

8th IERE Webinar on Advanced Metering Infrastructure (AMI)

July 23, 2024



ACROSS

Current status of smart meters in Japan and expectations for next generation AMI

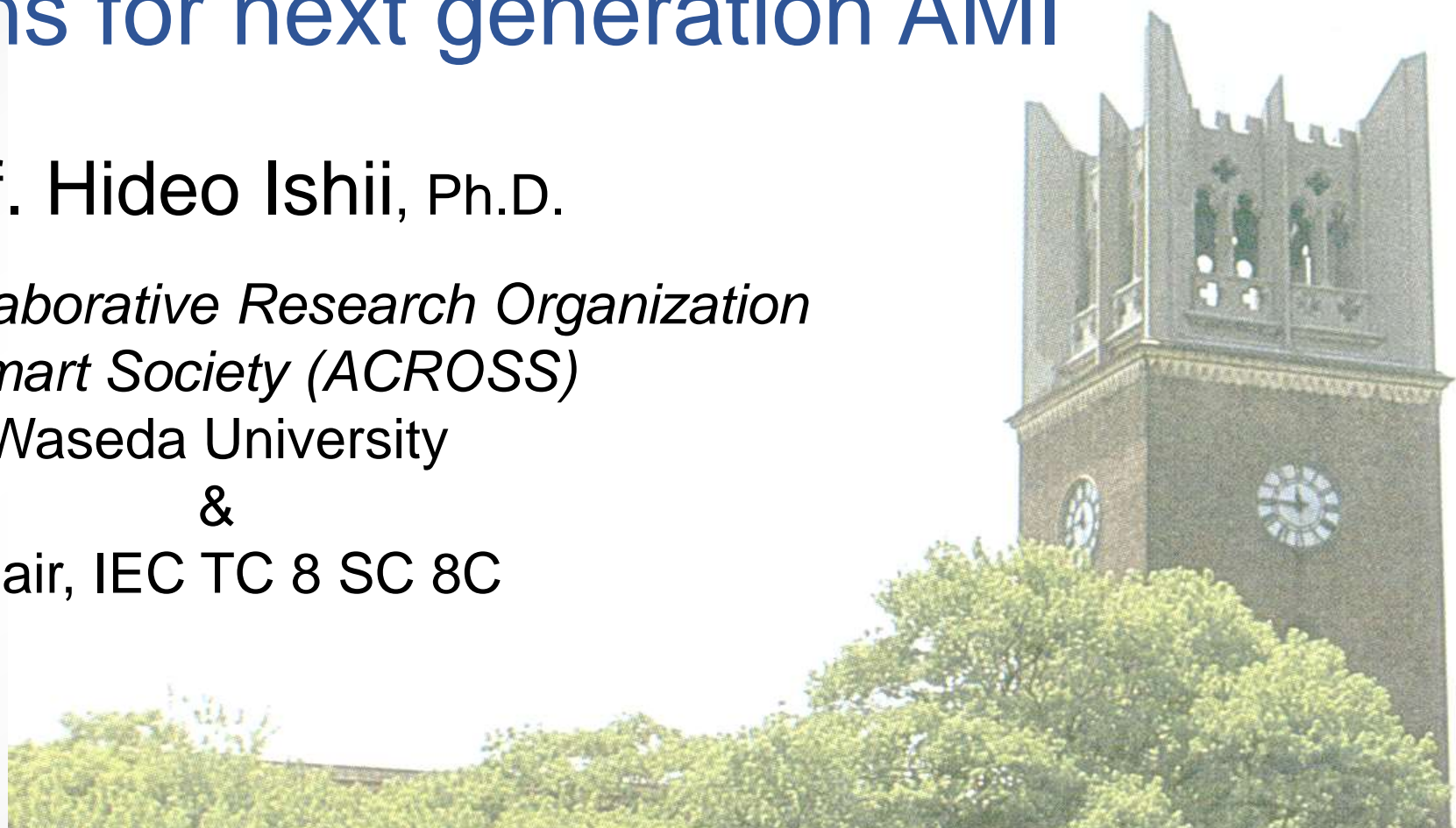
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&

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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

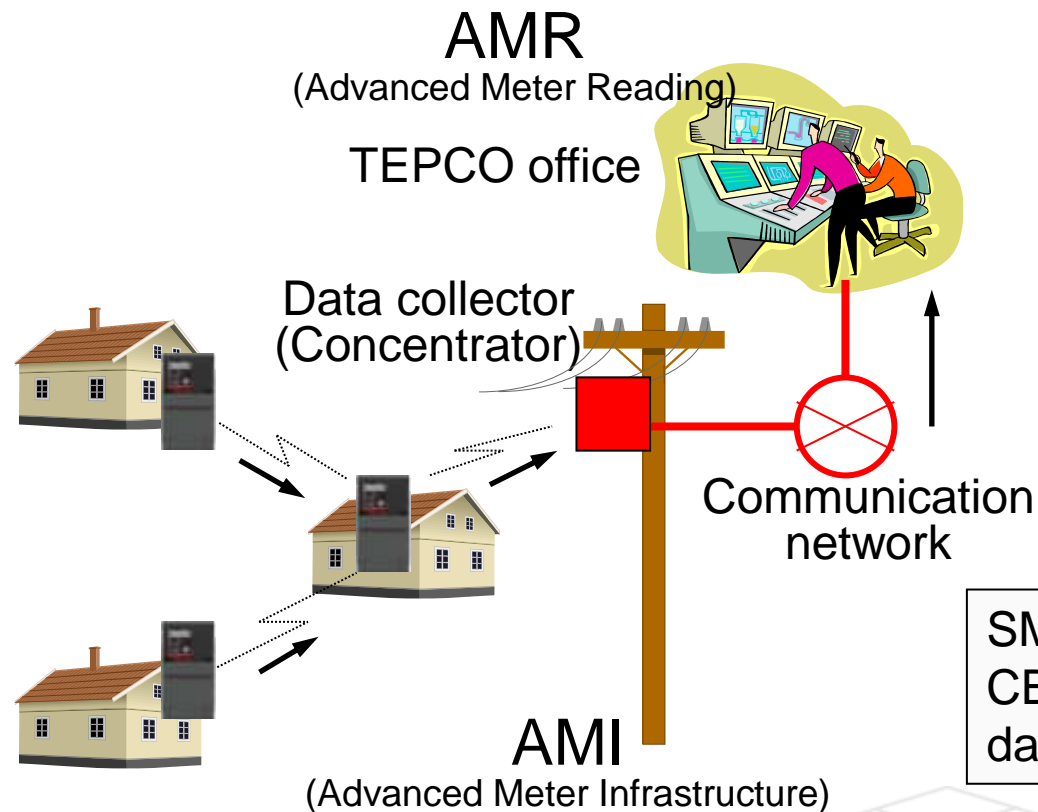
● First Generation

- ✓ 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

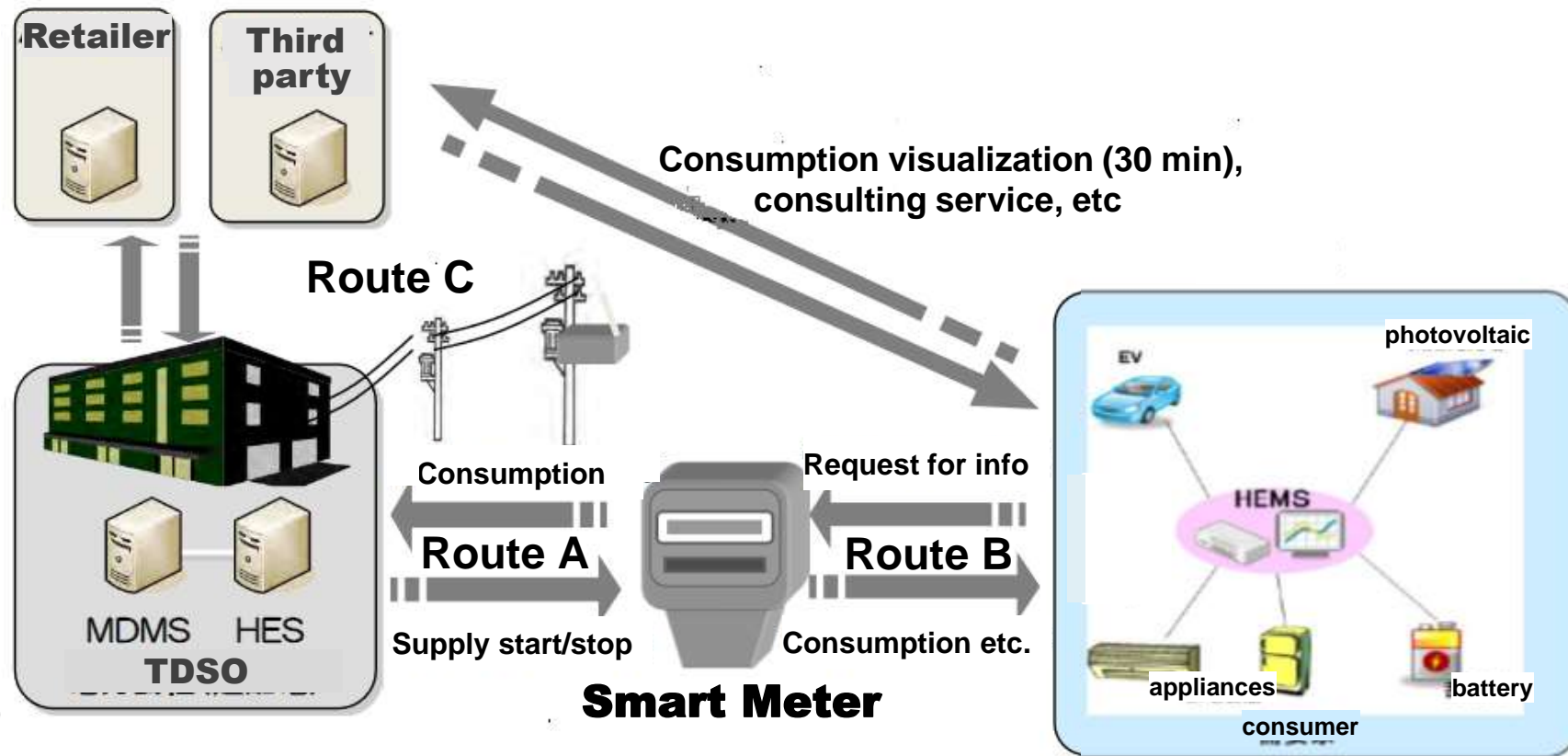
Conventional Mechanical Meter vs Smart Meter

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

	<div>Mechanical Meter</div> 	<div>Smart Meter</div> 
Major Function	<ul style="list-style-type: none">✓ Imported power measurement✓ Manual meter reading required	<ul style="list-style-type: none">✓ 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	<ul style="list-style-type: none">✓ Applicable only to flat rate.✓ Unable to be applied for Time of Use (TOU) customers	<ul style="list-style-type: none">✓ Enables variety of rate plans including TOU✓ Applicable to Demand Response, Peak-shift plans✓ Visualization of power usage

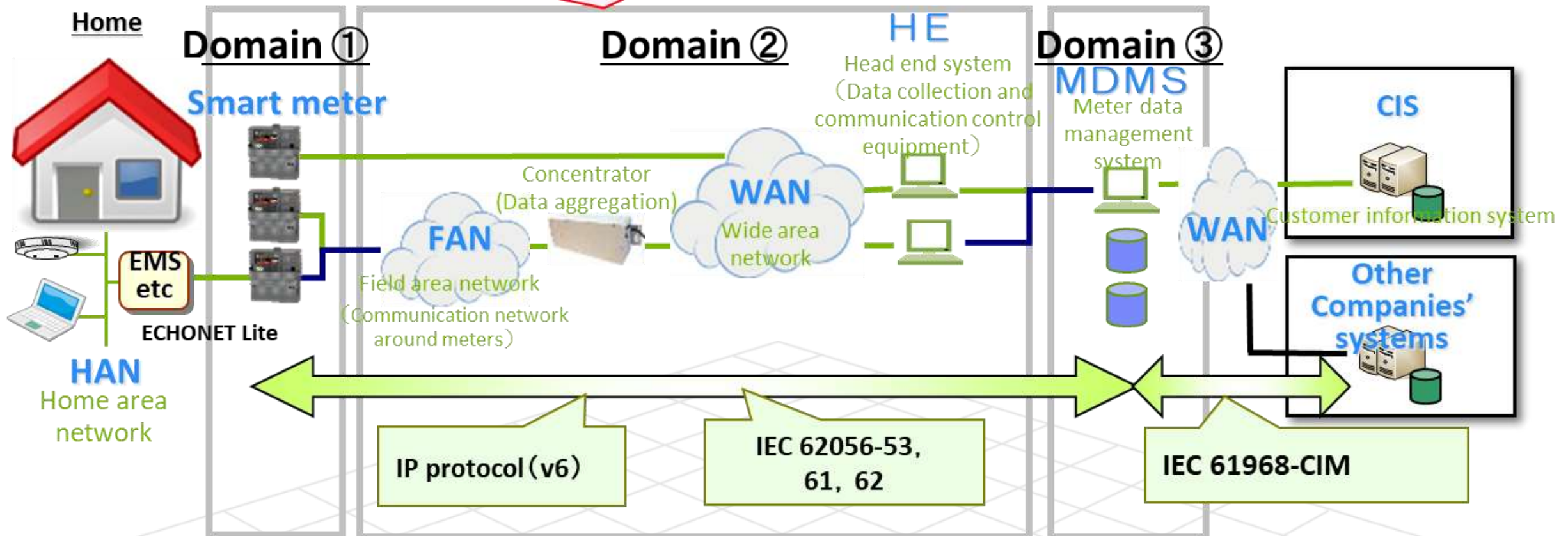
Entire System Architecture and Communication

- 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-kVWh, 1min-kVWh, 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

- ✓ Optimal choice among various rate plans
- ✓ Promotion of energy saving by energy consumption visualization
- ✓ Enjoy various added value services

For TDSO

- ✓ Improvement of business efficiency and service level (Operating cost reduction)
- ✓ Reduction of capital investment
- ✓ Creation of new profit sources

For Society

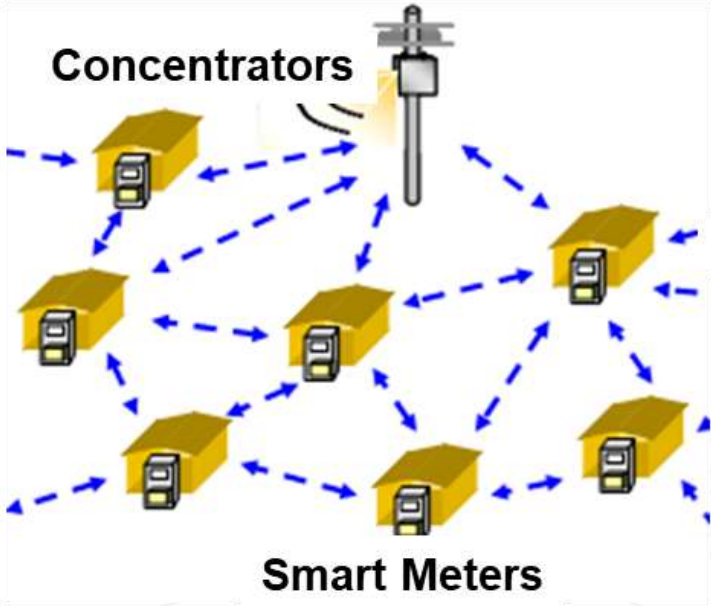
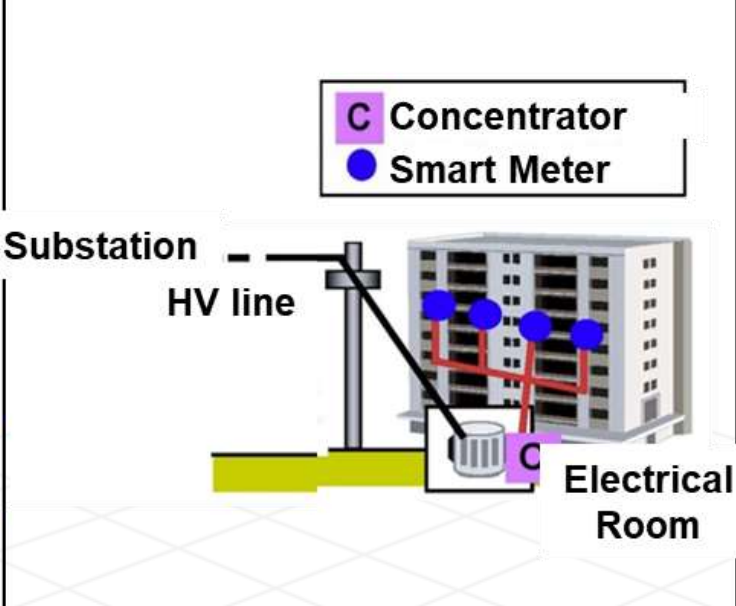
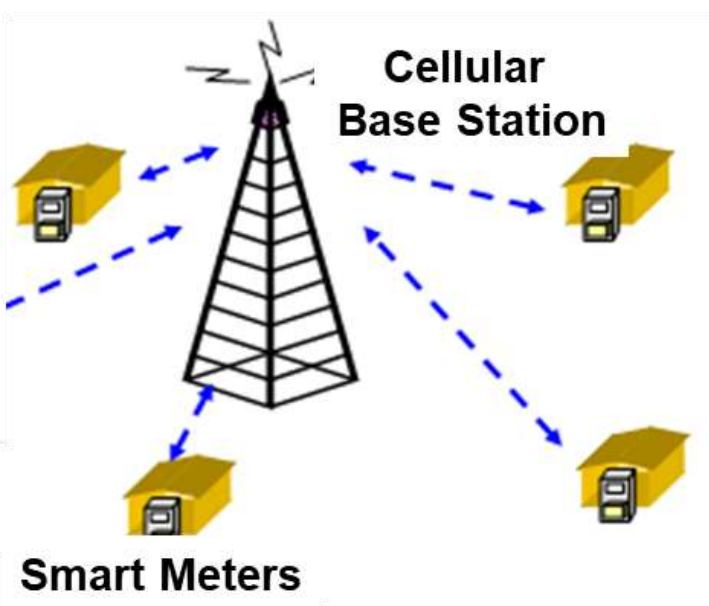
- ✓ Electricity system reform
- ✓ Realization of energy- saving society
- ✓ Revitalization of related industry
- ✓ Improvement of social infrastructure

“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

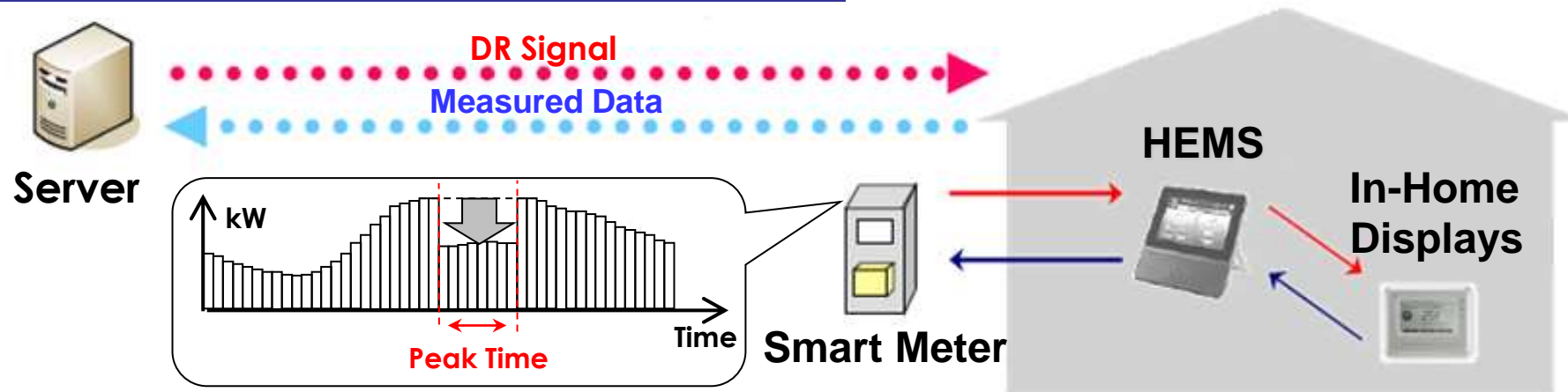
■ 3 types of communication technology

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.
 <p>Concentrators</p> <p>Smart Meters</p>	 <p>Substation</p> <p>HV line</p> <p>Electrical Room</p> <p>C Concentrator</p> <p>● Smart Meter</p>	 <p>Cellular Base Station</p> <p>Smart Meters</p>

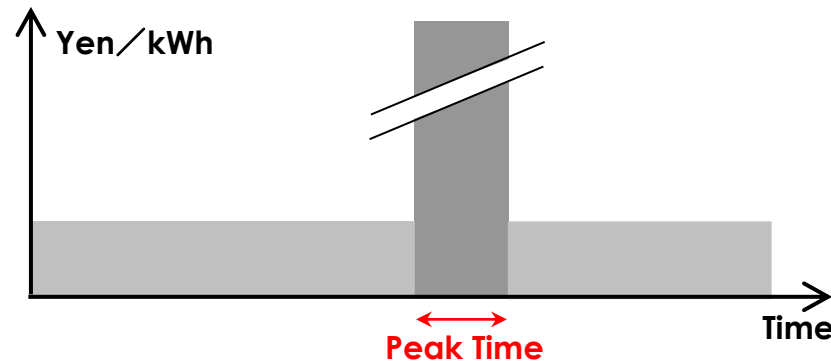
AMI enables Demand Response

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

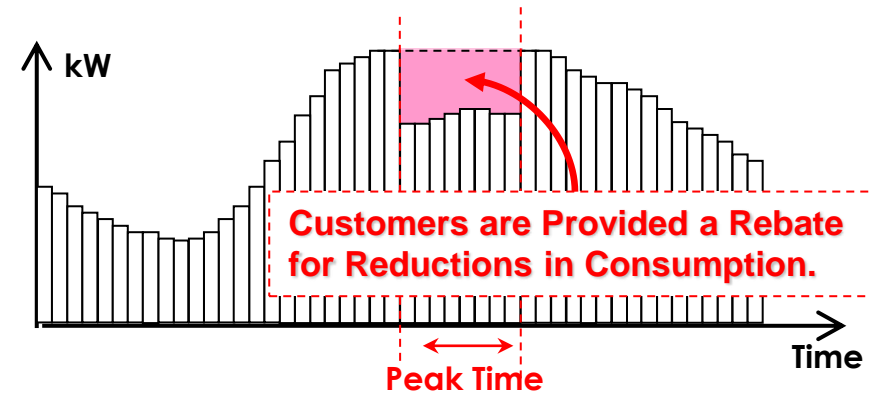
< DR for Residential Customers in YSCP >



CPP (Critical Peak Pricing)



PTR (Peak Time Rebate)



Revision of the Energy Conservation Law

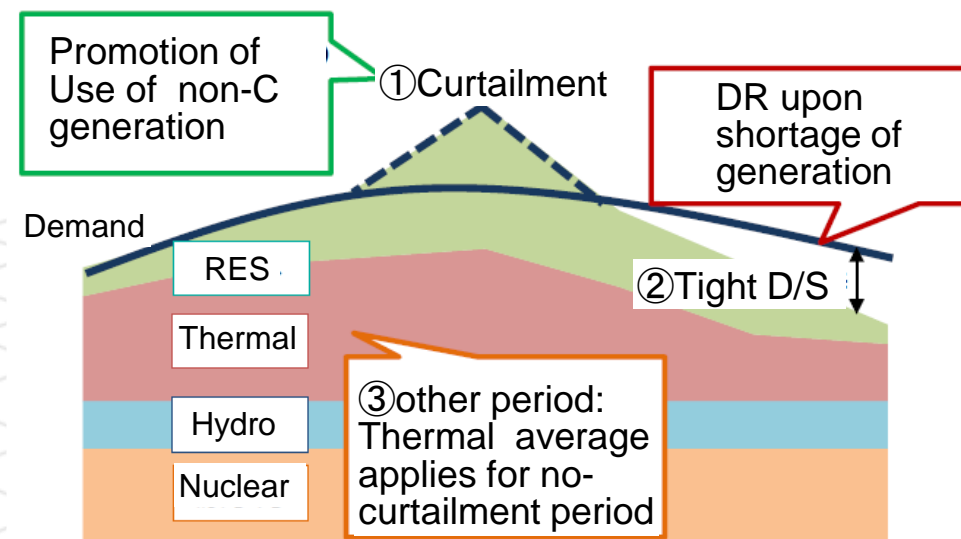
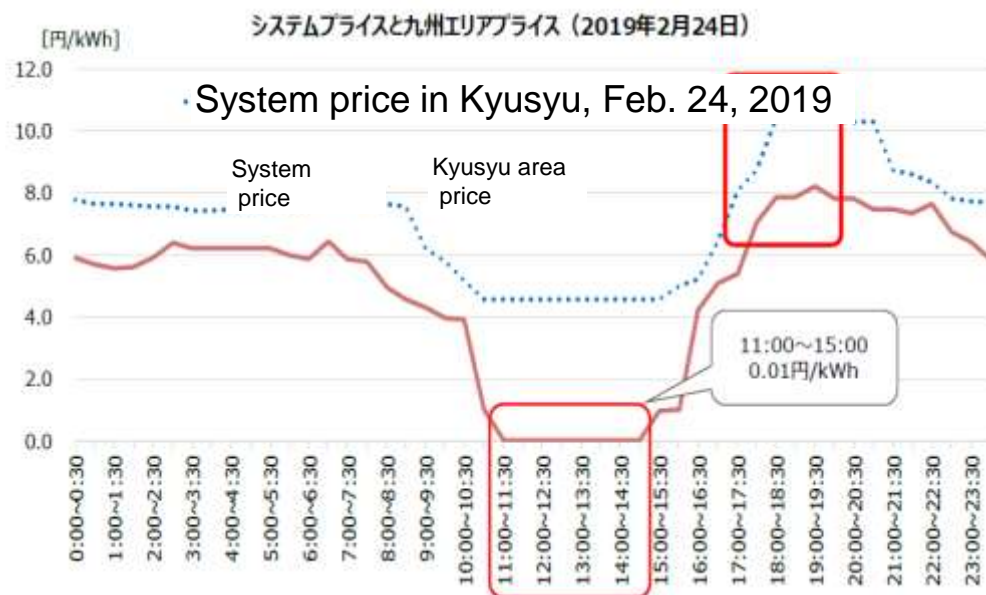
Laws Concerning the Rational Use of Energy (Energy Conservation Law) has been revised to transform supply-demand structure. (2022 -)

- 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 $9.5\text{MJ/kWh} \times \alpha$ (upon tight demand-supply)
- ③ 9.5MJ/kWh (others : thermal power av.)

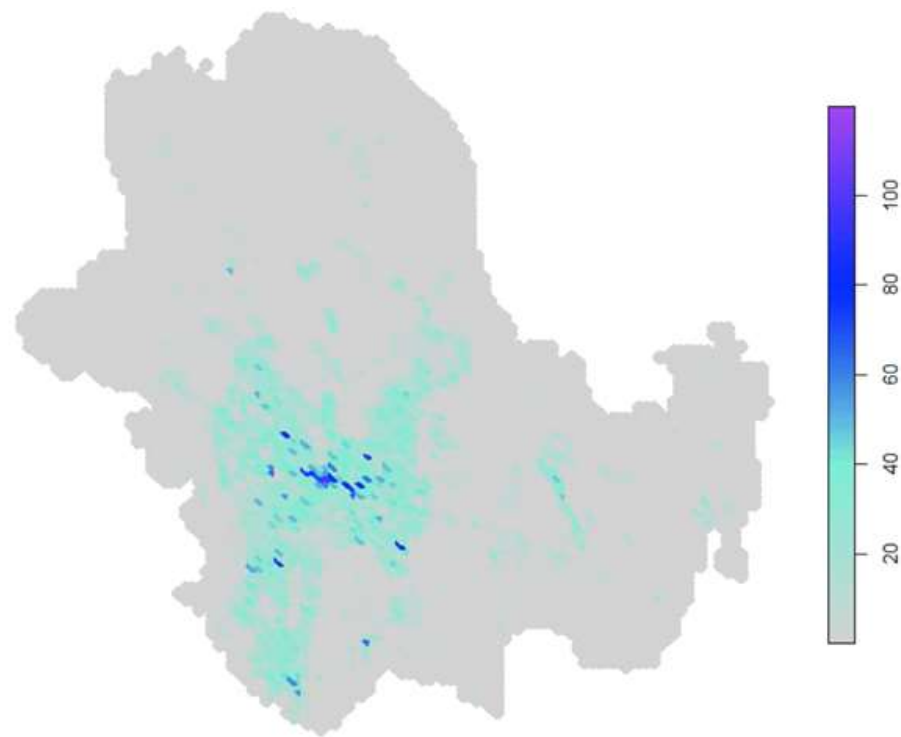


Use of Smart Meter Data

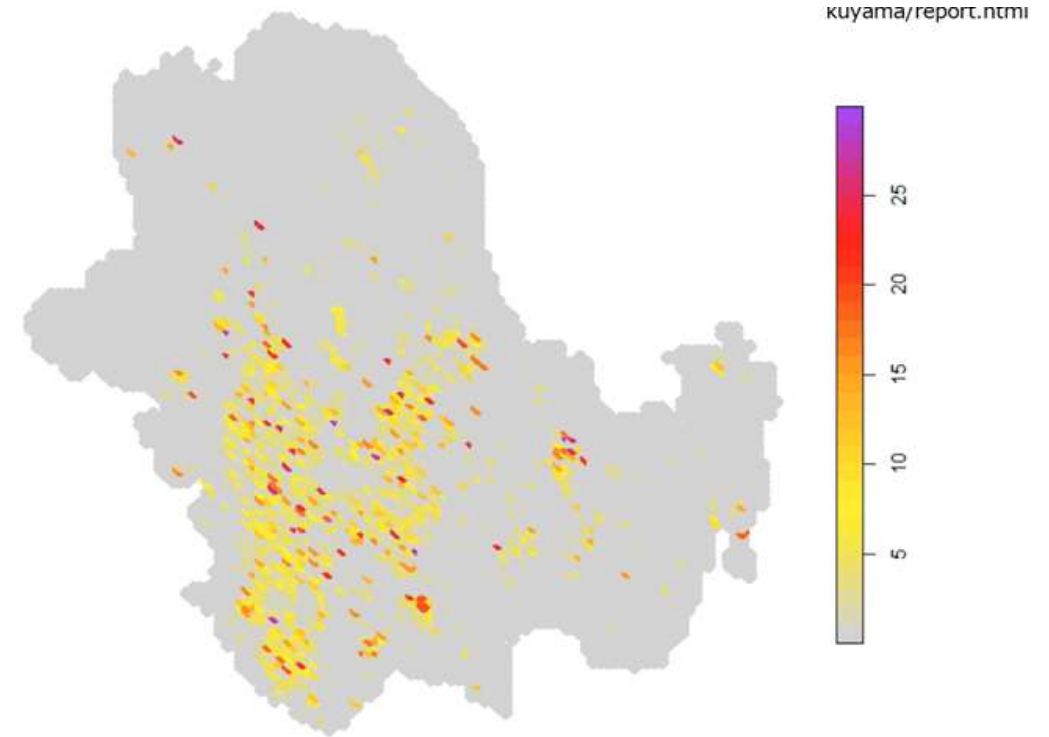
- Smart meter data is highly up-to-date and accurate, making trend analysis possible based on continuous data.
- The problems of SM data use:
 - ✓ The Electricity Business Act prohibited the use or provision of electricity for purposes other than electricity supply service.
 - ✓ Personal data protection (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



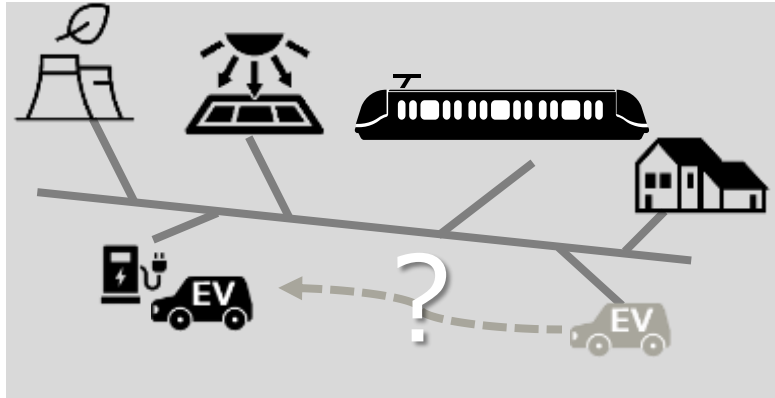
**Special distribution of electricity consumption
(August 1st, 2019)**



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

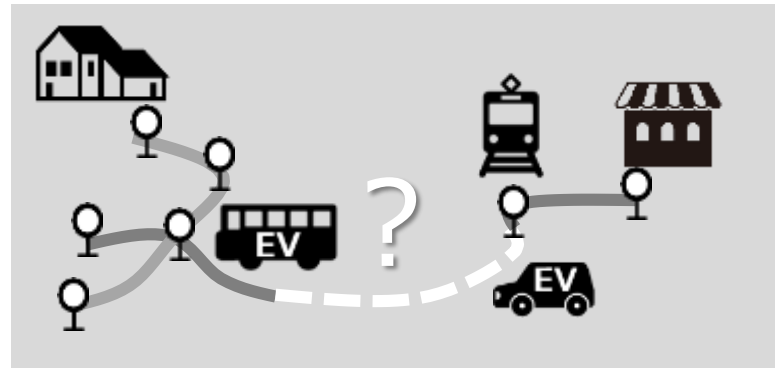
*Results obtained by the analysis based on the smart meter data provided by GDBL Corporation..

Sector coupling: Power Grid and Transportation Grid

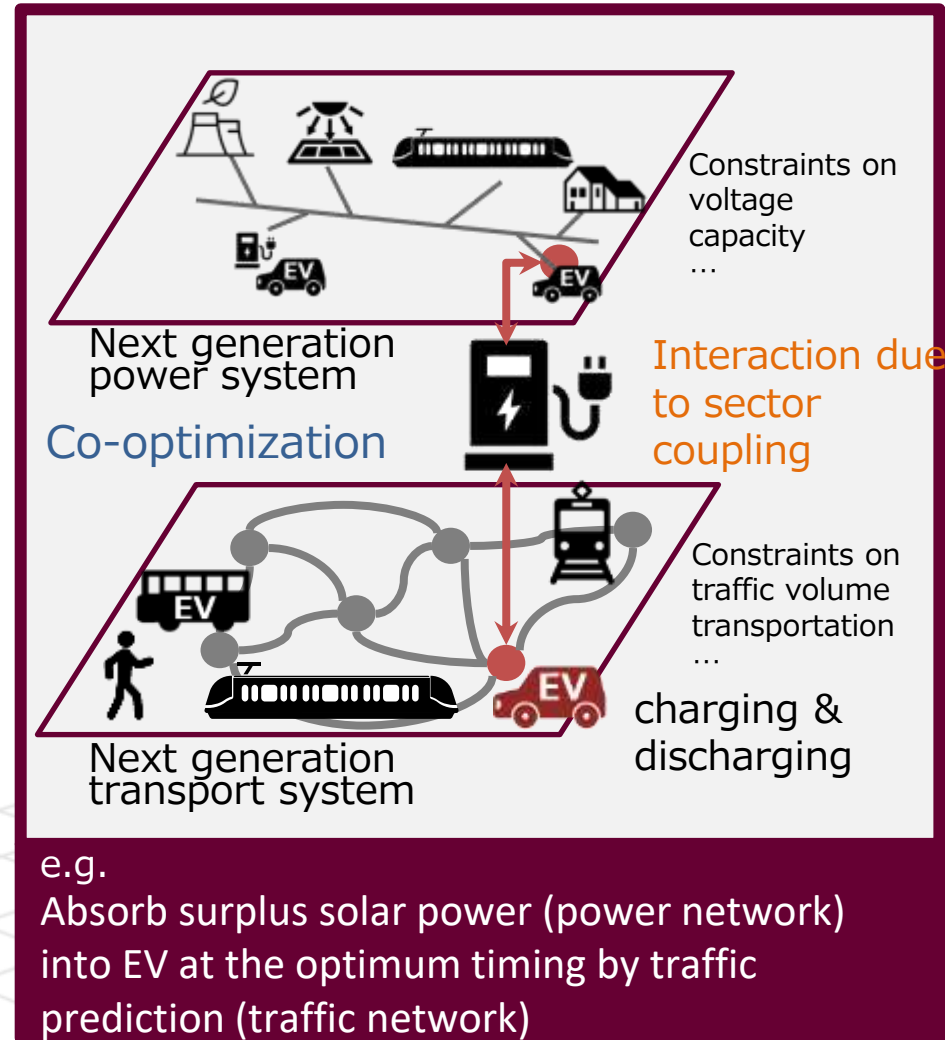


Optimization of electric power sector

"Wall" separates two sectors

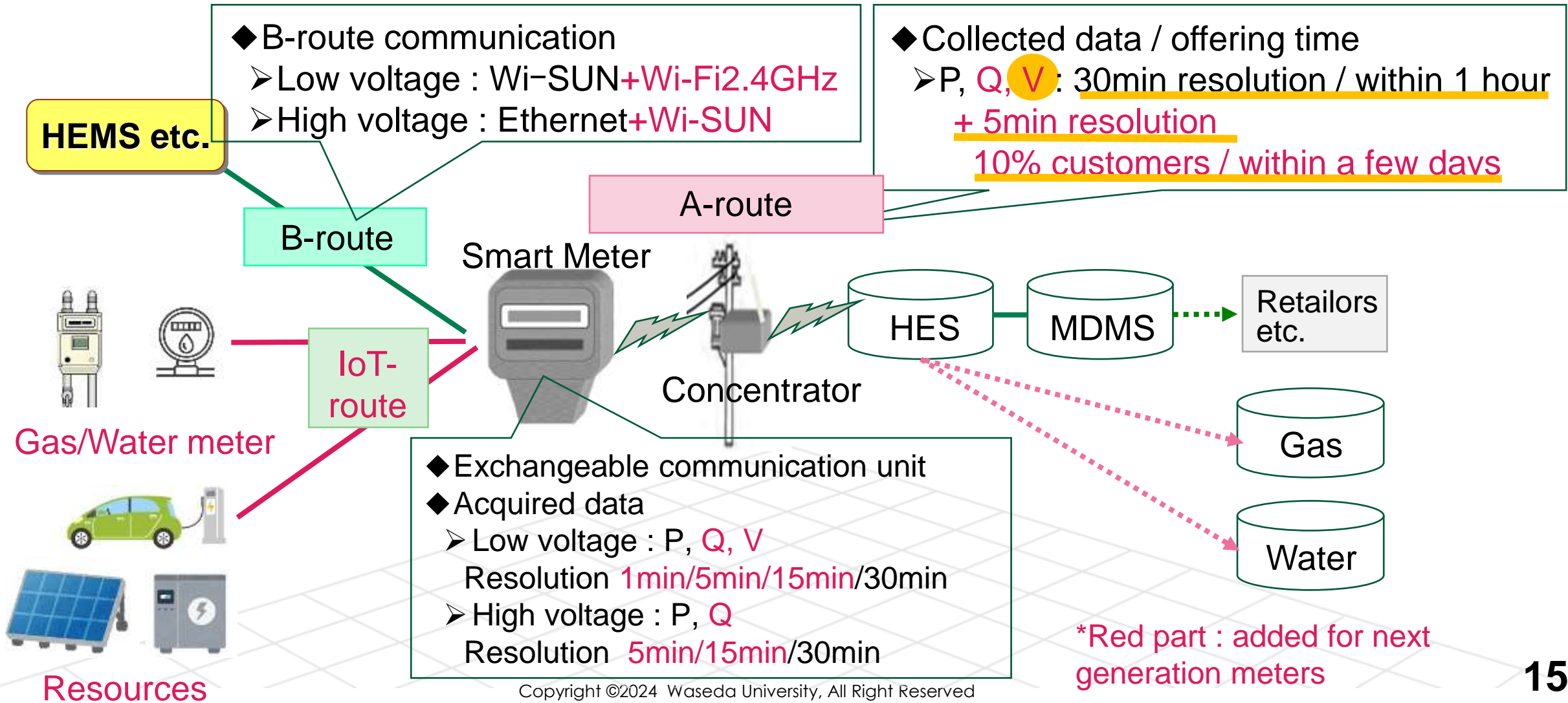


Optimization of transport sector

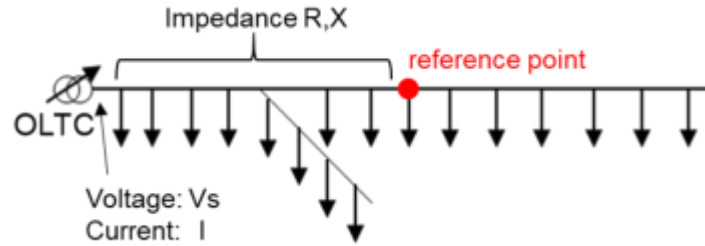


Specification of next generation smart meter

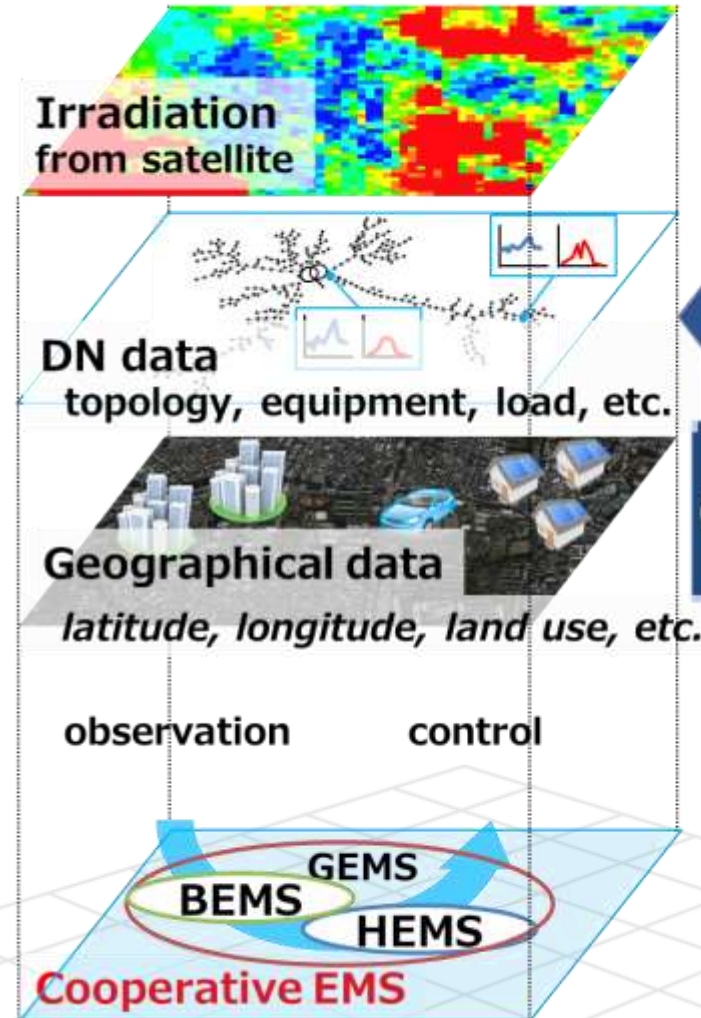
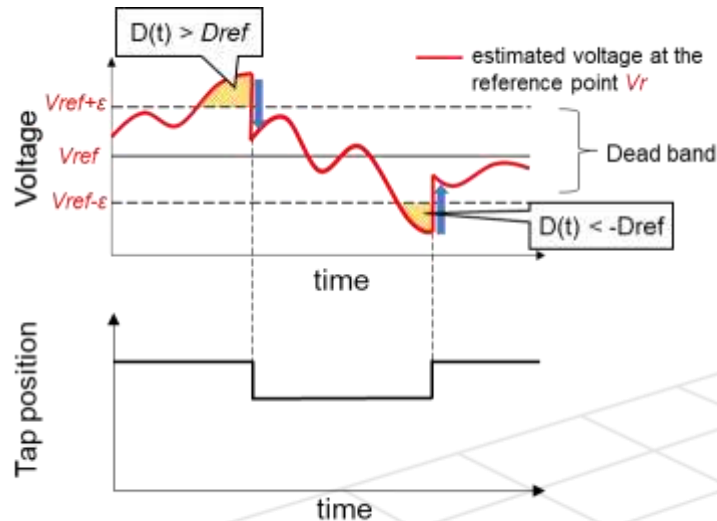
- Installation of 1st generation SM will be completed in 2024.
- 2nd generation SM will start to roll out since 2025.



● OLTC Control Method (LDC)



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

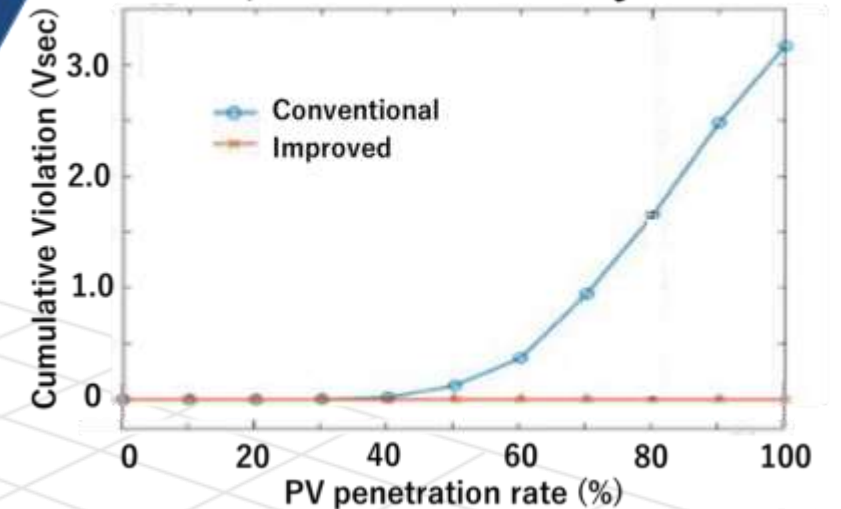
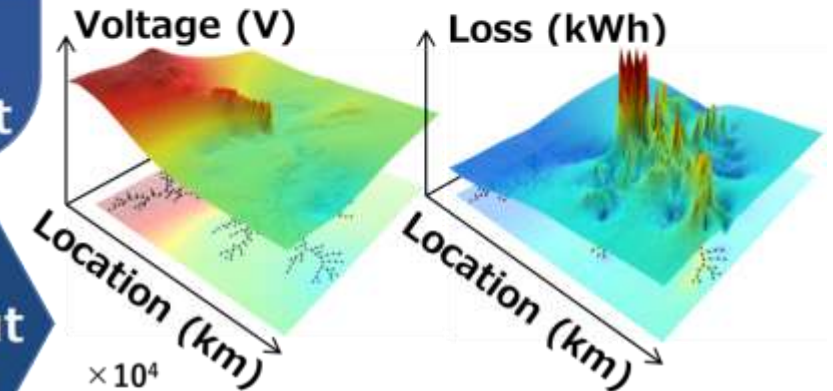


Simulation settings

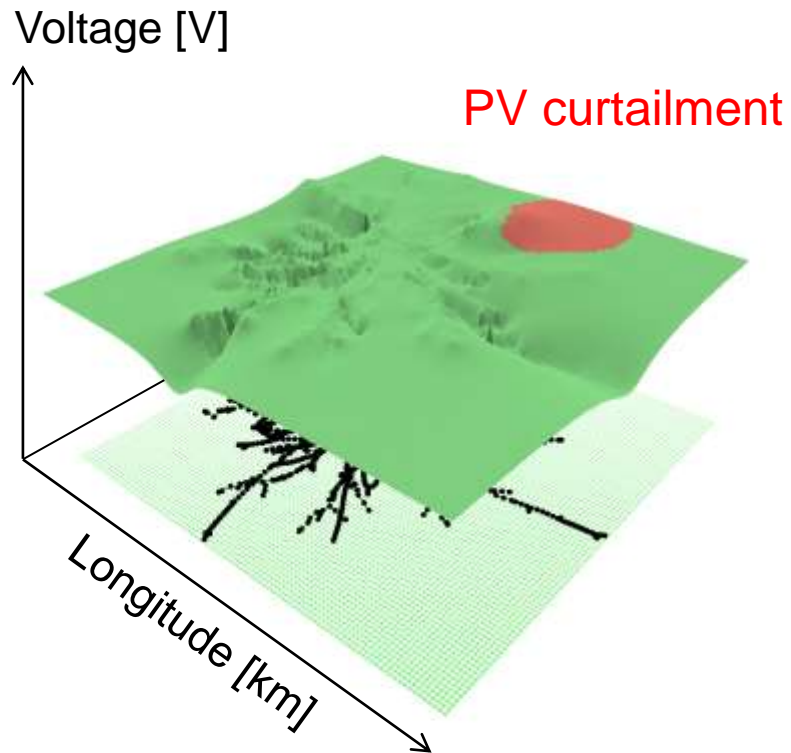
- ✓ Volume & Distribution of PV·EV
- ✓ Electrification of water heaters etc.

Input

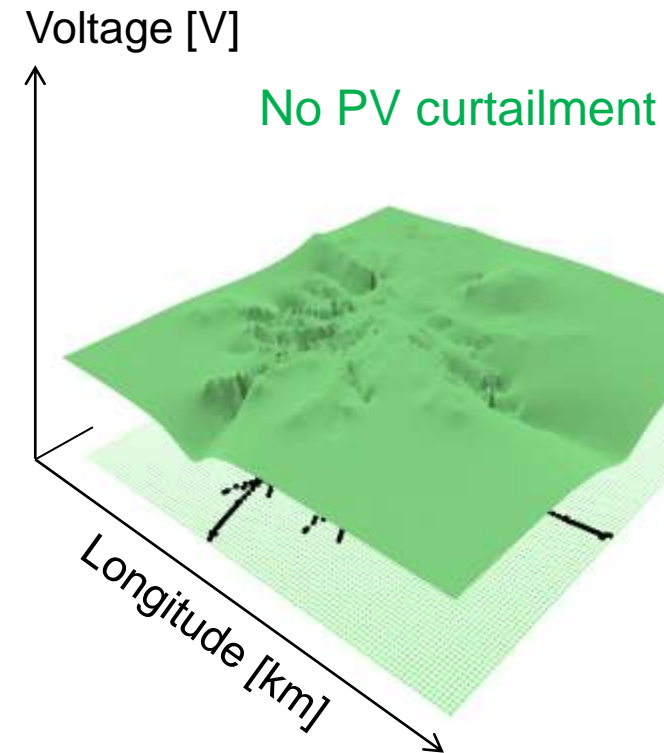
Output



Conventional GEMS



Advanced GEMS



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

- 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.