8th IERE Webinar on Advanced Metering Infrastructure (AMI)
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Current status of smart meters in Japan and expectations for next generation AMI

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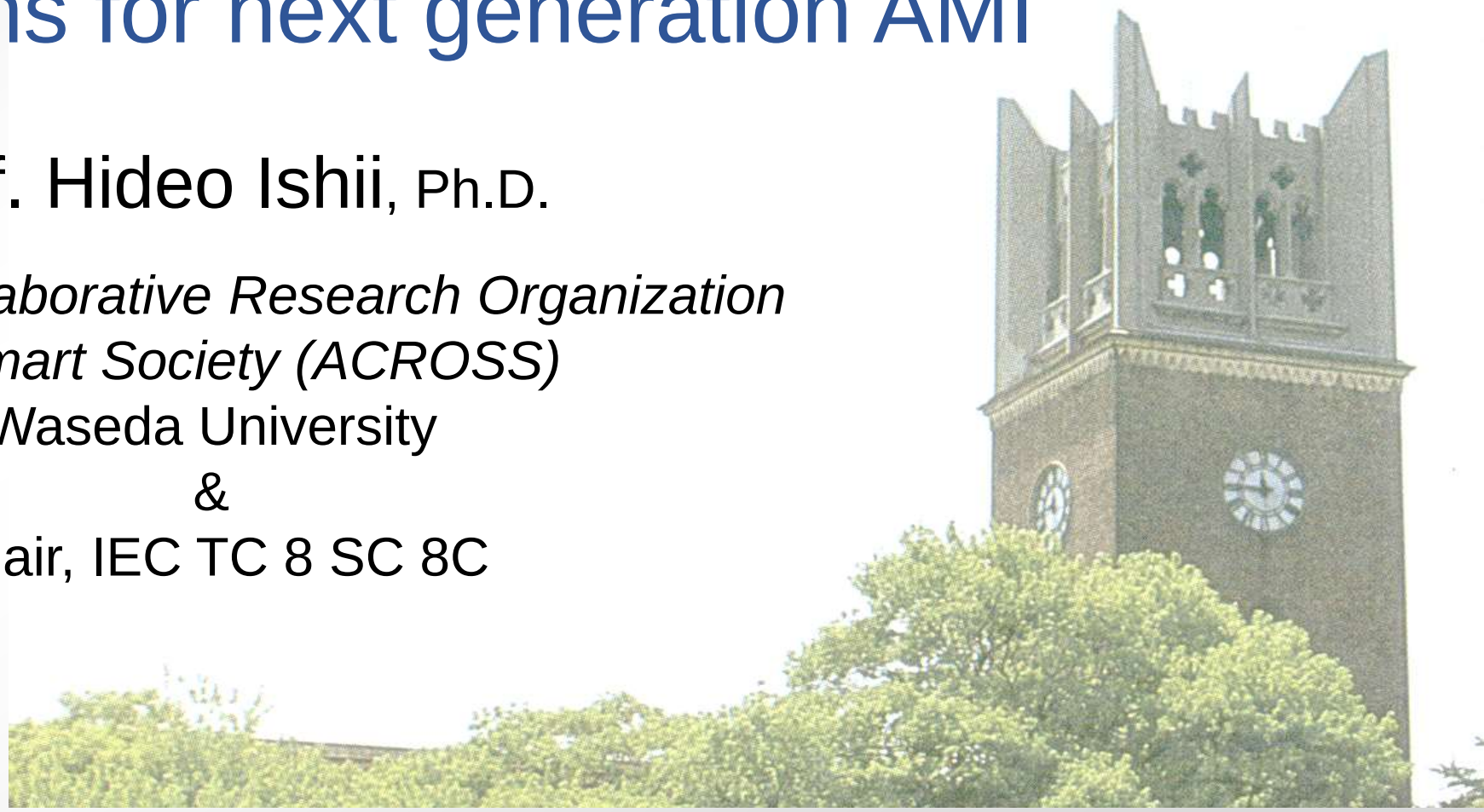


Agenda

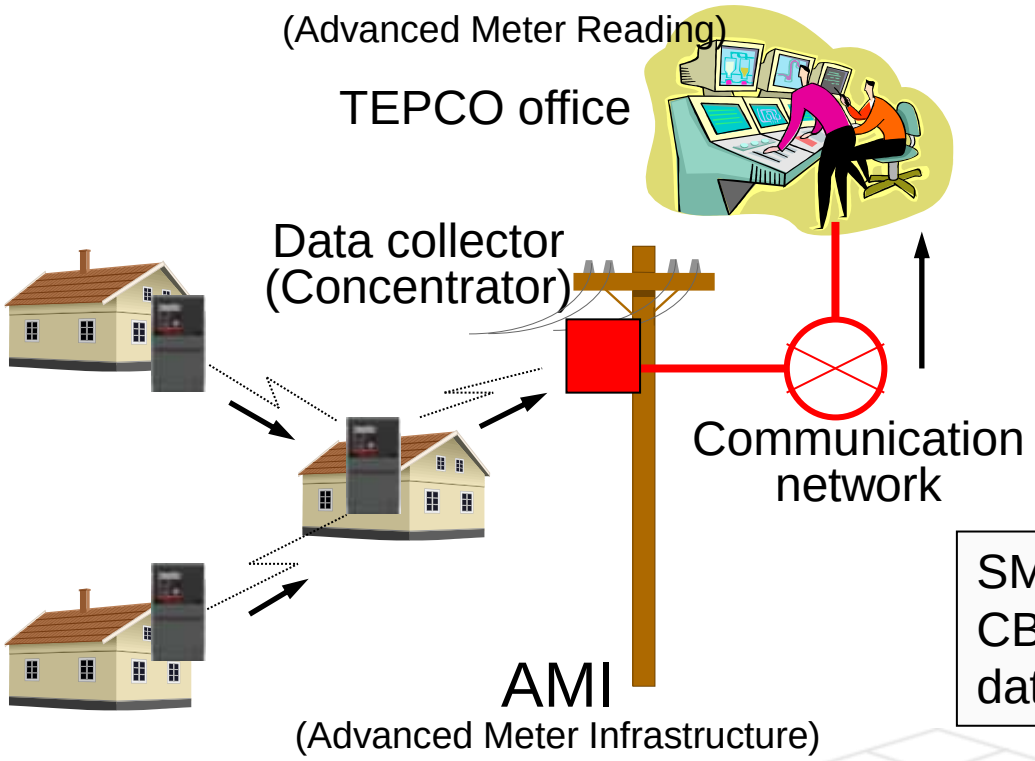
- History of AMI in Japan
- Specification, architecture, expected improvements over conventional system
- Utilization of smart meter data
- Specification of next generation smart meters and AMI, extended application of SM data
- Summary

History of AMI in Japan

- First Generation
  - ✓ Specification study :
    @ “Smart Meter System Deliberation Council”, May 2010 - Feb. 2011
  - ✓ Start of implementation, 2014
  - ✓ Installation complete, 2024 : 78.5 million meters across Japan

- Next Generation
  - ✓ Specification study :
    @ “Next-Generation Smart Meter System Deliberation Council”
    Sep. 2020 - May 2022
  - ✓ Start of implementation, 2025

Smart Meter, AMR and AMI



Smart Meter

SM with stylish shape, communication, CB and recording function of metering data for every 30 minutes

- Transmission of metering data
- Transmission of metering data to data collector through communication among AMIs
- Transmission of collected data to TEPCO office through communication network

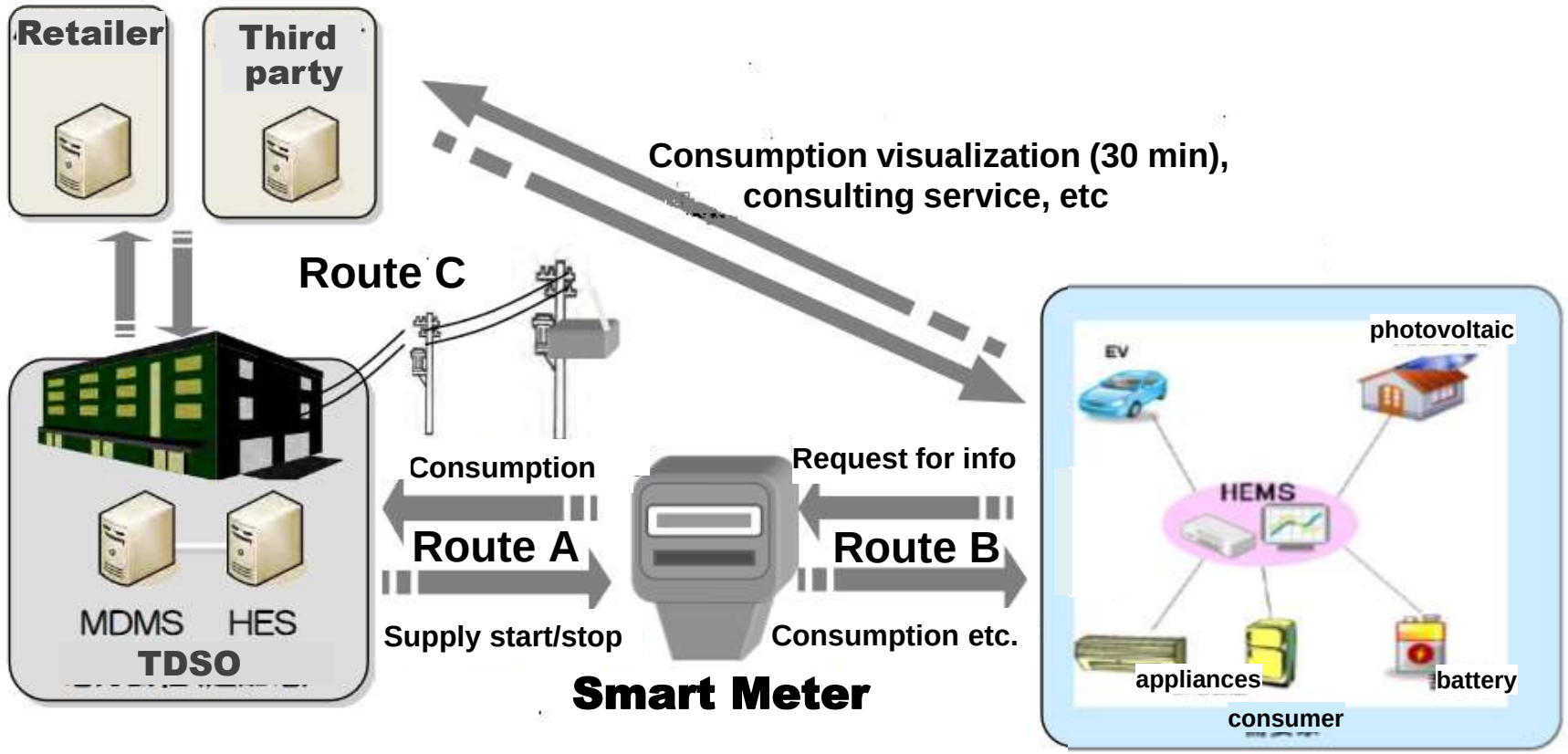
Conventional Mechanical Meter vs Smart Meter

■ Smart meter not only streamlines business processes but also improves customer services with visualization of power usage, providing variety of rate plans, etc.

	Mechanical Meter 	Smart Meter 
Major Function	✓ Imported power measurement ✓ Manual meter reading required	✓ Bi-directional Metering; 30-minute Net value is measured and recorded ✓ Electric Current, Voltage, Power (kW) measurement ✓ Bi-directional communication, Remote disconnect /reconnect, Remote demand limit setting including emergency demand limit, Event logging ✓ Automated Meter Reading ✓ Rout B function i.e., HAN connectivity enables sending meter read data to in-home devices
Enabled Services	✓ Applicable only to flat rate. ✓ Unable to be applied for Time of Use (TOU) customers	✓ Enables variety of rate plans including TOU ✓ Applicable to Demand Response, Peak-shift plans ✓ Visualization of power usage

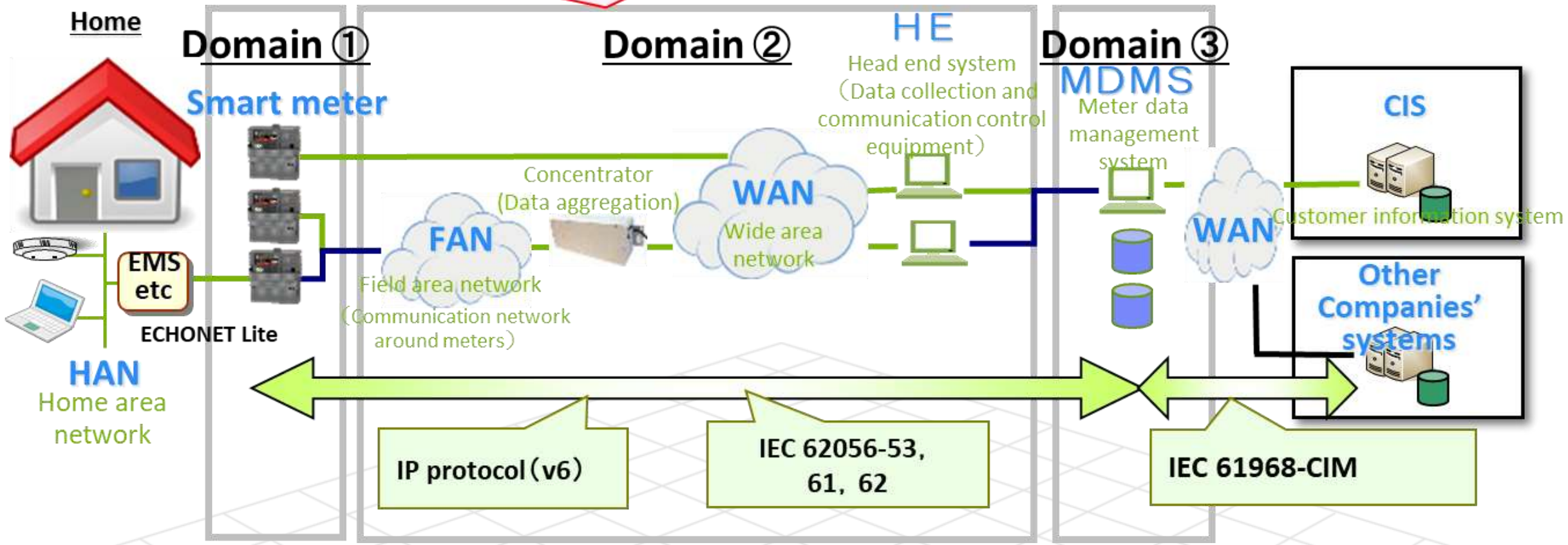
Entire System Architecture and Communication

- Transmission of 30 minutes consumption data to TDSOs (general electricity transmission and distribution company), followed by transfer to the retail electricity companies within an hour.
- Provision of consumption data to home area according to the request (30min-kWh, 1min-kWh, etc.)
- Remote supply start/stop, change of the contract capacity (amps), etc.



Communication with international standards

✓Technical scalability enabled by adoption of international standards
✓Cost-cuts by multi-vendor approach



Perspectives of AMI

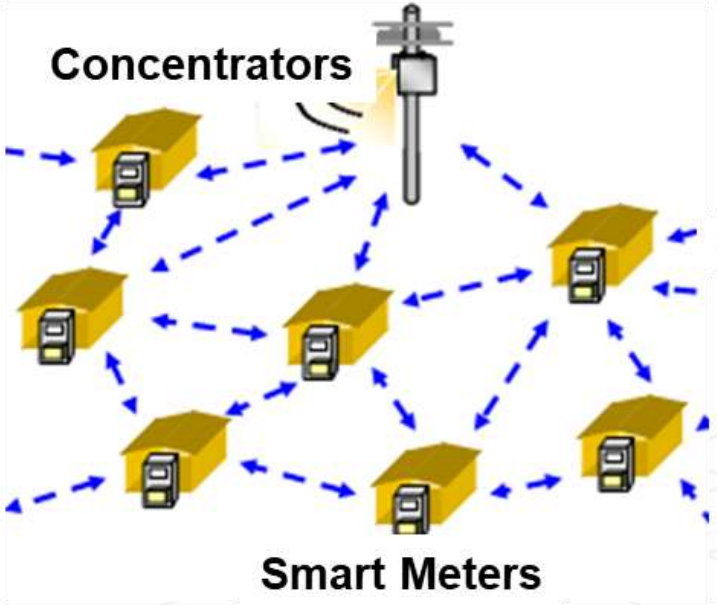
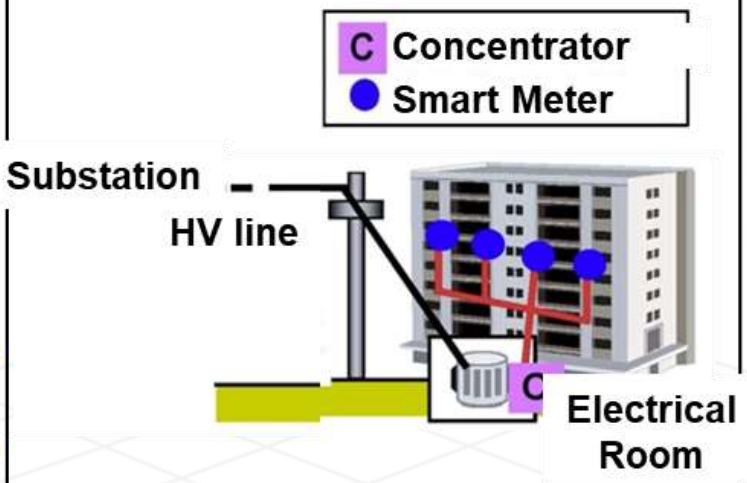
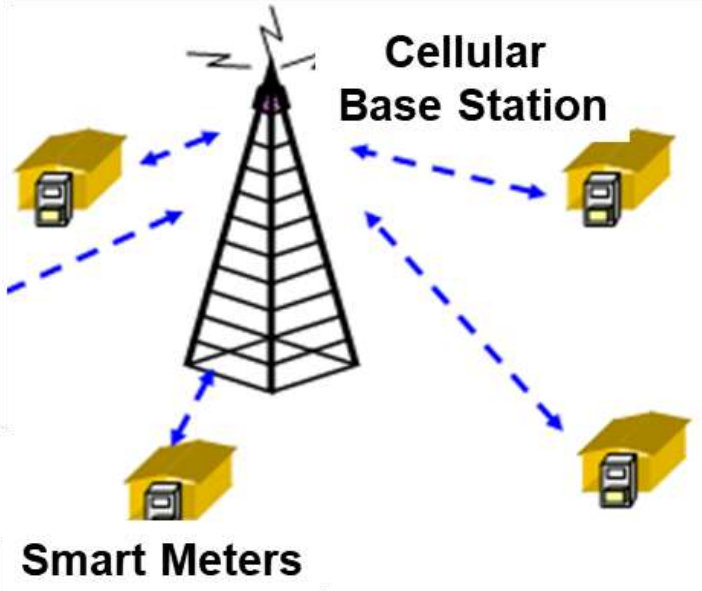
For Customer	For TDSO	For Society
✓ Optimal choice among various rate plans ✓ Promotion of energy saving by energy consumption visualization ✓ Enjoy various added value services	✓ Improvement of business efficiency and service level (Operating cost reduction) ✓ Reduction of capital investment ✓ Creation of new profit sources	✓ Electricity system reform ✓ Realization of energy- saving society ✓ Revitalization of related industry ✓ Improvement of social infrastructure

“Key” to be considered

- Reduce capital investment by making the best use of outside resources including existing services and infrastructure.
- Introducing open specifications that promote competition and enable drastic cost cuts.
- Building social infrastructure with technical scalability that enables demand response and other various services utilizing smart meter data.

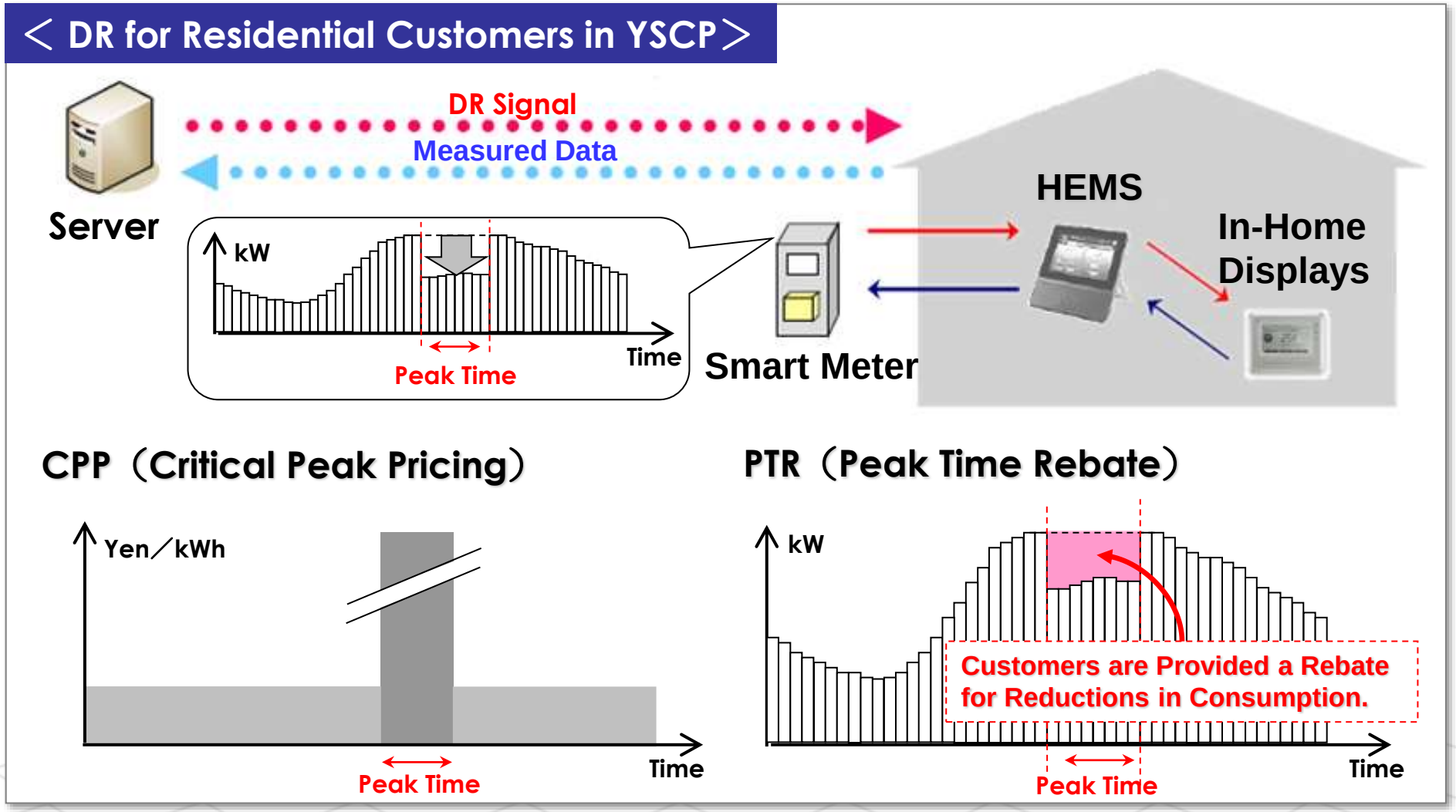
Right Communication Technology for Right Place

■ 3 types of communication technology

Wireless Mesh	PLC (Power Line Communication)	Cellular Network
Mesh created with meters with low cost. Suitable to relatively high-density areas.	Suitable to complex building where radio signals are likely to be blocked.	Cellular services such as 3G and LTE. Suitable to low density areas.
		

AMI enables Demand Response

- Measurement and Verification of Demand Response (DR) in Yokohama Smart City Project (YSCP)



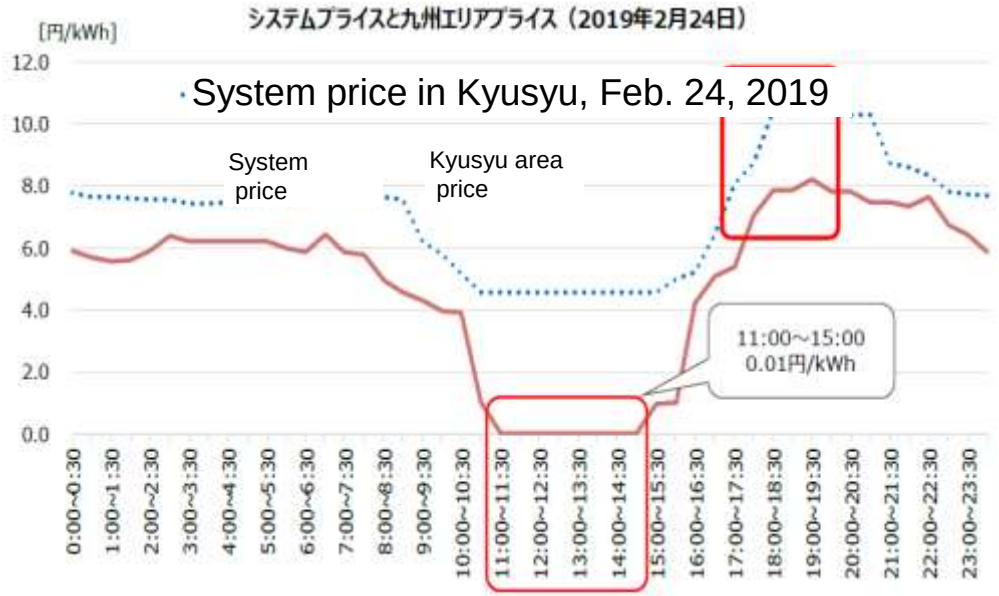
Revision of the Energy Conservation Law

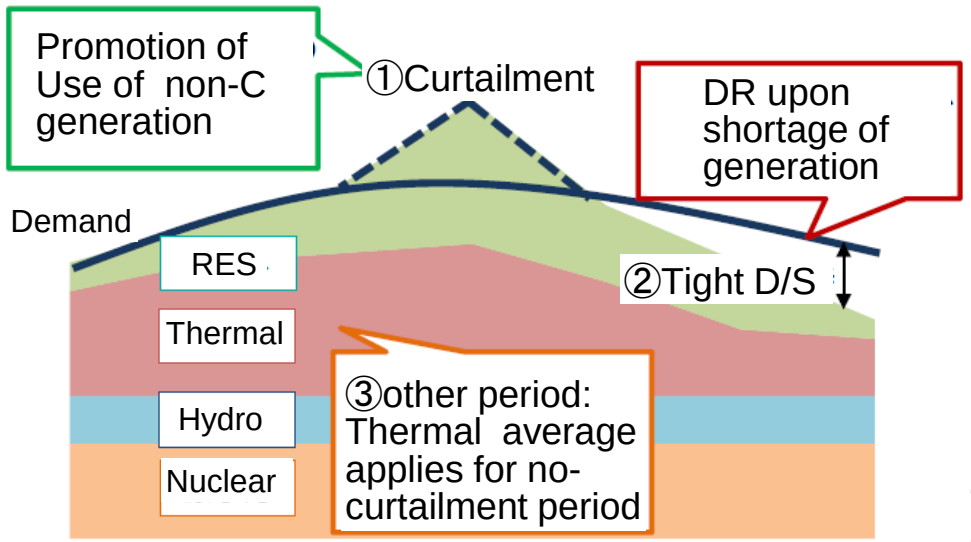
Laws Concerning the Rational Use of Energy (Energy Conservation Law) has been revised to transform supply-demand structure. (2022 -)

- Apply for all energy consumption including RE (originally use of fossil energy only)
- Large scale C&I customers are obligated to reduce primary energy consumption by 1% every year
- Conversion factor for primary energy consumption has been improved

9.5MJ/kWh to all time
(Thermal power average)

① 3.6MJ/kWh (upon curtailment)
② 9.5MJ/kWh ×α (upon tight demand-supply)
③ 9.5MJ/kWh (others : thermal power av.)





Use of Smart Meter Data

- Smart meter data is highly up-to-date and accurate, making trend analysis possible based on continuous data.

- The problems of SM data use:
  - ✓ The Electricity Business Act prohibited the use or provision of electricity for purposes other than electricity supply service.
  - ✓ Personal data protection (privacy)

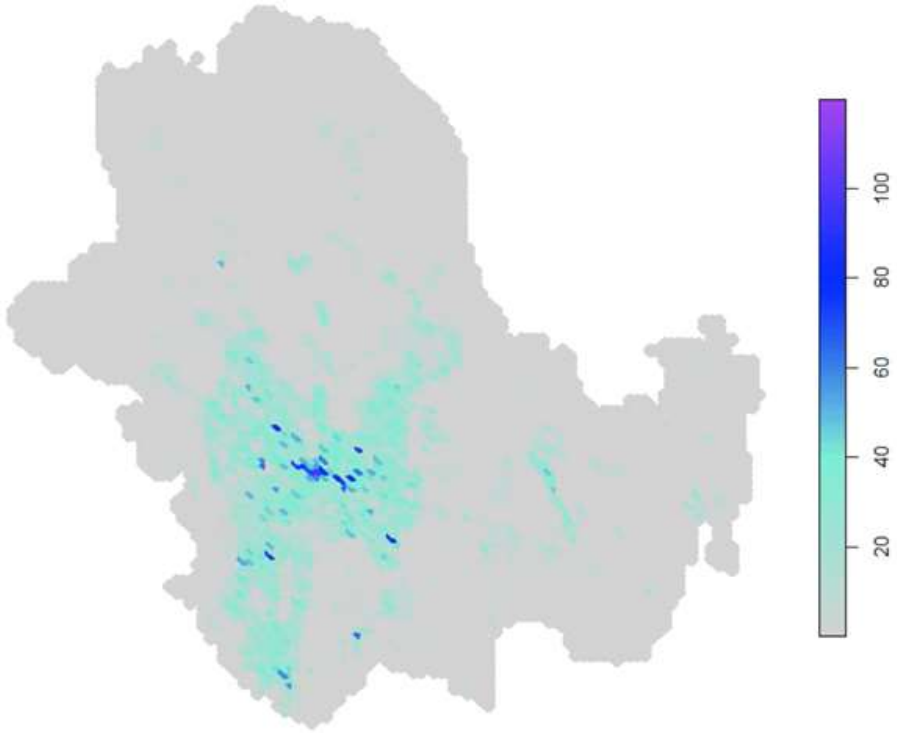
- The 2020 amendment to the Electricity Business Act:
  - ✓ Statistical data, processed to prevent re-identification and individual data with the individual's consent, is allowed to be used by businesses other than electricity

- Grid Data Bank Laboratory (GDBL) Corporation has been providing a service to use smart meter data (statistically treated) for development of various services since 2020. : Disaster response, Sales forecast for retail shops, Elderly care, etc.

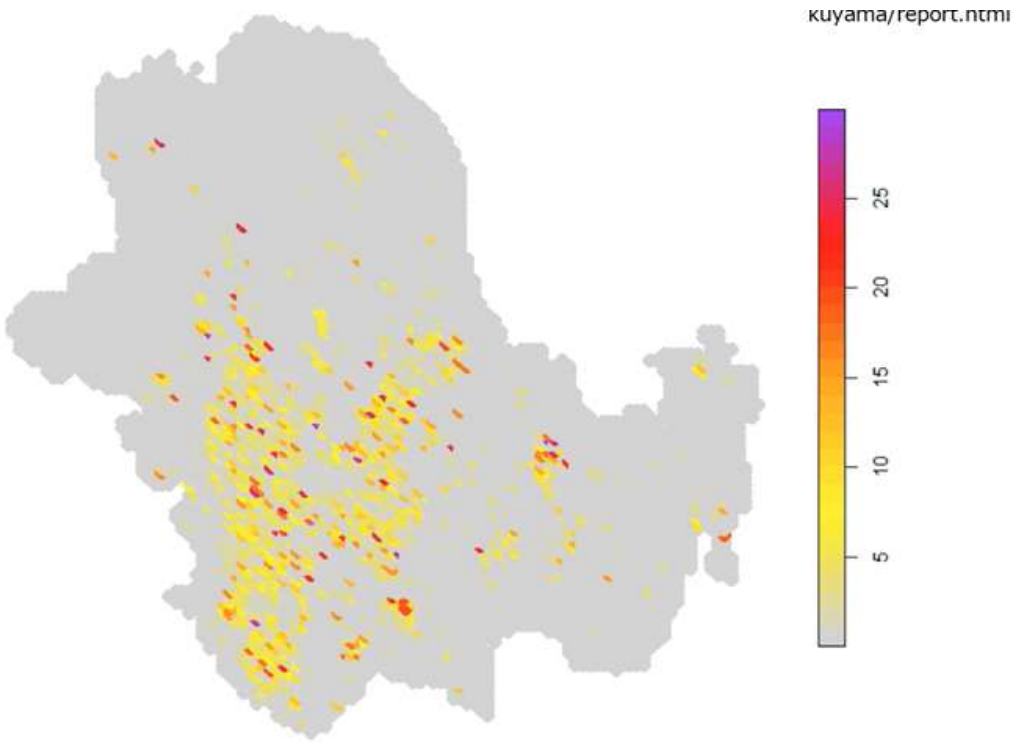
- Certified Electricity Consumer Information Utilization Association was established in May, 2022: expansion to entire area of Japan

Use of Smart Meter Data

Snapshots of electricity consumption and PV reverse power distribution



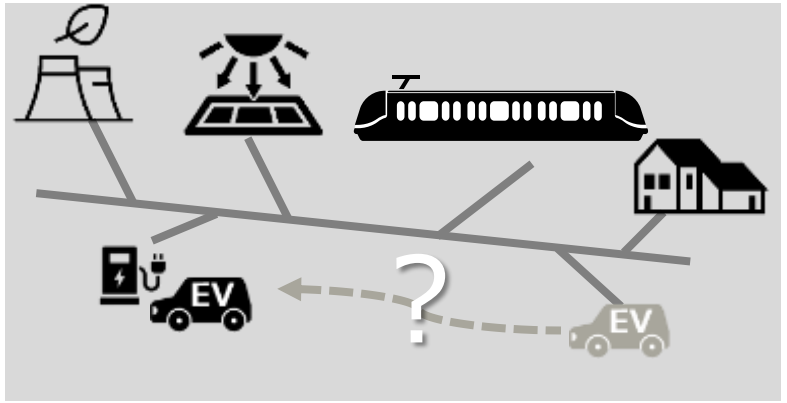
Special distribution of electricity consumption (August 1st, 2019)



Special distribution of reverse power flow (August 1st, 2019)

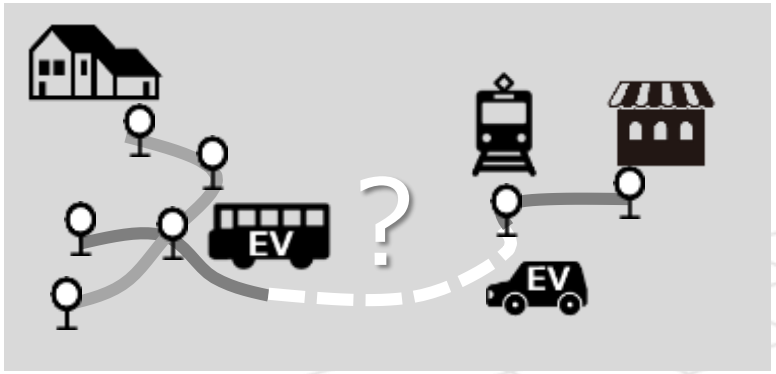
*Results obtained by the analysis based on the smart meter data provided by GDBL Corporation..

Sector coupling: Power Grid and Transportation Grid

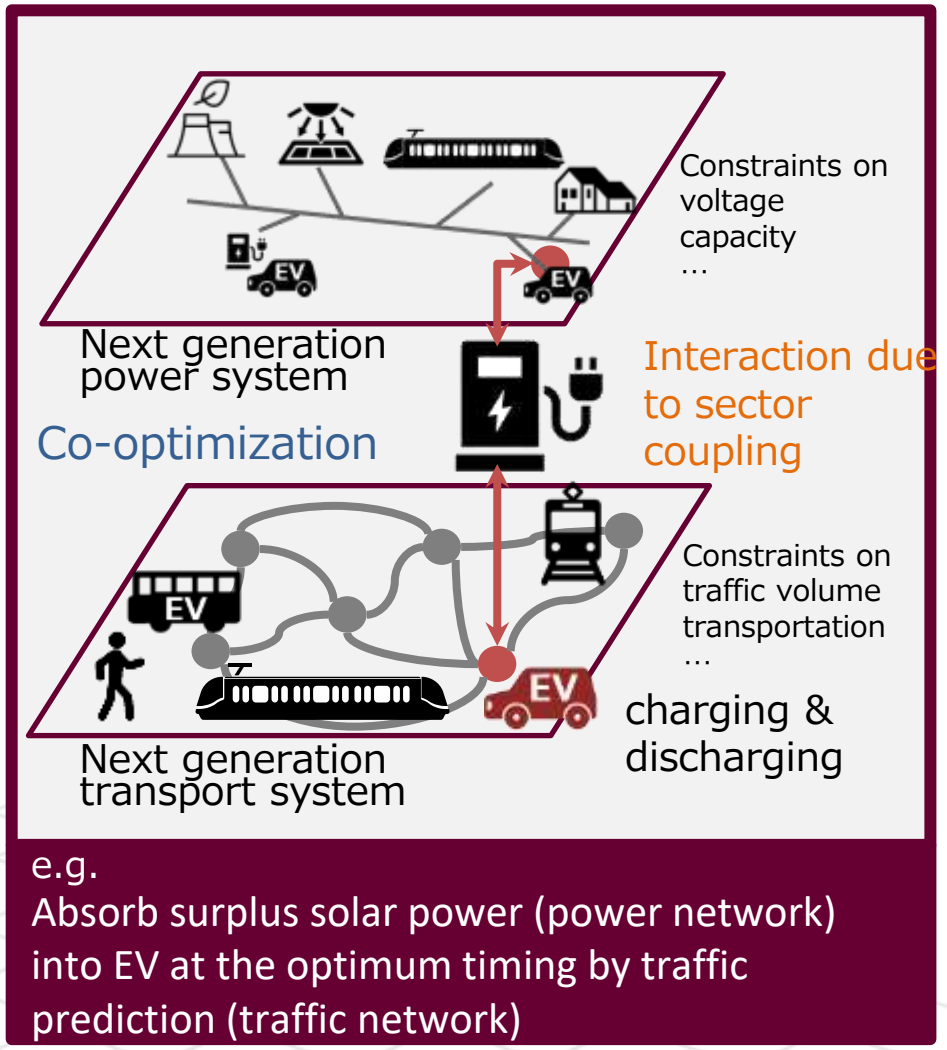


Optimization of electric power sector

"Wall" separates two sectors



Optimization of transport sector



e.g.
Absorb surplus solar power (power network) into EV at the optimum timing by traffic prediction (traffic network)

Specification of next generation smart meter

- Installation of 1st generation SM will be completed in 2024.
- 2nd generation SM will start to roll out since 2025.

◆B-route communication
- ➢Low voltage : Wi−SUN+Wi-Fi2.4GHz
- ➢High voltage : Ethernet+Wi-SUN

◆Collected data / offering time
- ➢P, Q, V : 30min resolution / within 1 hour
  + 5min resolution
  10% customers / within a few days

HEMS etc.

B-route

A-route

Smart Meter

IoT-route

Concentrator

HES

MDMS

Retailors etc.

Gas

Water

Gas/Water meter

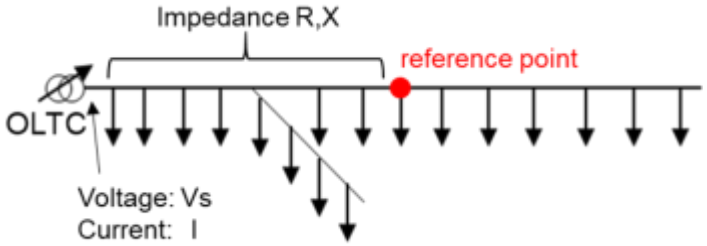
Resources

◆Exchangeable communication unit
◆Acquired data
- ➢Low voltage : P, Q, V
  Resolution 1min/5min/15min/30min
- ➢High voltage : P, Q
  Resolution 5min/15min/30min

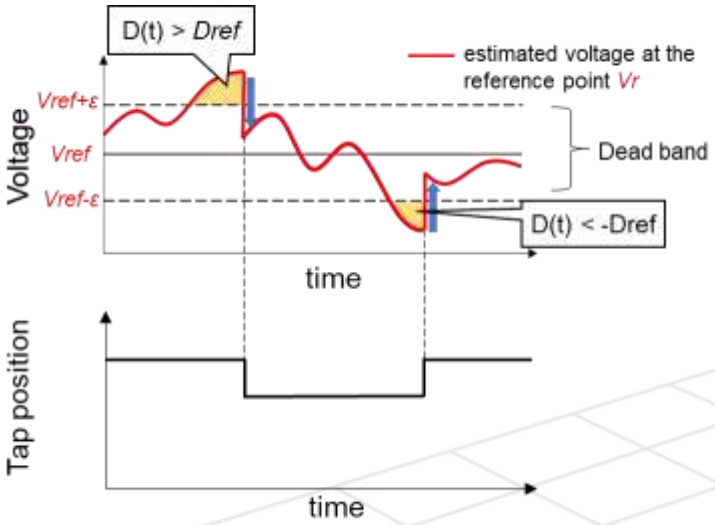
*Red part : added for next generation meters

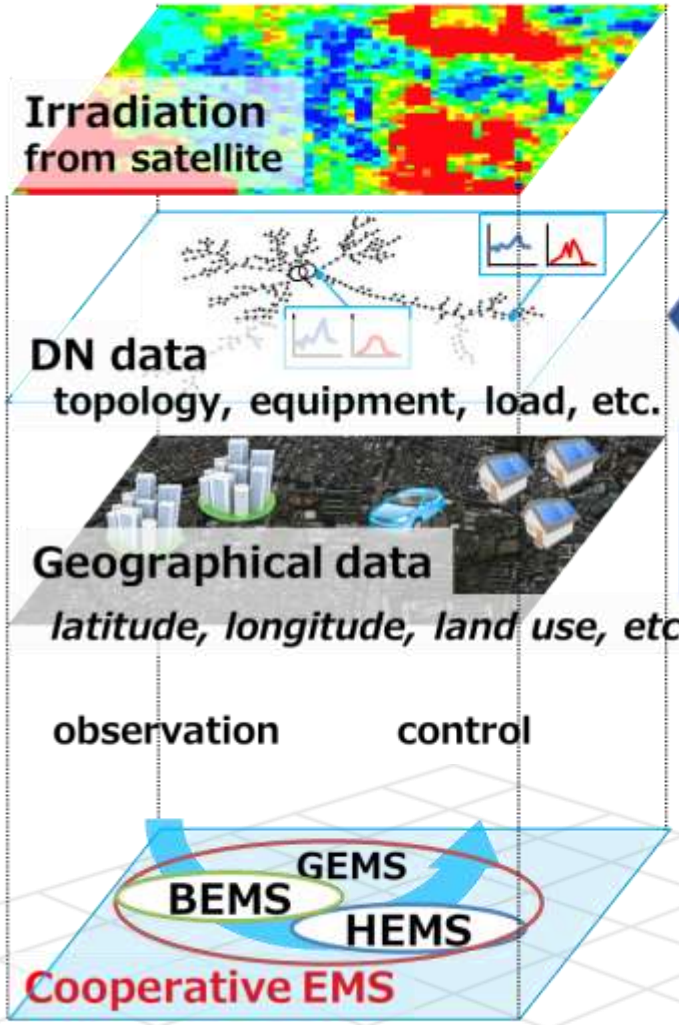
Cooperative EMS Simulation Platform

- OLTC Control Method (LDC)



$$V_r = \left| \dot{V}_s - (R + jX)\dot{I}_s \right|$$



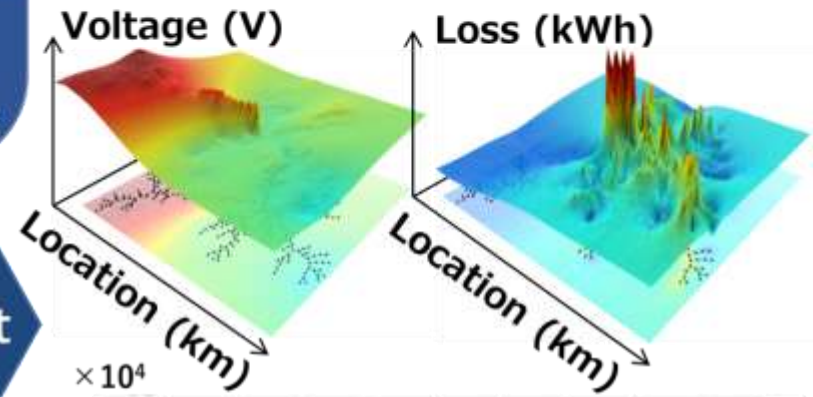


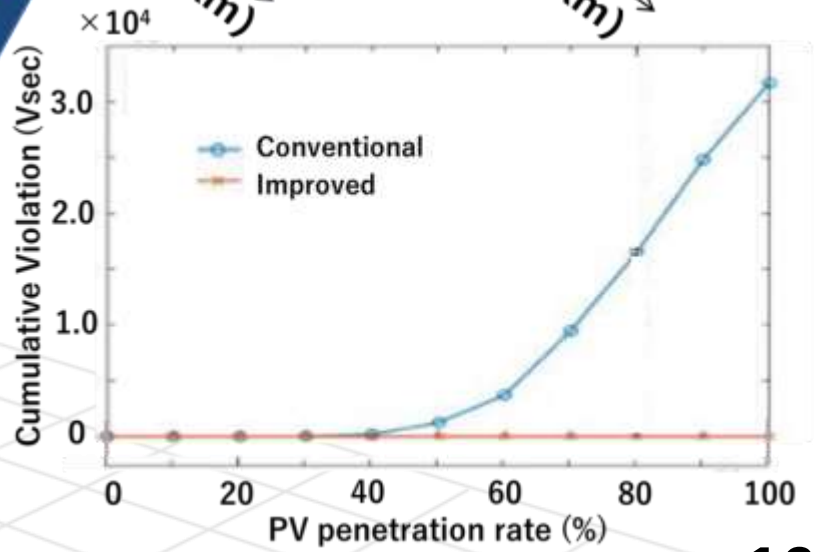
Simulation settings

- ✓ Volume & Distribution of PV·EV
- ✓ Electrification of water heaters etc.

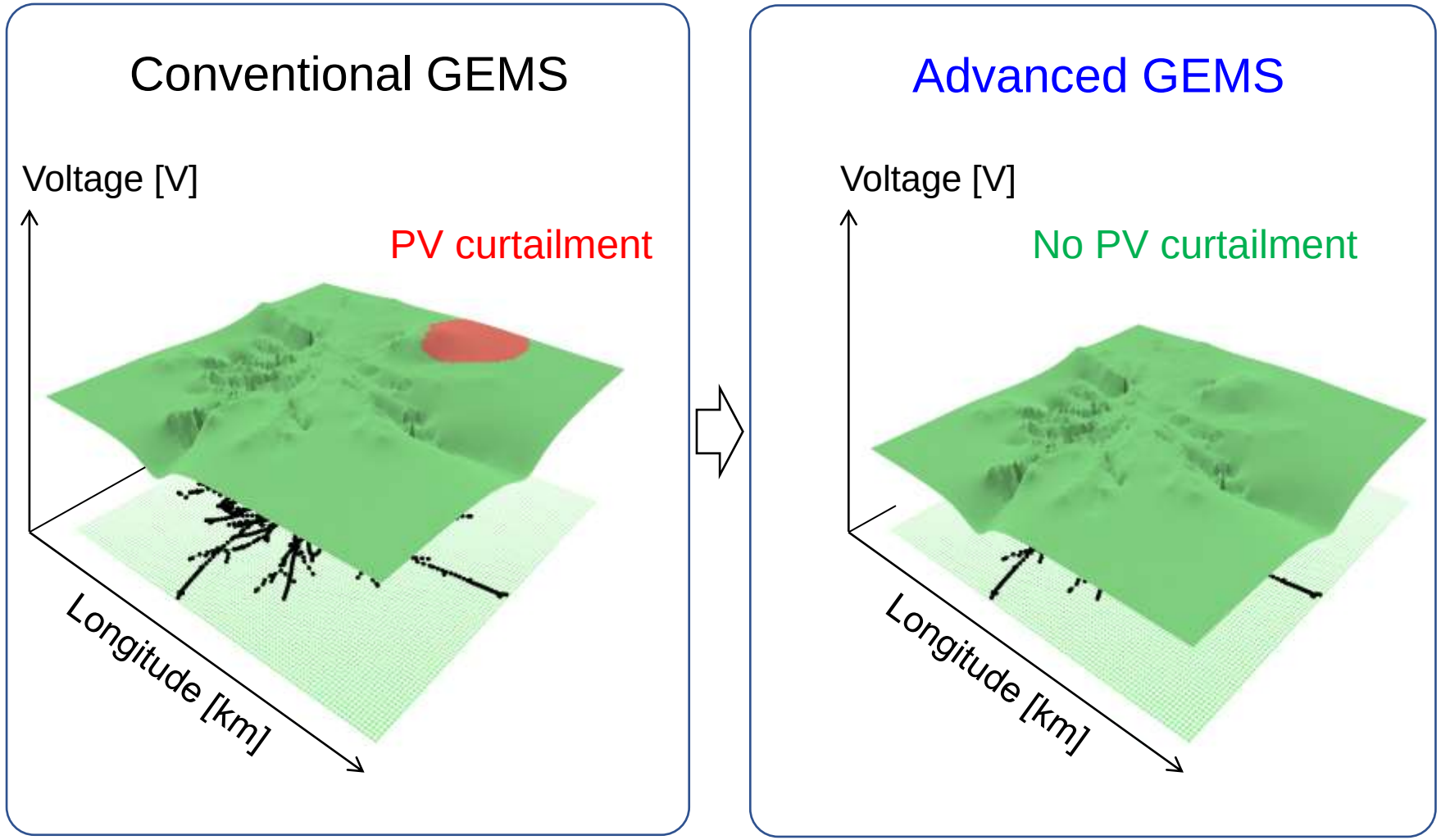
Input

Output





Improvement of voltage control with customer level info.



【Target city】10,546 households , PV 80%, 18 feeders

Summary

- First generation AMI, fully installed very soon.
- Certified Electricity Consumer Information Utilization Association was established in May 2022 and started to provide SM data for various purposes.
- Specification of next generation smart meter has been determined for deployment in 2025.
- Upgrade of network planning and management, co-metering with gas and water, integration of resources on customer premise, are expected with next generation SMs.