CHAdeMO EUR TWG

Global Trends on V2X in Electrical Power Grids and the TEPCO challenges on CN

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TEPCO research institute, Business Incubation Office

~~**Resource Aggregation office**~~

CHAdeMO Association

OCT05, 2022

Agenda

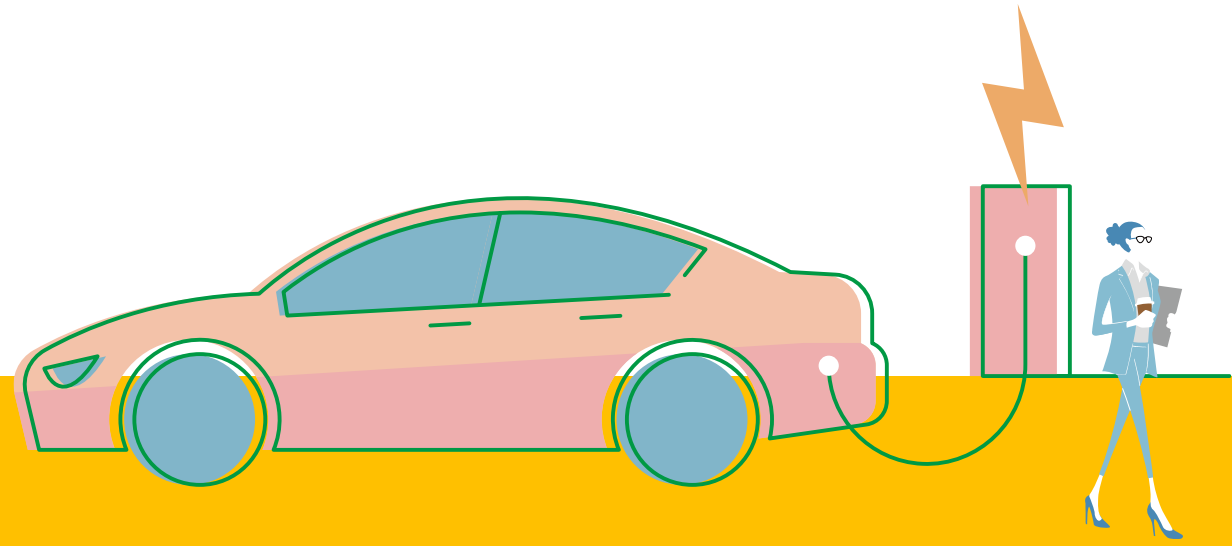
I. Introduction of

I. TEPCO
II. TRI (TEPCO Research Institute)

II. TEPCO challenge to CN, EV, V2X and V2H product

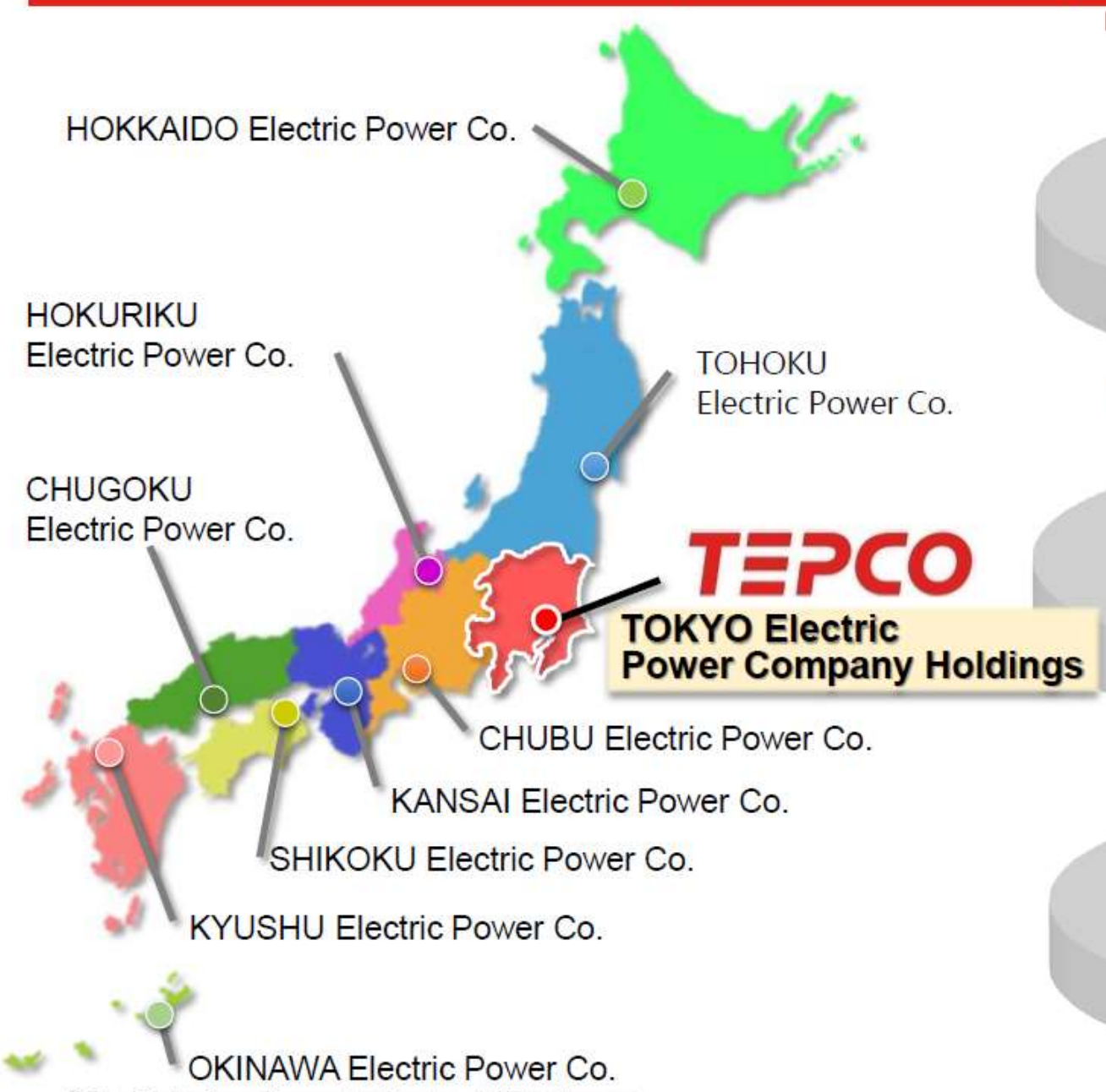
I. CN challenge of TEPCO
II. EV history in TEPCO
III. RA-V2X POC in TEPCO
IV. New products “BENIYA”

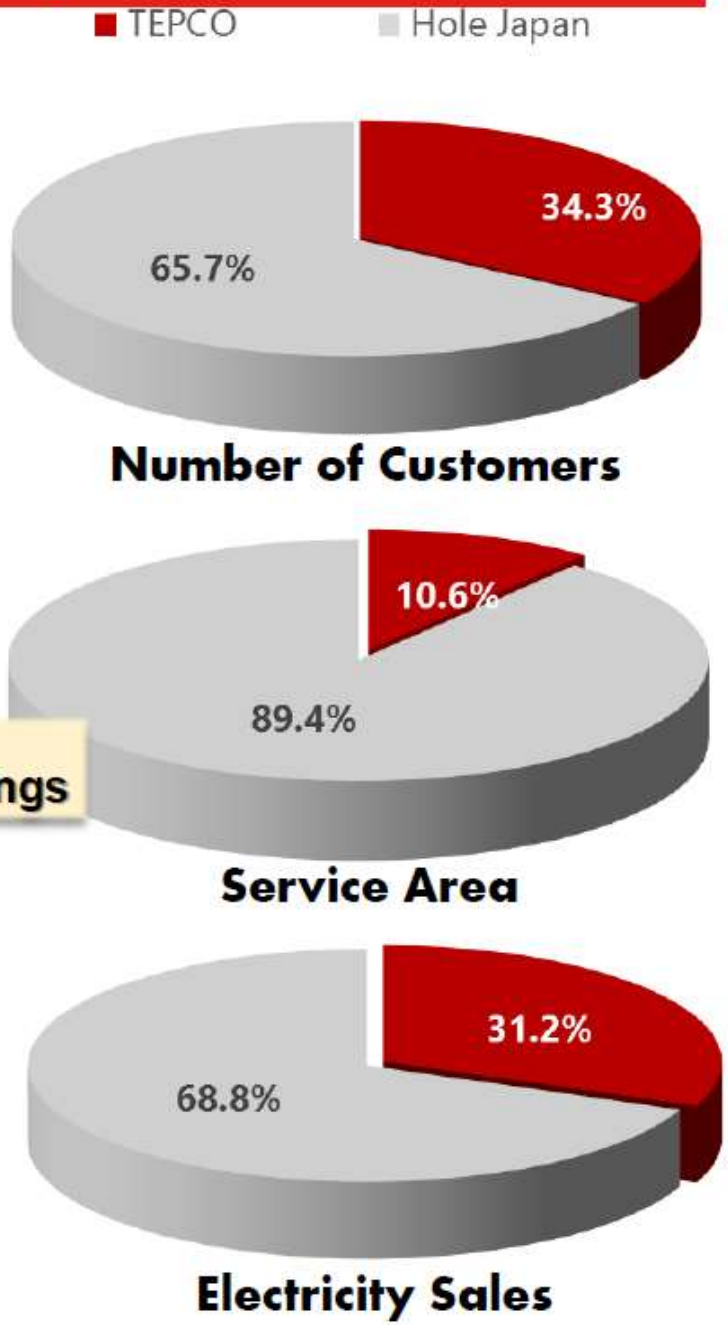
III. Conclusion



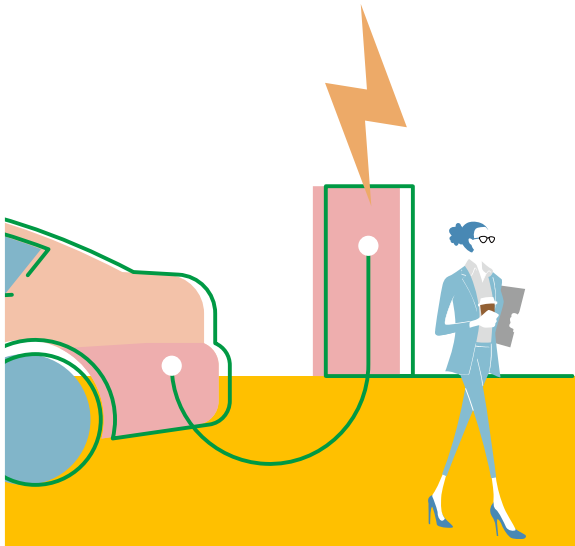
Electric Power Companies in Japan

TEPCO





TEPCO is one of the largest PG in the world.



TEPCO Holdings （31,000 employees ）

TEPCO

Main Holding Company
（6,000 employees）

TEPCO

- Fukushima Headquarters
- Fukushima Daiichi D&D Engineering Company
- Nuclear Power Stations
- Management Support
- Business Solution Company
- **TEPCO Research Institute**

TEPCO Group Companies

Fuel and Thermal Power Generation Company	General Transmission and Distribution Company	Retail Electricity Sales Company	Renewable Energy Power Generation Company
TEPCO	TEPCO	TEPCO	TEPCO
TEPCO Fuel & Power	TEPCO Power Grid	TEPCO Energy Partner	TEPCO Renewable Power
（30 employees）	（21,000 employees）	（3,100 employees）	（1,300 employees）

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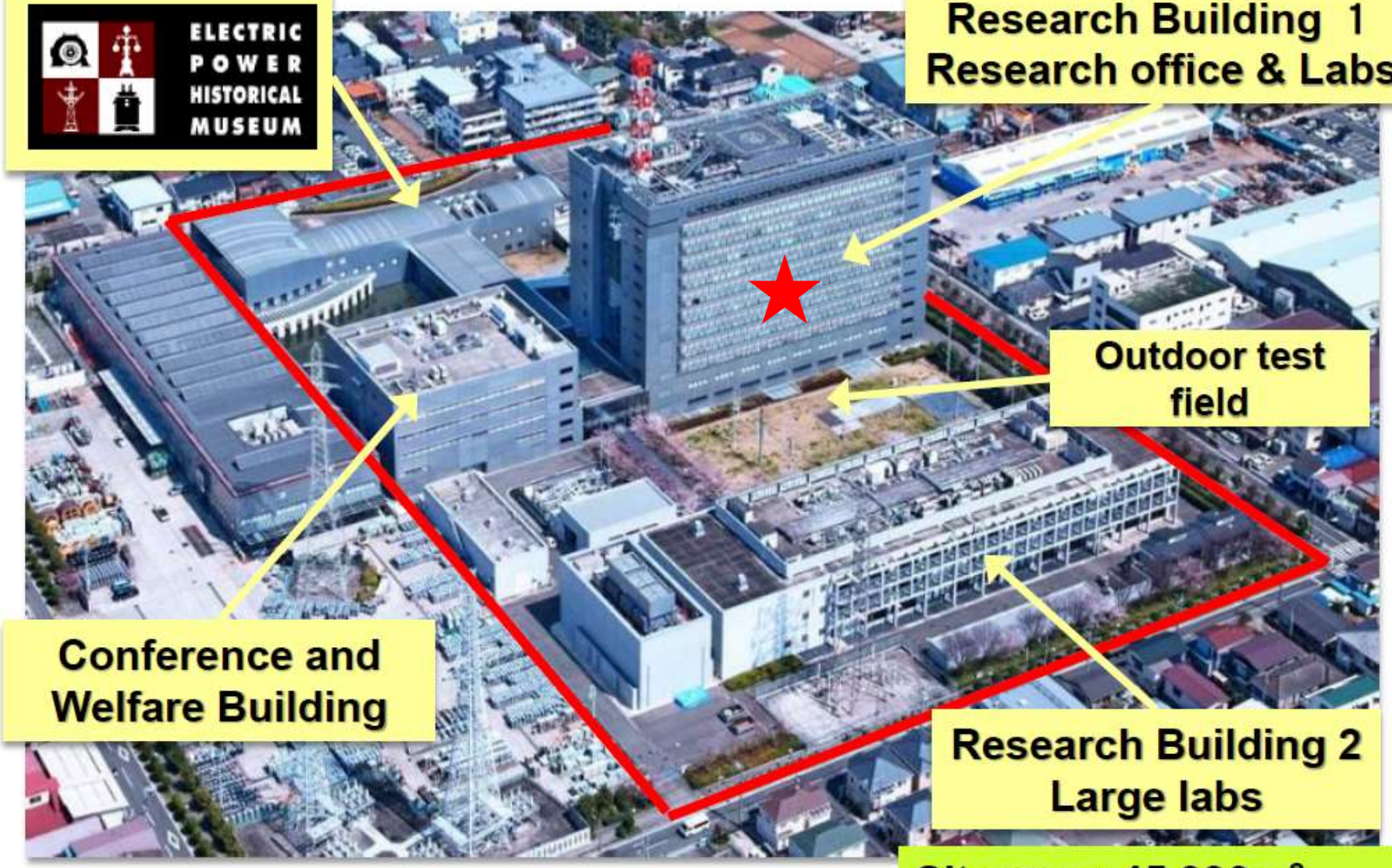
Bird's-eye View of TEPCO Research Institute

TEPCO



Site area: 45,990m²

Total floor area: 58,625m²

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Electric vehicles & DC quick charging

Objective : Reduction of CO_2 emissions in the transportation sector

Outline : As a major member of the CHAdeMO Council, DC quick charging and V2H (Vehicle to Home) have been researching to expand the charging infrastructure that is required for the spread of EVs.
In terms of standardization, the DC charging method (CHAdeMO method) for electric vehicles has published in the IEC standard and JIS standard in 2014.

V2H System
[Vehicle to Home]

V2L System
(Construction lighting)
[Vehicle to Load]

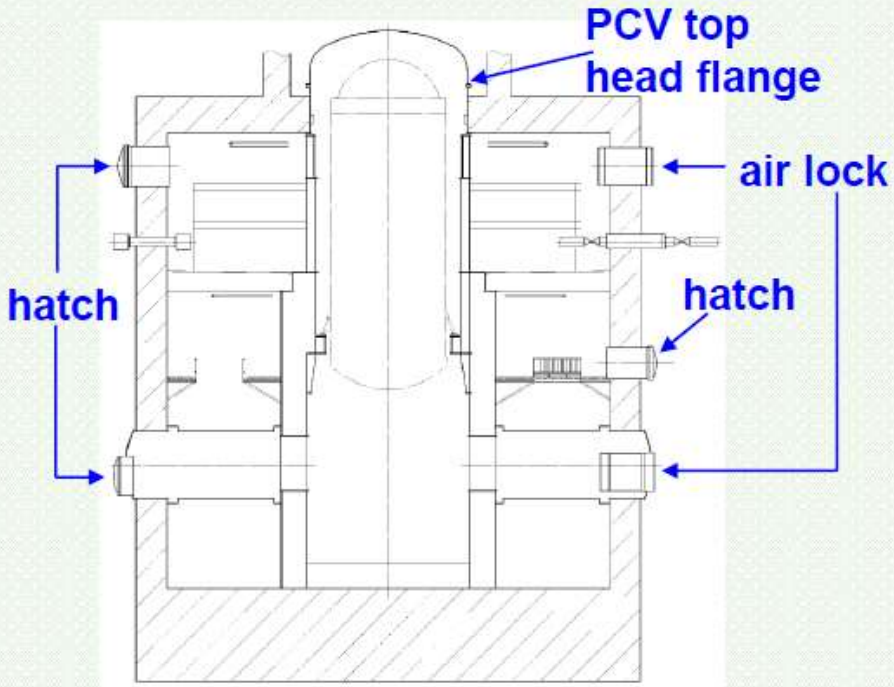
V2X System
[Vehicle to X]

Improving sealing performance of nuclear reactor containment flanges

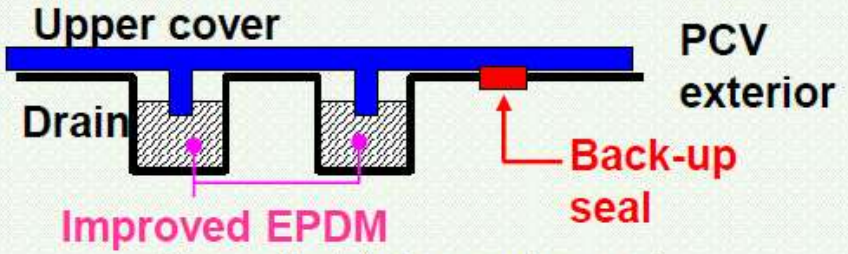
Objective : Ensure world's highest level of safety at Kashiwazaki Kariwa NPS (improving confinement function for radioactive materials in the event of severe accidents)

Outline : Improved material and backup seal

- Improving heat and radiation resistance by changing the sealant material from silicone rubber to improved EPDM.
- Improving air-tightness and long-term soundness by coating flange with back-up seal.



Nuclear reactor containment (RCCV)

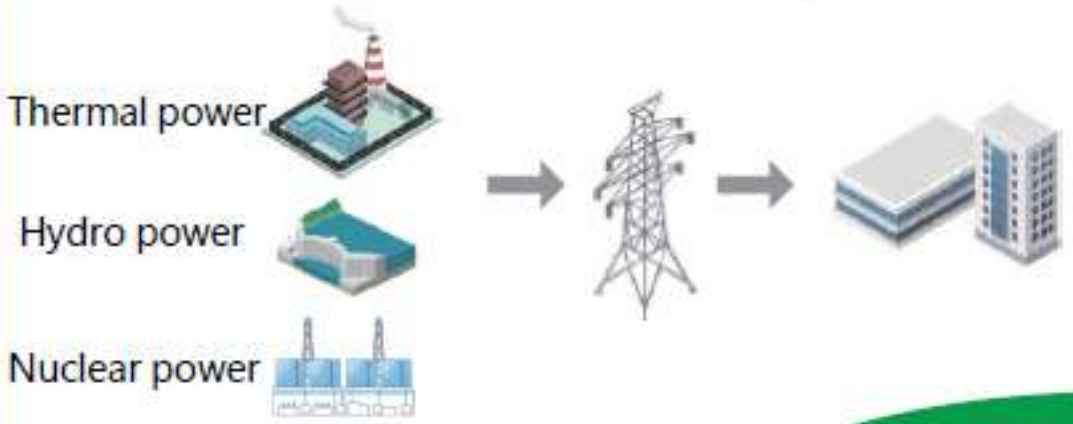


Flange/hatch-improving seal

Back-up seal
Nuclear power plant hatch test
(hatch closedown)

TEPCO's challenge for CN2050

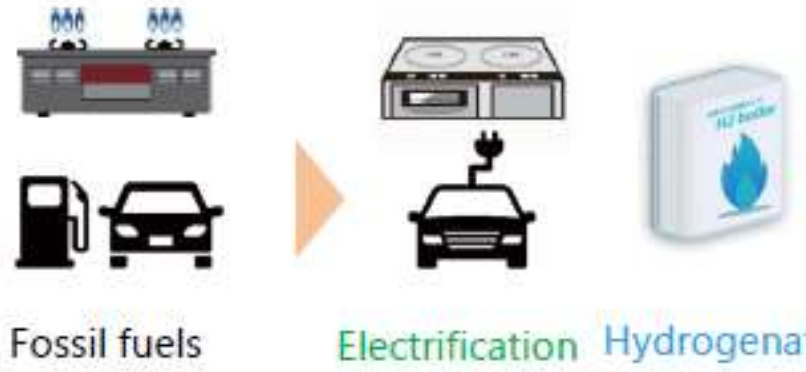
Coexistence of large-scale power sources and mass power transmission, and locally produced and locally consumed power sources



Change of demand structure

Zero emission of electricity

Electrification of energy demand



TEPCO's challenge for CN2050 - SUPPLY

Solar power

- Development of energy services using onsite and offsite solar power for corporate customers
- Installation of solar power through electrification packages for households

Offshore wind power

- Promotion of seabed offshore wind power by increasing competitiveness to win the public bidding process
- Becoming the top runner in Japan by advancing demonstration of floating offshore wind power

Geothermal

- Site development mainly in the Kanto region

Hydro power

- Improved equipment reliability, longer service life and increased power generation by repowering existing power stations

Nuclear power

- Important stable power source that does not emit CO_2
- Returning to the starting point of "reflecting on and learning from the Fukushima Daiichi Nuclear Power Station accident", safety first is enforced in light of the series of incidents that caused great anxiety to the society

Zero-emission thermal power

- Support for JERA's efforts to eliminate all inefficient coal-fired thermal power plants by 2030 and to achieve zero emissions through mixed burning of ammonia and hydrogen

TEPCO's challenge for CN2050 – from SUPPLY to DEMAND

Supply

Offshore wind power

GI Fund※

- Low-cost floating offshore wind power
- Practical application of versatile multi-terminal DC transmission system

Hydrogen / ammonia

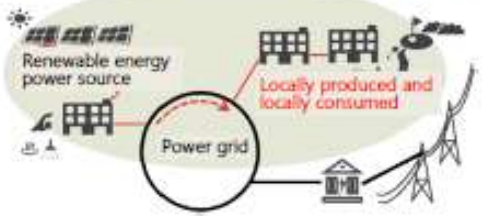
GI Fund※

- Large-size and low-cost hydrogen production originating from renewable energy
- Advanced ammonia synthesis technology (JERA)

Grids

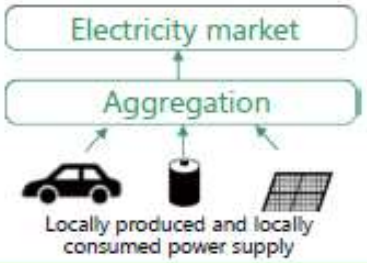
Independent and dispersed

- Development of energy management system
- Improvement of accuracy of power generation and demand forecasting



Adjusting power

- Establishment of VPP and V2G technologies according to market needs
- Evaluation of inertial forces and establishment of countermeasure technology



Demand

Electrification + Added values

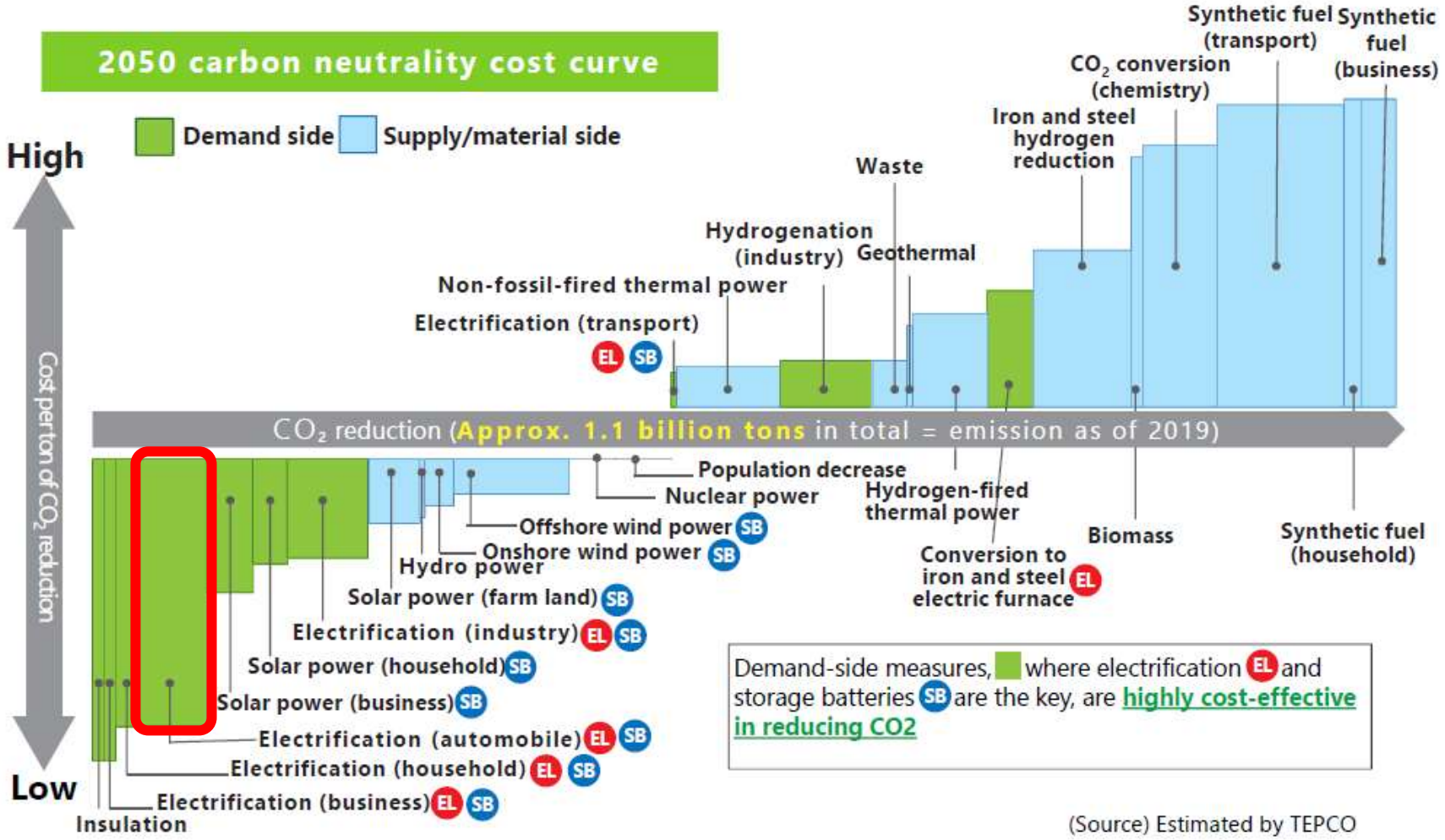
- Energy-saving measures
- Equipment development in view of UX service (multi-functional PCS, smart distribution board, etc.)

Power storage

- Development of multiple-use storage battery system
- Establishment of methods for evaluating safety and performance of the storage battery system

TEPCO's challenge for CN2050

■ In order to realize a carbon neutral society, we need to reduce our dependence on fossil fuels in the mid to long-term and mobilize all CO2 reduction measures. Considering cost-effectiveness, relatively affordable demand-side initiatives (electrification, solar power, installation of storage battery, etc.) are effective.



TEPCO's history of EV challenges!

- **Expanding a wide variety of EV activities, as an early adopter, 15-yr history, not only R&D but also Business!**

2007

Full-scale Start of EV adoption

Deployment of compact EVs for our fleet use

2008

Social Recognition Enhancement

Introduction of DC Fast Chargers @ G8 summit (Toya-ko, Hokkaido)

2014

Boosting Public charger Installation

Establishment of NCS (collaboration between OEMs & utilities)

NCS 合同会社日本充電サービス

2019

"EV100 & EV30@30" Enrollment

As the first entity in Japan to join EV100 (400→4,400 vehicles)

EV 100

2019

Utility-led Expansion

✓Launched "EV Promotion Office"
✓Establishment of "e-Mobility Power" (utility only)

e MOBILITY POWER

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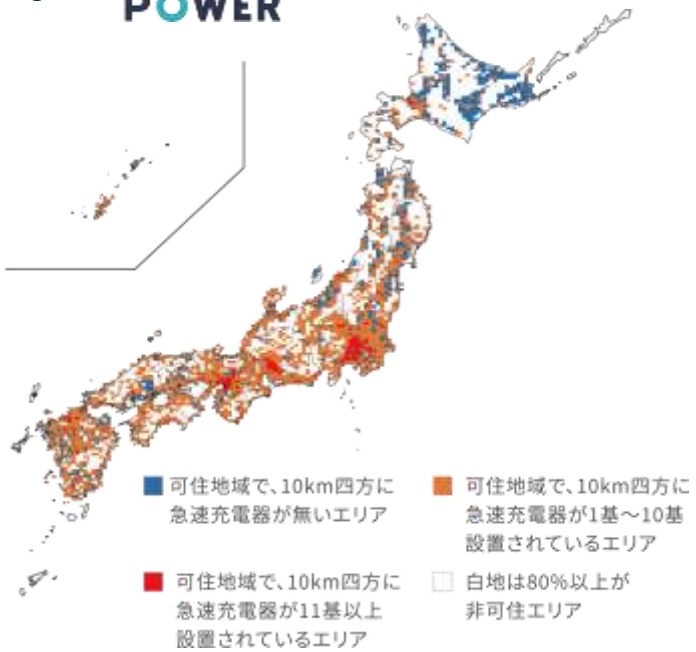
TEPCO as a leader of EV charging infrastructure

- 1st step: NCS completed 2-dimensional cover in Japan (1st step)
- 2nd step: E-mobility power, high power 50kW→120kW etc, simultaneous multi-plug for avoiding congestion
- **We'll offer area-dependant cost effective solution for striking the balance between customer benefit/loss**, introducing viewpoints of Utility/infrastructure

8000 QCs installed by e MOBILITY POWER



Dual/multi-Quick Charger Development/deployment

Dynamic multi for highway SA

6EVs at one time
max 90[kW/vehicle]
200A-15min/125A-cont.
natural cooled
Total 200[kW]

Dynamic dual for Shakado PA

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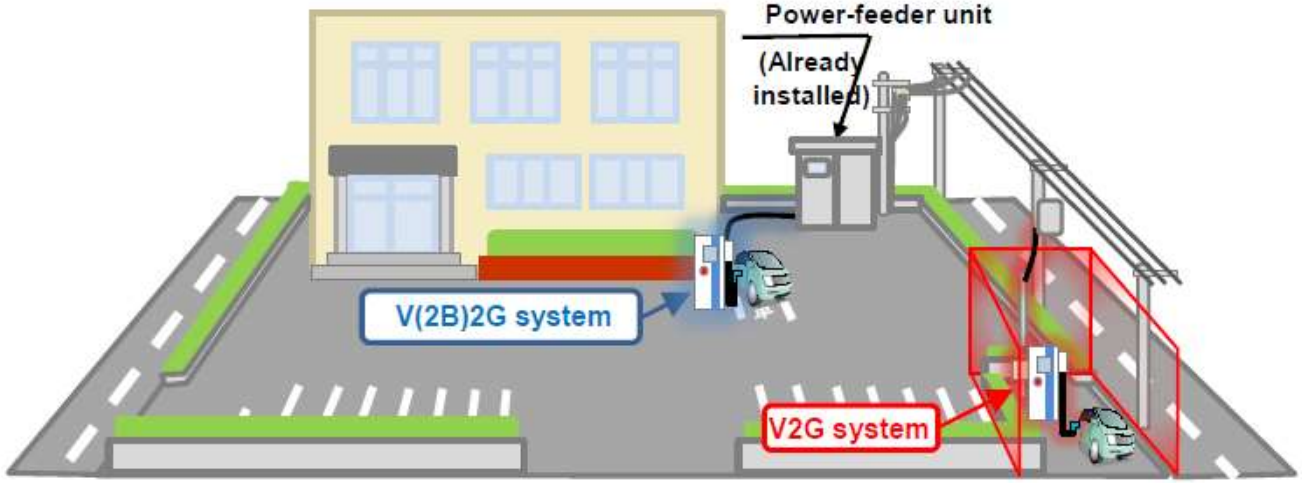
V2X Types and Applications

Vehicle to Everything (V2X)

Model	Conceptual Image	Description
V2L model Vehicle to Load		The outlets supplied with the system provide electric power to electric devices when at an event or away from home.
V2H / V2B model Vehicle to Home Vehicle to Building		The system supplies electric power for home or office use while feeding any excess power for use by certain power-system-type services.
V2G model Vehicle to Grid		The system is primarily feeds power for use by power-system-type services.

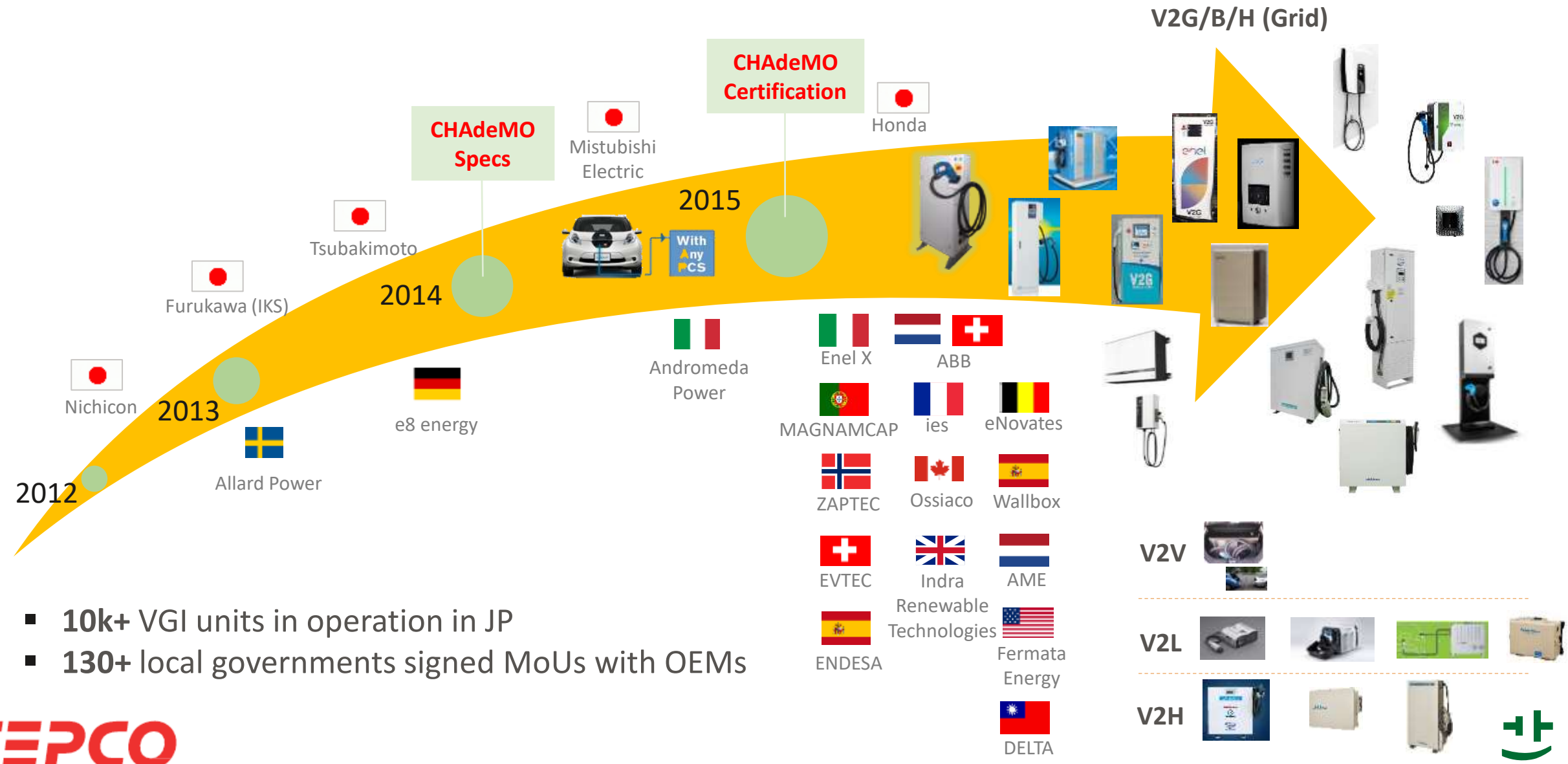
Vehicle to Grid (V2G)

EVs function as moving storage batteries for supply and demand adjustments, trend adjustments, and voltage adjustments, by connecting to the power grid



CHAdeMO V2G Product development

Appendix



- **10k+** VGI units in operation in JP
- **130+** local governments signed MoUs with OEMs

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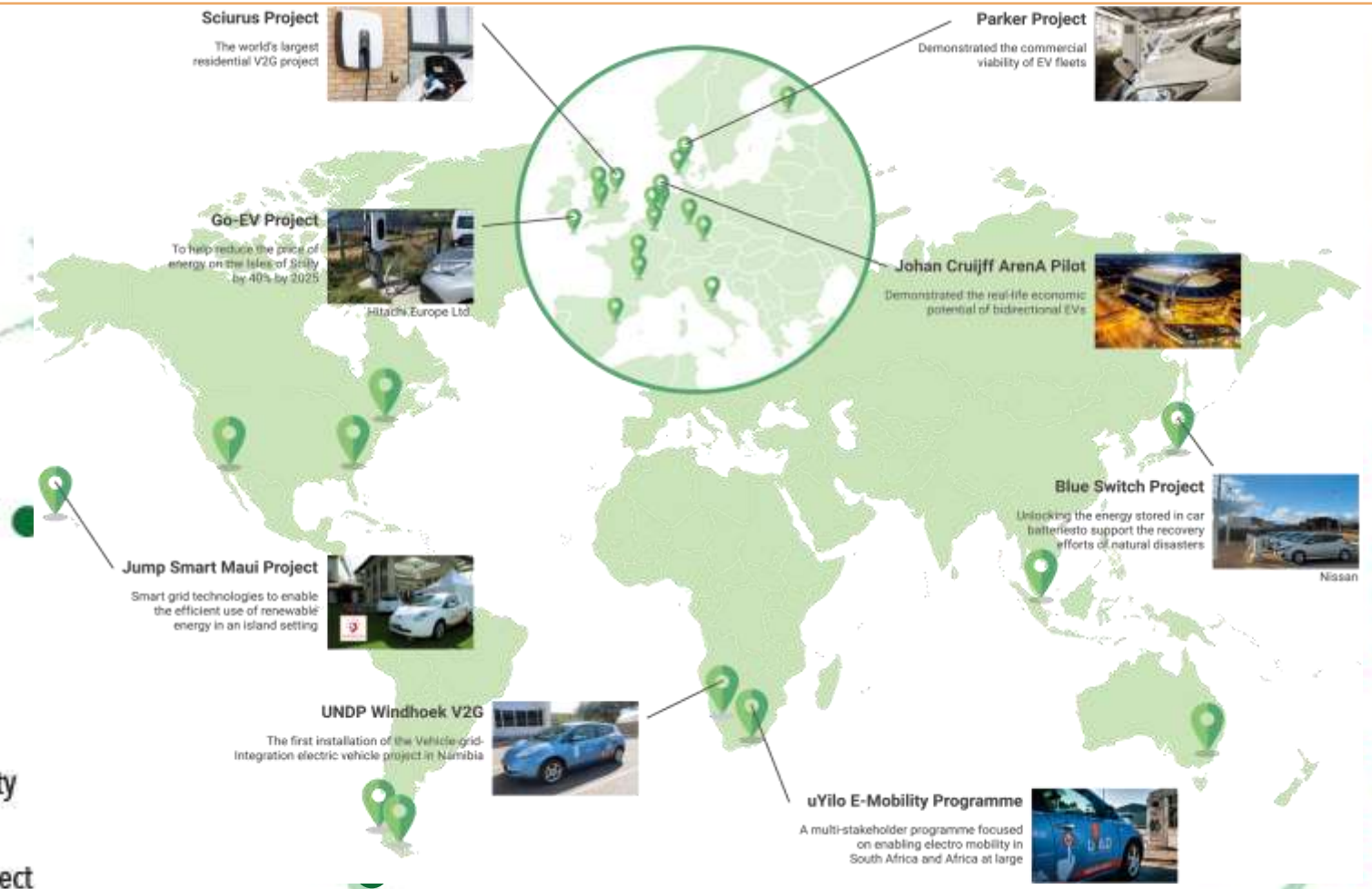
V2X projects & commercial applications



- JUMPSmartMaui, USA
- LA Air Force Base, USA
- UCSD, USA
- PowerStream, Canada
- Yokohama Smart City Project, Japan
- Nikola Project / Parker Project, Denmark
- Nuvve Project, Denmark
- Amsterdam Smart City, Netherlands
- NewMotion V2G Project, Netherlands
- GrowSmarter, Spain
- Peak Drive, Canada
- Nissan HQ Project, France
- GridMotion, France
- Genoa Pilot, Italy
- Suvilahti Pilot, Finland
- Nissan-Enel Project, UK
- DriveElectric, UK
- OVO, UK
- Redispatch V2G, Germany
- SEEV4-City, UK, Norway, Netherlands, Belgium, Germany
- **UNDP Windhoek V2G** Namibia
- **Domestic Energy Balancing EV Charging Trial** UK
- **Direct Solar DC V2G Hub** NL
- **Share the Sun Project** NL
- **V2G Zelzate** BE
- **MASERA microgrid project** Singapore
- **Realising Electric Vehicle to Grid Services** AU
- **UYILO E-Mobility Programme** South Africa

Source: CHAdeMO website, https://www.v2g-hub.com

TEPCO's VPP/V2G Pilot Project

■ TEPCO leads Japan's largest VPP/V2G Pilot by 30/6 companies

V2G Pilot Members

【Aggregation Coordinator】
Tokyo Electric Power Company, Inc.

【Cooperation Company】
Mitsubishi Motors Corporation

【Cooperation Company】
TEPCO Power Grid, Inc.

【Cooperation Company】
TEPCO Energy Partner, Inc.

Site A

【Resource Aggregato
Shizuoka Gas Co., Ltd.

【EVPS Installation】
Shizuoka Gas Co., Ltd.

Site B

【Resource Aggregator】
Hitachi Systems PS, Ltd

【EVPS Installation】
Mitsubishi Motors Corporation

Other Sites

【EVPS Installation】
Local Municipalities

TEPCO's V2G Pilot Sites

Appendix

■ 63 EVs + 63 Chargers for DR, V2works, and local balancing

V2G Sites

V2B2G Sites

Fleet Charging Station

Pilot Control Room

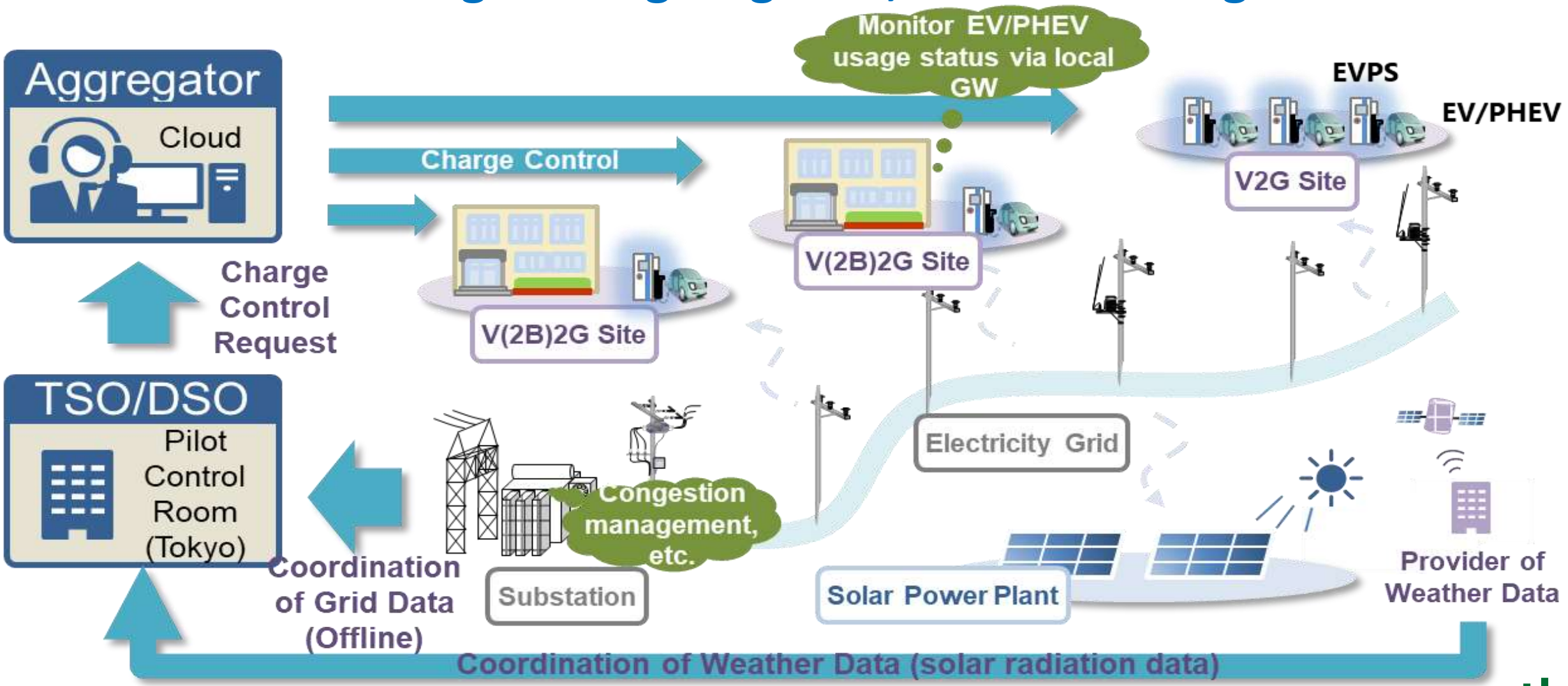
Pilot Control Room

Control Terminal

Site Monitoring Terminals

V2G Pilot scope

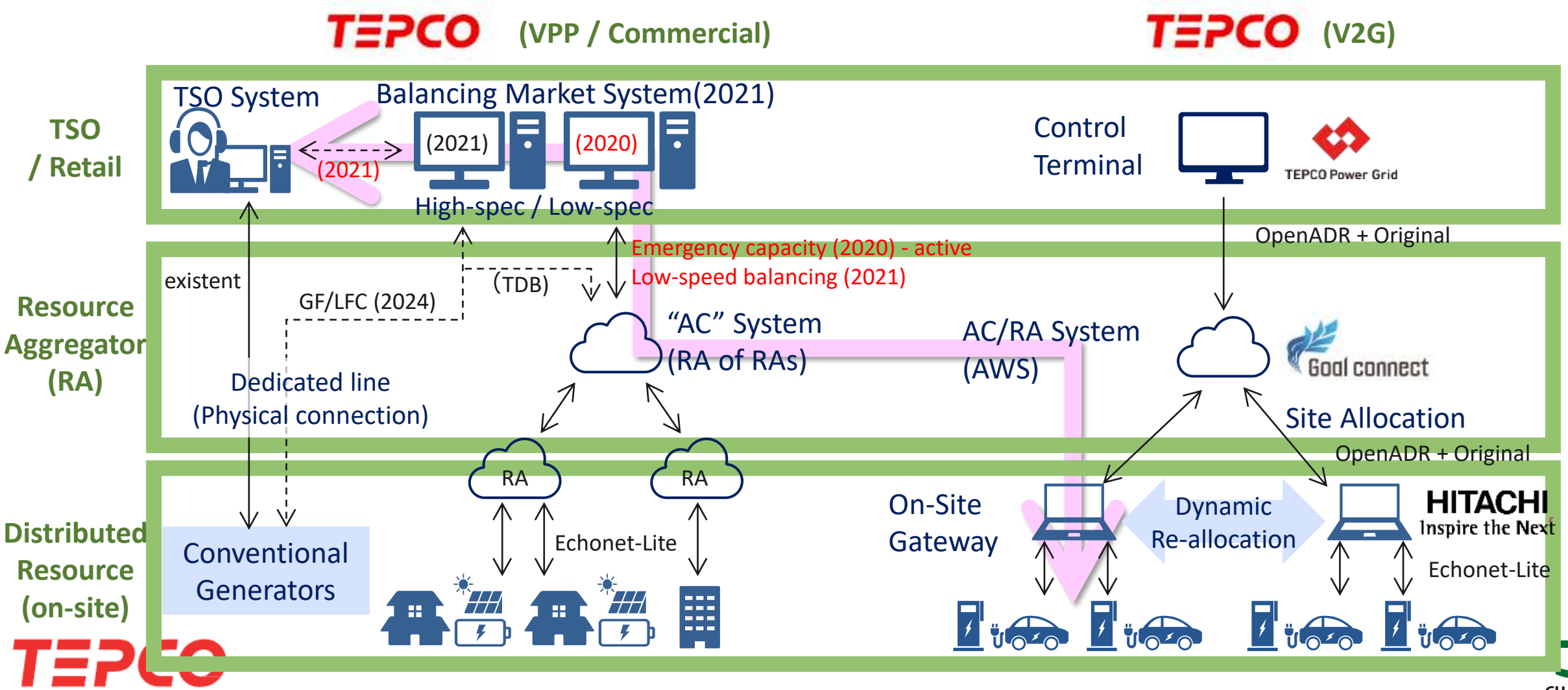
– Distribution Management grid-global, local balancing



※An assumption was made that all pilot sites are connected to the same commercial grid.

Field test/demonstration configuration of VPP & V2G (TEPCO)

■ total energy/power flow management and coordination with other aggregation resource



Lessons learnt from the demos and some expectations

Customers

- Much interest in V2G but customers need reassurance and education
  - Private consumers
  - Fleet customers
- Limited number of V2G car models available
- Resilience needs would be sufficient incentive for V2H, location dependant

Business

- Yes, V2G business case works, but not for every user type or location
- Local flexibility – flexible operation by V2G with limited capacity of distribution system, location dependant
- Costs and supply a constraint
  - Grid connection, installation, equipment
- Whole-system benefits exist

Energy

- Improve complex grid connection process and charges
- Distributed artificial inertia or damping factor for stabilization by smart V2G-PCS would be a new value
- Moves towards V1G smart charging could improve receptiveness to V2G.
- Need to enable local flexibility markets for relevant services

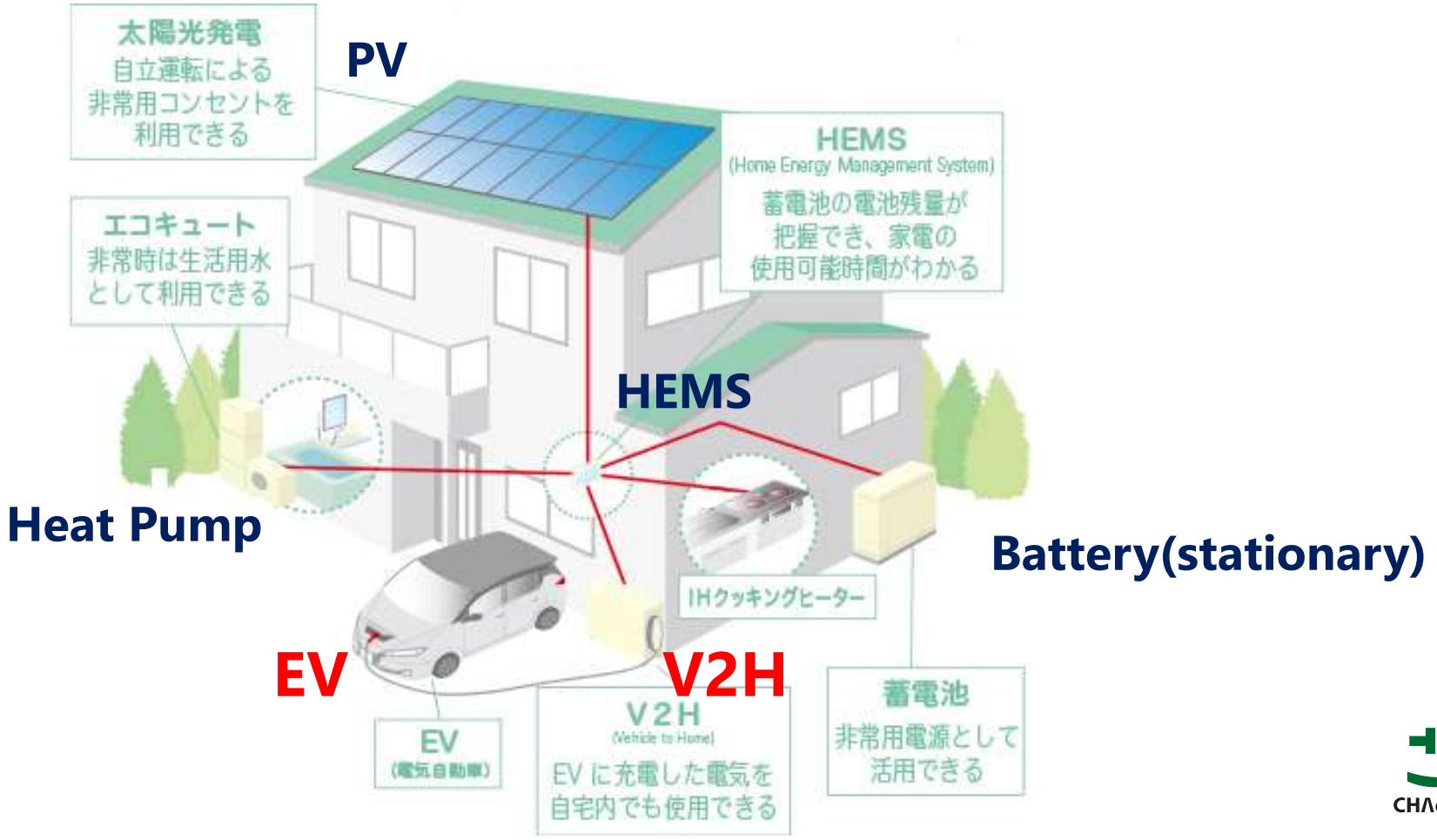
Source: "Learnings from the UK's V2G Programme" https://www.chademo.com/wp2016/wp-content/uploads/2021/05/CHAdeMO_V2G_Innovate_UK.pdf; Imperial college/OVO Energy "Blueprint for a post carbon society"

V2Hs for Retailer – Eco & Outage-less House

■V2Hs are already service-in in TEPCO with market-available /long-proven chademo-V2X products

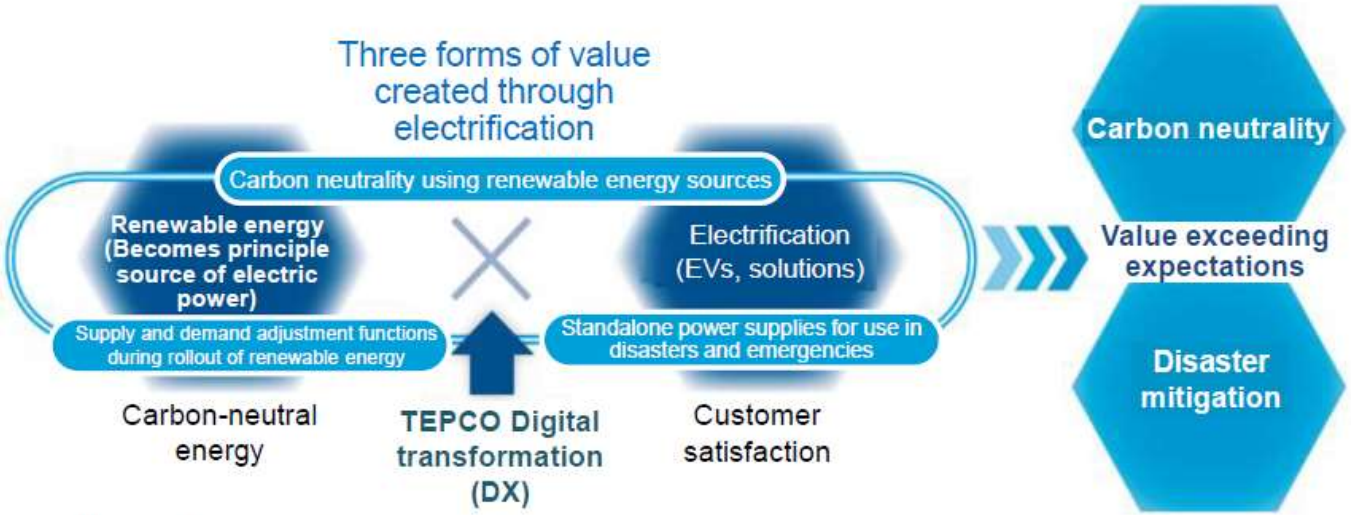
From TEPCO EP webpage

Retailing Menu with combination of EV-V2H, PV, heat pump, stationary battery, HEMS etc



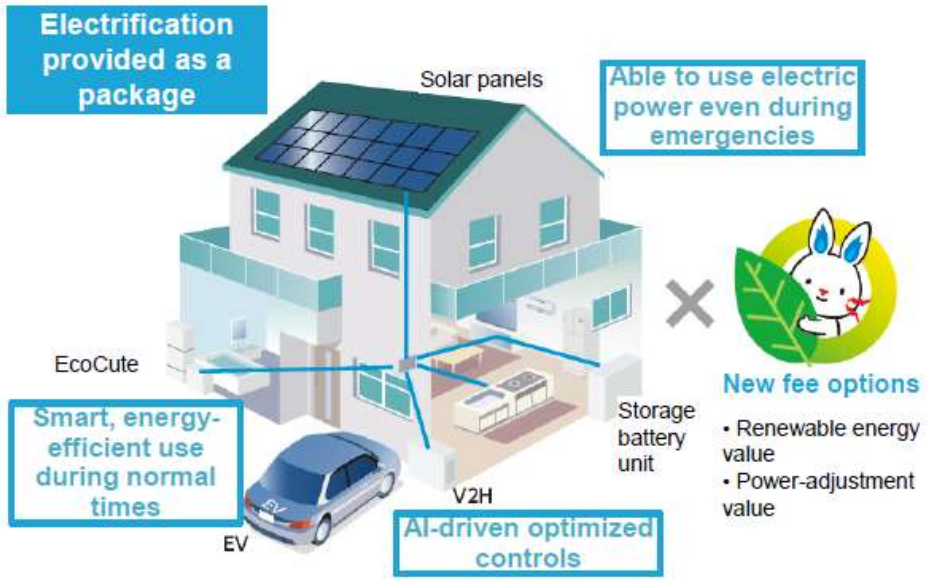
New Electrification Contributes to Carbon Neutrality and Disaster Mitigation

- Provides integral value in the form of security, energy savings, and carbon neutrality by generating, storing, and consuming non-fossil-based electric power
- Development of subscription services and electrification options for new electrification equipment and installations



Three forms of value:

Carbon neutrality using renewable energy sources
Supply and demand adjustment functions during rollout of renewable energy
Standalone power supplies for use in disasters and emergencies



Subscription services and electrification options for electrification equipment and installations

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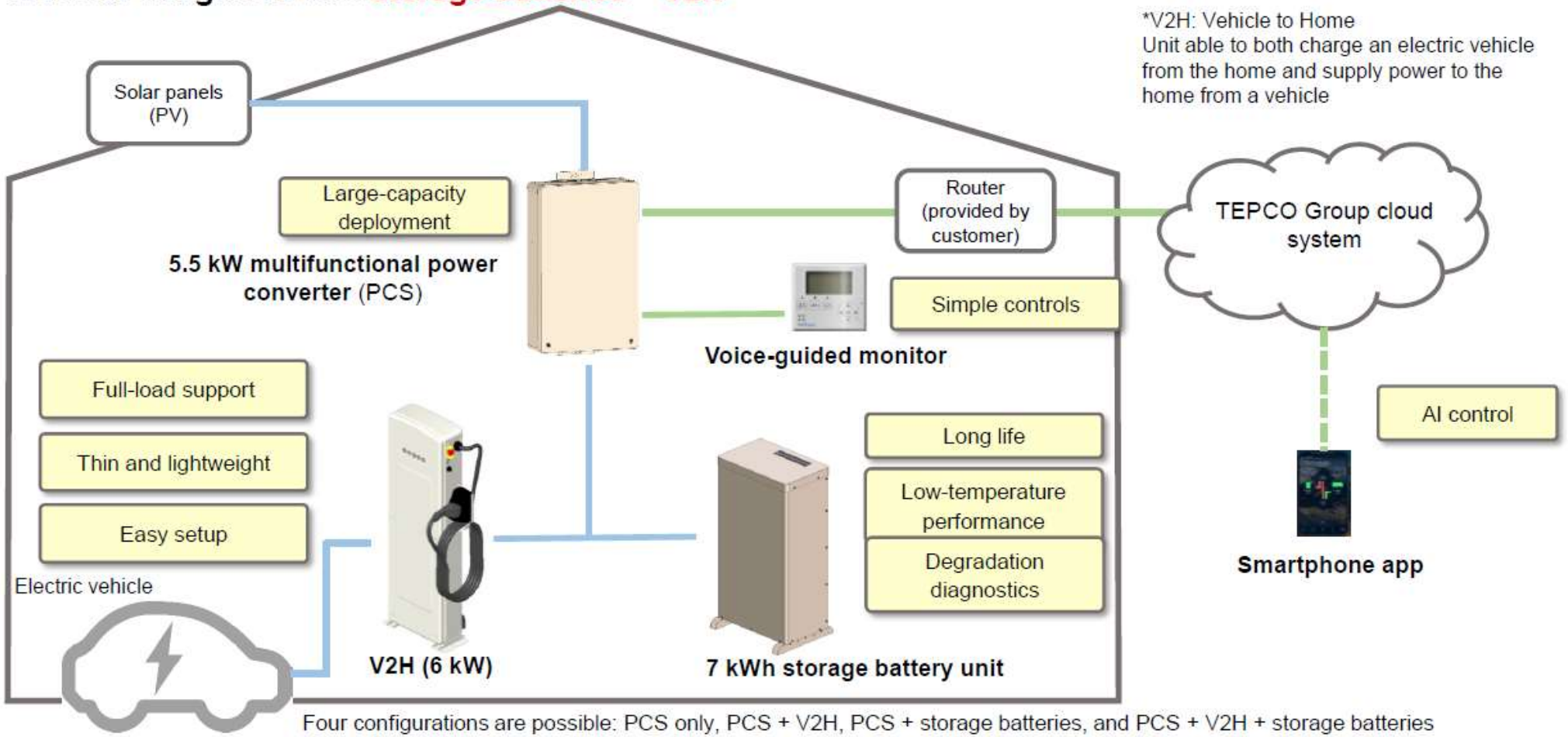
The New Electrification Concept: Provide Services that Integrate PV + LIB + EV + RA

New Electrification makes it possible to deploy services (such as storage battery degradation diagnostics) that combine TEPCO Group's cloud system with multifunctional power conditioner systems, with outstanding safety and functionality that only TEPCO can offer, to address rising demand for post-FIT and disaster mitigation with storage batteries + V2H*

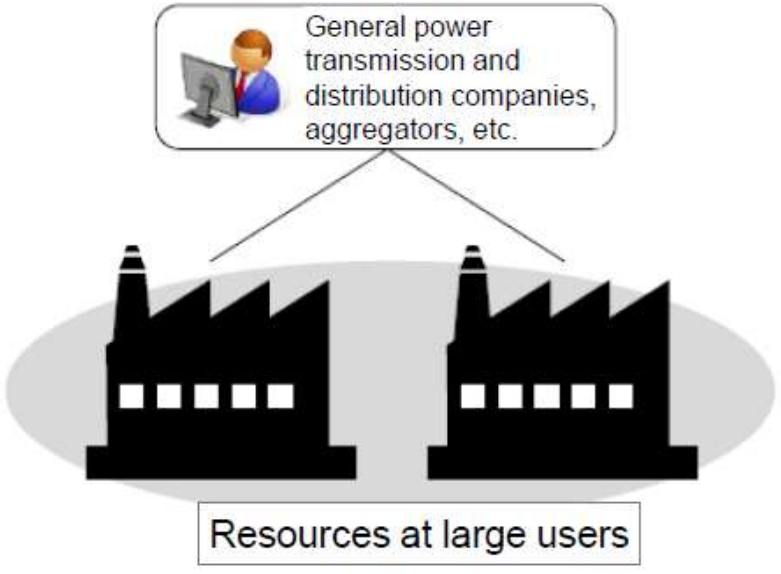


Four configurations are possible: PCS only, PCS + V2H, PCS + storage batteries, and PCS + V2H + storage batteries

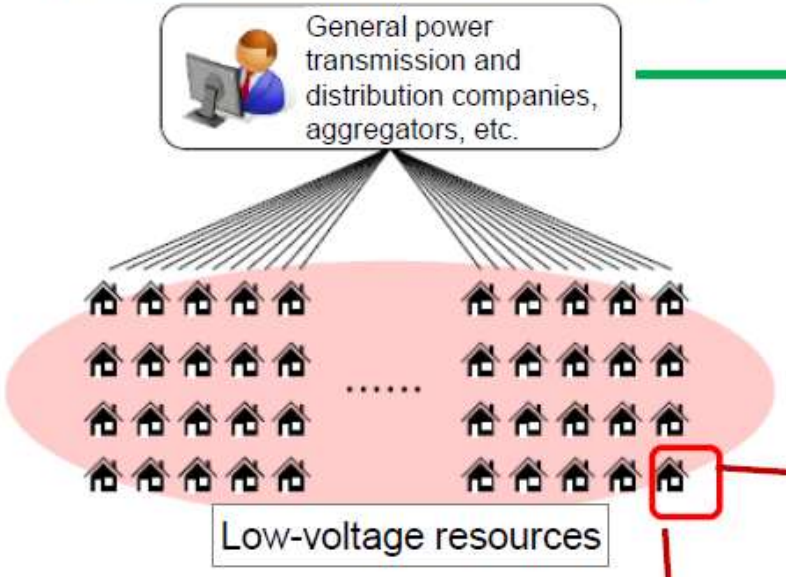
Vision of Low-Voltage Aggregation

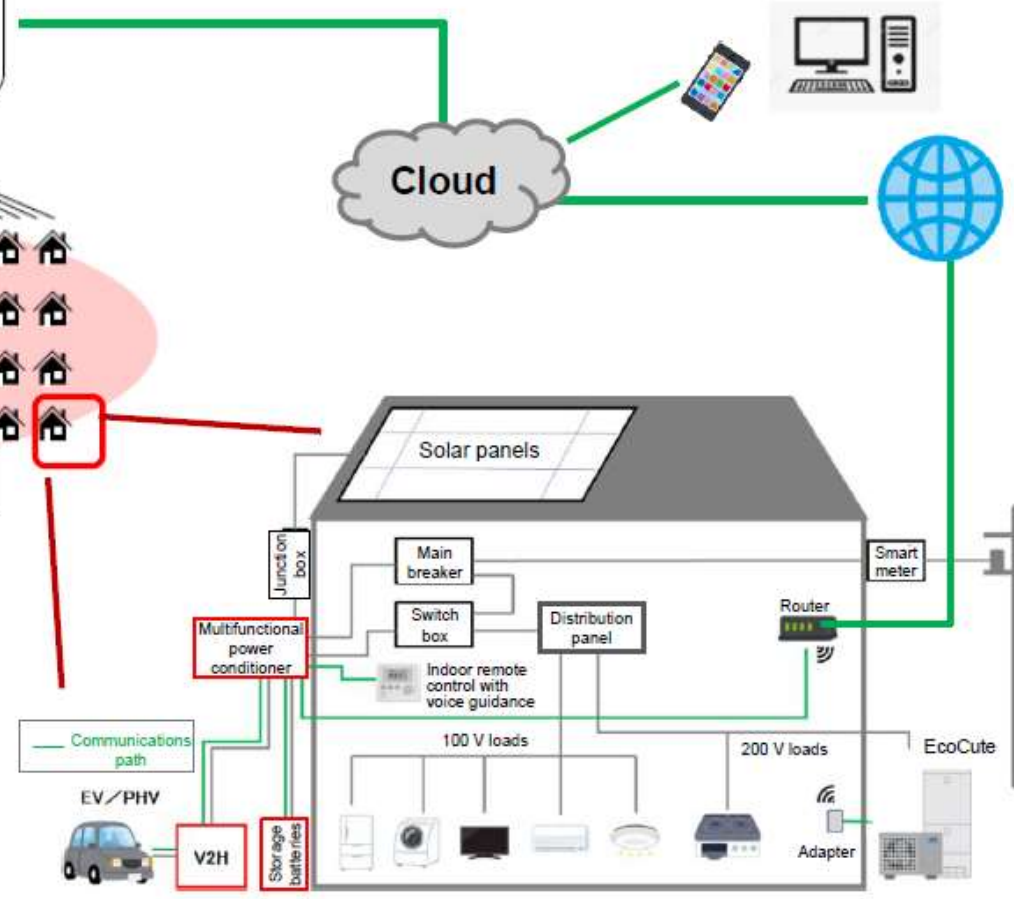
In-vehicle control functions are being studied, in view of future reverse low-voltage power flows

Current envisioned aggregation



Aggregation of low-voltage resources





<Comparison of aggregated resources>
If ΔkW is 1 MW: 500 kW x 2 facilities = 1 kW x 1,000 homes
If ΔkW is 100 MW: 500 kW x 200 facilities = 1 kW x 100,000 homes

Taken from materials presented at the 17th meeting of the Study Subcommittee on Supply and Demand Adjustment Markets

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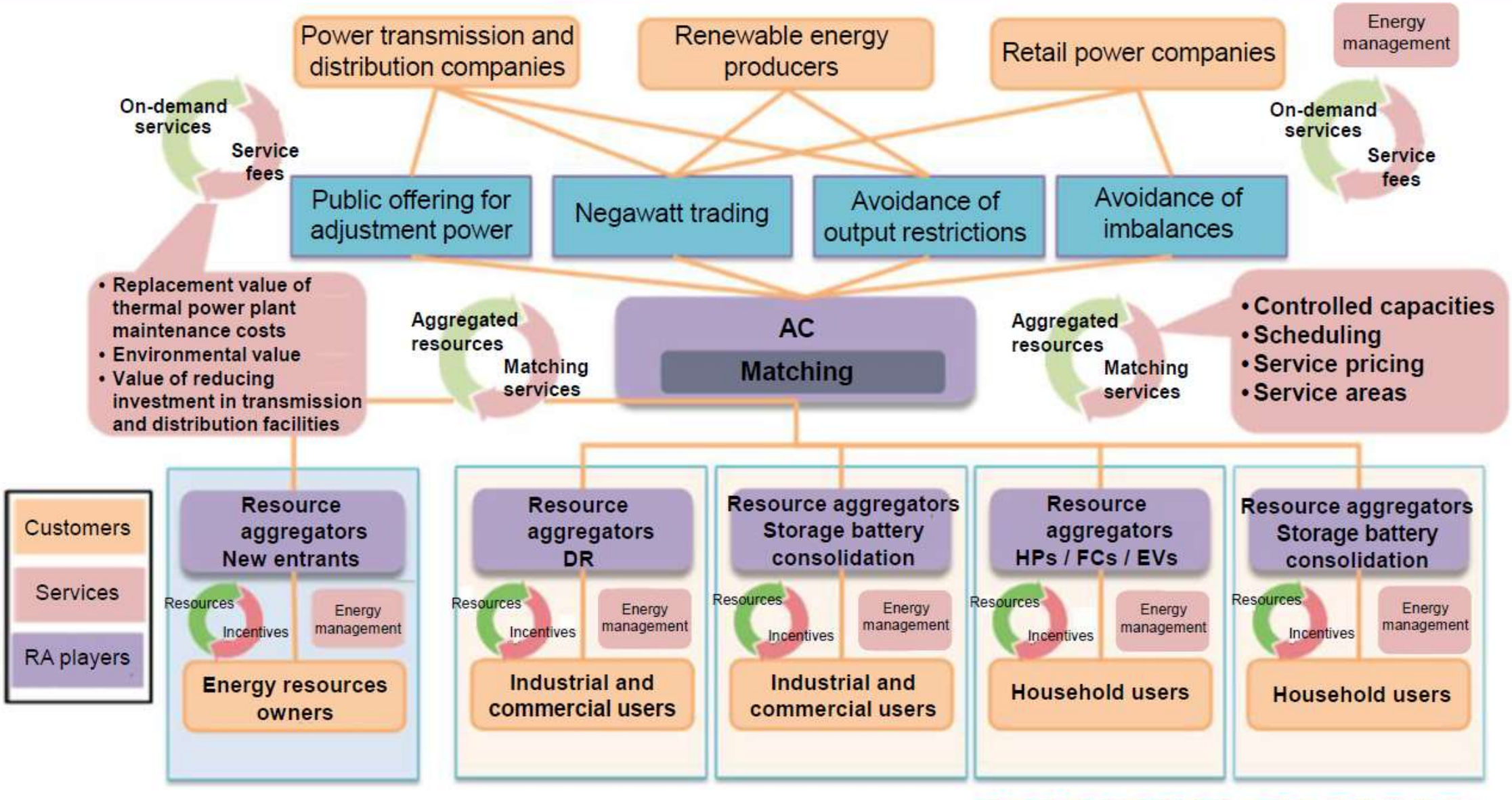
Conceptual Diagram of VPP Aggregation



Conclusions

CHAdeMO provides:

- **EV bi-directional power transfer (V2G) that can assist CO2 reductions**

V2X:

- **Provides values as distributed power/energy storages for greener(CN) operation depending on local needs**
- **Can be a big promotion of mobility electrification with local grid smart communication system for CN**

TEPCO:

- **Is conducting POC on EV-VPP/RA in Japan and in global**
- **Is about to introduce V2H product “BENIYA” next year for transition from kWh selling to asset/service subscription business**

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Thank you

For more information:

TEPCO research institute, Resouce Aggregation Office

and

CHAdeMO association www.chademo.com

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