Current Situation and Integration Potential in Electricity Area in Japan

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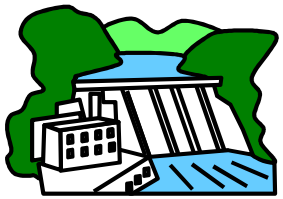
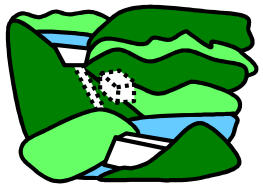
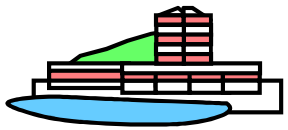
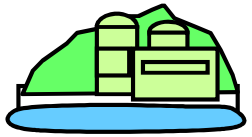
Basic Roles of Grid (Power System) and Utility

Power plants

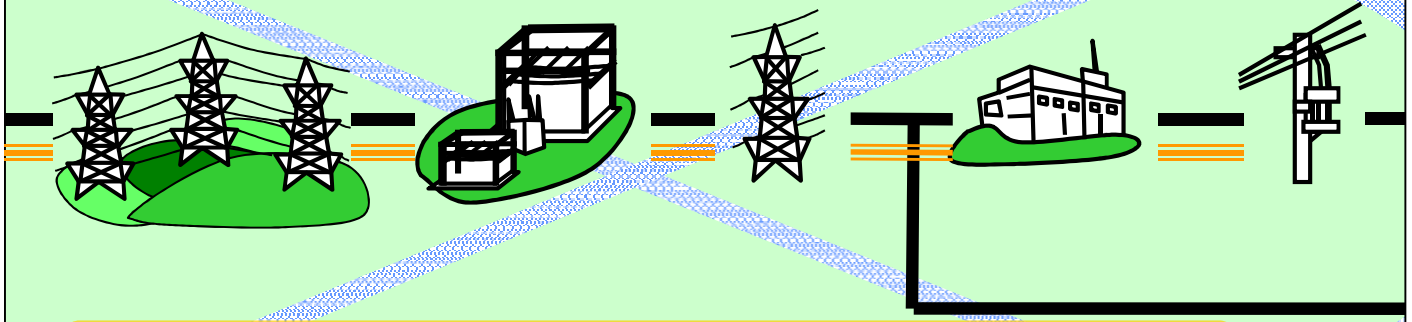








Grid (power system)



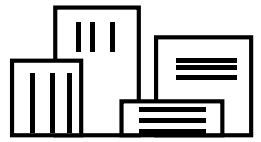
“S”＋３“E”s

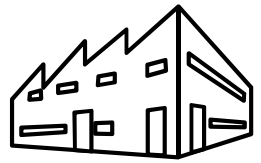
Safety + 3”E”;

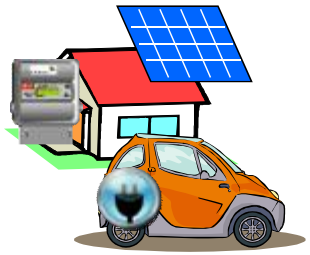
- **u High quality [Energy Security]**
  - **Frequency (60±0.1Hz (95% or higher))**
  - **Voltage (101±6V, 202±20V）**
  - **High reliability**
- **u Inexpensive [Economy]**
- **u Low carbon [Environment]**

Increased recently

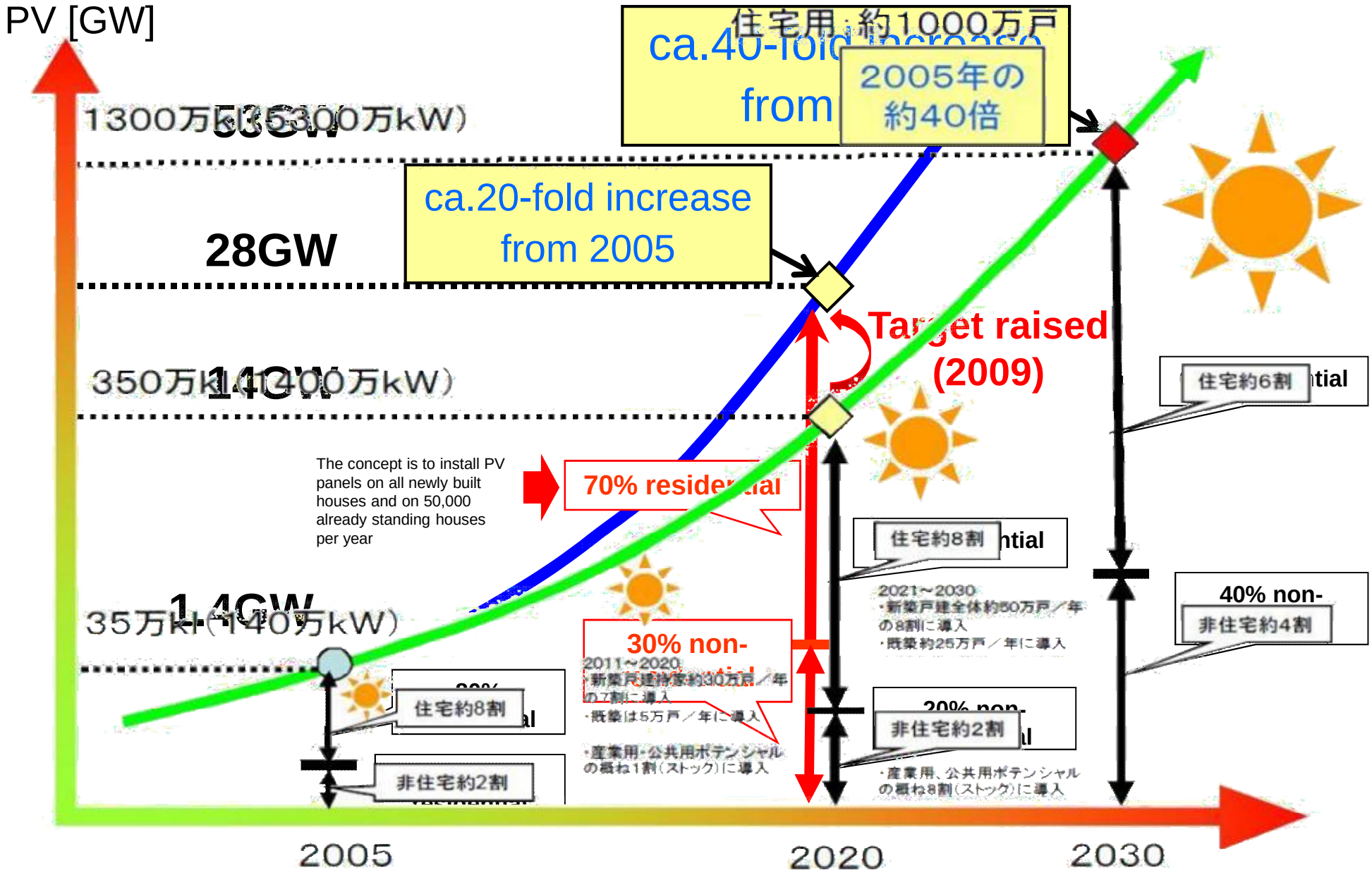
Customers



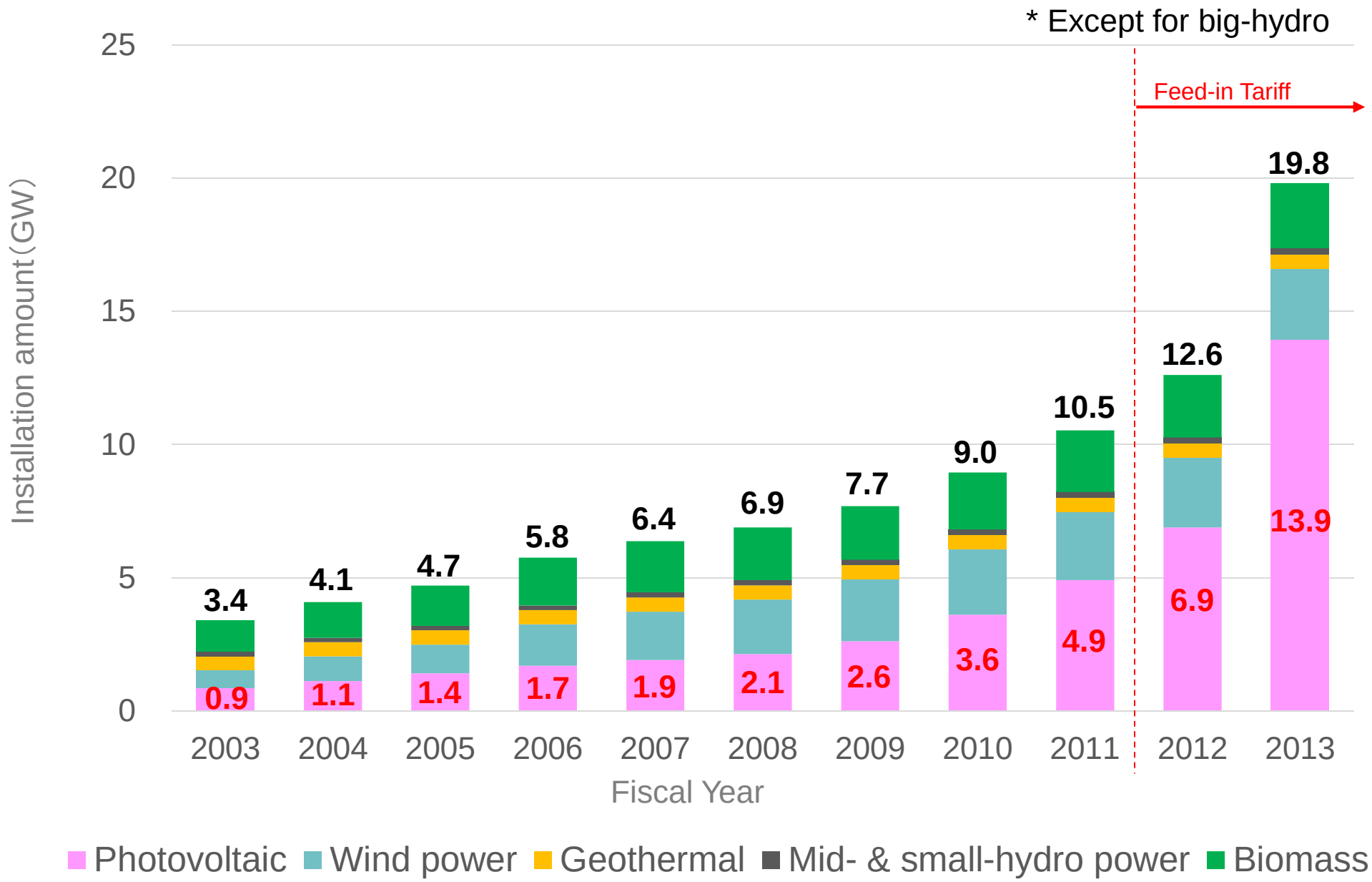




Target Amount of Solar Power Generation in Japan

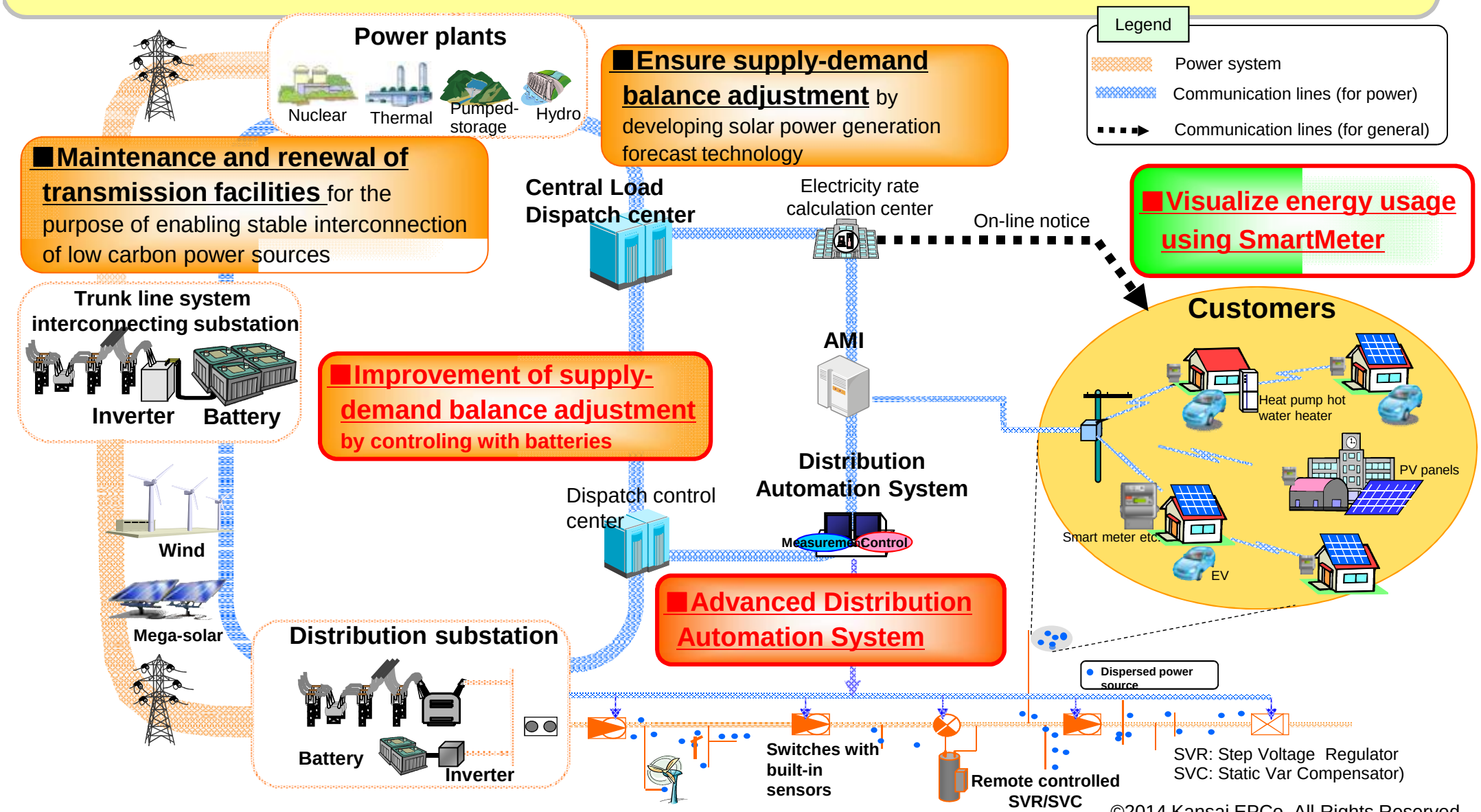


Installation amount of Renewable Energy in Japan



KEPCo's Smart Grid Vision

- Safety, low-carbon, and improvement of our customers' conveniences
- Efficient, high-quality and reliable grid using new technologies (e.g. ICT, batteries)



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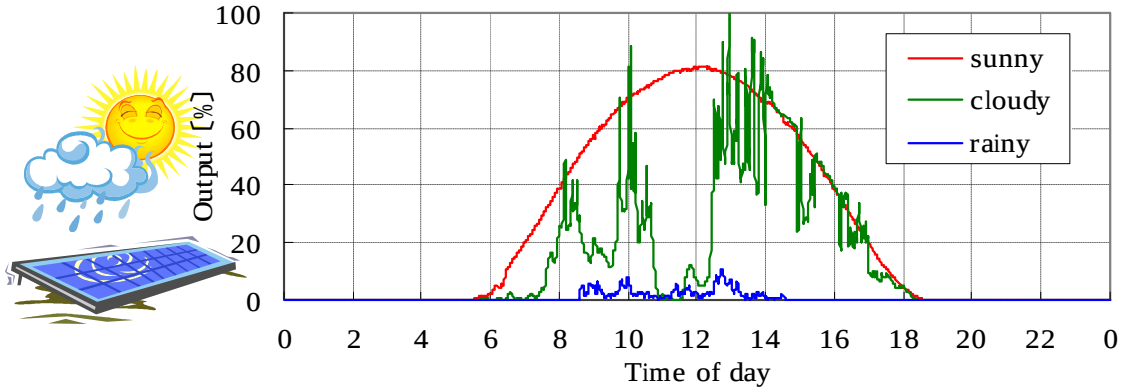
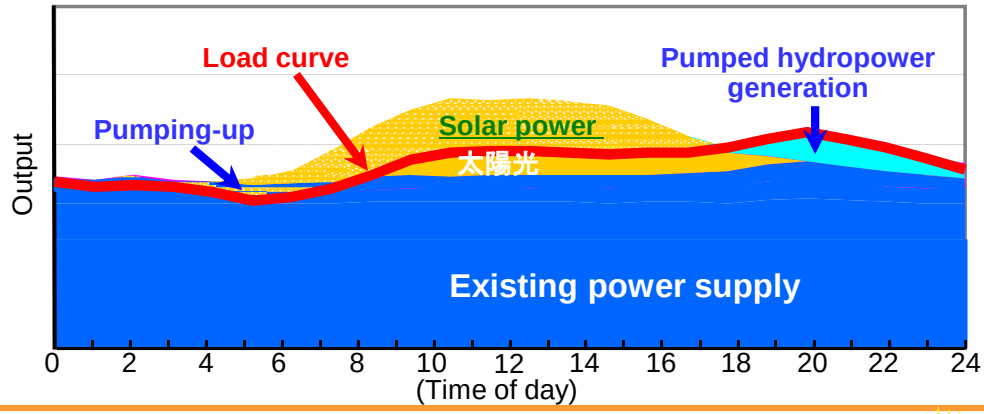
Grid issues with large-scale penetration of PVs

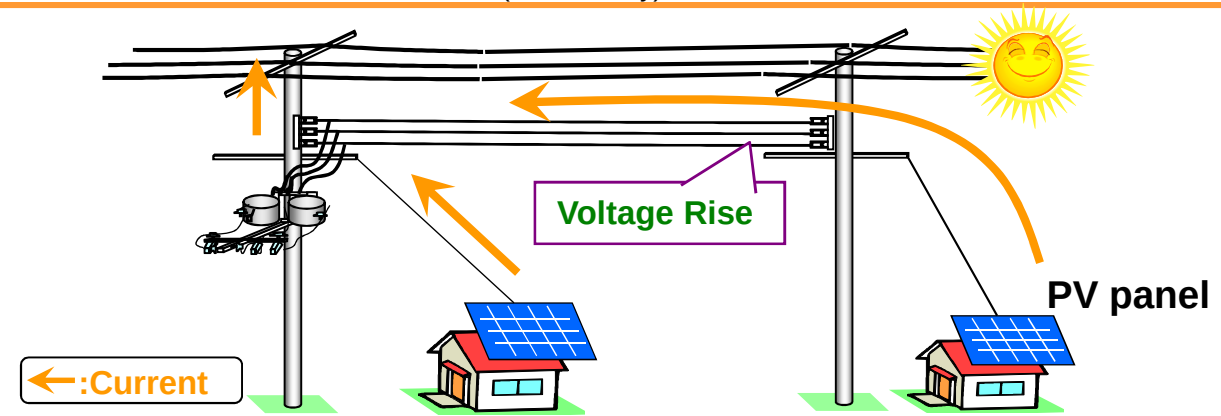
Fluctuation

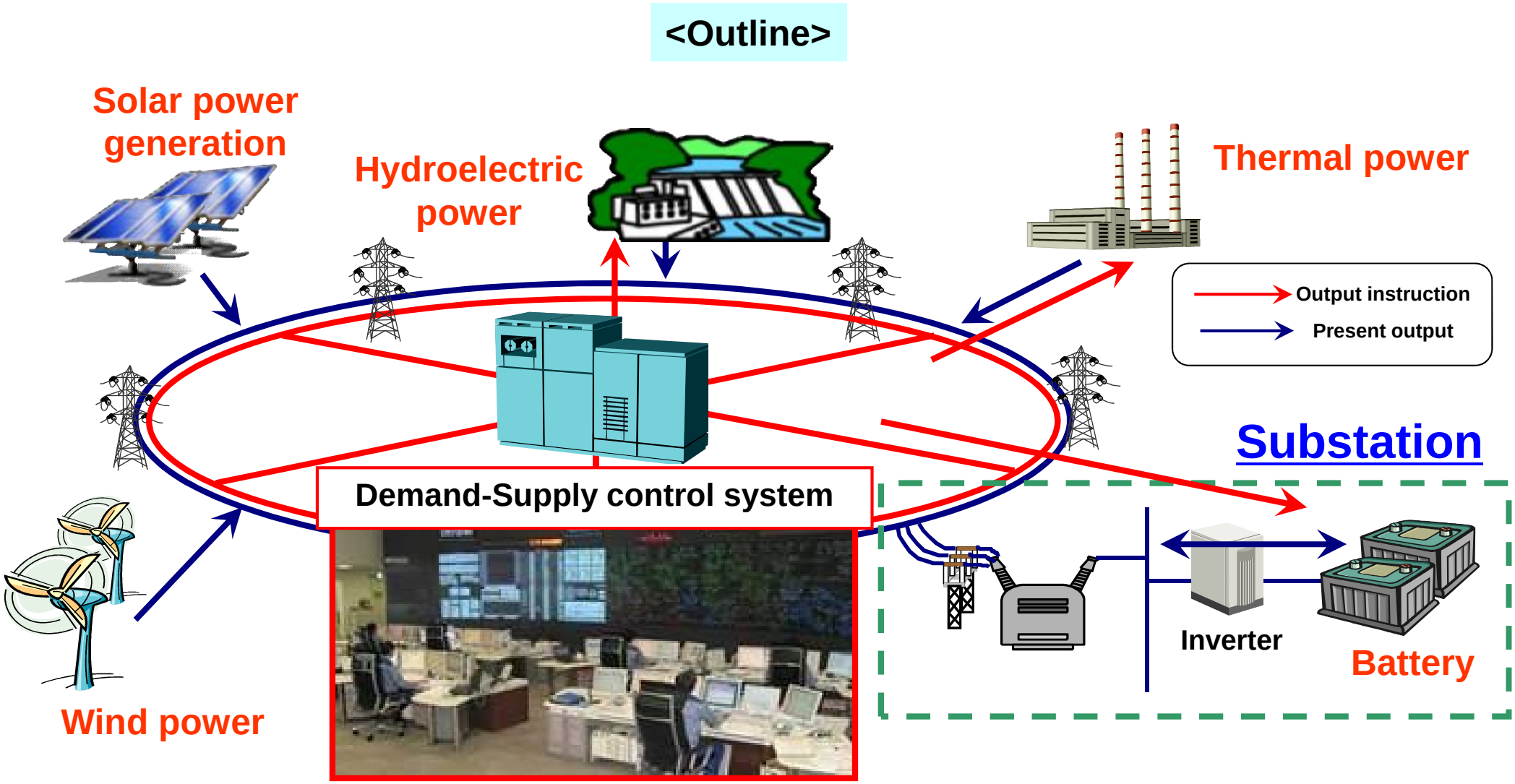


Surplus



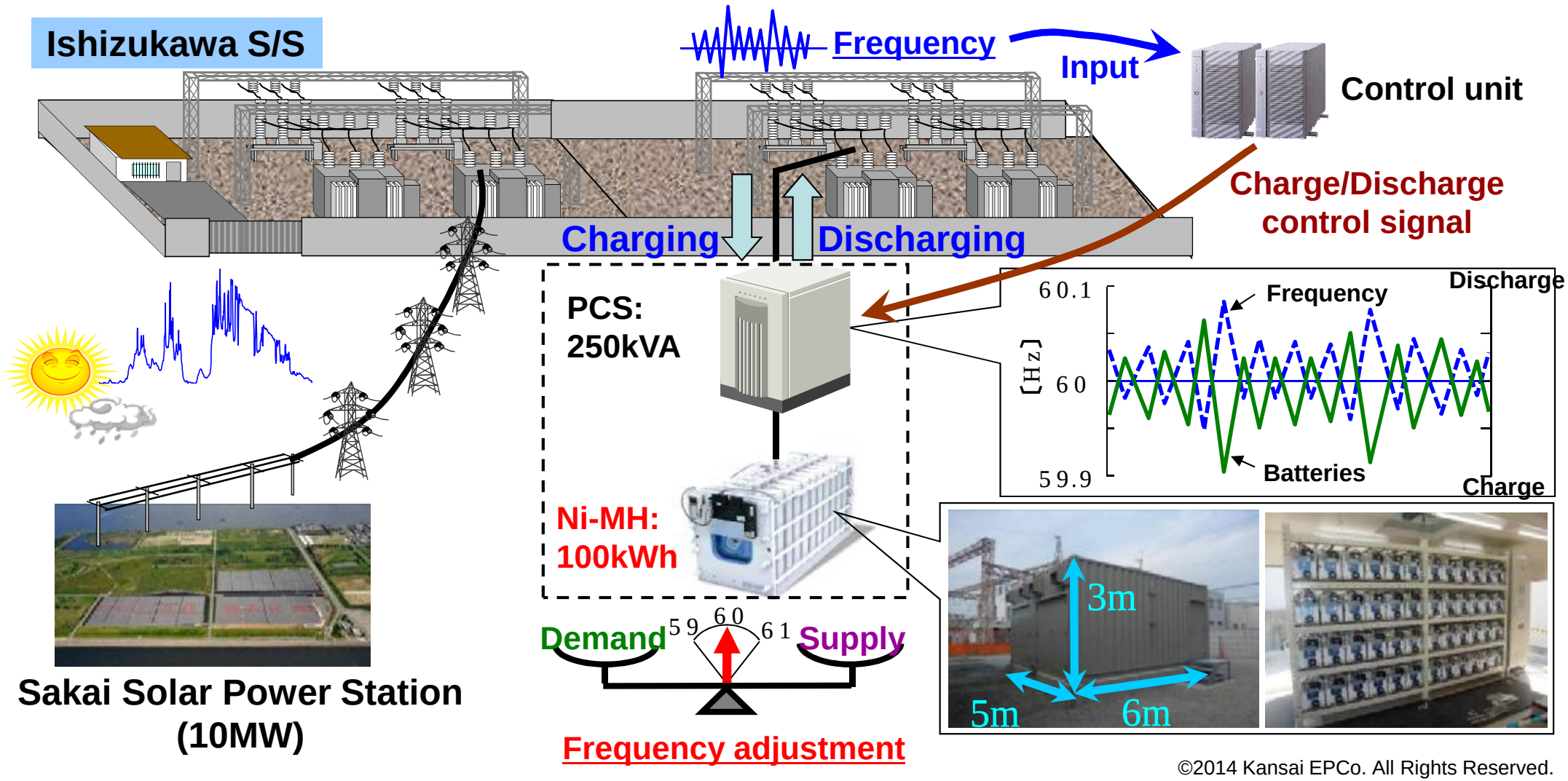
Reverse power flow



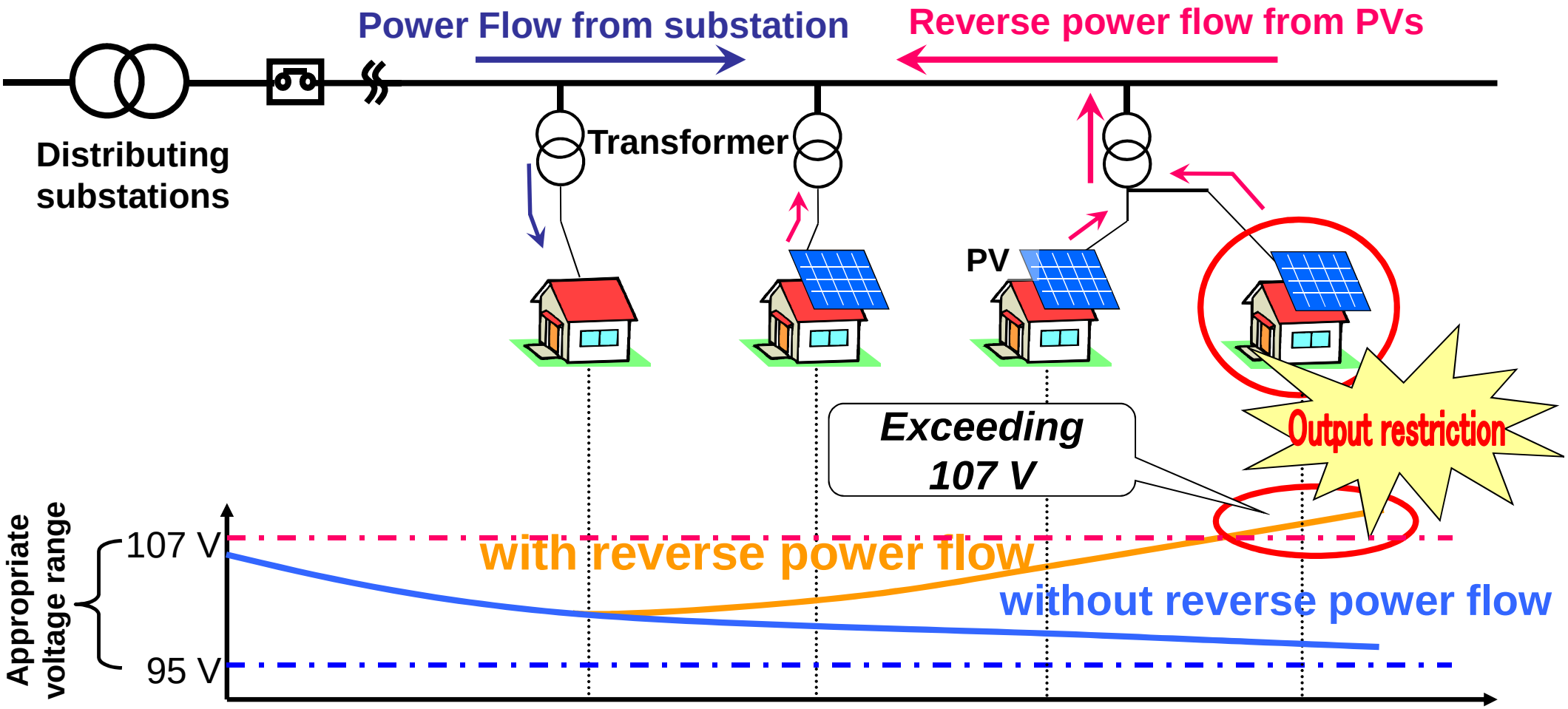


(Study point)

- Coordination with thermal and hydro power stations and SOC management of batteries
- Battery characteristic such as life-length, loss, SOC measurement



Voltage Rise Problems of Distribution Lines



When the voltage of distribution lines goes beyond the standard range (101±6V), the PVs output are automatically restricted soon.

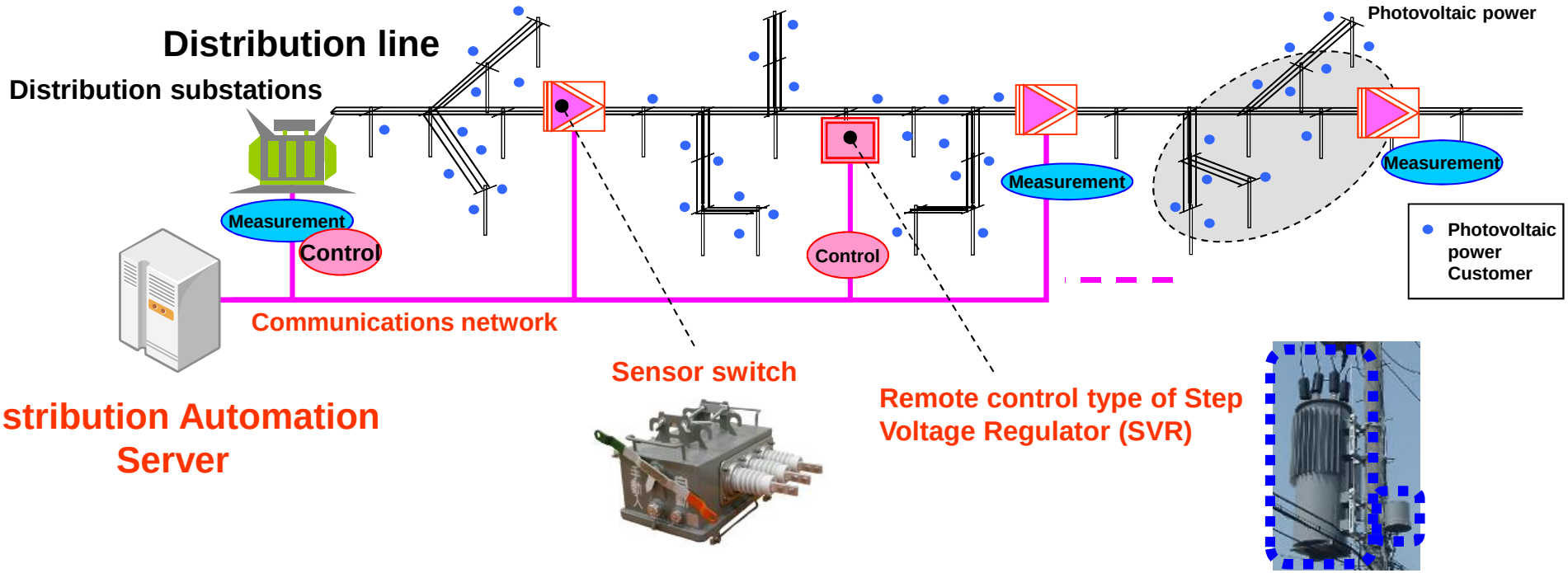
⇒ The more PVs are installed, the more PVs output are restricted.

Advanced Distribution Automation system

In addition to the feature of conventional distribution automation system, new function is added.

- **Monitor and control of power quality (mainly voltage) by sensor switches**
- **Step Voltage Regulator by remote control**

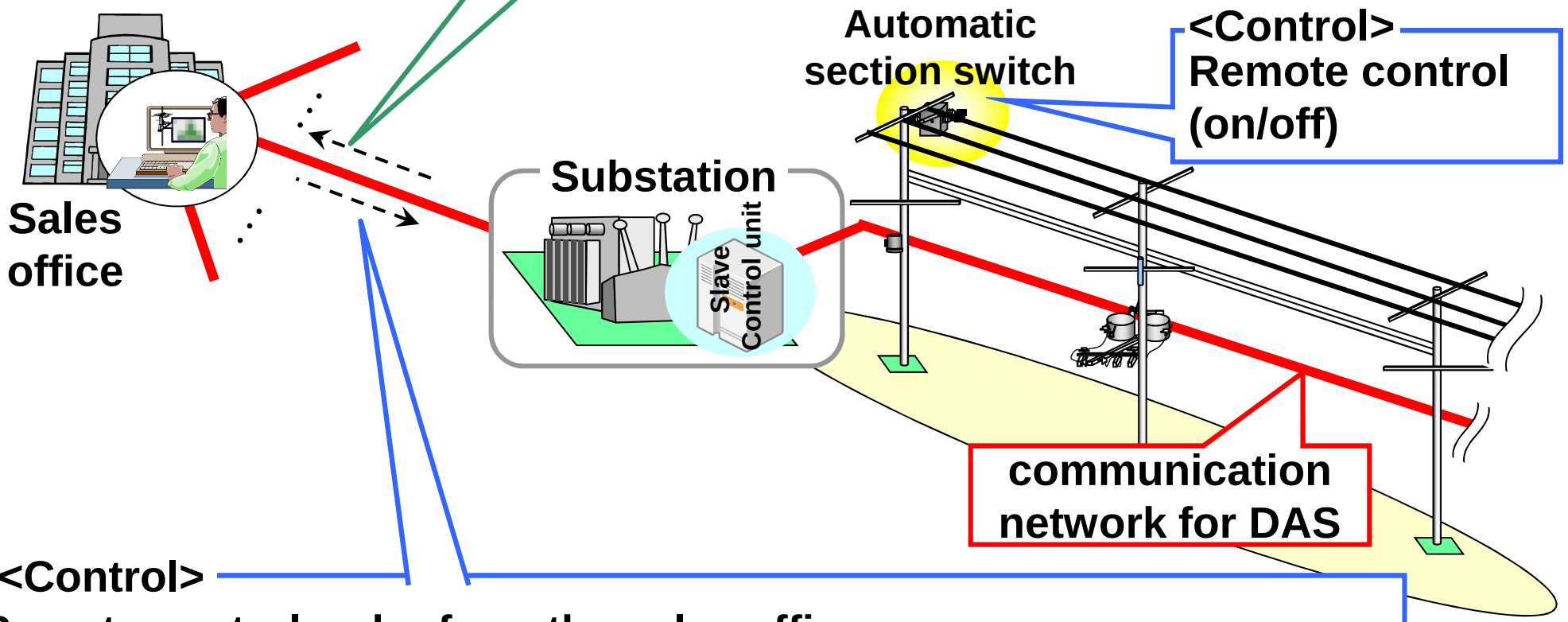
Outline of Advanced Distribution Automation system



Overview of Distribution Automation System (DAS)

<Supervision>

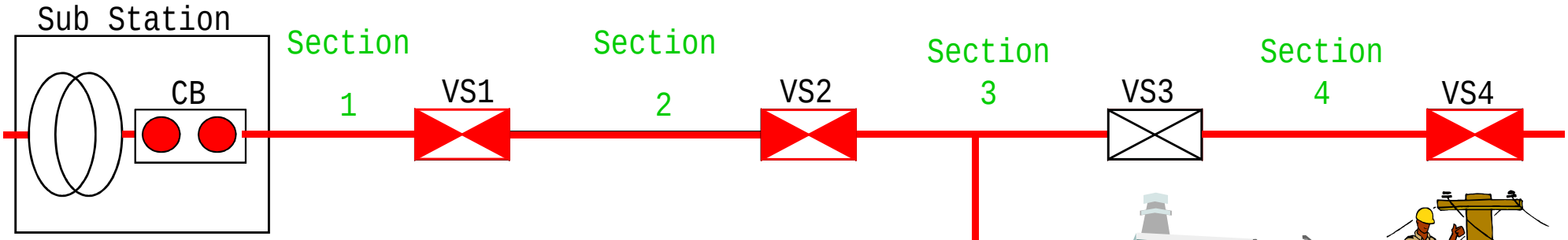
•Transmitting some operational information of automatic Sectionalizing switch and substation to the sales office.
•Monitoring the current and voltage information.

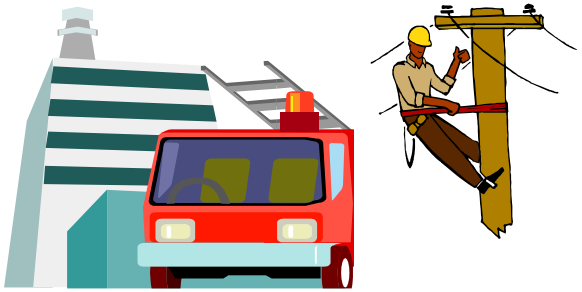


<Control>

Remote control order from the sales office
• Reduction of outage duration, and minimization of outage areas
• Automatic power transmission except for the fault section

DAS Operation Sequence





0m 00s Fault occurs
CB-trips VSs-open

1m 00s relay closes CB

1m 07s VS1- re-close

1m 14s VS2- re-close
CB-trips VSs open (VS2 locked*1)

DAS system automatically runs.

1m 14s＋α DAS automatically close VS4
& VS6 to supply section 4 & 5

4m 14s relay re-close CB

4m 21s VS1 – re-close

- VS2 has already locked and not re-closed
- fault section 3 is isolated

6m 00s relay reset

Lineman goes to section 3, and searches the fault point and restore.

Automatically close VS4 & VS6 to supply non-fault sections, 4 and 5

— Contents —

KEPCo's Smart Meter (Plug-in module type)

Conventional
- Integrated structure

Smart Meter
- 3unit structure

Same size

Communication unit

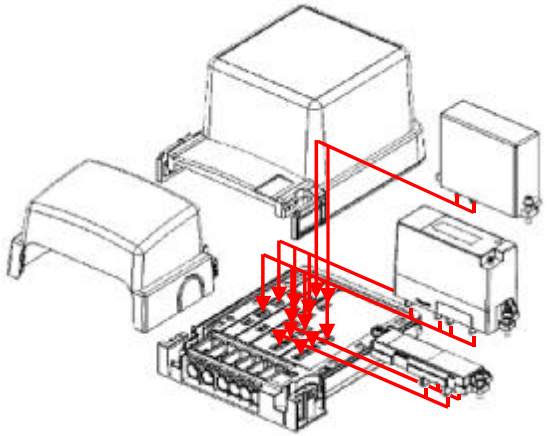
Proper communication media can be selected.

Metering unit

- Ø Certification is only for this unit
- Ø Plug-in structure realize no live-line work

Switching unit (option)

- Ø Switching function is achieved by SW-unit
- Ø On/Off is switched remotely

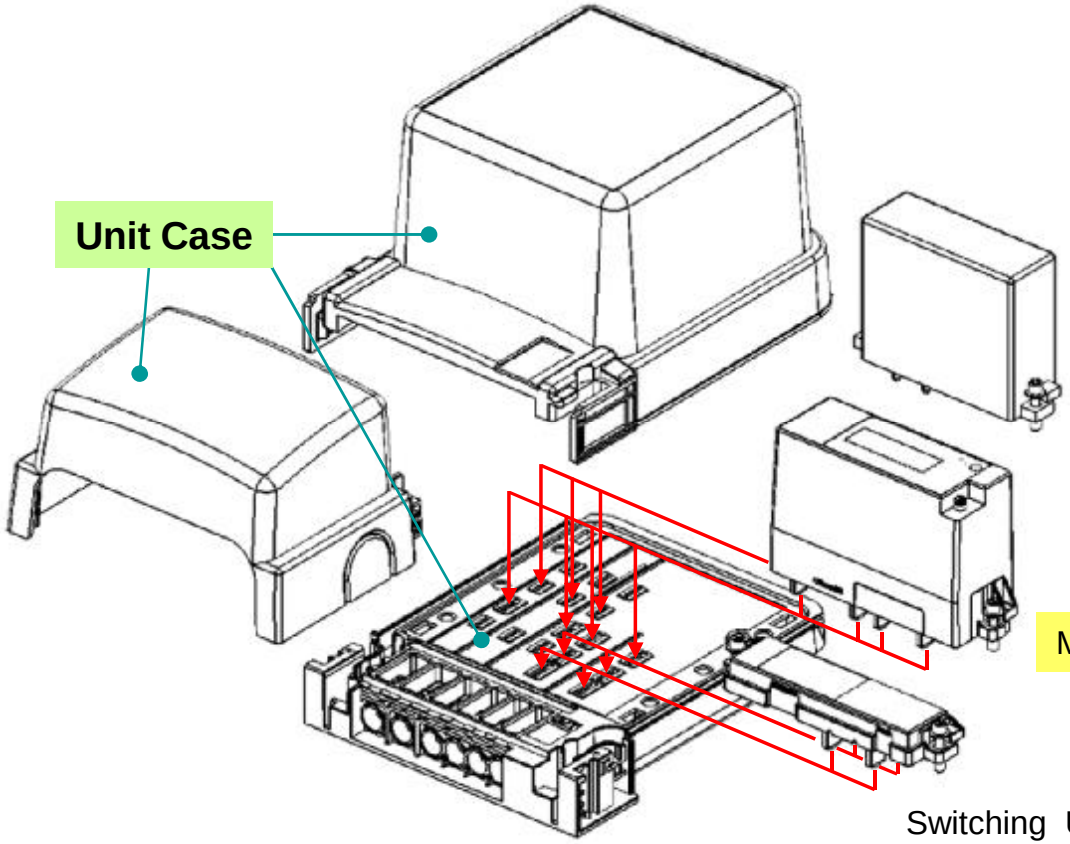


- Plug-in module structure frees us from live-line work !!
- SW unit or other value-added function unit can be installed if necessary

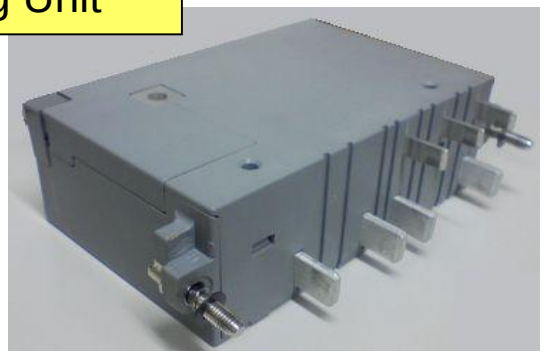
3 million Smart Meters are deployed (As of August, 2014)

Structure of KEPCo's Smart Meter

Unit Case



Metering Unit

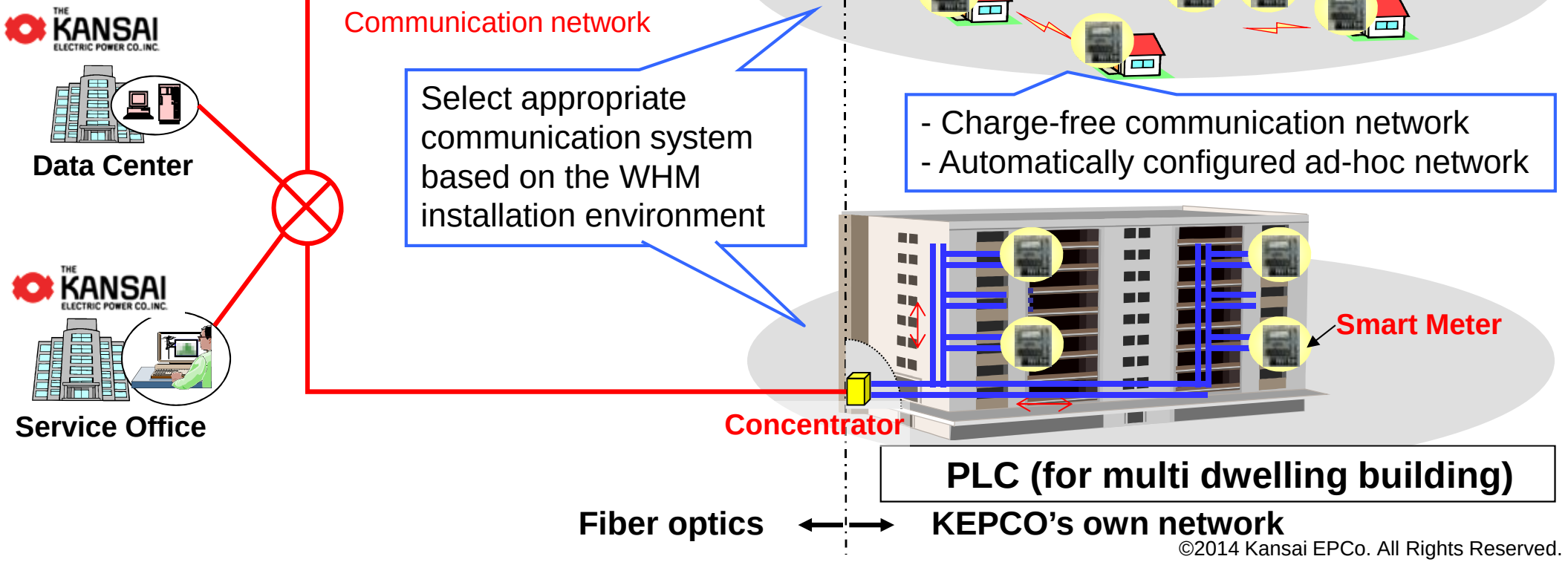


Outline of KEPCo's Advanced Metering Infrastructure

Remote meter reading

- Improving operational efficiency.
- Reducing injury accident risk for meter readers
- Solving hard-to–access meter problem

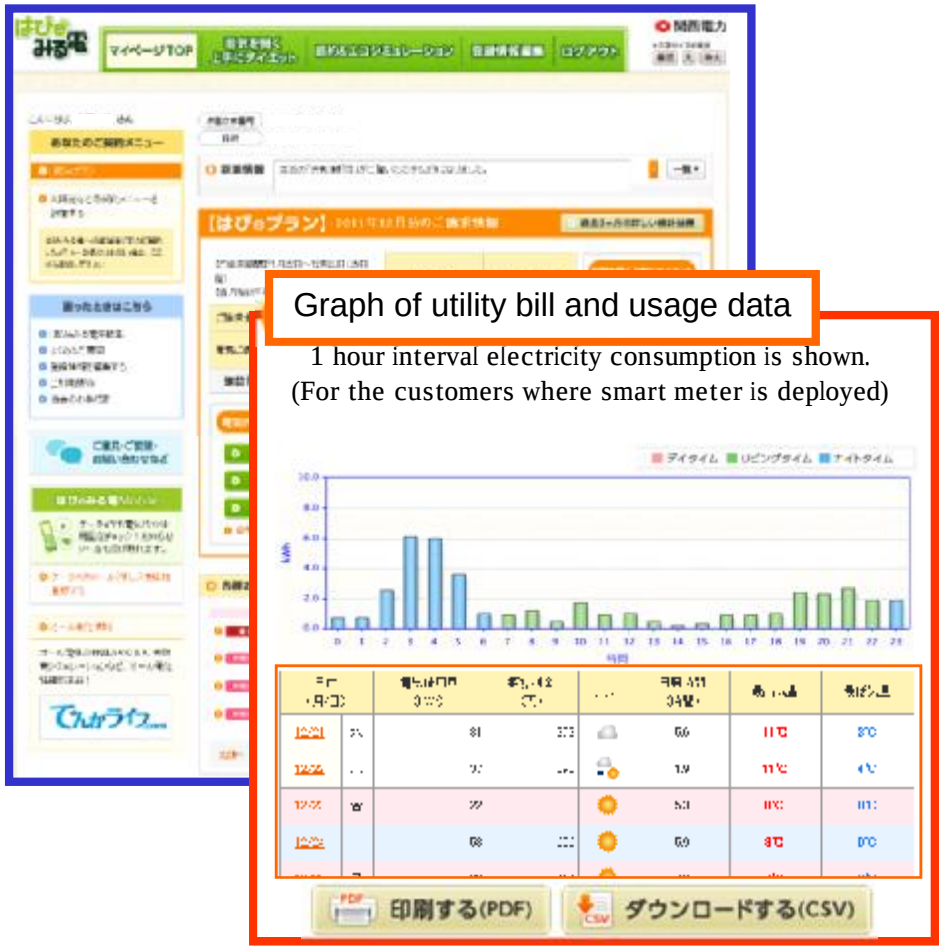
Electric Charge calculation based on 30-min usage data at the Data Center



Visualization of Energy Consumption

［Purpose］◆ **Send utility bills to our customers (not posting)**

◆ **Support energy saving for our customers**



◆ Customers can check the bill anytime, anywhere.
- Charge information will be sent.
- Able to access via PC or Cell Phone
- **Able to check the purchase rate generated by Solar Panel.**
- Able to check last 24 months data.
- Able to compare with the bill **(last month, last year)**

◆ **Compare with the bill with the others**
- Show CO2 emission

◆ **Show the simulation result of energy saving**

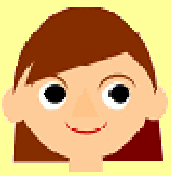
◆ **Make the power saving target, and record**

◆ **Able to download the usage data (.csv, .pdf)**

740,000 Customers joined (2014.3)

［**Customer's Voice**］(Woman, 40s)

"This service is very useful and we are happy we can check our utility bill and interval usage data via internet."



Visualization of Energy Consumption

Show utility bill and energy usage (in ranking format)

Based on Type of House, Number of Rooms、Number of Family members)

Customer's rank after replacing home appliance

Utility bill saving effect of home appliance replacement

Saving Result (Whole Year)

Show the energy saving simulation result by replacing Eco-friendly home appliances (such as refrigerator, air-conditioner,…)

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Japanese Demonstration Projects of Smart Community

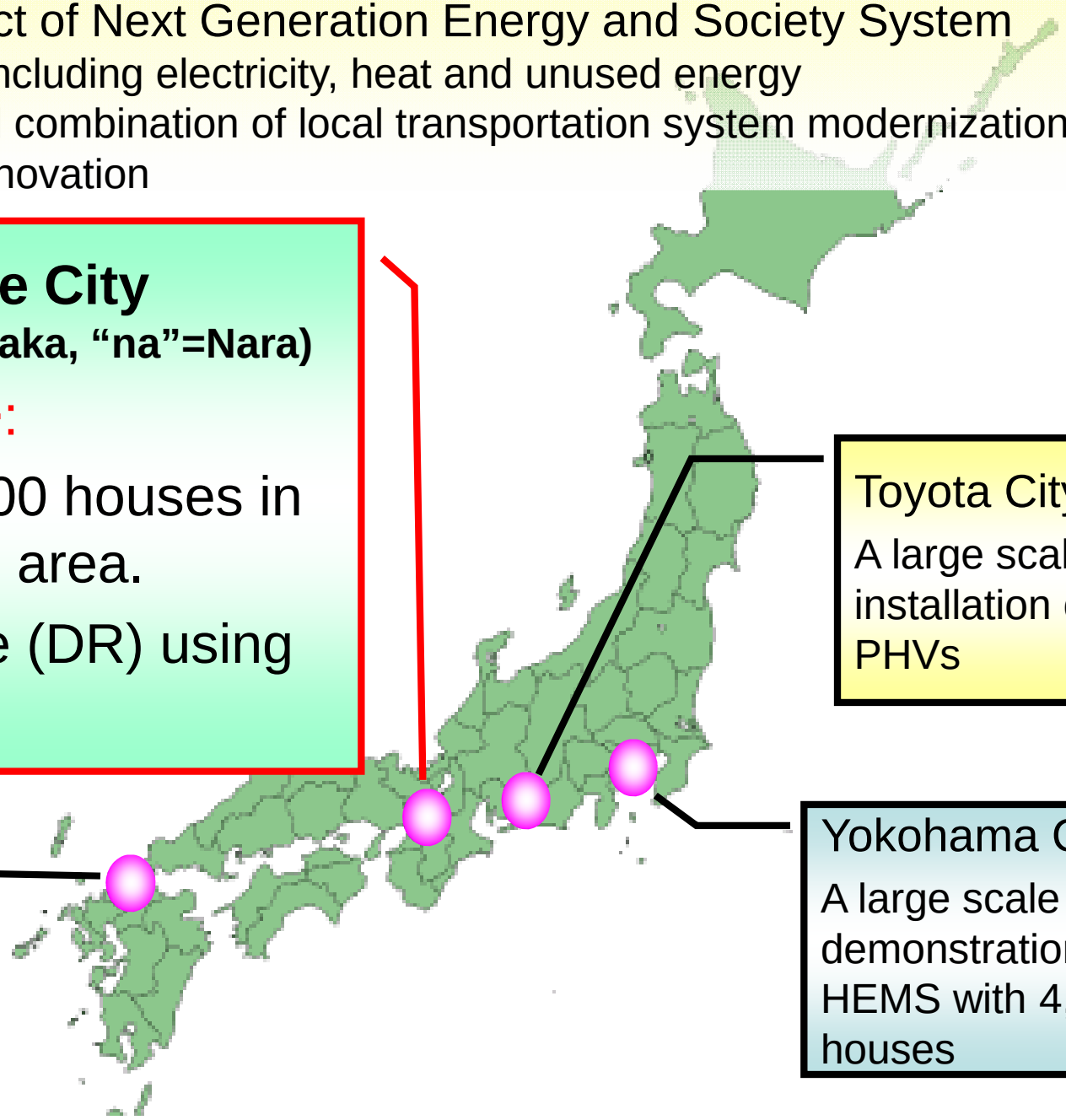
- Demonstration Project of Next Generation Energy and Society System
  - Energy utilization including electricity, heat and unused energy
  - Demonstration and combination of local transportation system modernization and citizen's lifestyle innovation

Kei-han-na Science City
("Kei"=Kyoto, "han"=Osaka, "na"=Nara)

<Kansai EP joined>:

Demonstration of 700 houses in a normal residential area.

(Demand Response (DR) using Smart Meter)



Toyota City:

A large scale installation of 4,000 PHVs

Yokohama City:

A large scale demonstration of HEMS with 4,000 houses

Kitakyushu City:

Demonstration of dynamic pricing model in a local grid

DR Demonstration Project in Kei-han-na

Home

Power consumption

Notice of dates for CPP

Remaining points

Tablet

WLAN

30-min usage data

Smart meter

CPP(Critical Peak Pricing) Method

◆ A simulated point system instead of the regular contracted rate

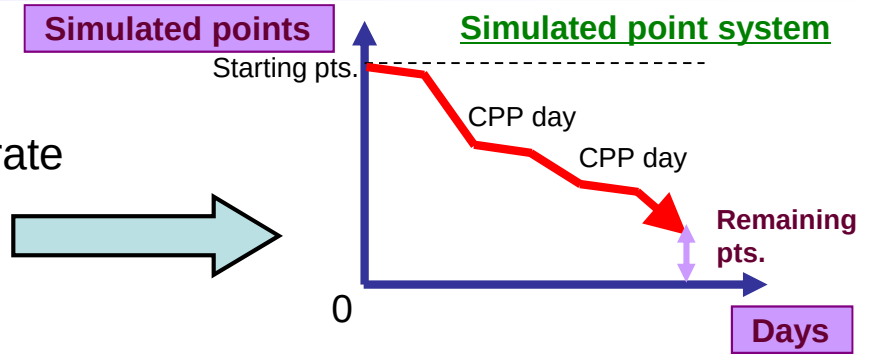
◆ Simulated point system (C D)

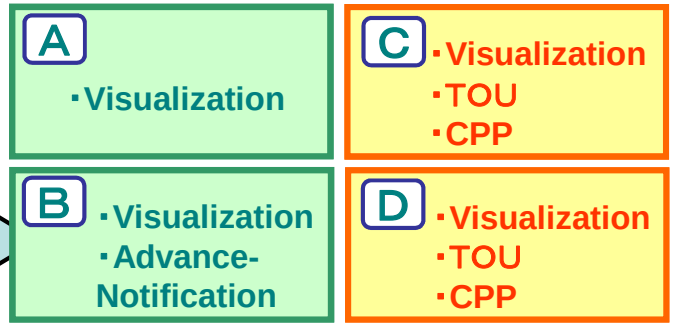
✔ All participating residents were given points at the start.

✔ When customers consumed power during peak hours, points were deducted at a rate as follows;

- On normal days : 20 P / kWh. (TOU)
- On CPP days : 2x(40P/kWh), 3x(60P/kWh), 4x(80P/kWh)

◆Participating household were divided into four groups, with each group being subject to specific DR measures.





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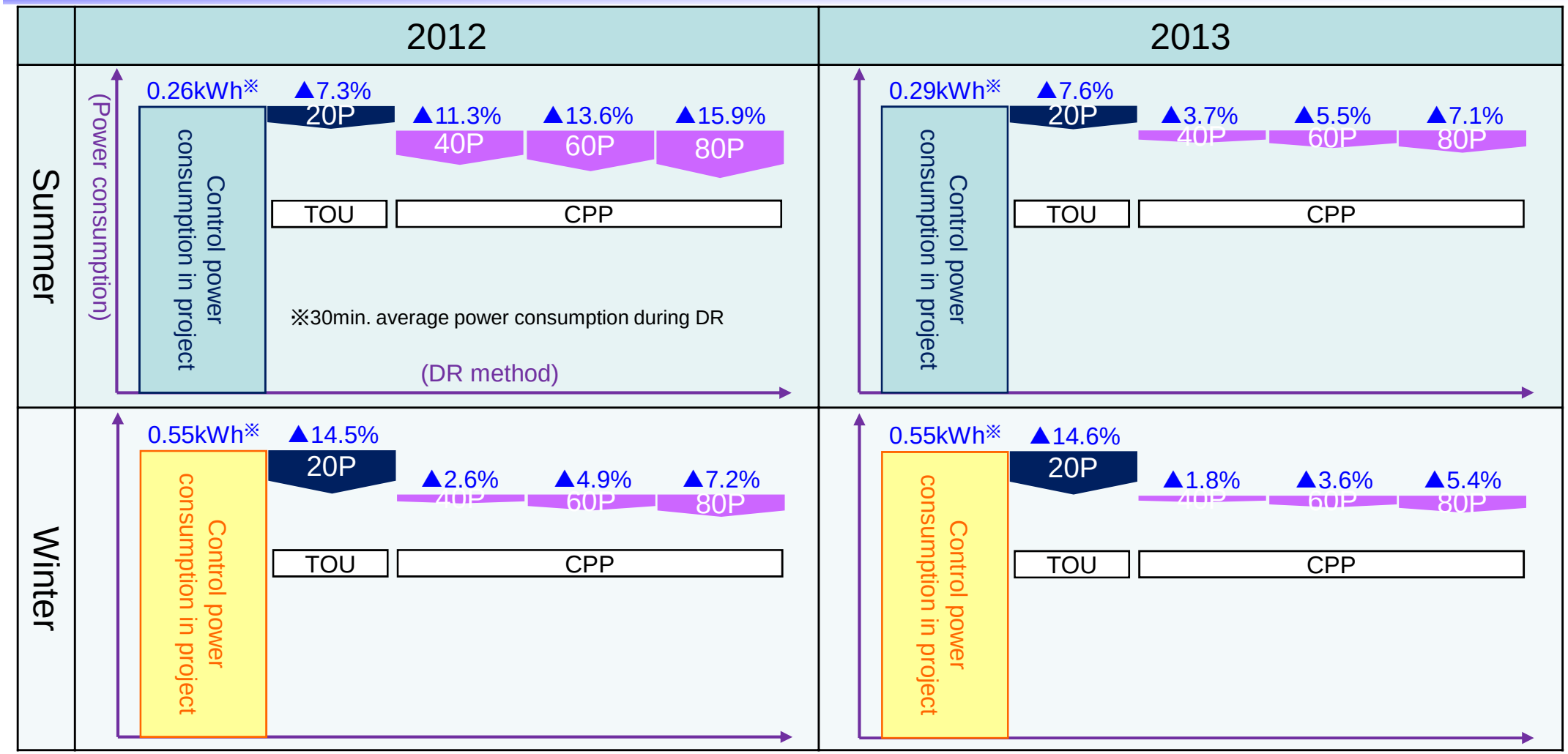
	Summer	Winter
Peak hours	Weekday 1 p.m. - 4 p.m. (3hours)	Weekday 6 p.m. - 9 p.m. (3hours)
Term	[2012] Jul.23 - Sep.28 [2013] Jul. 8 - Sep.18 (46 Weekdays)	[2012] Dec.17 - Feb.28 [2013] Dec. 2 - Feb.13 (46 Weekdays)
Requirement	maximum temperature ≧ 30℃	maximum temperature ≦ 14℃
Repeat	15 - 16 (40P, 60P, 80P x 5 - 6 each)	21 – 24 (40P, 60P, 80P x 7 – 8 each)
Starting Pts.	7,000 P	16,000 P

DR Demonstration Project in Kei-han-na



Effect	2012 to 2013 (Summer)	2012 to 2013 (Winter)	Winter to Summer
TOU	2013 ≒ 2012	2013 ≒ 2012	**Winter ≒ Summer x 2**
CPP	**2013 ≒ 2012 x 1/3 or 1/2**	**2013 < 2012**	**Winter << Summer**

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Conclusion

- S (Safety) + 3E (Energy security, Economy, Environment) will continue to be the priority mission in pursuing the best energy policy in the future.

  We the KEPCO will also advance our Smart Grid construction with S+3E as the premise.

- As we pursue the road toward the Smart Grid, the following points must be emphasized:
  ① That our grid will accommodate large-scale renewable energy generators; and
  ② That our energy conservation methods do not sacrifice our customers' conveniences.

Thank you for your kind attention