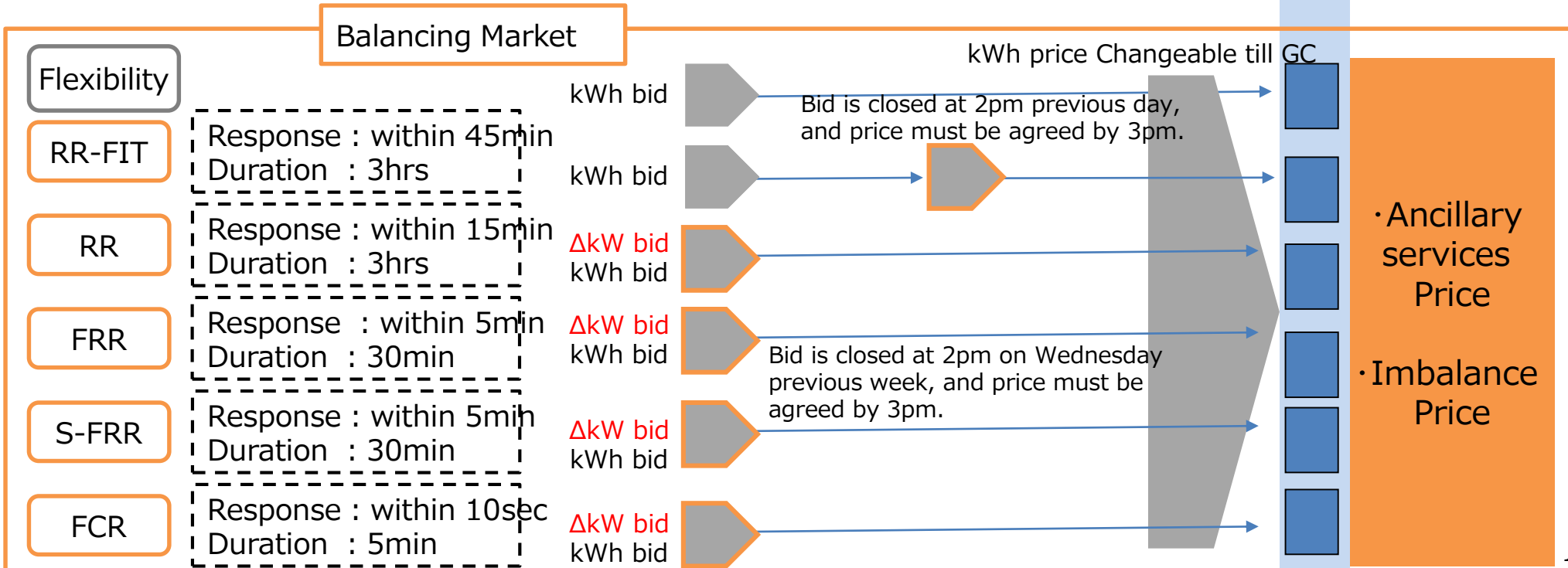
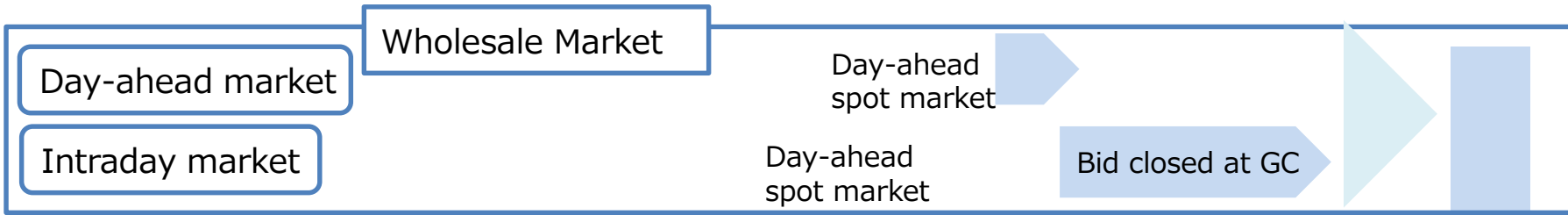
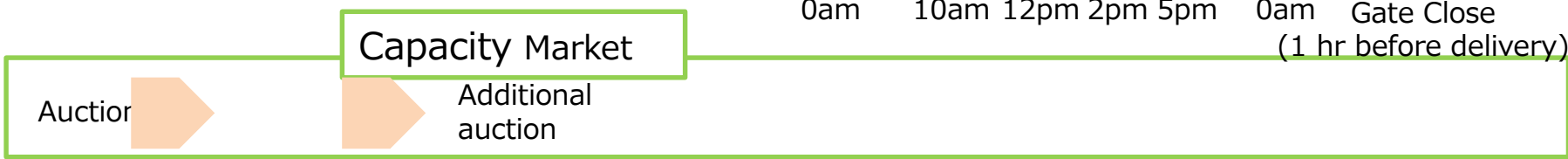
(Ref.) Product specification in balancing market

- Market specification decides who can enter the balancing markets.

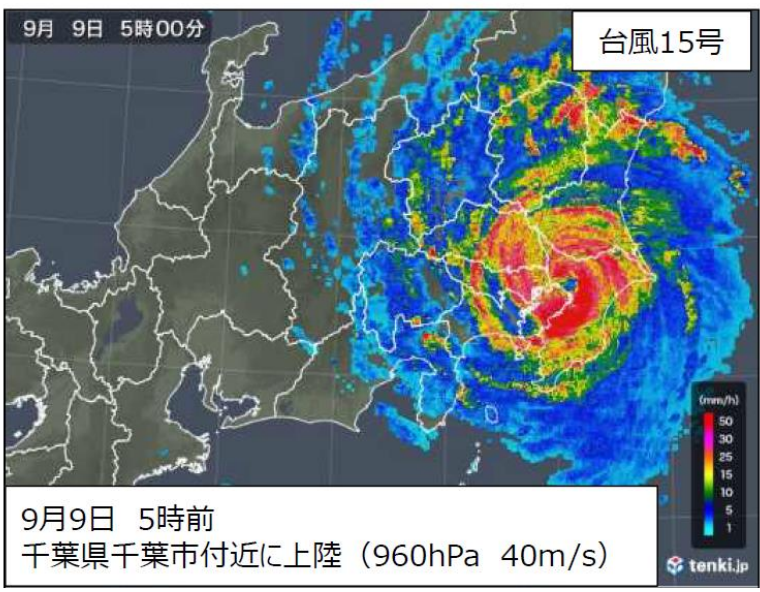
Major requirements in balancing market, as of now

	Frequency Containment Reserves (FCR)	Synchronized Frequency Containment Reserves (S-FCR)	Frequency Restoration Reserves (FRR)	Replacement Reserves (RR)	Replacement Reserves for FIT (RR-FIT)	Ref. Auction : Severe peak reserve	Ref. Capacity Mechanism
Open of Markets	2024	2024	2024	2022	2021	2017-2023	2024
Response time	Within 10 Sec.	Within 5 Min.	Within 5 Min.	15 Min.	45 Min.	3 hours	3 hours
Duration time	5 Min. or more	30 Min. or more	30 Min. or more	3 hours	3 hours	3 hours	3 hours
Minimum Capacity	5MW (1 MW Of-line)	5MW	5MW	5MW	1MW	1MW	1MW

(Rf.) Transaction schedule



Natural disasters require more resilient energy system



Typhoon No.15 hit Tokyo area in Sep. 2019



Collapsed transmission tower



Destroyed utility poles and fallen trees



Damaged floating solar power plant

DERs making energy system more resilient

- DERs (CHP, FCV/PHEV, Battery Storage), provided electricity to the locals in Chiba Prefecture, when power outage happened.

Power outage in Mutsuzawa Wellness Smart Town (Distributed Energy System)



FCV/PHV supplies electricity to homes

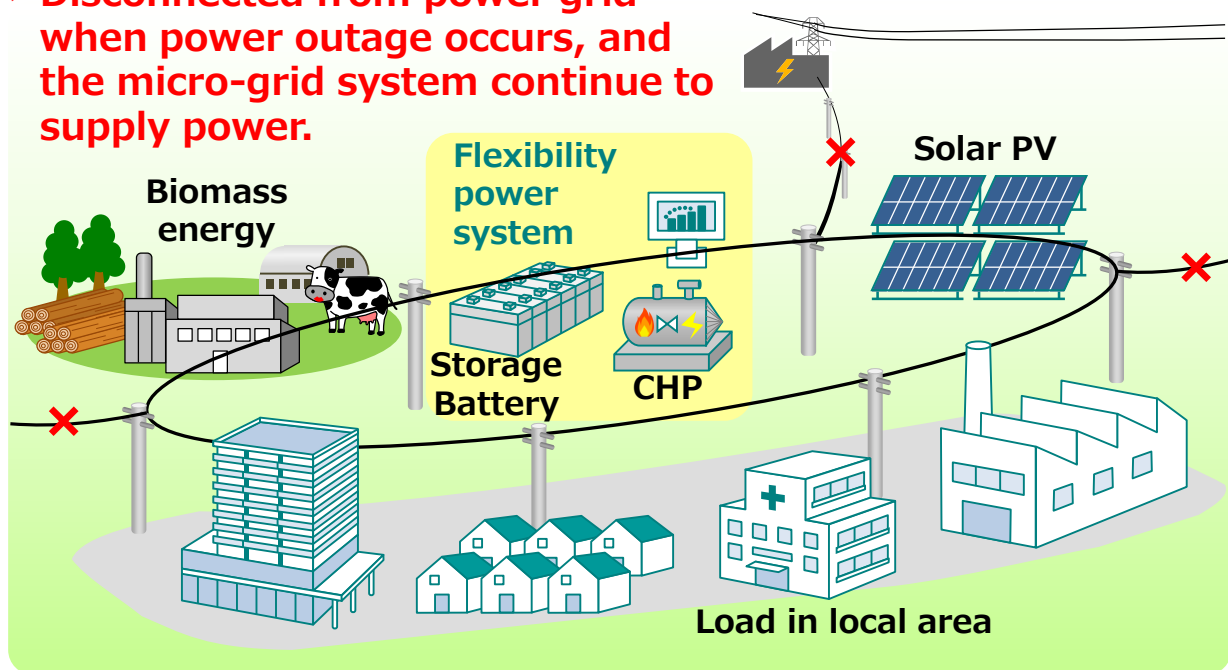


Local micro-grid system

- Local micro-grid system can contribute to reducing cost to run private power distribution lines and improving power sector resilience to natural disasters.
- 2 local micro-grid projects has been developed in Odawara and Miyako in Okinawa. 25 feasibility studies was conducted as of now.

Local micro-grid system

✓ **Disconnected from power grid when power outage occurs, and the micro-grid system continue to supply power.**



Local micro-grid projects

1. Local micro-grid project in Miyako

- Membership: NEXTEMS, Okinawa EPCO., Miyako-city
- Location: Miyako island, Okinawa
- Resources: Residential PV, Industry-scale BS

2. Local micro-grid project in Odawara

- Membership: Kyocera, TEPCO, Odawara-city
- Location: Odawara-city, Kanagawa
- Resources: Solar PV, EVs, Large-scale loads

- **DER market development;**
 - **Residential PV in Post-FIT** accounts for 2GW in 2019, and will reach **7GW in 2023.**
 - Lithium-Ion battery storage in BTM reached **3GWh at the end of 2020.**
- **Demand-side Response (DR);**
 - **Reducing loads by DR for severe peak time accounts for 1.8 GW in 2021.**
 - **4GW DR** won the auction in **Capacity Market**, which will **deliver in 2024.**
 - **Reshaping load curves based on JEPX prices make use of electricity from renewables.** Smart charging system of EV has possibilities to improve energy system.
 - DR has started to enter **RR-FIT in April 2021.**
- Micro-grid systems can **use renewables as much as possible, reduce cost to construct and run private power distribution lines,** and **improve power sector resilience to natural disasters.**