Grid Stabilization with EVs

TEPCO Power Grid, Inc.

2th November, 2018

Expert Dialogue for Grid Stabilization in 2017-18

- ✓ May 30 2017, both Ministries started a discussion as Joint meeting and established Expert Dialogue to discuss about India Grid Stabilization.
- ✓ The 1st expert dialogue was held in May/June under the Japan-India Energy Dialogue, the Joint Meeting Electric Working Group.
- ✓ 3 Working plans from Japan are proposed at the 5th dialogue

2017/5-6	2017/7	2017/8	2017/10	2018/1
1st.Visit	2nd.Visit	3rd.Visit	4th. Visit	5th. Visit
Surveying current situation of Indian grid	Giving Japan side experience and technology	Discussion a proposal from Japan	Discussion about final proposal	Submission of the final proposals

January 9 2017, Minister Seko held a meeting with Mr. Goyal agreed that they will start discussions toward the realization of a model for supplying high-quality electricity in India

India and Japan on September 14th , both prime ministers appreciated **Japan's proposal for Japan-India Clean Energy and Energy Efficiency Cooperation Plan**.

Approved Proposals of Grid Stabilization

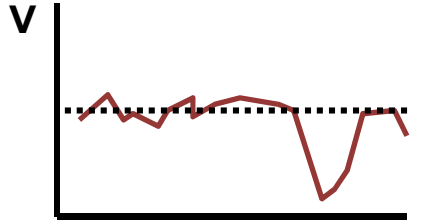
To contribute to development of variable RE and providing high quality electricity in India, our **3 proposals** are as below,

- ✓ Installing reactive power management for **voltage stabilization**
- ✓ Installing adjustable speed hydro pump for **frequency control reinforcement**
- ✓ Establishing working group for discussing **ancillary market design and relevant technologies**

Challenges

Rapid Demand Increase (A/C, Irrigation etc.)

Impact



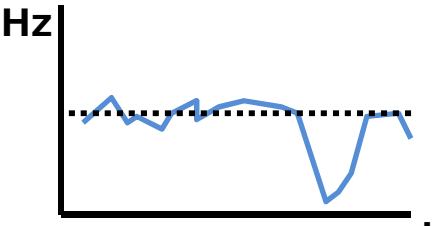
Voltage fluctuation

Installing Reactive Power Management

Challenges

Development of variable Renewable Energy 175GW by 2022

Impact



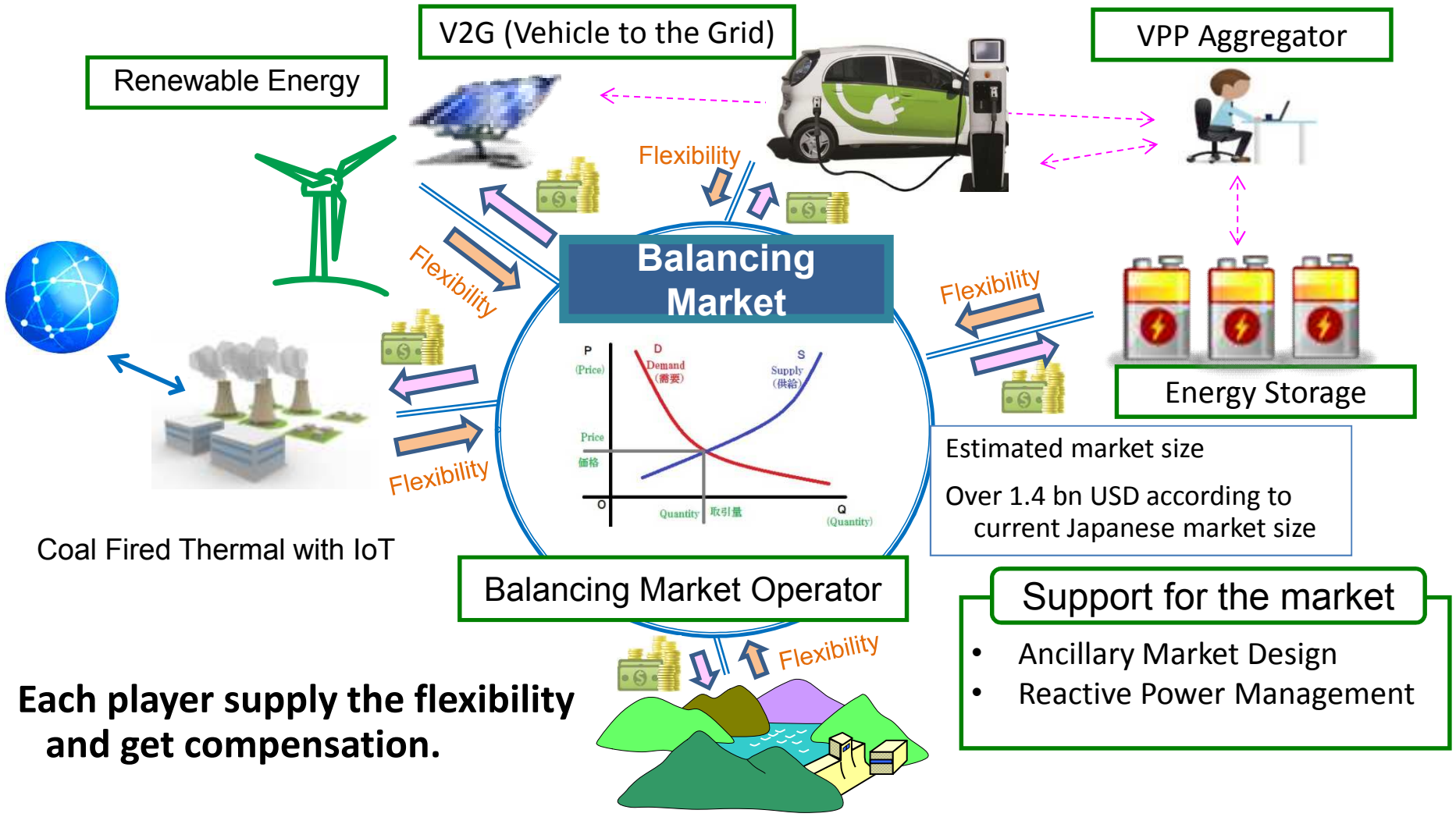
Frequency fluctuation

Installing Adjustable Speed Hydro Pump

Establishing Working Group for Ancillary Market

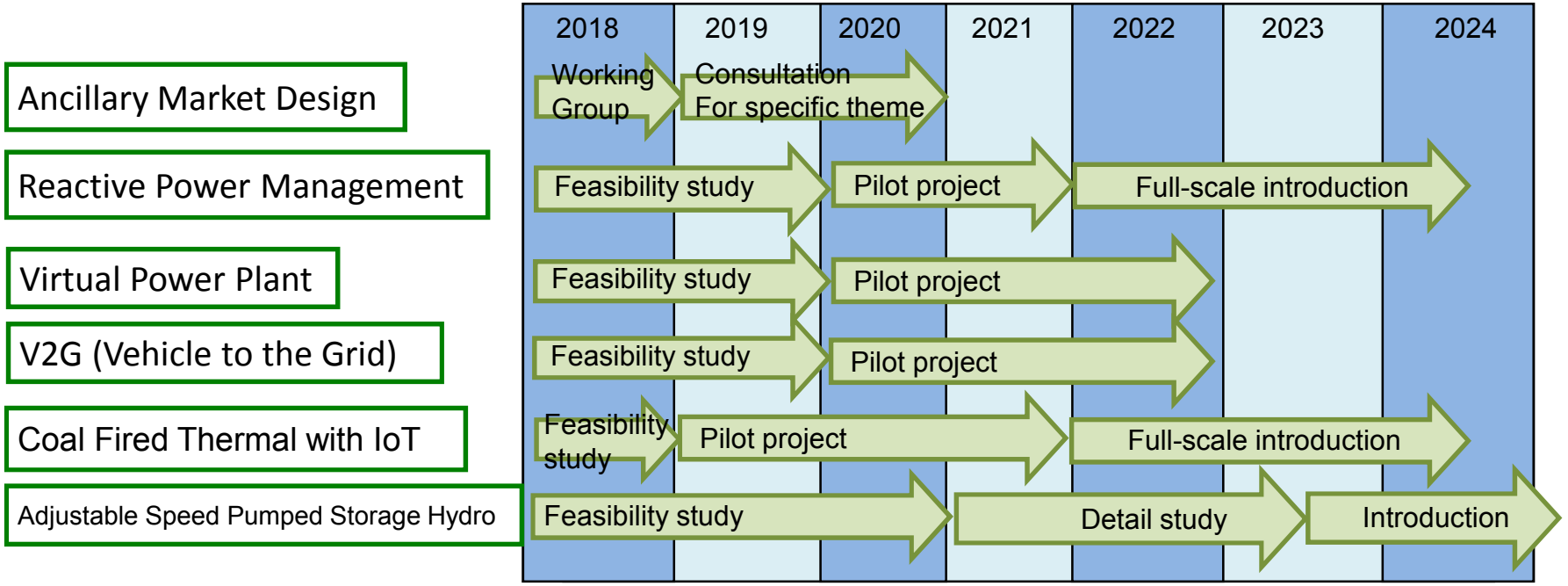
Grid Stabilization for RE integration and EV

TEPCO can provide Technology, scheme and policy comprehensively.

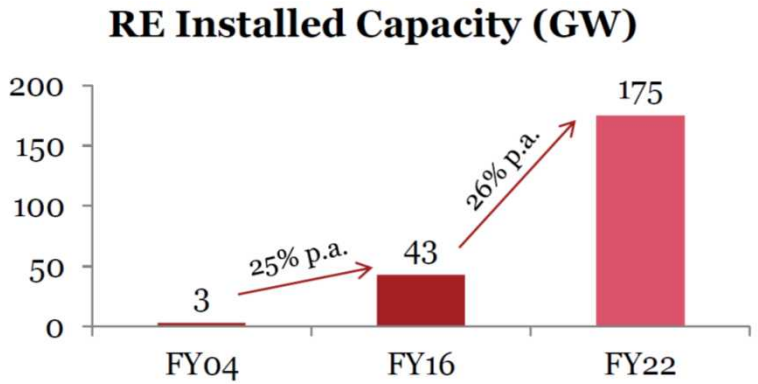


Formulation of the Road Map to Integrate Grid Stabilization Technology for EV Era

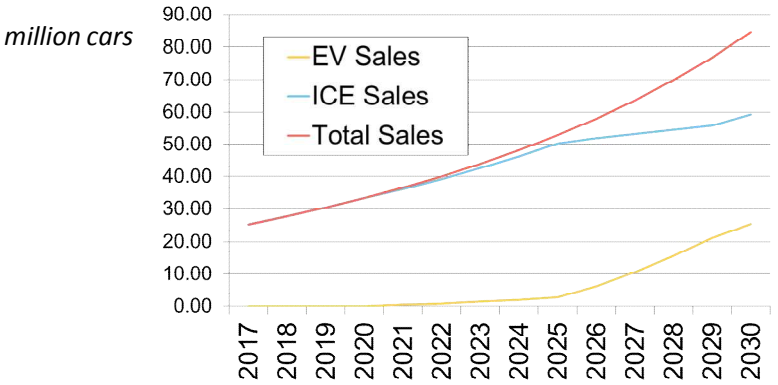
TEPCO also can formulate the road map for various grid stabilization technology.



RE integration to be 175GW in 2022



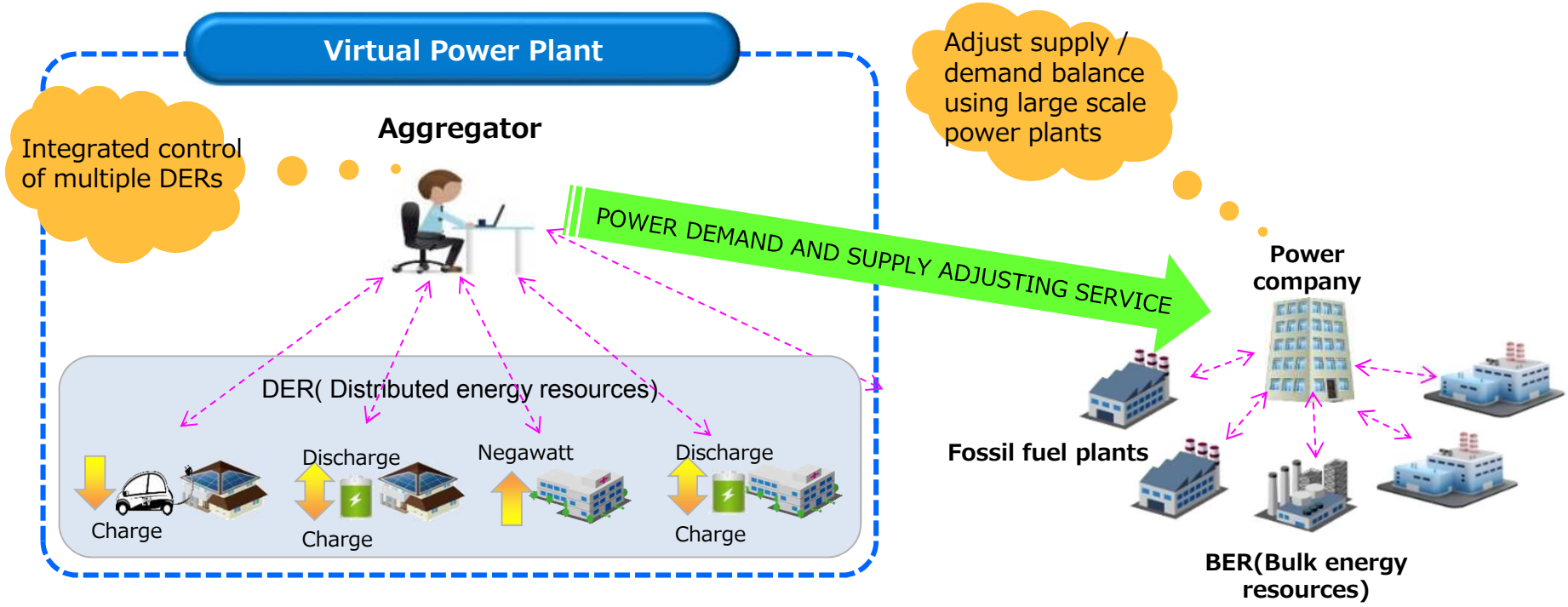
EV Sales to be 30% of total Sales in 2030



Source: SIAM India & Morgan Stanley

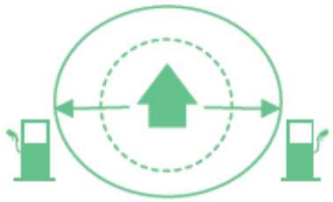
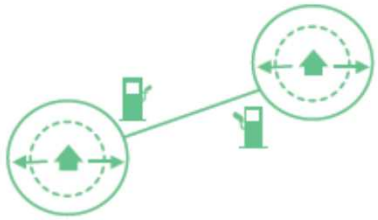
How VPP works?

- ✓ The aggregator remotely controls various energy resources on the customer side by using IoT so that they are combined optimally and function such as a large scale power plant.
- ✓ VPP will utilize not only energy management for customers but also provide adjustment ability for power supply system and achieve substitution of existing high cost adjustment function such as fossil fuel plants.
- ✓ EV is expected as one of the VPP resources, as EV charging demand has high flexibility.



EV as a Distributed Energy Resources

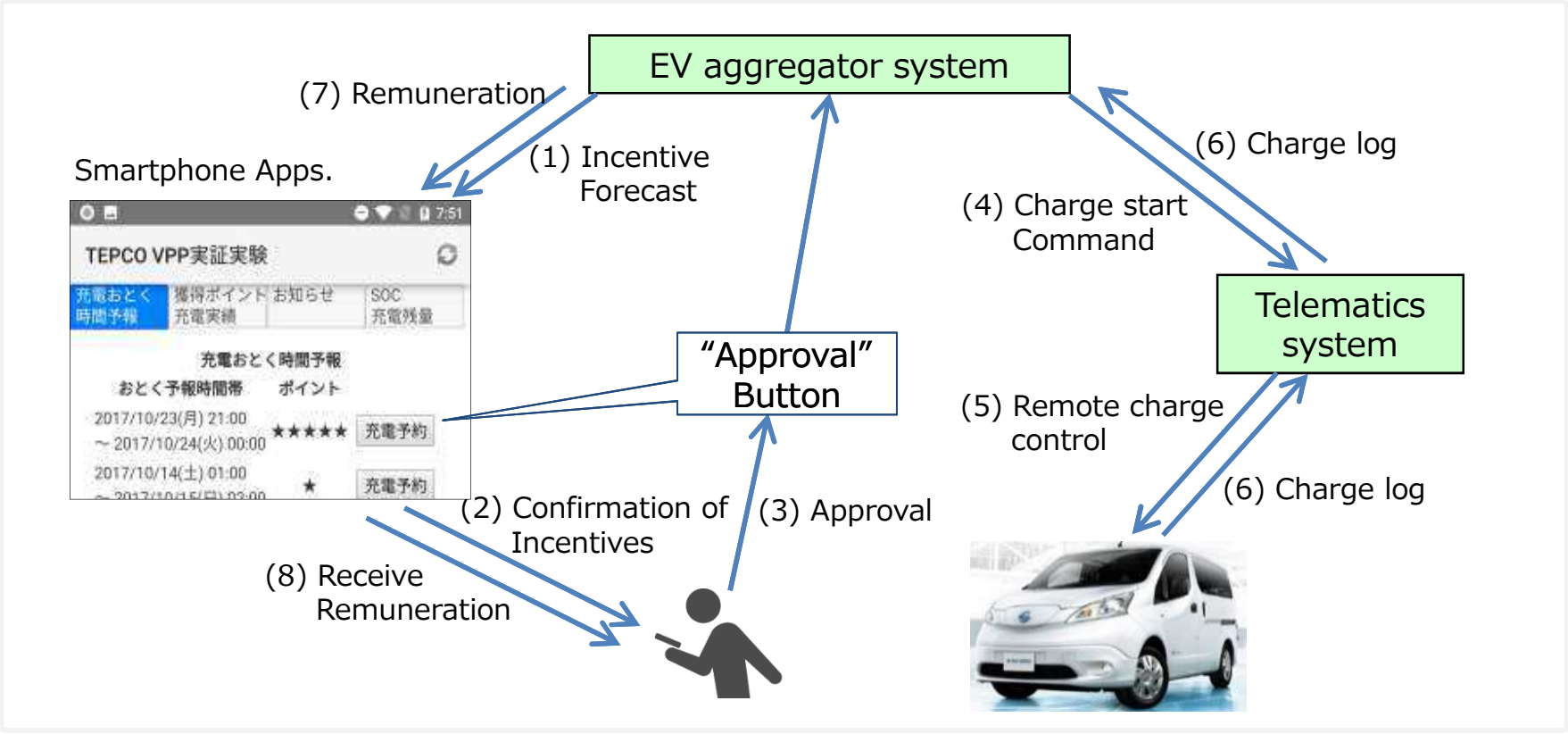
- ✓ EV has a large capacity battery which has a cost advantage as DER.
- ✓ In the future, EV will surely spread rapidly around the world, and it can be expected to become the leading role of DER.
- ✓ When EV is used as DER, it is necessary to consider schedule optimization according to the use conditions of the owner.

Length	Short Distance 	Mid Distance 	Long Distance 
Charging type	Office charging 	Destination charging 	Pathway charging 
Charging Site	Home/Office	Urban area (Super Market, Mall, Restaurant, Parking Lot or Gas station in city)	Inter city / National network (Service Area, Gas station)

TEPCO EV aggregation system overview (1)

a. Development of smart charging system using smartphone

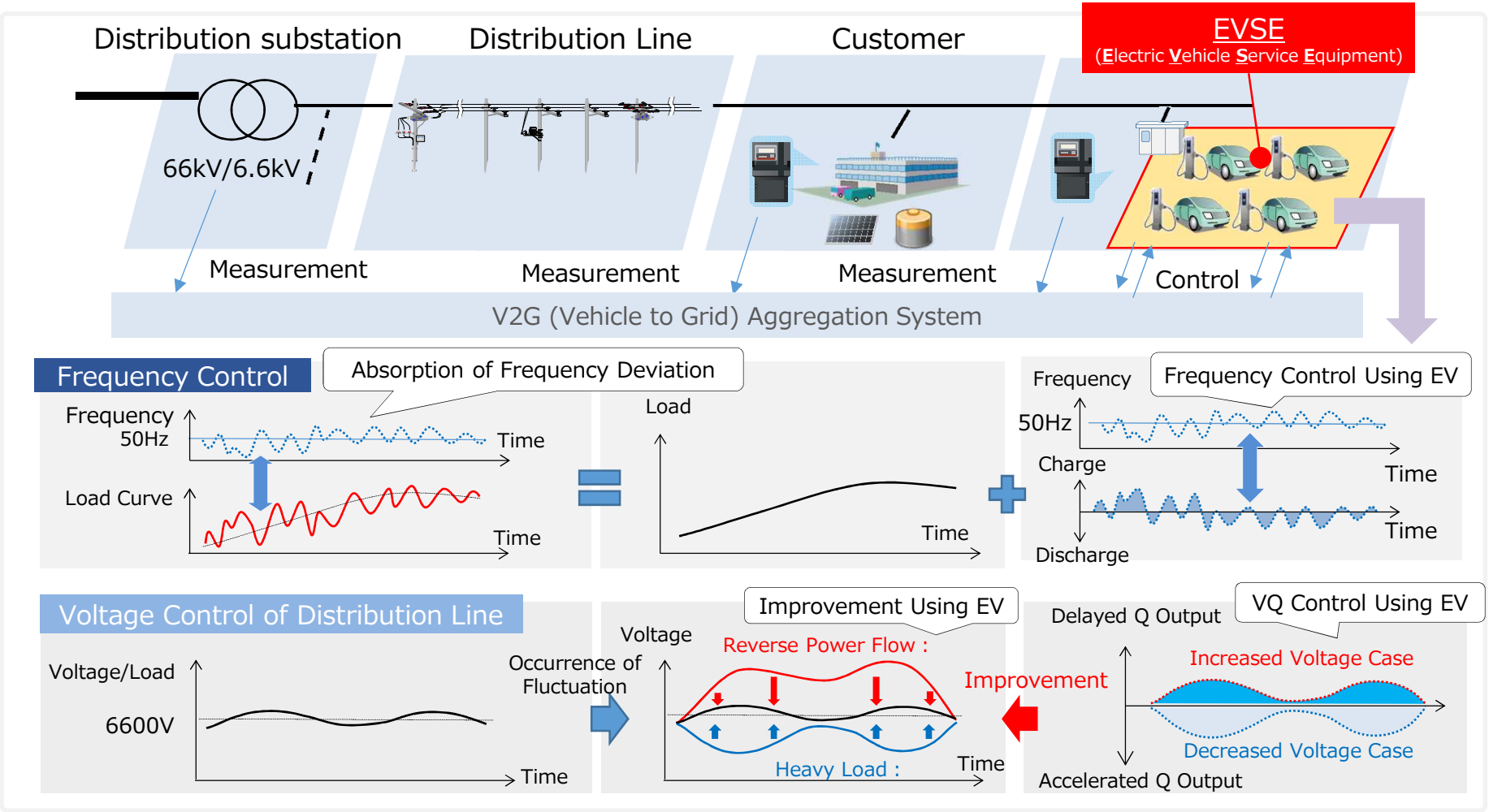
- ✓ TEPCO is implementing a pilot project of VPP in Japan from 2017.
- ✓ TEPCO's system can control the charging simply by using smartphone and EV's telematics system. This way is the most user friendly and low cost.



TEPCO EV aggregation system overview (2)

b. Development of V2G (Vehicle to Grid) Aggregation System

✓ TEPCO is examining grid stabilization measures using discharge from EVs as a future model of EV Aggregation. This activity is starting in V2G(Vehicle to Grid) Demonstration Project on 6th June, 2018.



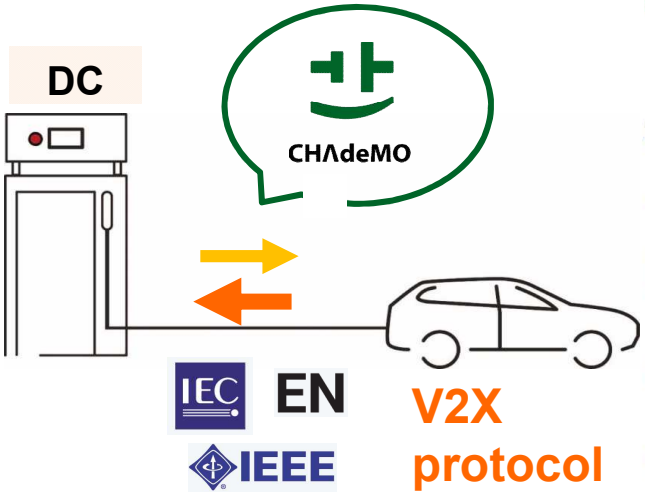
Cooperation through CHAdeMO Association

CHAdeMO brings together top players from various sectors in e-mobility: Automakers, utility companies, operators, manufacturers of chargers, and battery management.

Members make sure CHAdeMo develops according to market needs and continues its growth such as V2X, cooperatively.

408 members

41 countries



And many, many more..

CHAdeMO Compatibility vs. Flexibility

Problems:

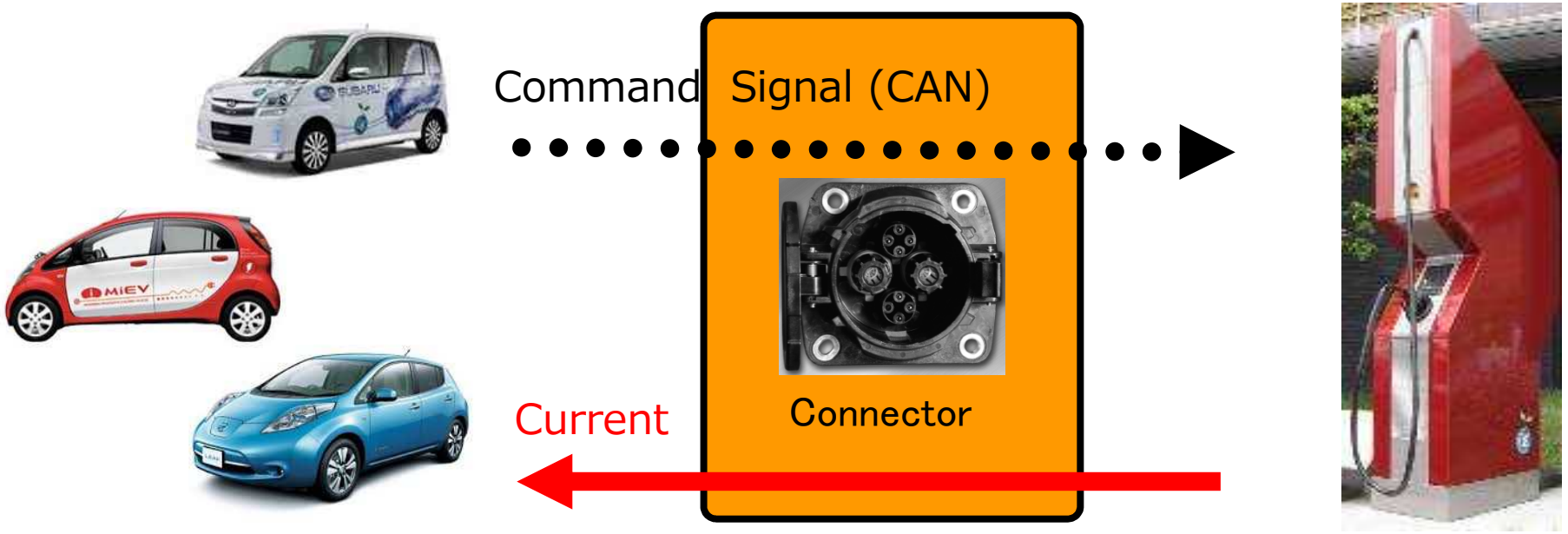
Various kind of batteries can be used.

Standardization may kill battery improvement.

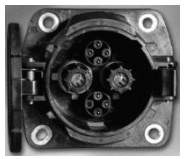
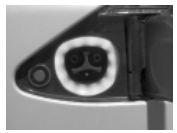
How CHAdeMO works:

EV computer controls charging speed.

Keep it flexible as much as possible !



International DC charging systems

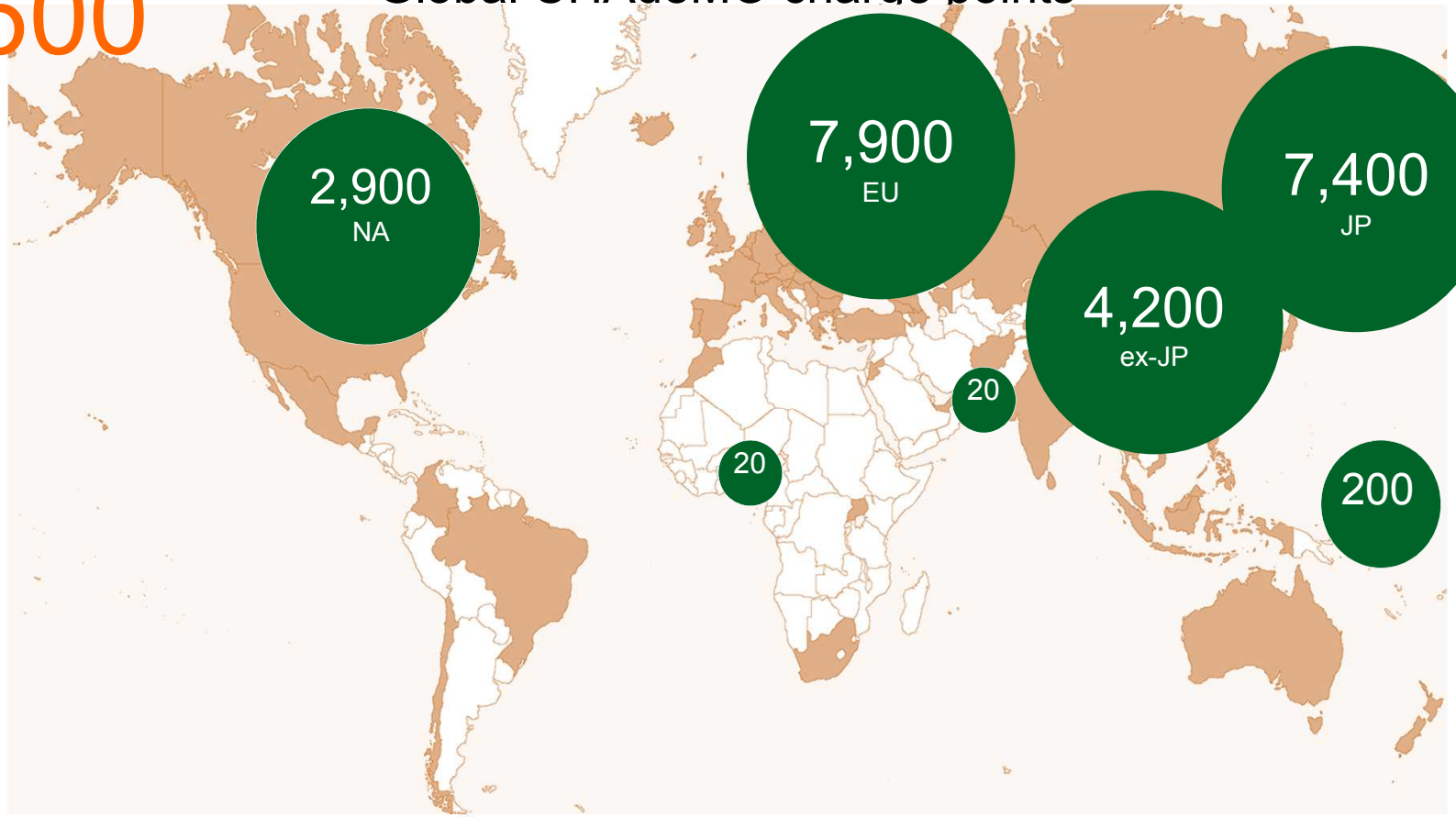
	CHAdeMO (Japan)	CCS Combo1 (US)	CCS Combo2 (DE)	GB/T (PRC)	TESLA
Connector					
Vehicle Inlet					
IEC	✓	✓	✓	✓	
IEEE	✓	✓ (SAE)			
EN	✓		✓		
JIS	✓	✓	✓	✓	
GB				✓	
Max Power	100kW 500Vx200A	120kW 600Vx200A	200kW 1kVx200A	185kW 750Vx250A	?
Real-world Usage	50kW	50kW	50kW	50kW	120kW

Multistandard is the de-facto standard in Europe

CHAdeMO installation in the world

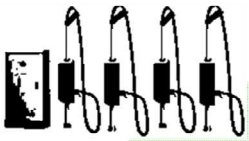
TOTAL
22,600

Global CHAdeMO charge points



Note: as of September 2018
Source: ChargeMap, EAFO, Zap-Map, NOBIL, Gireve, GoingElectric, ChargeHub

CHAdeMO HIGH POWER Roadmap



350-400kW
Power share

PANTOGRAPH

150-200kW

High power connector

50kW

Liquid Cooling

125Ax500V → 400Ax500V → 400Ax1kV

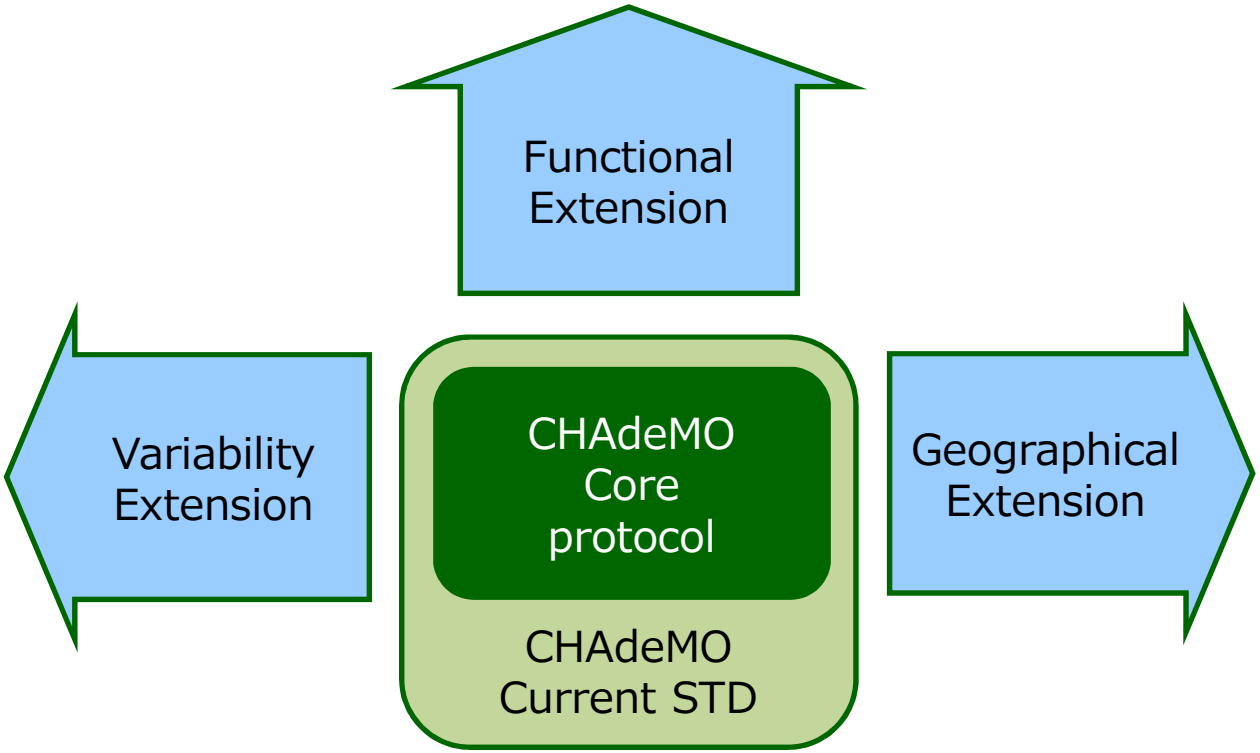
Dynamic Control (Smart charging)

2016 2018 2020

Extended Functionality/Variability

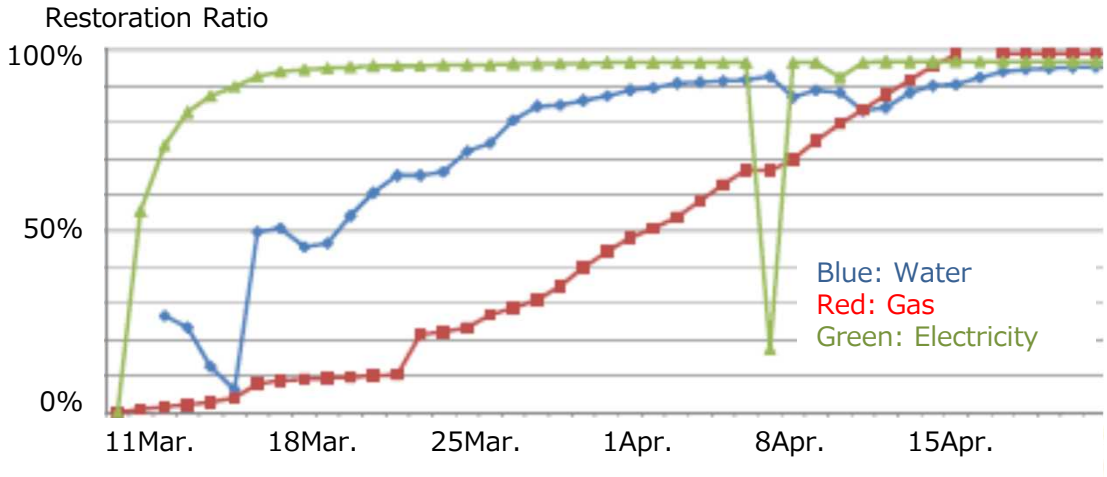
CHAdeMO can extend flexibly to meet various market needs with supporting its core protocol.

e.g. Geographical Extension (India, China, …)
Variability Extension (Bus, Truck, Motorcycle, …)
Functional Extension (Authentication, V2X, …)



Resilience of EV against disaster

- Electricity supply can be restored rapidly in case of disaster.
- Transportation by EVs can be utilized immediately after suffering disaster.
- EVs can also supply electricity to electric equipment.



Restoration of Infrastructures after the East Japan Earthquake in 2011 [Left]
(Source: N. Nojima, JSCE)

EV in Tohoku after the East Japan Earthquake [Left]
(Photo: K. Kawada)

Electricity supply from EV to home [Right]
(Source: Nissan Motor Corp.)

Summary

- Renewable energy resources in India would be increased dramatically in near future, in the line with the world trends.
- The introduction of DER control system for grid stability such as VPP will be essential for India to handle the large amount of RES.
- Especially, EV has a large capacity battery which has a cost advantage as DER, and EV can be expected to become the leading role of DER.
- CHAdeMO is the only one international DC charging standards which can work both way charging and discharging, and it would meet various needs based on the function.

Thank you for your attention.