Utility's Perspective : "Integration of Renewable Energy in Japan"

Hiroshi Okamoto, PhD
Senior Manager, Smart Grid Strategy
Tokyo Electric Power Co.

TEPCO

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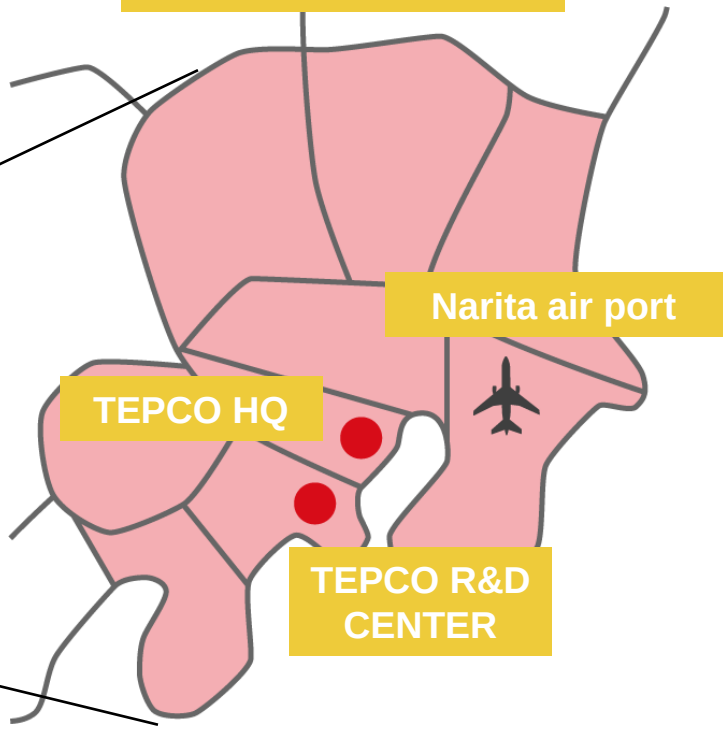
Outline of TEPCO

Total service area of Japanese 10 Utility companies

Population(million):127.68
Area(km2):377,915
Electricity sales(TWh):882.6
Peak demand(GW):179(1)

TEPCO service area



Population(million):43.91
Area(km2):39,494
Electricity sales(TWh):288.7
Peak demand(GW):64.30

(1)rough fig. Aug 22, 2007

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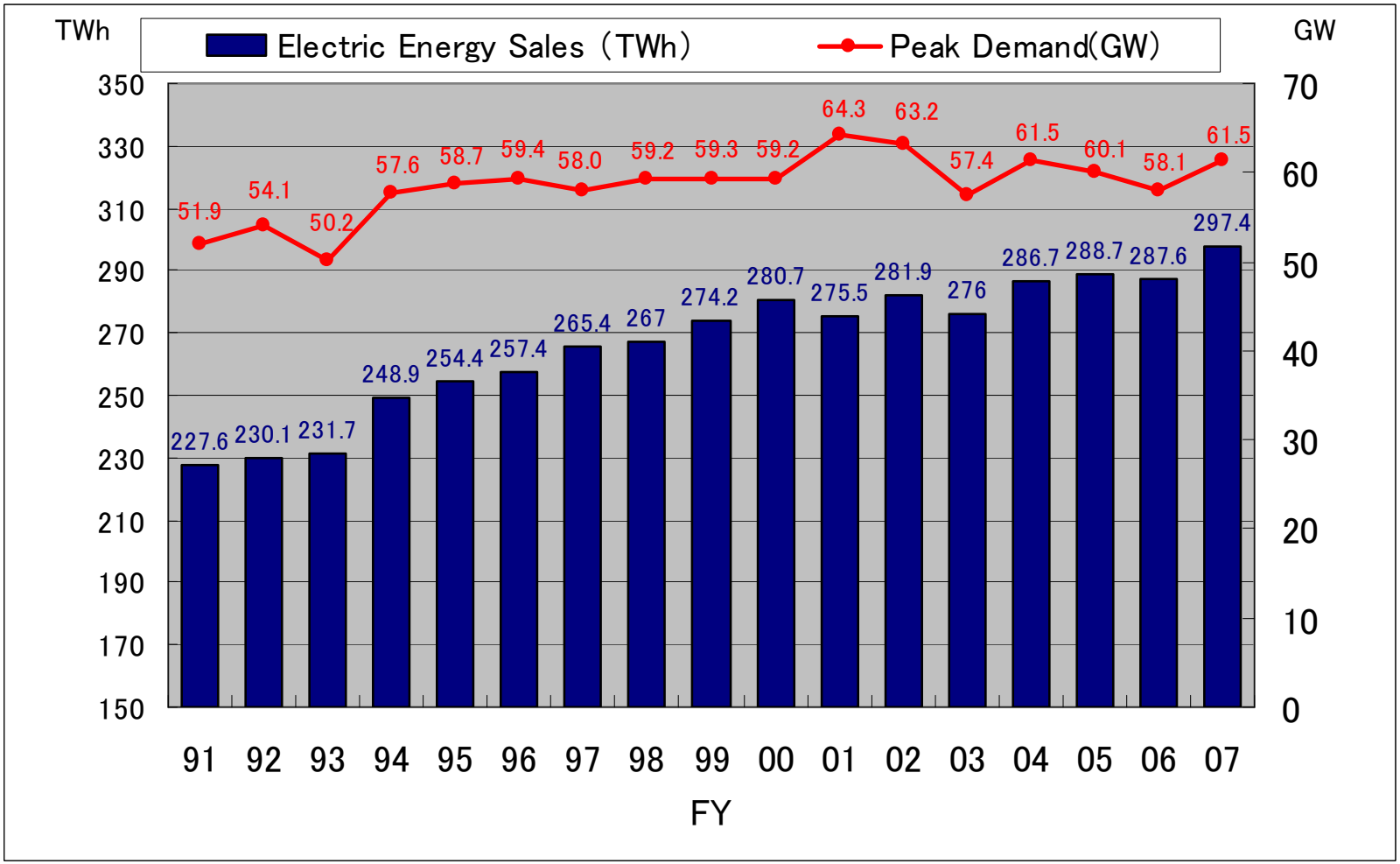
Change in Power Demand

- **Power demand is constantly increasing in slow growth .**



Change of power demand in TEPCO

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1. Low Carbon Society Realized by Electrification

(1) Supply Side

Reduction of CO2 emission by Generation Mix

- **Promotion of Nuclear Power and Renewable Power**
- **Improvement in Efficiency of Fossil Plants**

×

(2) Demand Side

Smart Use of Electricity

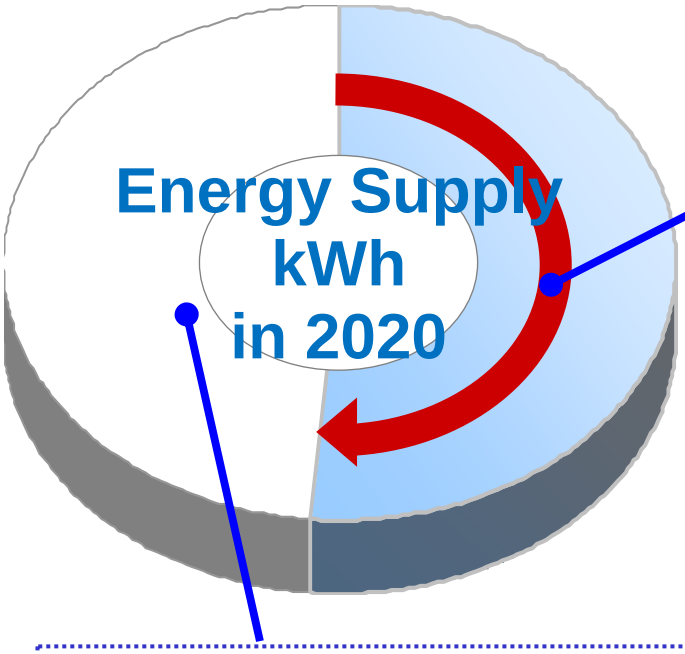
- **Heat Pump, Induction Heating**
- **EV etc.**

Cope with changes in supply and demand utilizing ICT flexibly

Smart Grid

Low Carbon Society by Electrification

2. Smarter Supply



- Improvement in availability factor of nuclear power plants
- Further nuclear development (Fukushima and Higashidori)
- Increase in renewable energy

➲ Non Fossil Generation will exceed **50% by 2020**

- Reduction of CO2 emission from fossil fuel plants
- Introduction of most advanced combined cycle, whose efficiency exceeds 61%

CO2 emission density in TEPCO will be reduced to

0.28kg-CO2/kWh in 2020

(**more than 25% reduction compared to 1990**)

3. Smarter Use of Electricity

Heat Pump (HP) and Induction Heating (IH) Technologies

Commercial Building	Electrification of Factory	All Electric House
Hot water supply and air conditioning by Heat Pumt	No-steam factory realized by HP and IH technologies	27% reduction in CO2 emission

Highly efficient heat supply (COP: 3 to 6)

HP has potential to reduce 130 million t-CO2 emissions per year in Japan, if used in all available areas in the residential, commercial, and industrial sectors.

Transportation Electrification

EV

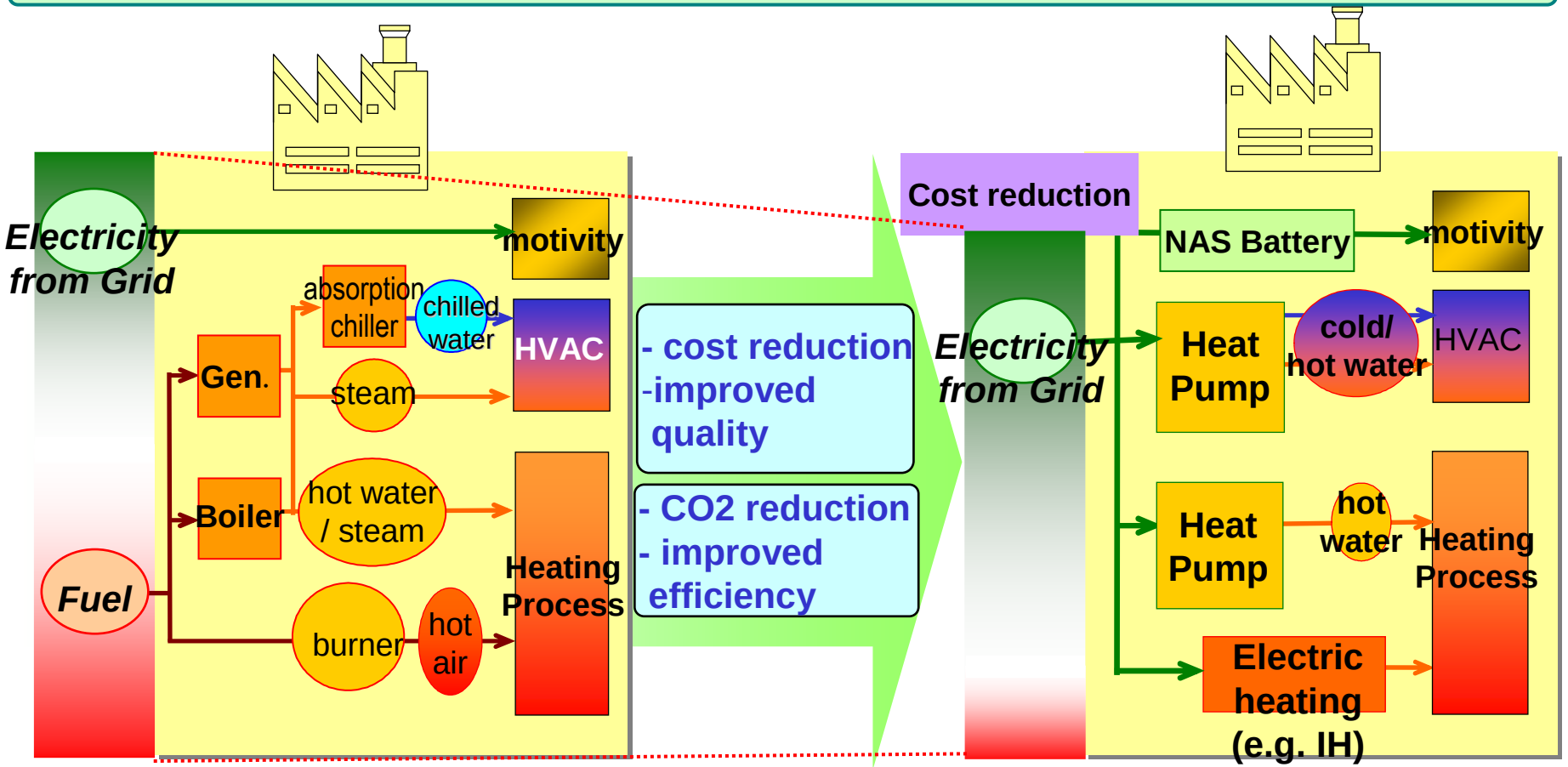
75% reduction in CO2 emission

90 milion t-CO2 reduction/yr in Japan

Promotion of Quick Charger

<Smarter Use of Electricity (1): Electrified Factory>

Fully utilization of the state-of-the-art heat pump and other electric heating technologies in manufacturing processes in the factory.



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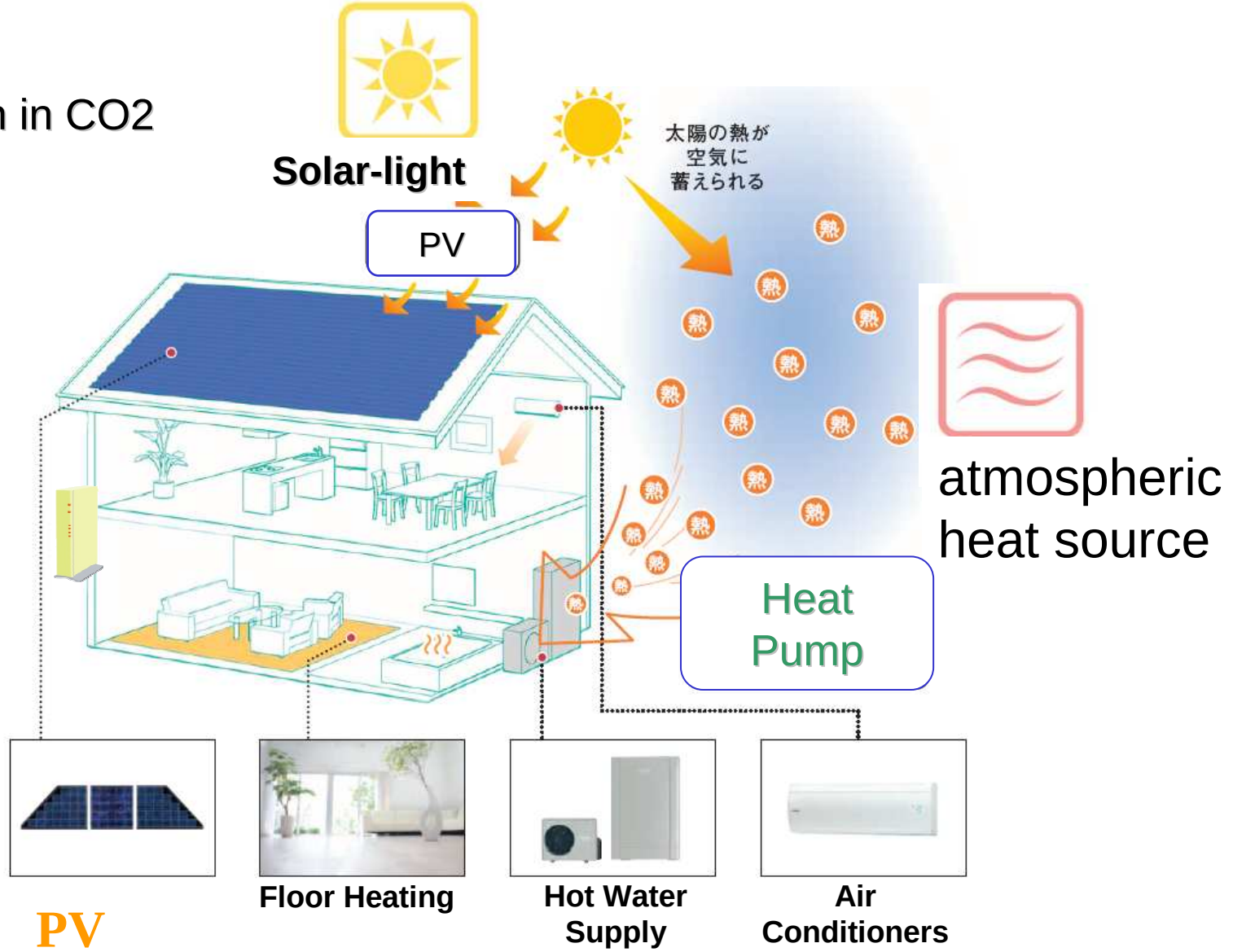
<Smarter Use of Electricity (2) :Twin-Solar>

56% reduction in CO2 emission



<Smarter Use of Electricity (3): EV and Quick Charger>

- Development of quick charger for EV
  5 min for 40km driving range、10 min for 60km driving range
- TEPCO plans to introduce about 3,000 Electric Vehicles for business use
- Establishment of CHAdeMO Alliance to promote international standardization of Quick Charging Technology

3phase/200V

DC
125A

Quick Charger
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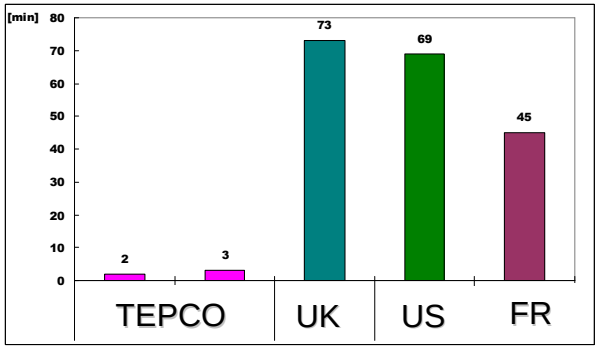
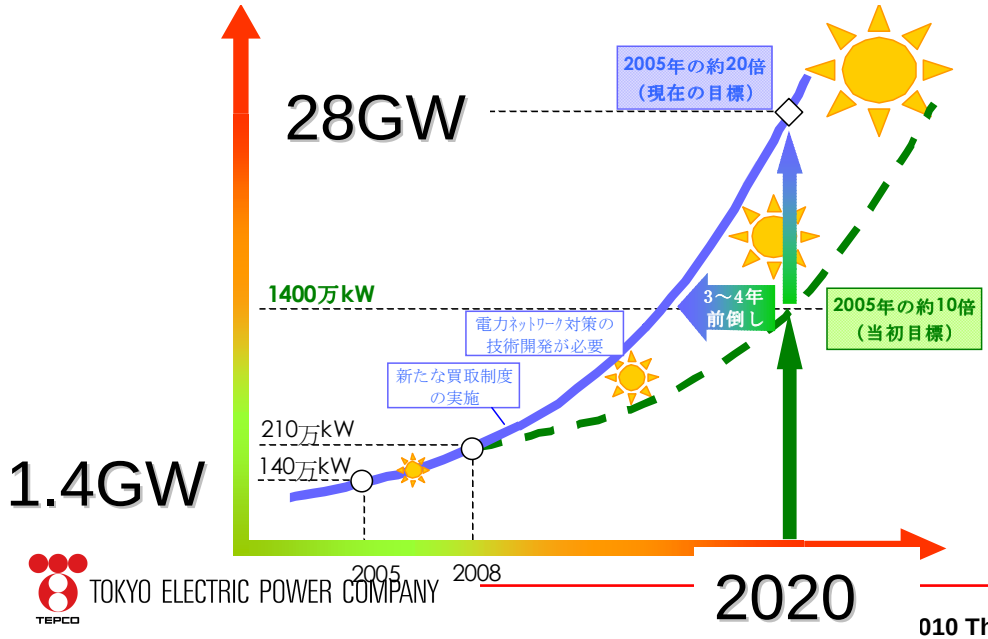
4. Needs for Smart Grid in Japan

- **Present Japanese Grids**
  - – Enough investment and coordinated construction in Generation and Transmission sectors, Modernization by ICT
    -> Highly reliable power grids
  - – Load leveling with help of TOU and load curtailment program

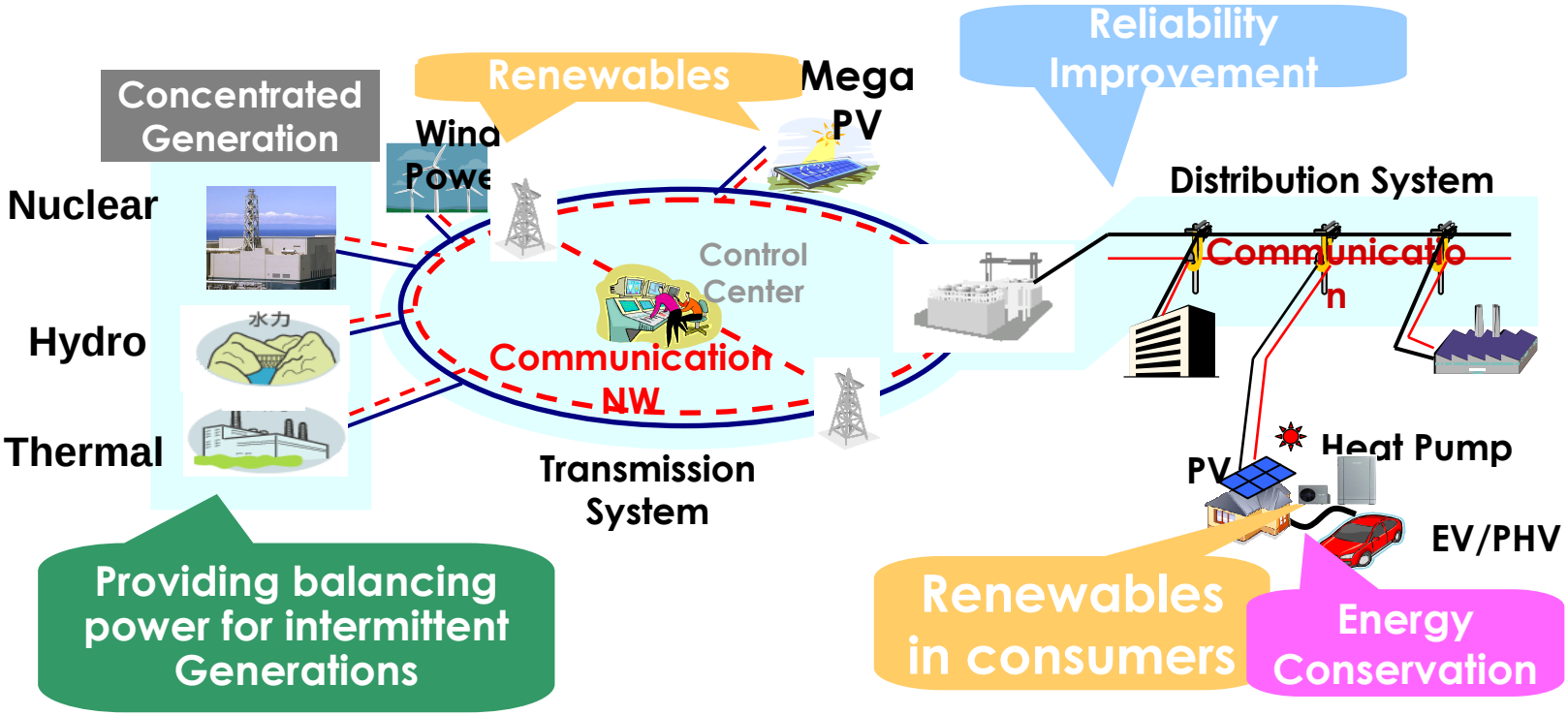
Annual Power Outage (SAIDI)





Needs for Smart Grid to integrate a huge amount of renewables (e.g. residential PV)

5. Vision of Smart Grid in TEPCO



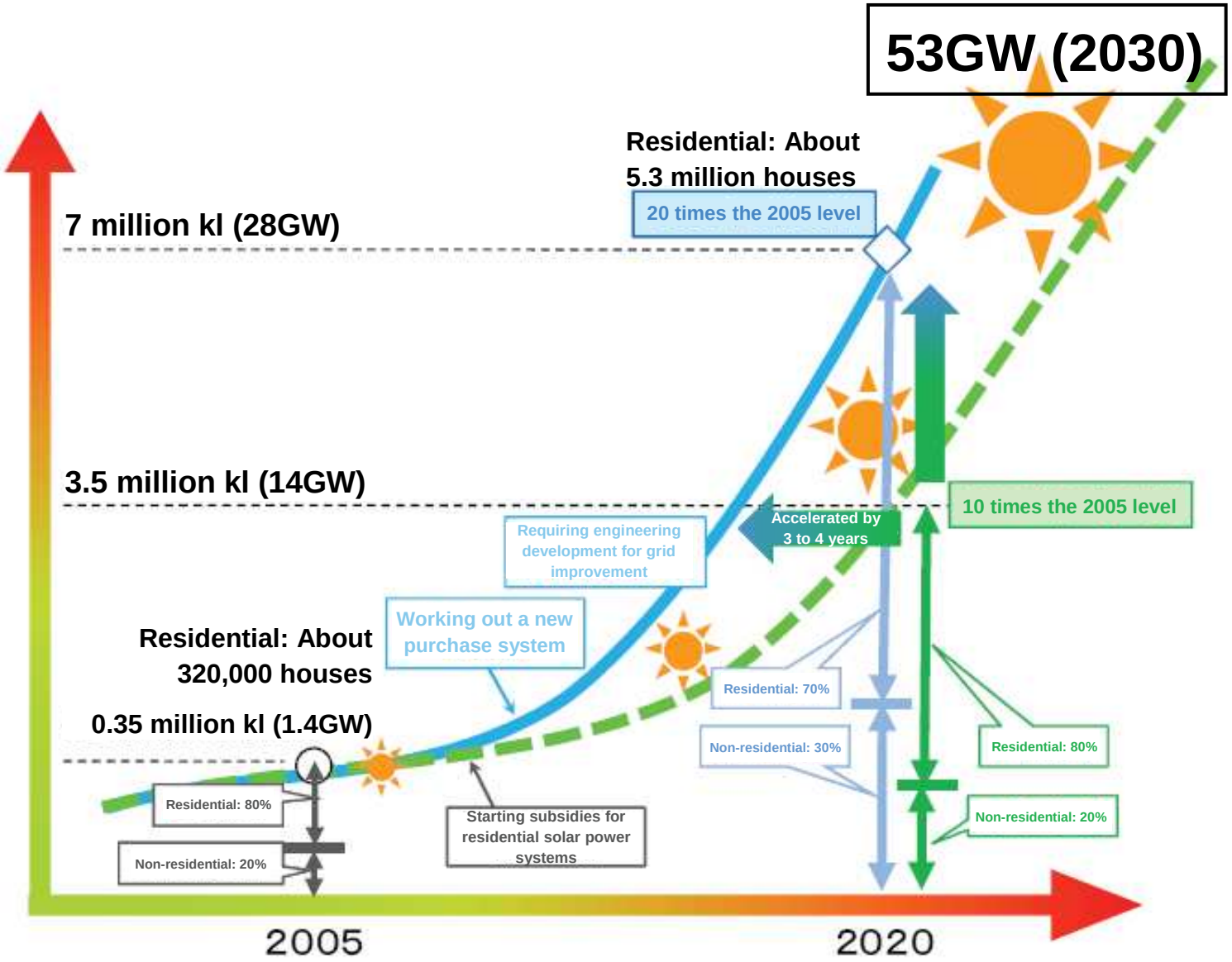
Integrated solution by utilization of ICT

(1) Integration of Renewable Energy

(2) Support for Smart Use of Electricity

(3) Modernization of Transmission and Distribution

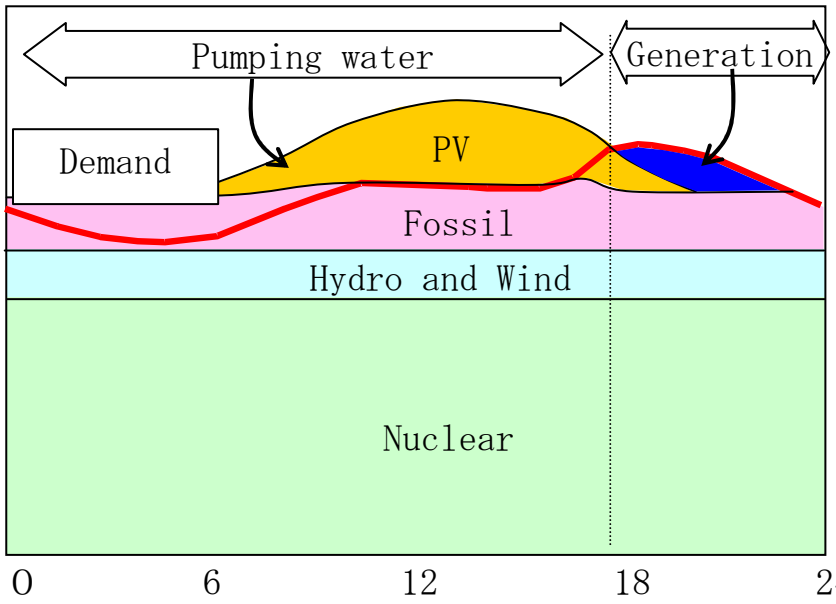
5-1 Integration of a huge amount of PV



Surplus electricity in low demand season with 53GW PV penetration in 2030

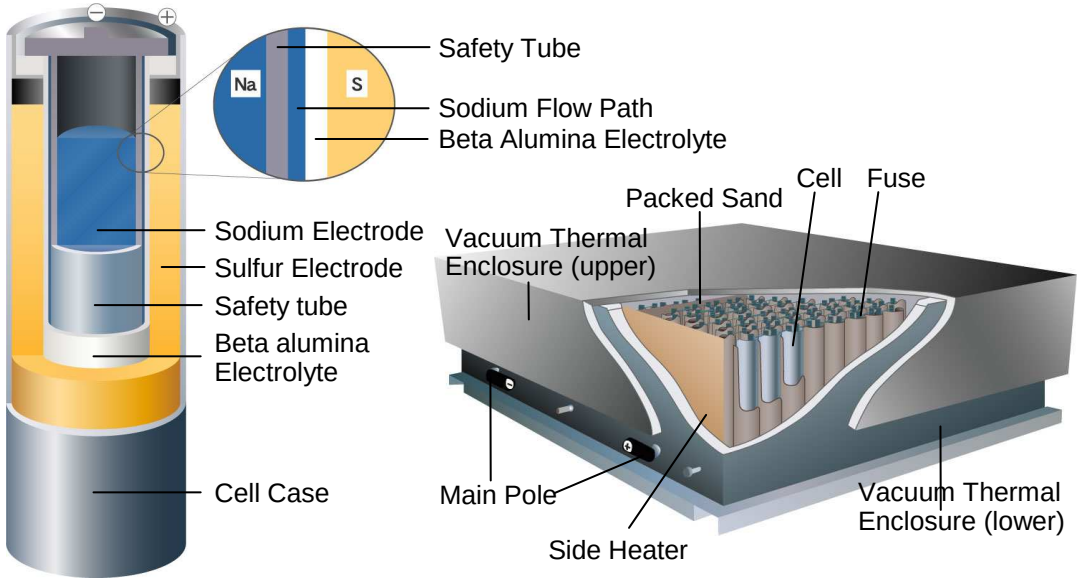
- It will become difficult to maintain supply-demand balance especially in spring and autumn.
- Electrification (e.g. Heat Pumps and EV) (and demand shifting) will be able to reduce the electricity storage requirement.

Supply-demand balance under the high penetration of PV
(it will require storage devices such as pumped storage, batteries)



System side solution
- energy storage (NAS battery) -

- **Sodium-Sulfur (NAS) battery**
  - **Typical System: 2,000kW (50kW times forty), 12,000kWh**
- **More than three times of energy density compared with lead-acid battery**
- **Load leveling, Peak shaving, Support renewable energy installation**
- **95 units of 176MW installed on the site of commercial customers of TEPCO**



CELL **MODULE**

A model site of NAS cell

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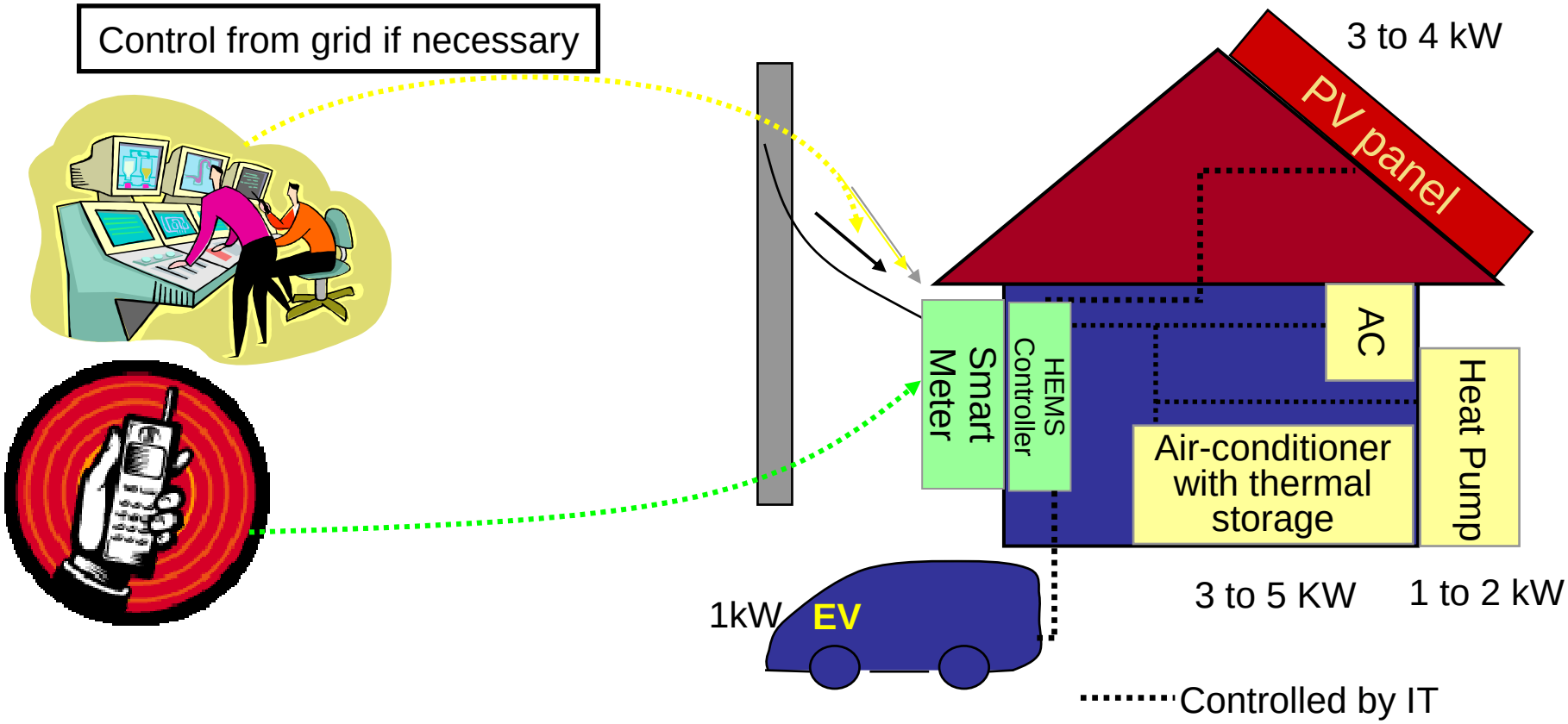
Demand side management at home in future
- load leveling via smart interface -



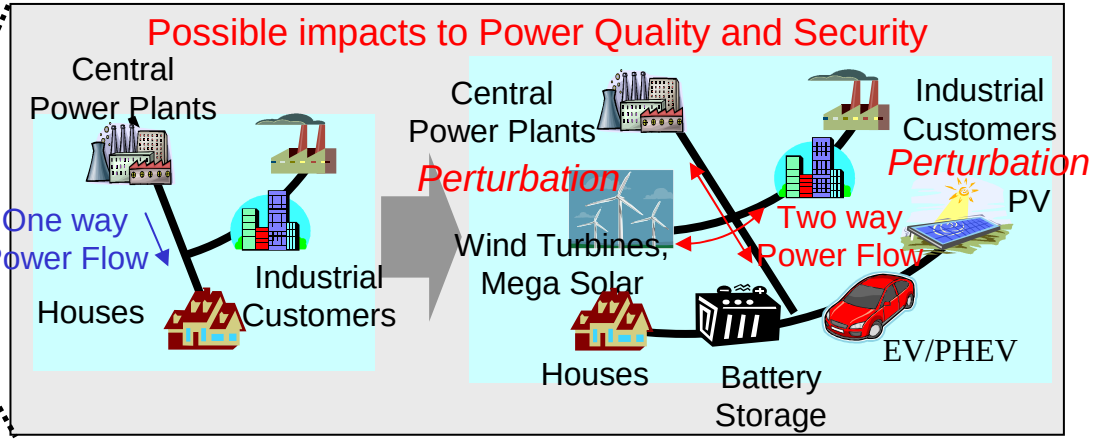
6. Smart grid field tests

Social requirements for CO2 Reduction
Tangible constraints of fossil fuels

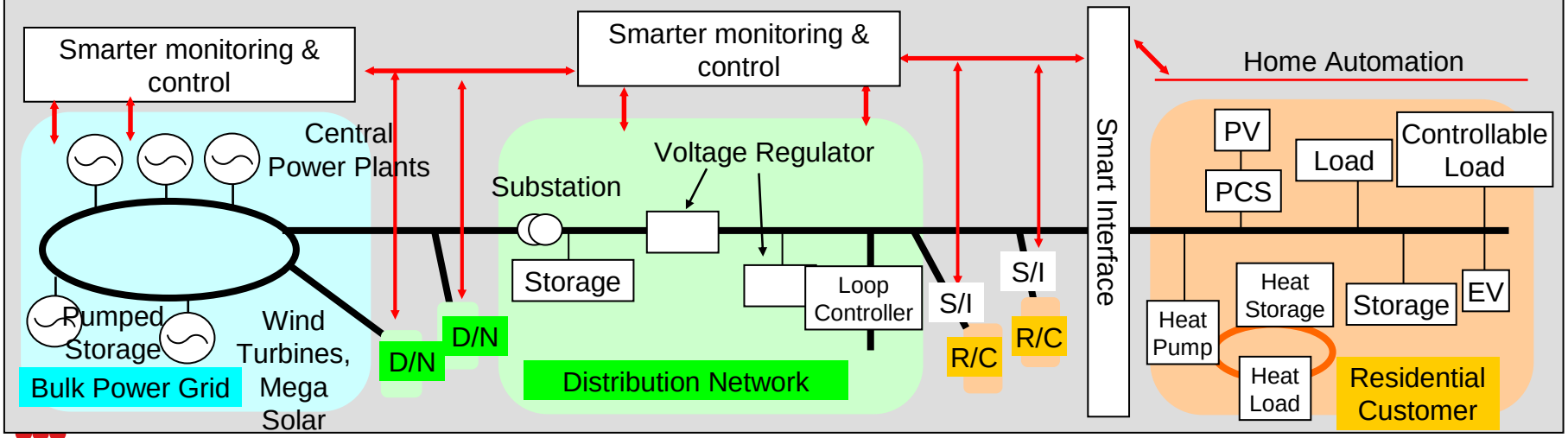
Low-Carbon Power Grid

Massive penetration of Renewables

Reduction of CO2 from Power Plants
（Nuclear, IGCC, CCS）

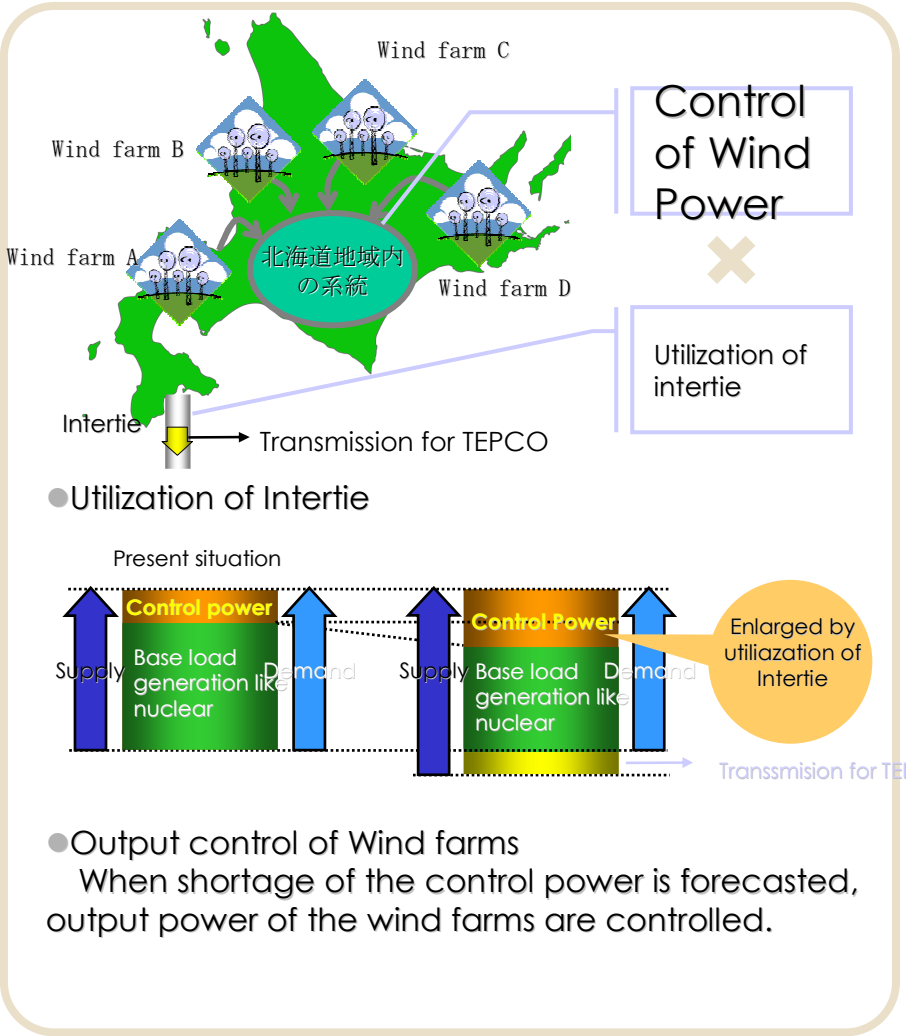


Vision: Minimize CO2 emissions and social costs and enhance power quality and security by making both of power grid and customers smarter



Field test of wind integration by TEPCO and Hokkaido Electric Power Co.

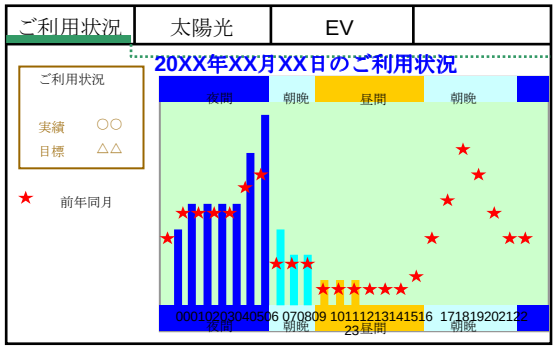
- Background
  - Hokkaido : suitable places for wind energy, but limit installed capacity of wind energy from the viewpoint of supply-demand balance problem because of the small control area
  - TEPCO area : large control area but limited wind energy resource
- Objectives
  - Increase in the wind energy in Hokkaido area with the cooperation of the two companies
- Field tests
  - Combination of new control scheme of wind farms and utilization of the interconnectors.
  - Install new wind farms (100-200MW) before 2014



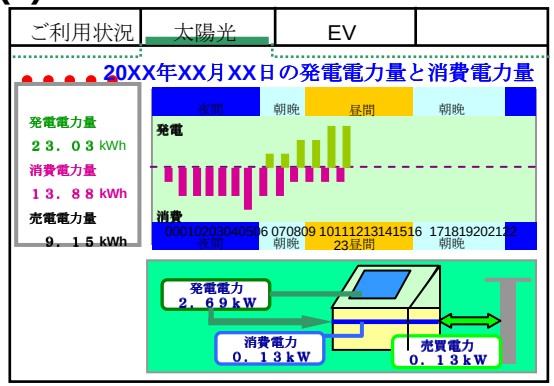
5-2 Support for Smart Use of Electricity

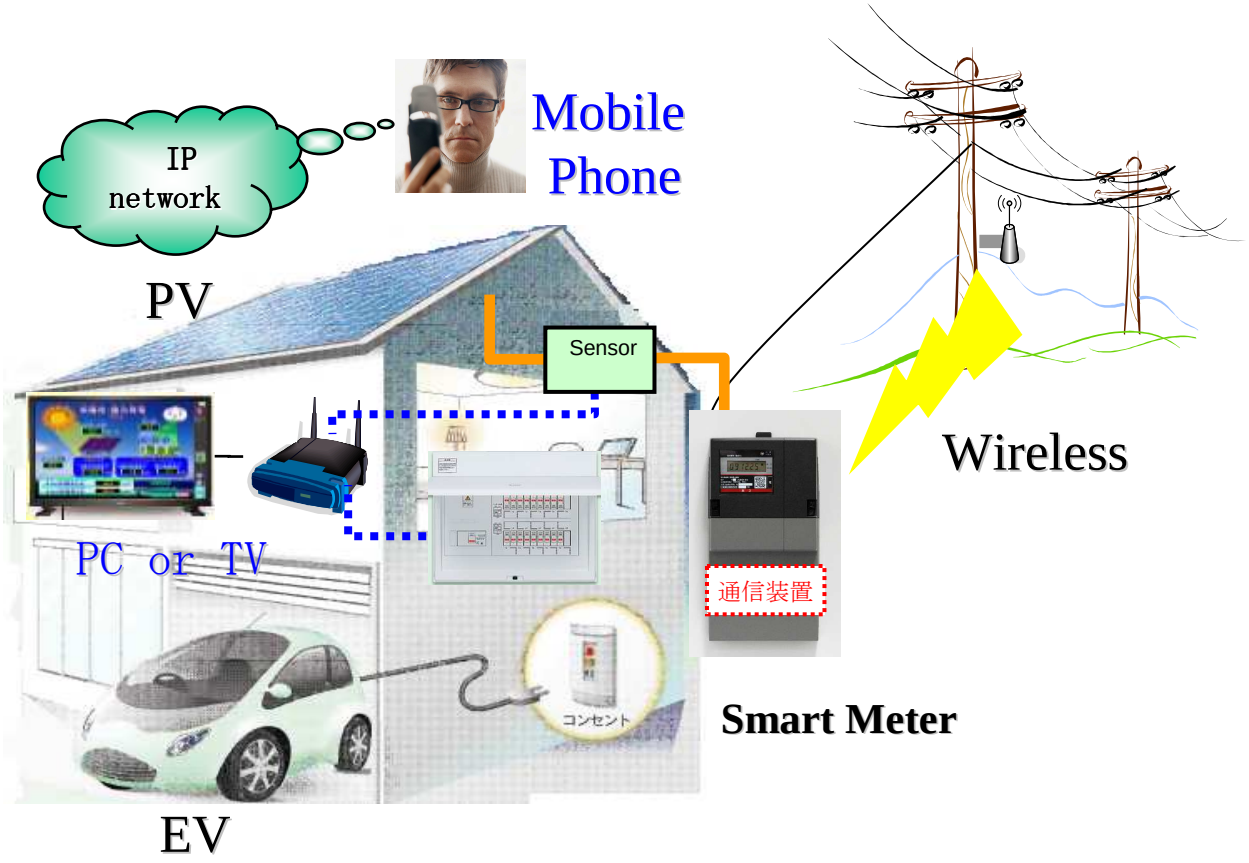
- AMR will enable business efficiency in utility and visualization of electricity usage, which helps customers save the energy.

(1) Visualization of Electricity Usage



(2)Generation of PV





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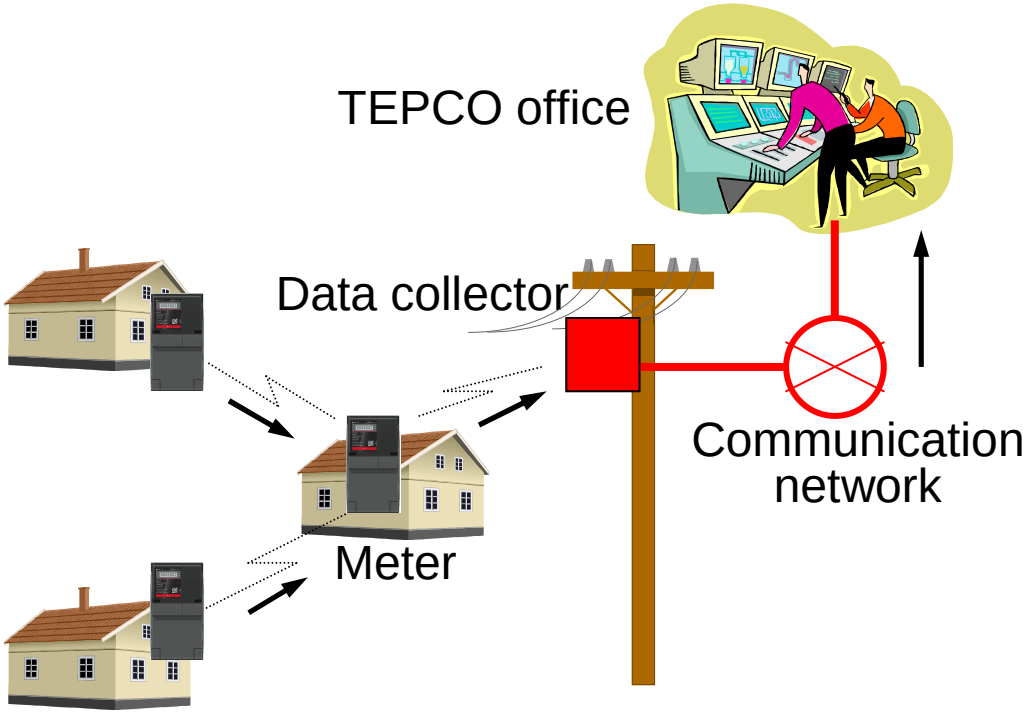
Planned Field Test of Smart Meter

Field Test of Advanced Metering Infrastructure (AMI)

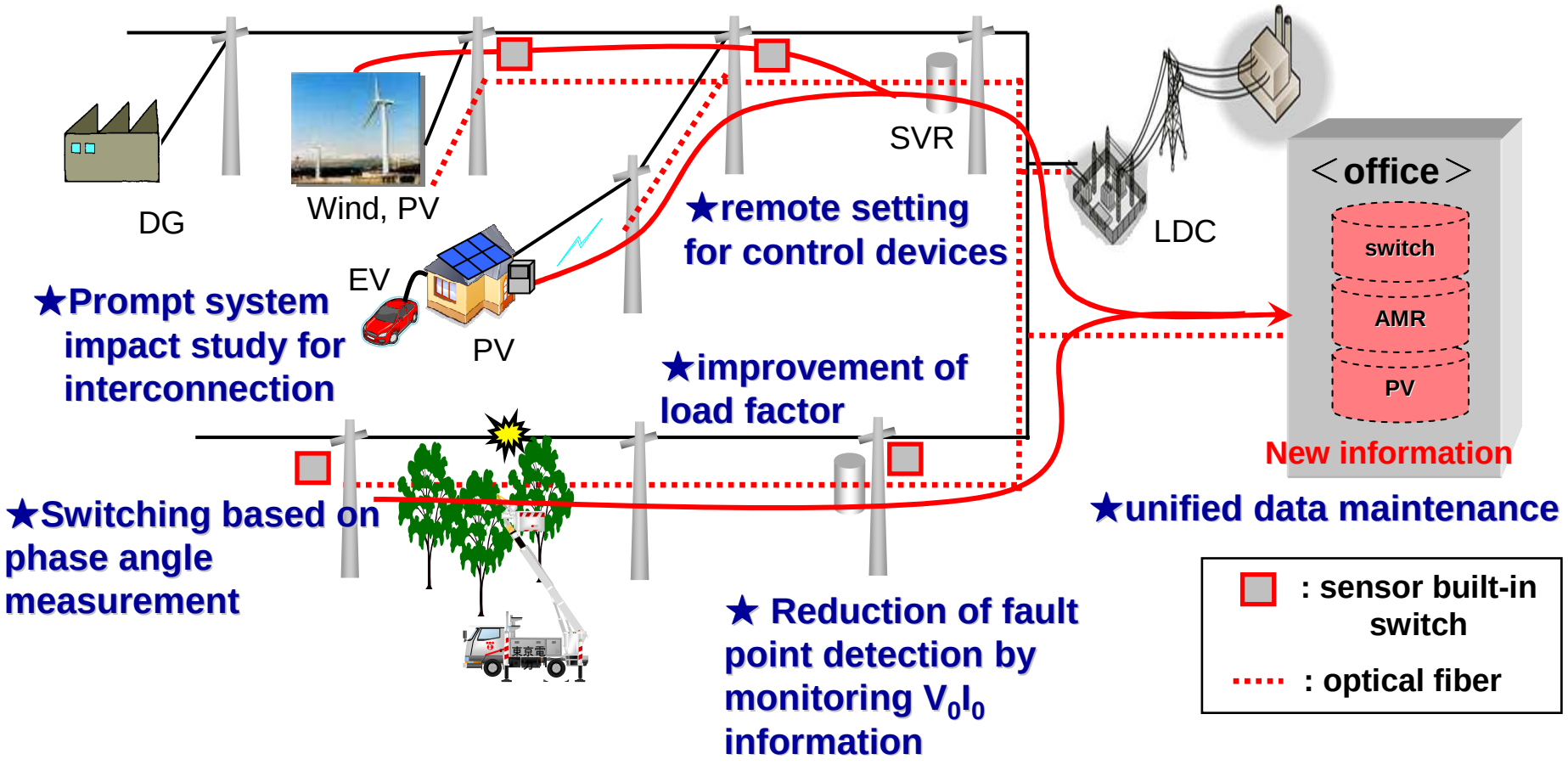


Developed Meter

- **Objective: verification of functions of AMI and AMR (<u>not for DSM or DR</u>)**
- **Test period: 2-3 years**

5-3 Modernization of Transmission and Distribution

Advanced Distribution Automation System



6. Conclusions

- "Smart Use of Electricity" is needed to achieve 3E. "Smart Grid" is a platform for realizing "Smart Use of Electricity".
- The objectives of smart grid in TEPCO are as follows,
  1. **Integration of renewable power to the grid**
  2. Support for energy saving and smart use of electricity
  3. Further improvement of transmission and distribution.
- TEPCO will pursue "potential" of Smart Grid through broad-range collaboration between relevant parties. "Robustness" is also needed as the indispensable infrastructure.
- We proceed steady approaches to ensure the following issues based on the field tests,
  1. Maximization of cost-benefit performance
  2. Acceptance of customers and society, maximization of social benefits

Appendices

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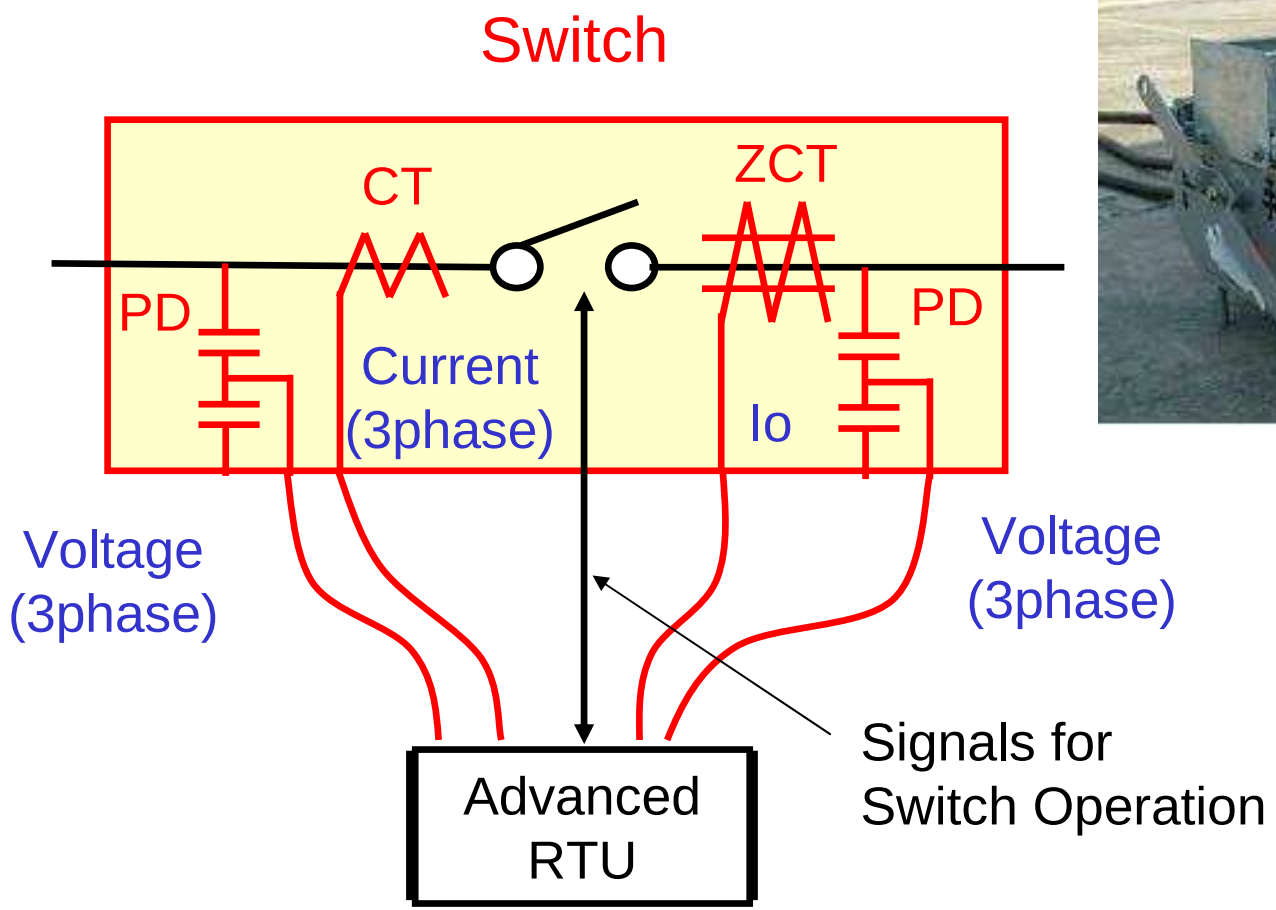
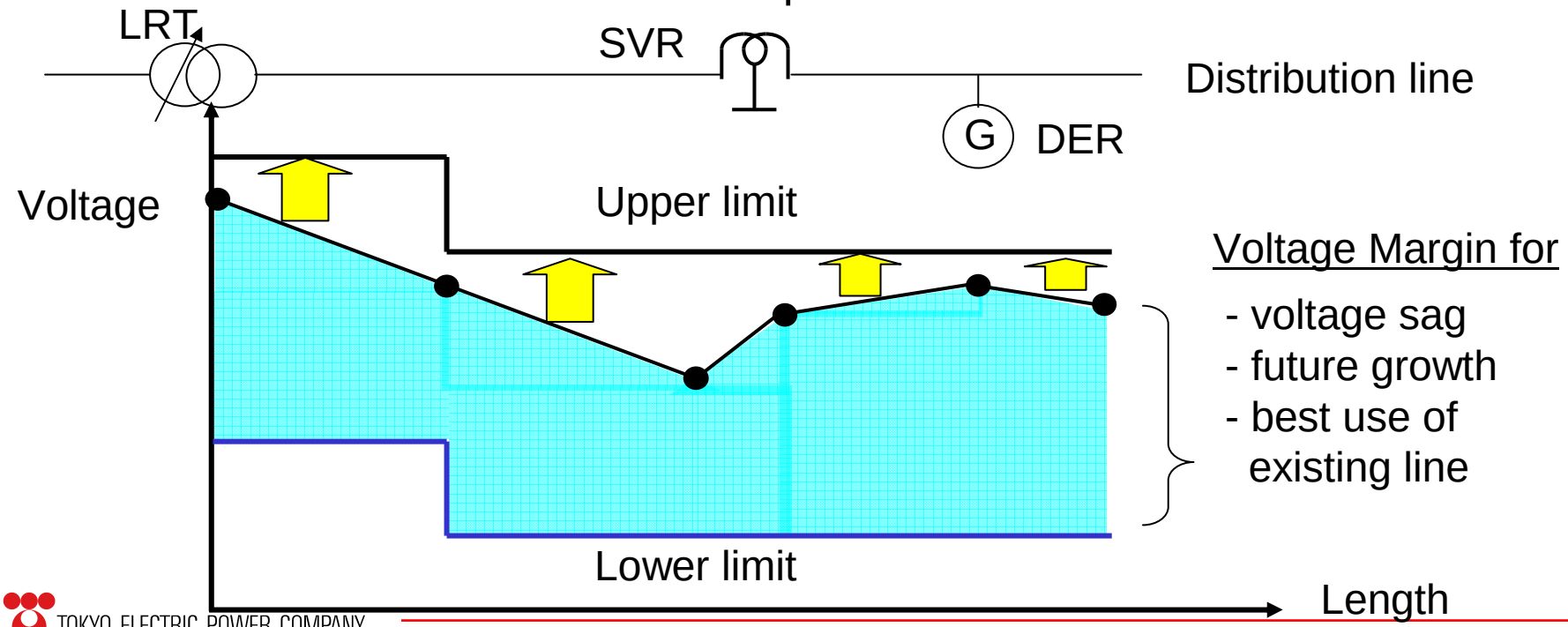
Sensor built-in automatic switch



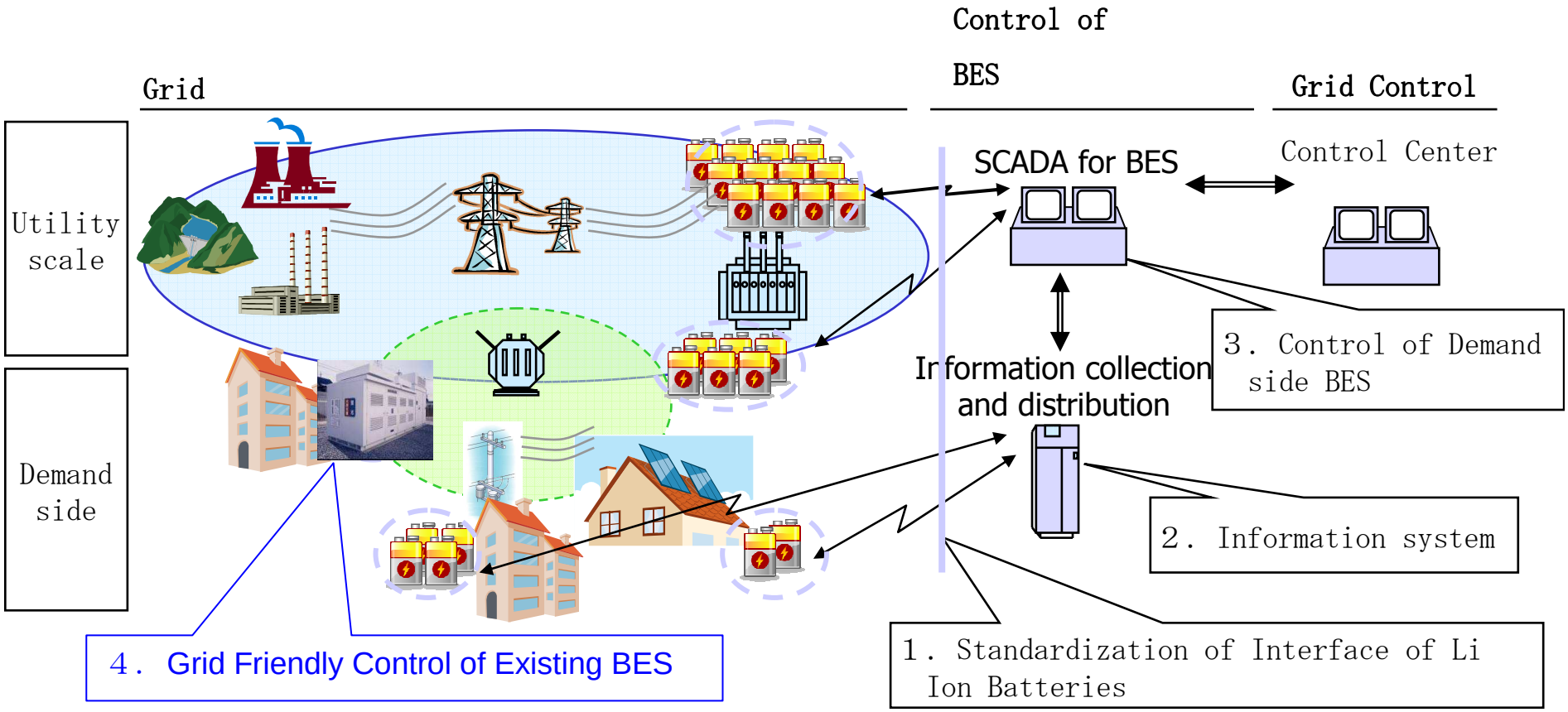
Central Voltage Control System

Central Voltage Control System automatically makes

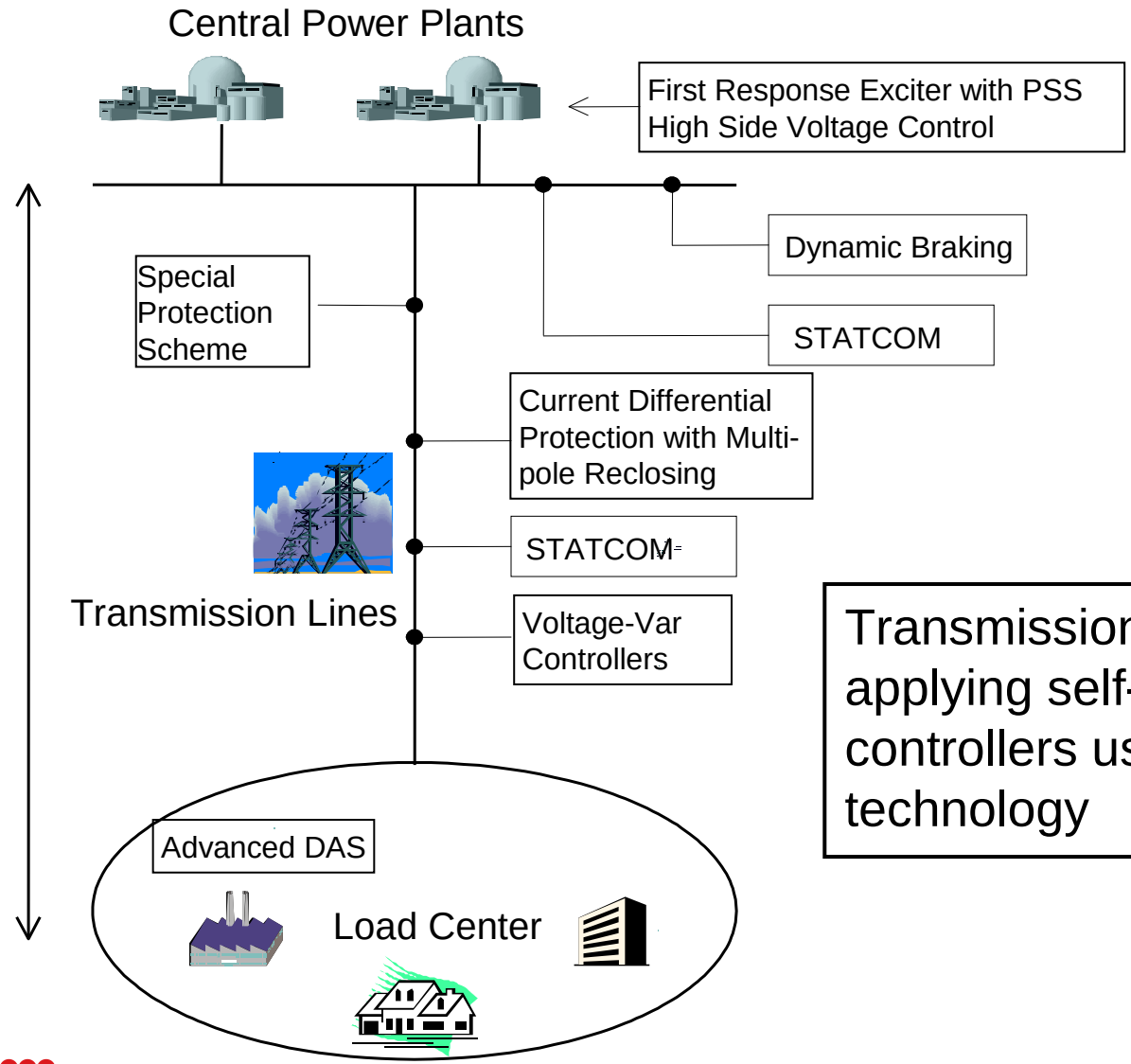
- collection of P, Q and V data
- decision of LRT/SVR tap positions, taking account of…
  1. Entire system voltage must exist within the permissible range
  2. Keep voltage close to the upper limit
  3. Minimize the number of tap actions of LRT/SVR



Field test of integrated control of battery energy storage (BES)



Self-healing & automatic controllers using smart grid related technology



Transmission investments reduced by applying self-healing and automatic controllers using smart grid related technology