

*Presented at EPRI Workshop, Nice, France
December 9, 2008*

CRIEPI's Research on Smart Grid, **TIPS**

Yoshizumi Serizawa

(seri@criepi.denken.or.jp)

System Engineering Research Laboratory

Central Research Institute of Electric Power Industry, Japan

Outline

◆ Scope for Next-generation Grid:

TIPS

- *Triple I (Intelligent, Interactive and Integrated) Power System*

◆ *ADAPS*

- *Autonomous Demand Area Power System*

◆ ICT Infrastructure for TIPS



Scope for Next-generation Grid: *TIPS*

Future of Power Grids

- ◆ CO₂ Reduction throughout Grids (from Generation to End Use)
 - Large penetration of unstable renewable energy source (Targeted value of PV in 2010: 4.8GW, 2030 : 53 GW)
 - Increase of inflexible generation (IGCC etc.)
 - Increase of uncertainty in supply/demand control
- ◆ Demand change
 - Enhancement of energy-conscious in consumers
 - Shift to electricity and Intelligent/ICT society (digital society)
- ◆ Increase of aged grid apparatus to be replaced

Requirements of Next-generation Grid

TIPS - Triple I (Intelligent, Interactive and Integrated) Power System

CO₂ reduction

1

**Integrate
supply/demand**

Enable conservation and efficient utilization of energy with integration of demand and supply

2

Utilize DER

Enable large penetration and effective utilization of distributed energy resources

3

**Minimize
blackout risk**

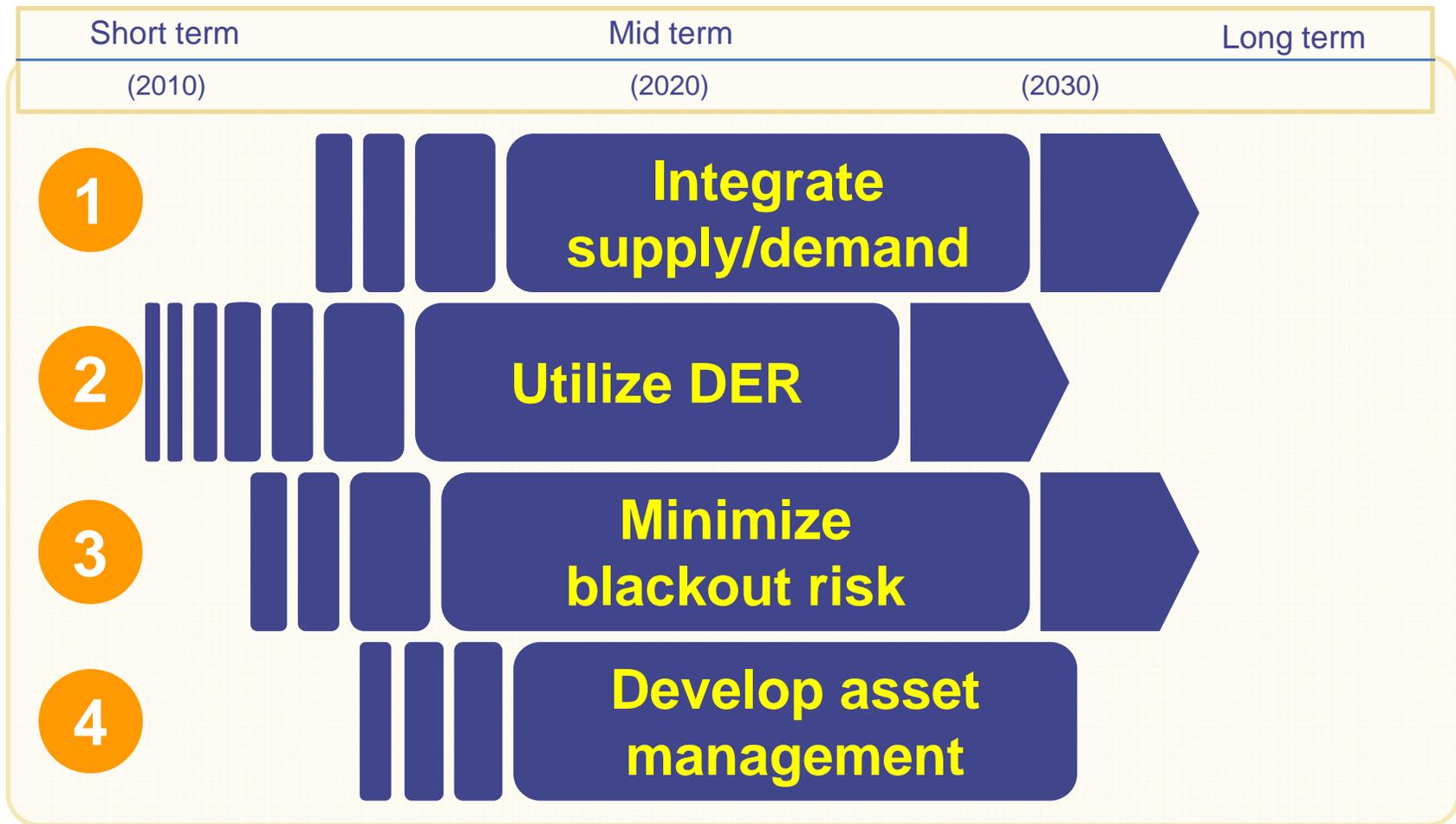
Minimize the risk of large blackout with secure and stable operation of resilient and self-healing system

4

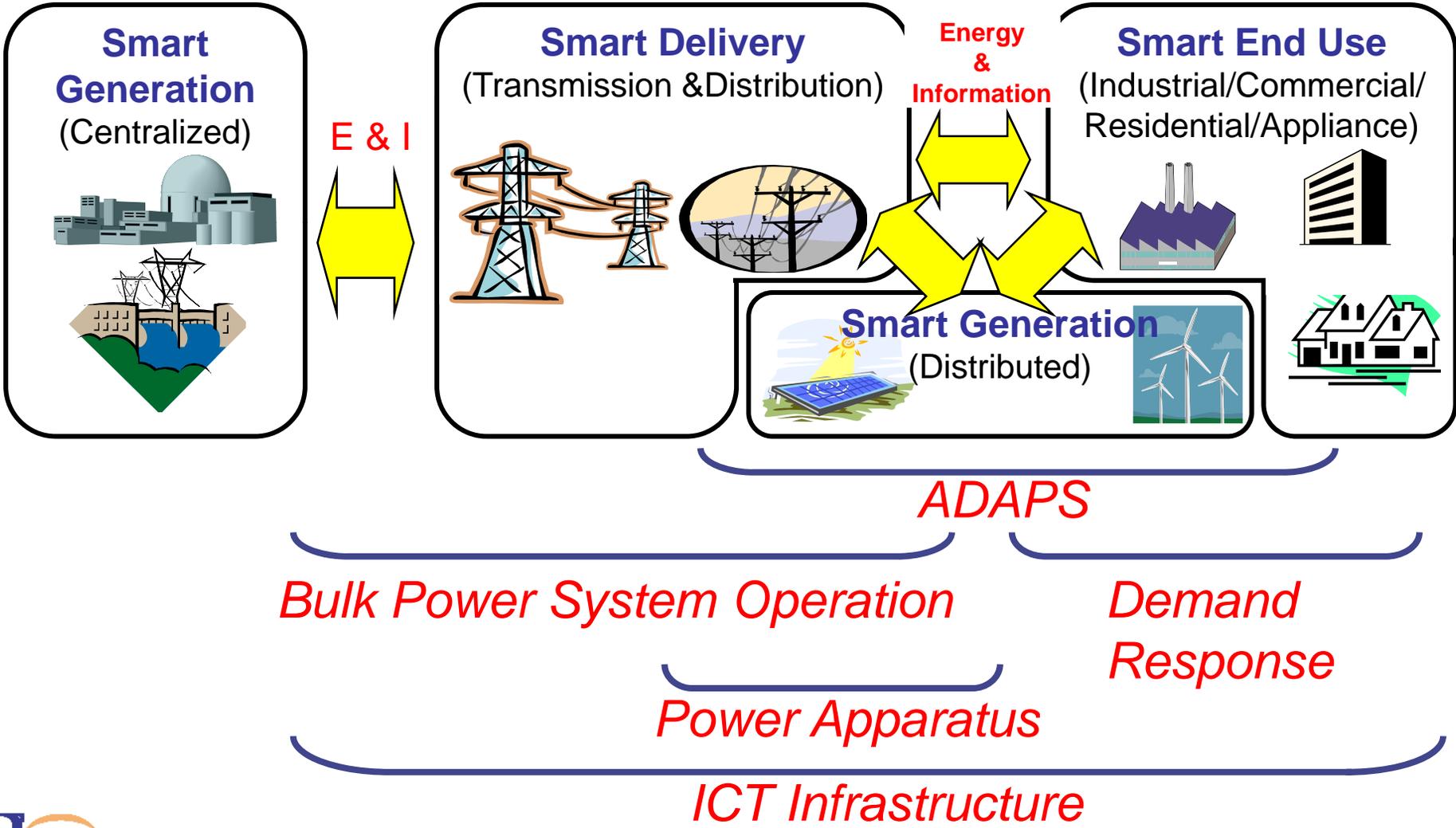
**Develop asset
management**

Sophisticate asset management and introduce advanced power system maintenance and devices

Road Map of TIPS

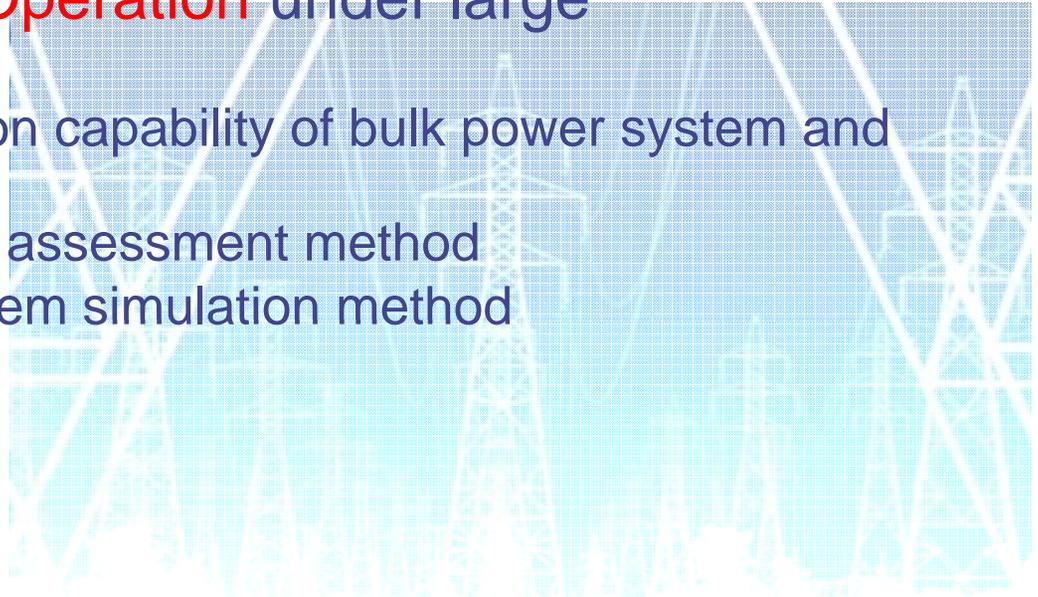


5 Research Areas on TIPS



Research Items (1), 2008-2010

- ◆ **ADAPS** operation and control under demand/supply integration
 - Load and storage control techniques according to PV power output
 - Demand/supply integration control techniques in grid emergency
 - Utilization techniques of DG and ADAPS developed
- ◆ **Bulk Power System Operation** under large penetration of DER
 - Evaluation of regulation capability of bulk power system and distribution system
 - Generation adequacy assessment method
 - Long-term power system simulation method



Research Items (2), 2008-2010

◆ ICT infrastructure

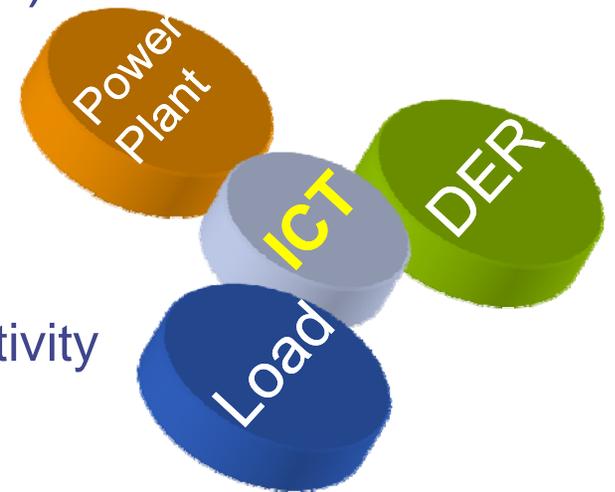
- Secure communication network for demand area
- Wide area and high-speed networks for monitoring, protection and control
- Sensor networks for facility maintenance and operation

◆ Evaluation of Demand Response (DR)

- Evaluation method of DR program
- Feasibility of DR program in Japan
- Energy management system for DR

◆ Power Apparatus

- 6.6 kV current limiter using superconductivity
- Solid insulation mold transformer
- Hybrid gas insulated bus

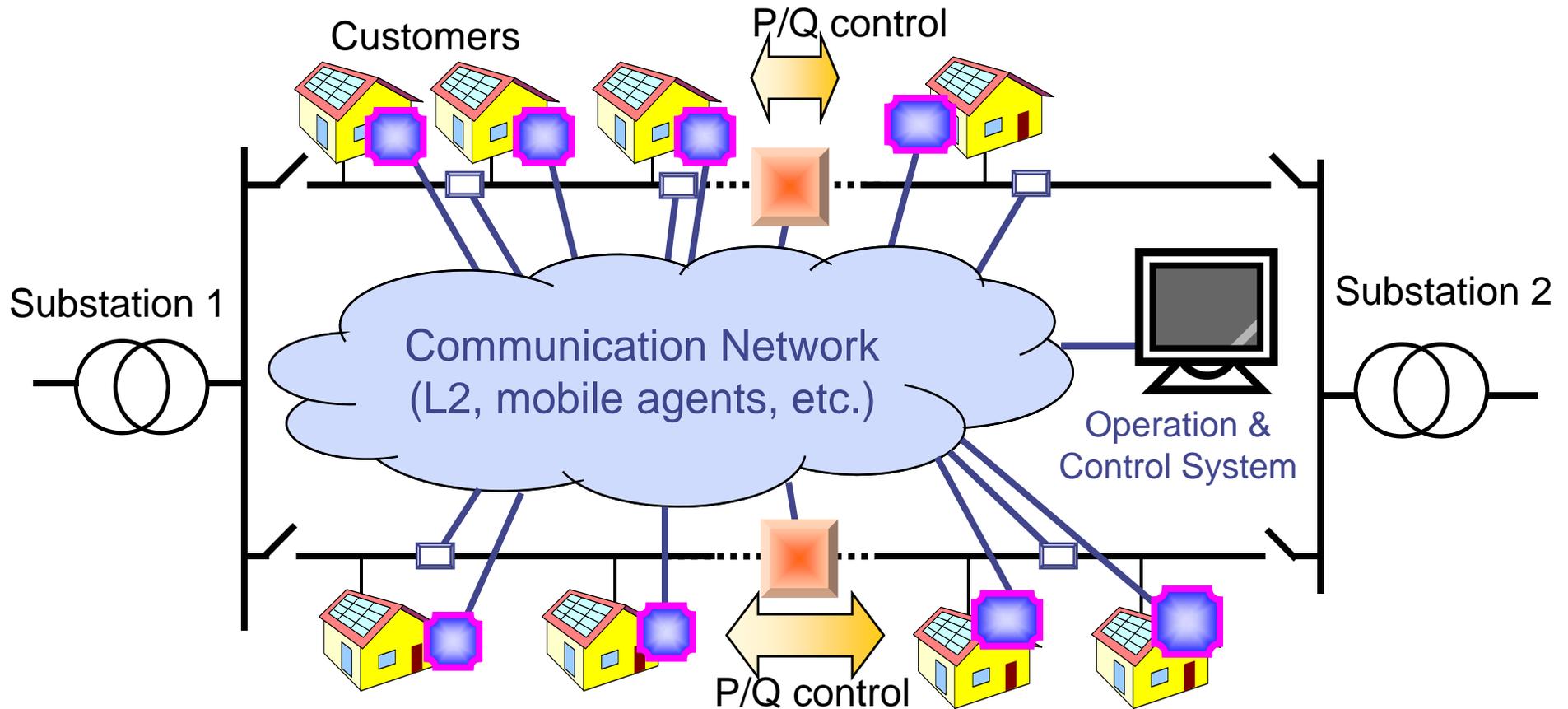




ADAPS (Autonomous Demand Area Power System)

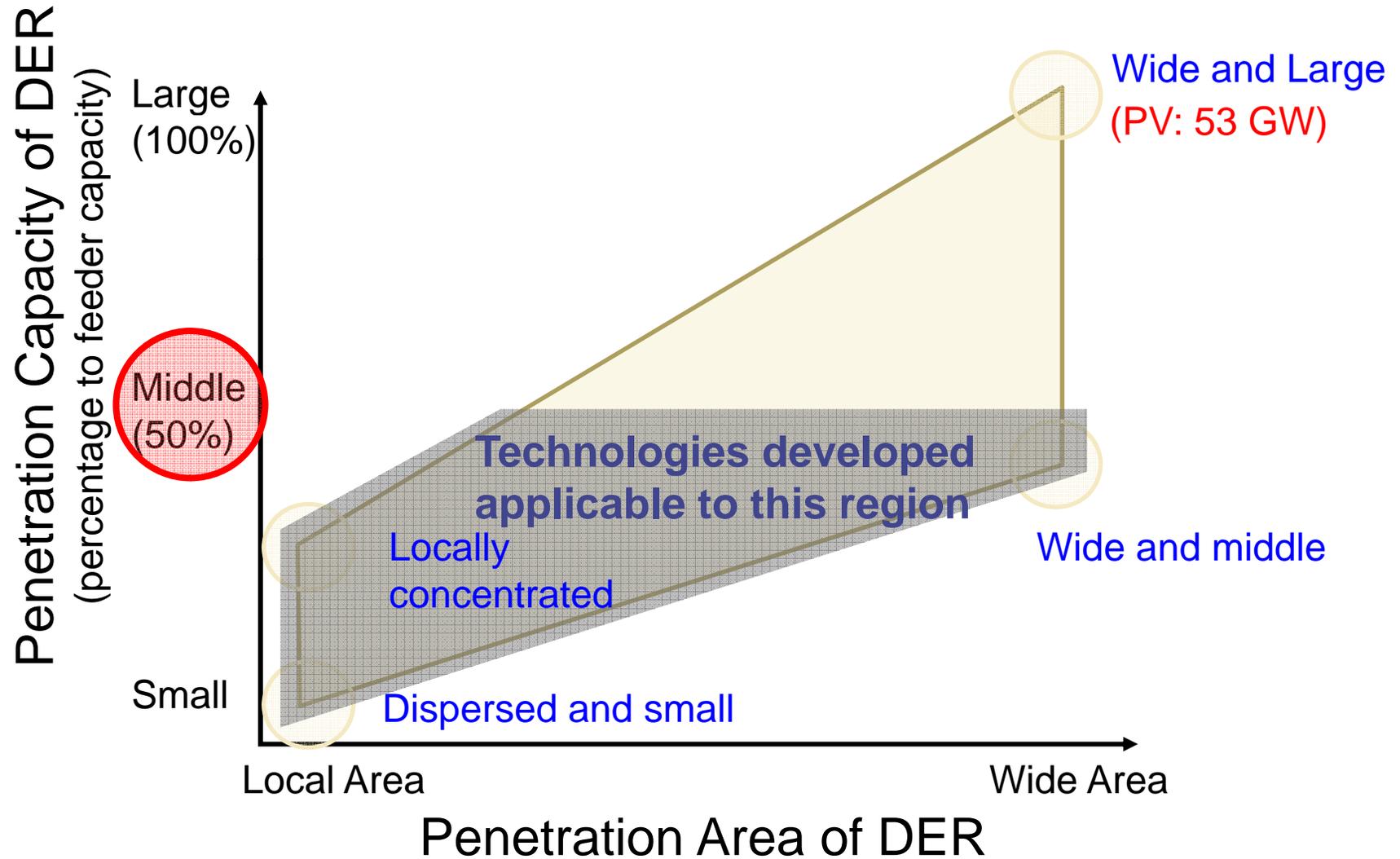
– Preceding and Current Projects –

Schematic Configuration of ADAPS



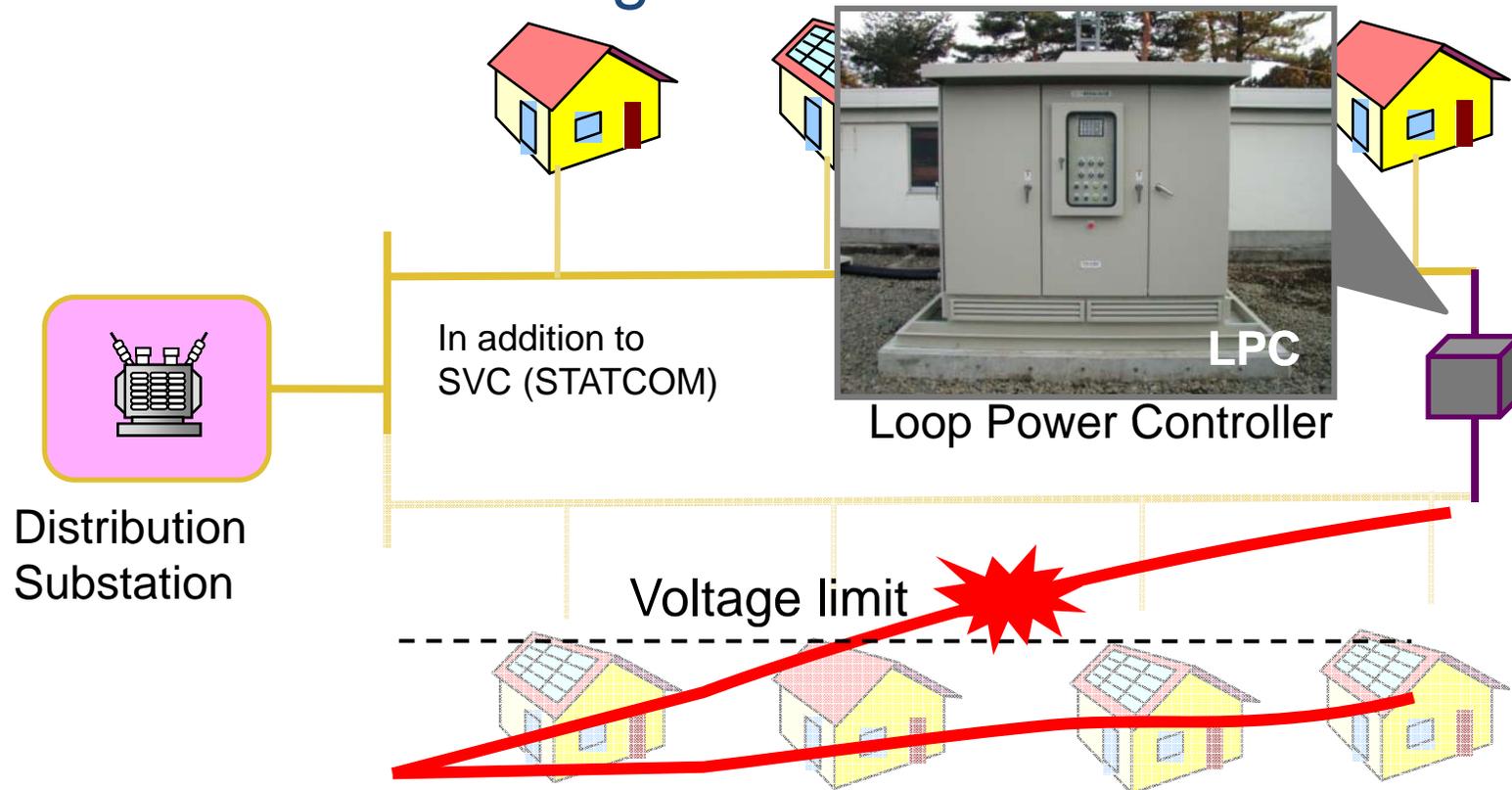
 <p>Supply & Demand Interface to support customer demands and operate emergency DER shedding</p>	 <p>Loop Power Controller to control power flow and voltage of distribution line</p>	 <p>Section switch with fault sensor</p>
--	--	--

ADAPS: Accomplishment to date

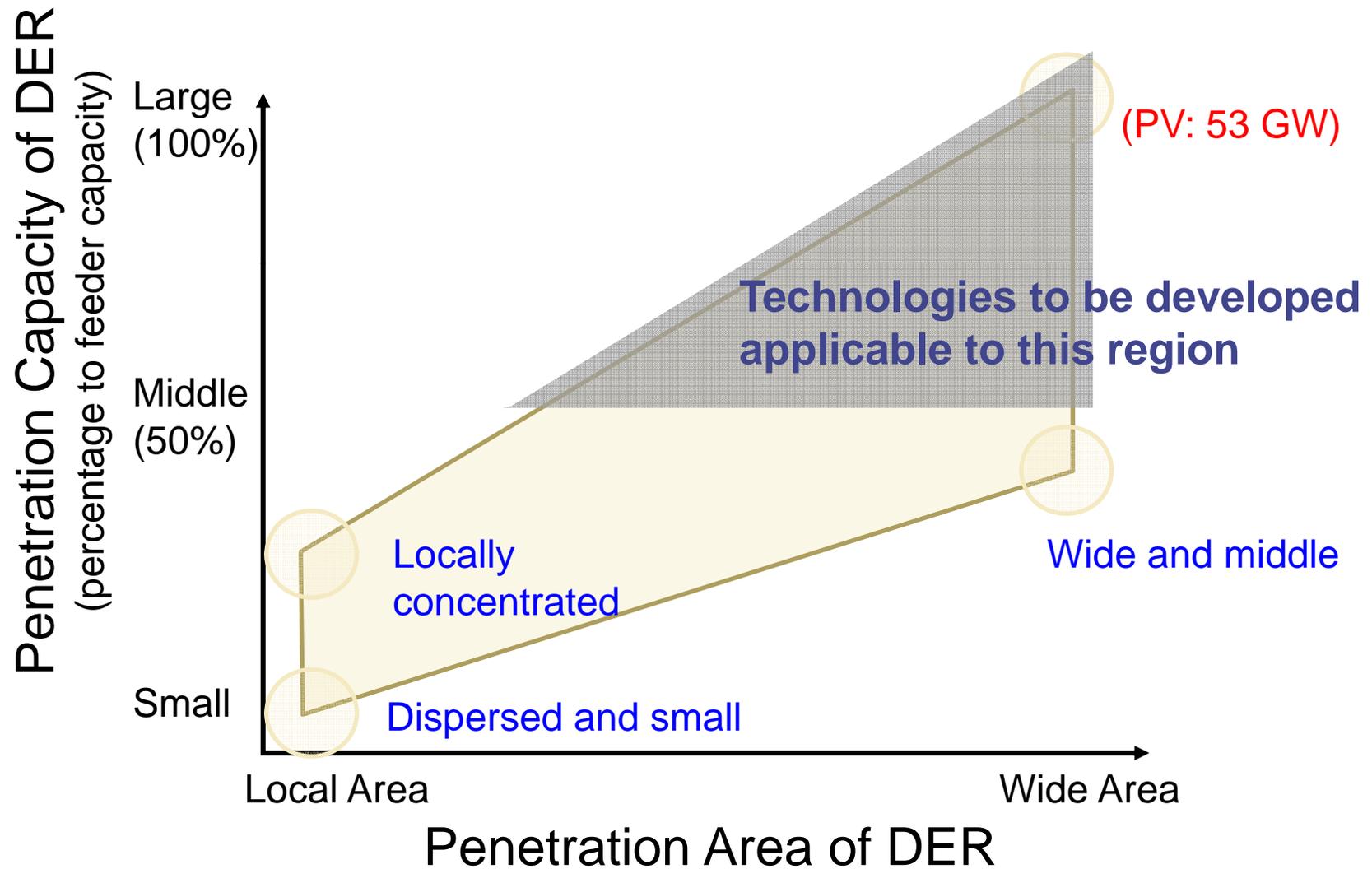


ADAPS: Accomplishment to date

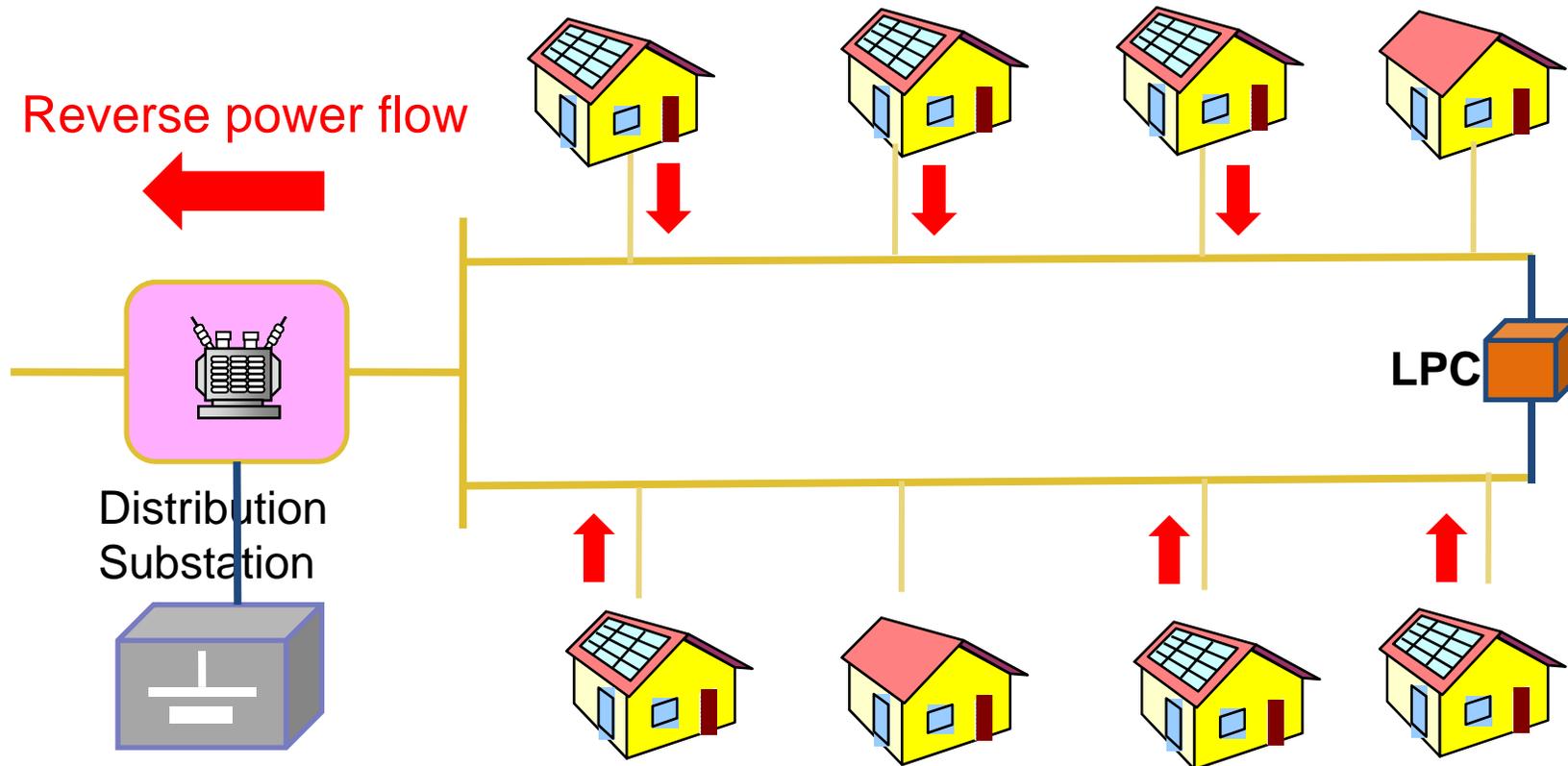
✓ Centralized Voltage Control



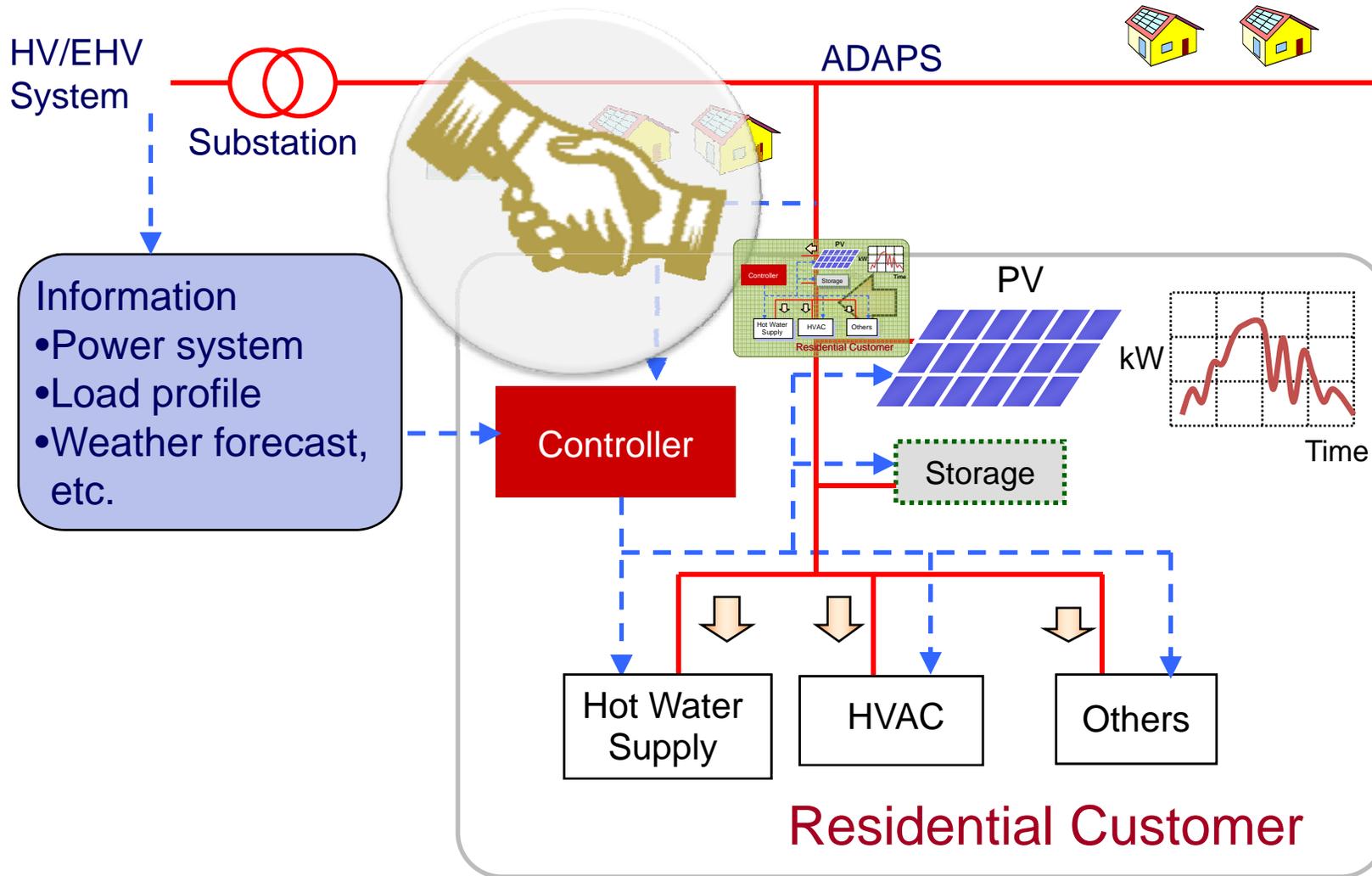
ADAPS: New project undertaken



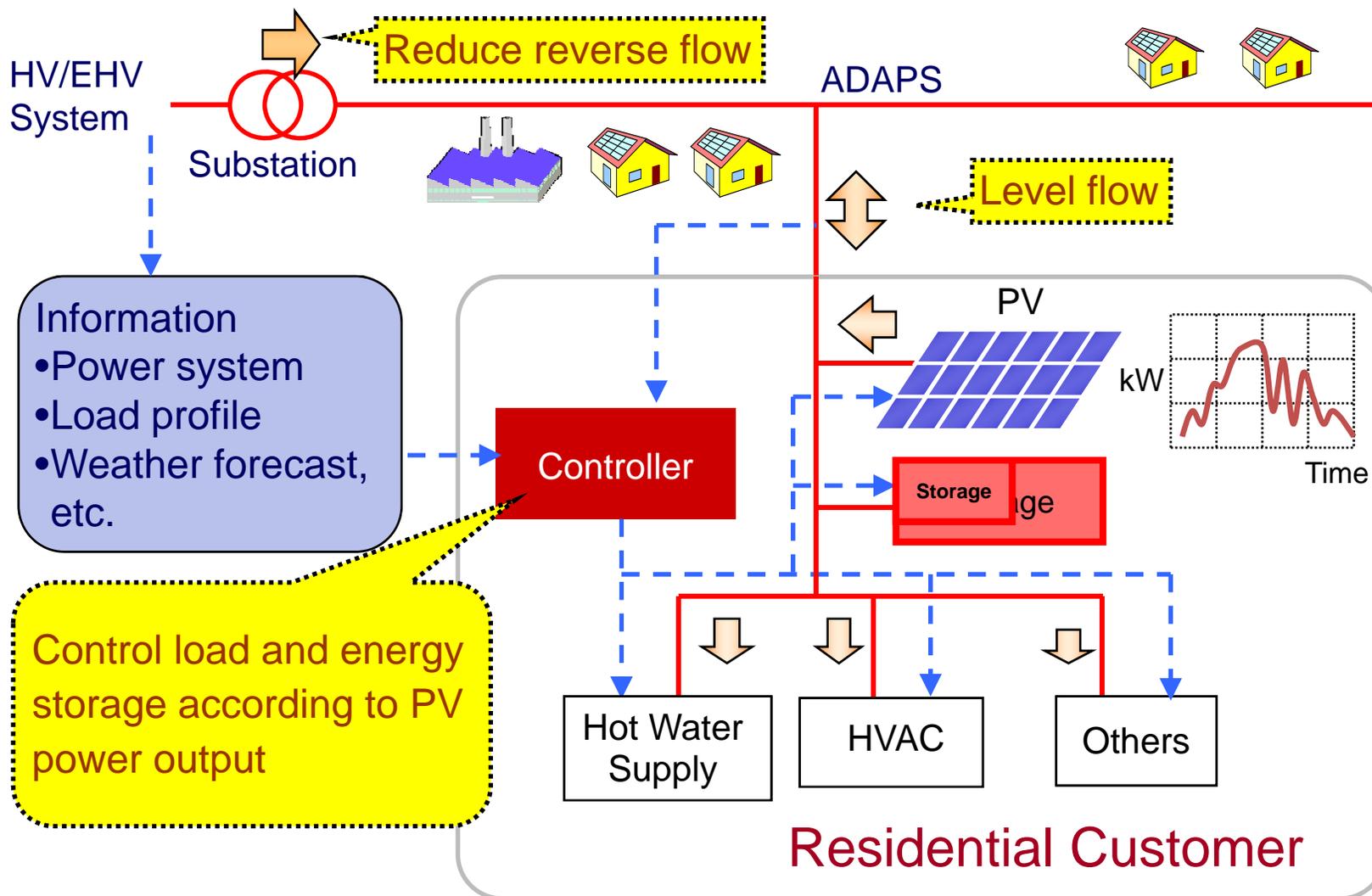
Problem in large penetration



Demand/Supply Integration



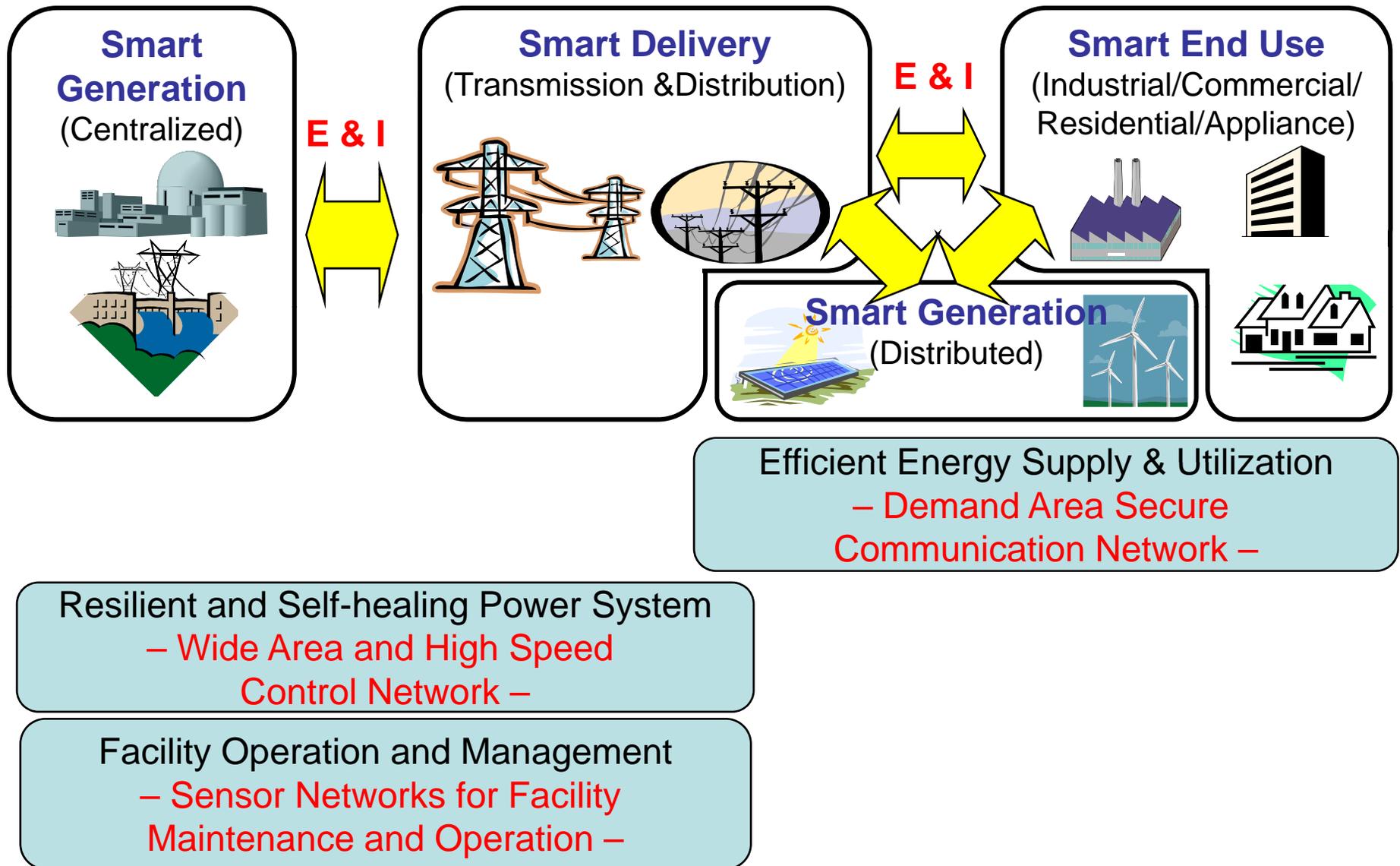
Demand/Supply Integration





ICT Infrastructure for TIPS

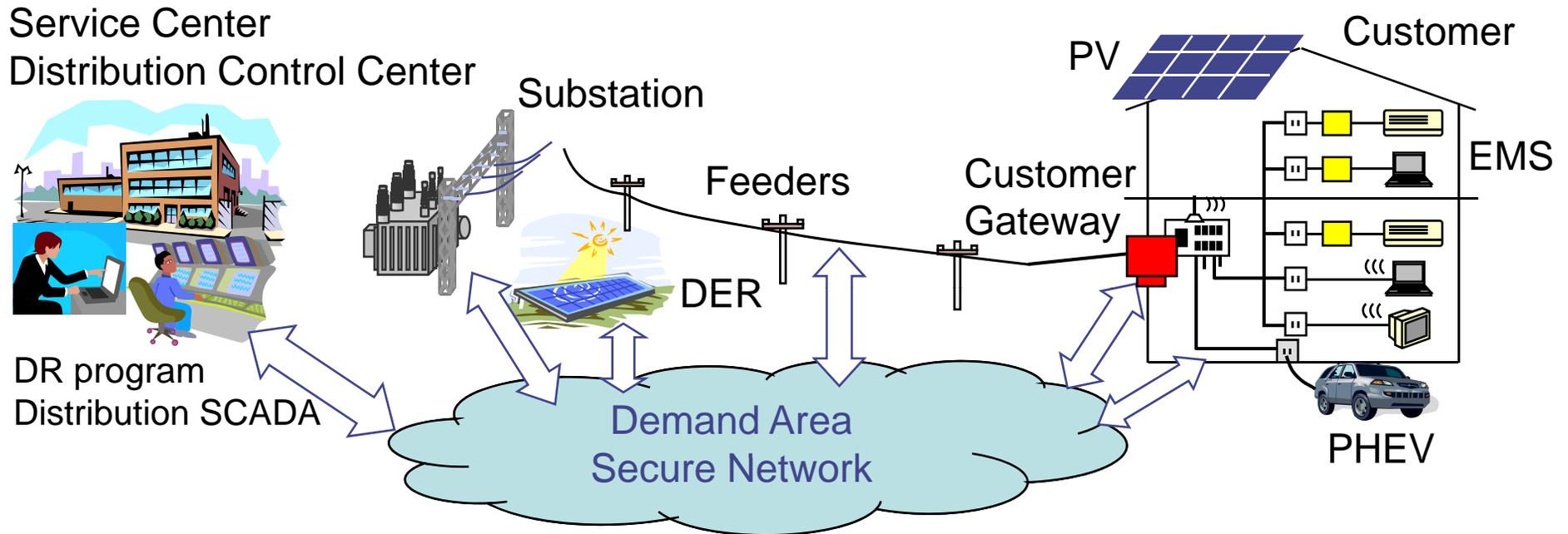
ICT Infrastructure for TIPS



Scope of ICT Infrastructure

- ◆ **Demand Area Secure Communication Network**
for distribution and DER management, smart metering, demand response, customer access, energy management, and premises communication
- ◆ **Wide Area and High Speed Control Network**
for power system monitoring, adaptive protection and emergency control to prevent large blackout and localize disruption
- ◆ **Sensor Network for Facility Maintenance and Operation**
based on DRNA (Distributed computer Network Architecture) and field network technologies and the concept of Plug-and-Play

Demand Area Secure Network



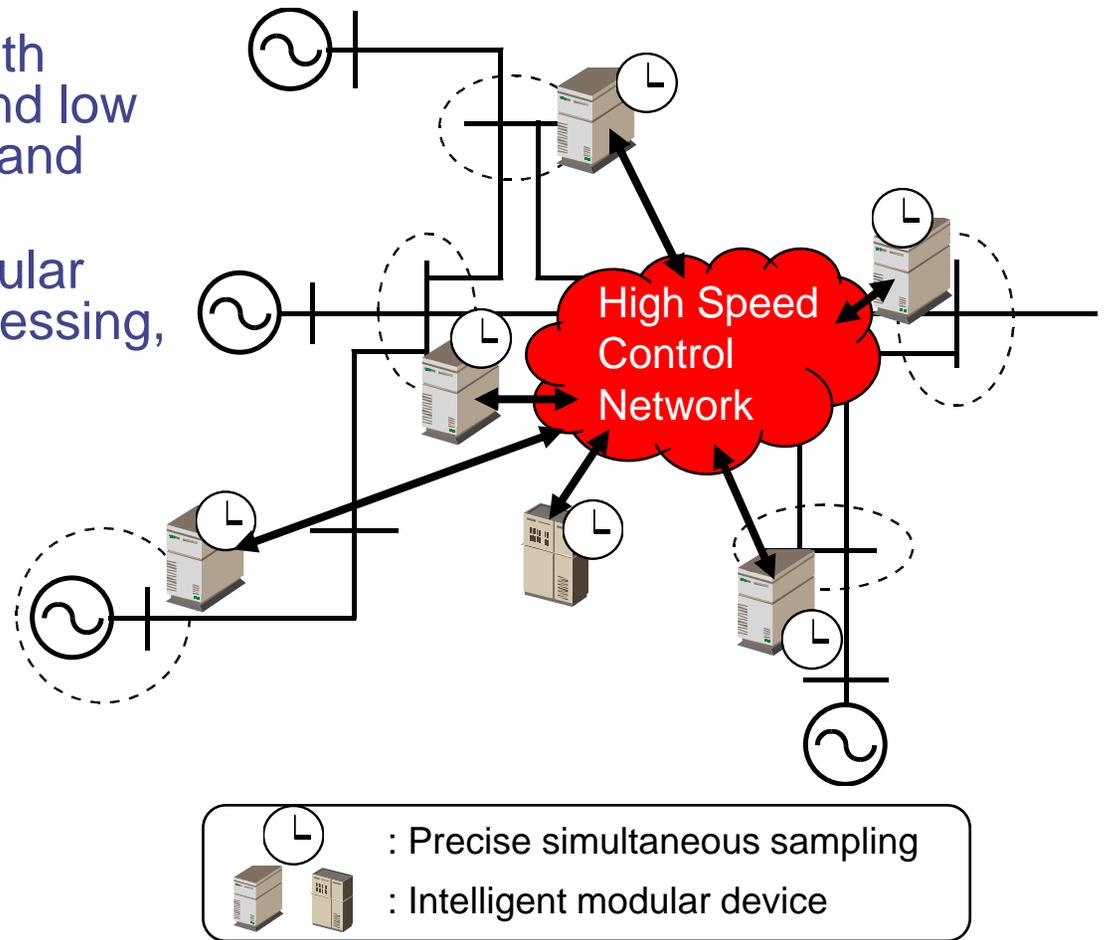
- ◆ **Media-integrated** (wireless and/or wired) structure
- ◆ IP-based communication **protocols and data management**
- ◆ **Security measures** for embedded and easily accessible equipment
- ◆ **Customer gateway**

Wide Area and High Speed Control Network

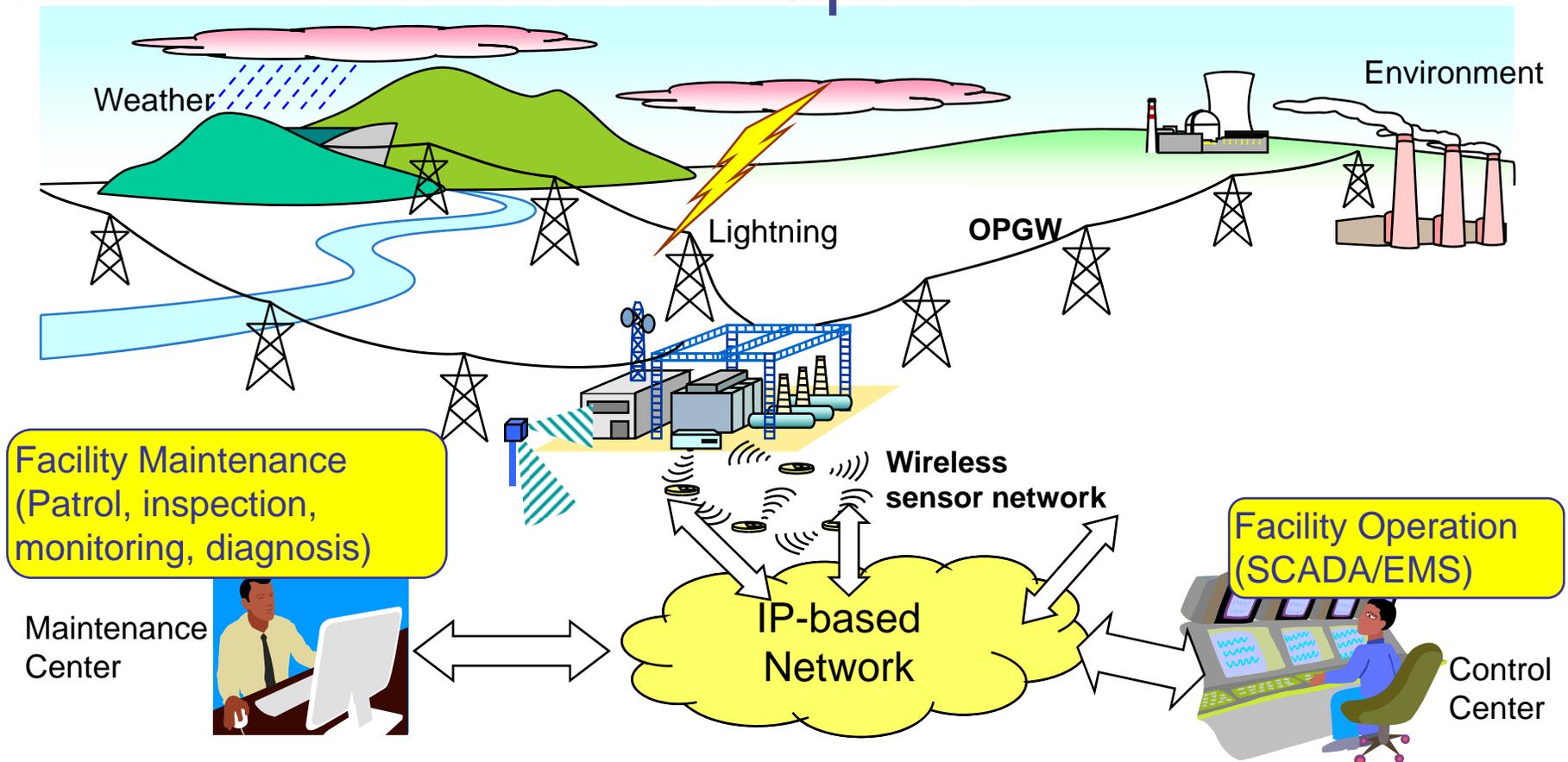
- ◆ **Ethernet-based network** with extremely high reliability and low latency for data exchange and time synchronization
- ◆ **Intelligent device** with modular functions (monitoring, processing, control, communication)



Flexible and scalable to various schemes of monitoring, protection and control, and to power system configurations



Sensor Network for Facility Maintenance and Operation



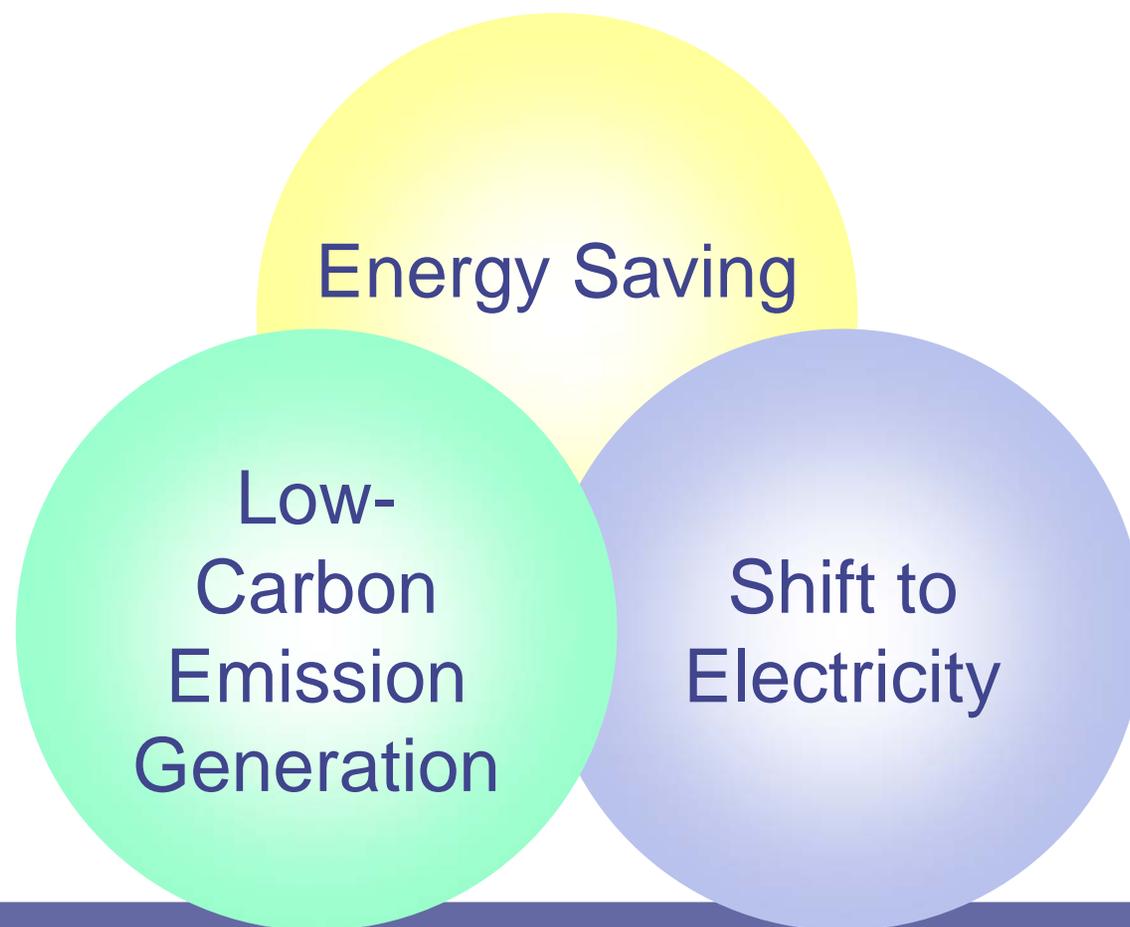
◆ Plug-and-Play and Ad Hoc schemes

- Wired/wireless sensor and access network for field information collection
- Wide area and premises networks (DRNA-based)
- Data exchange and management



Conclusion

TIPS to support CO₂ reduction and stable power supply



TIPS - Triple I (Intelligent, Interactive and Integrated) Power System

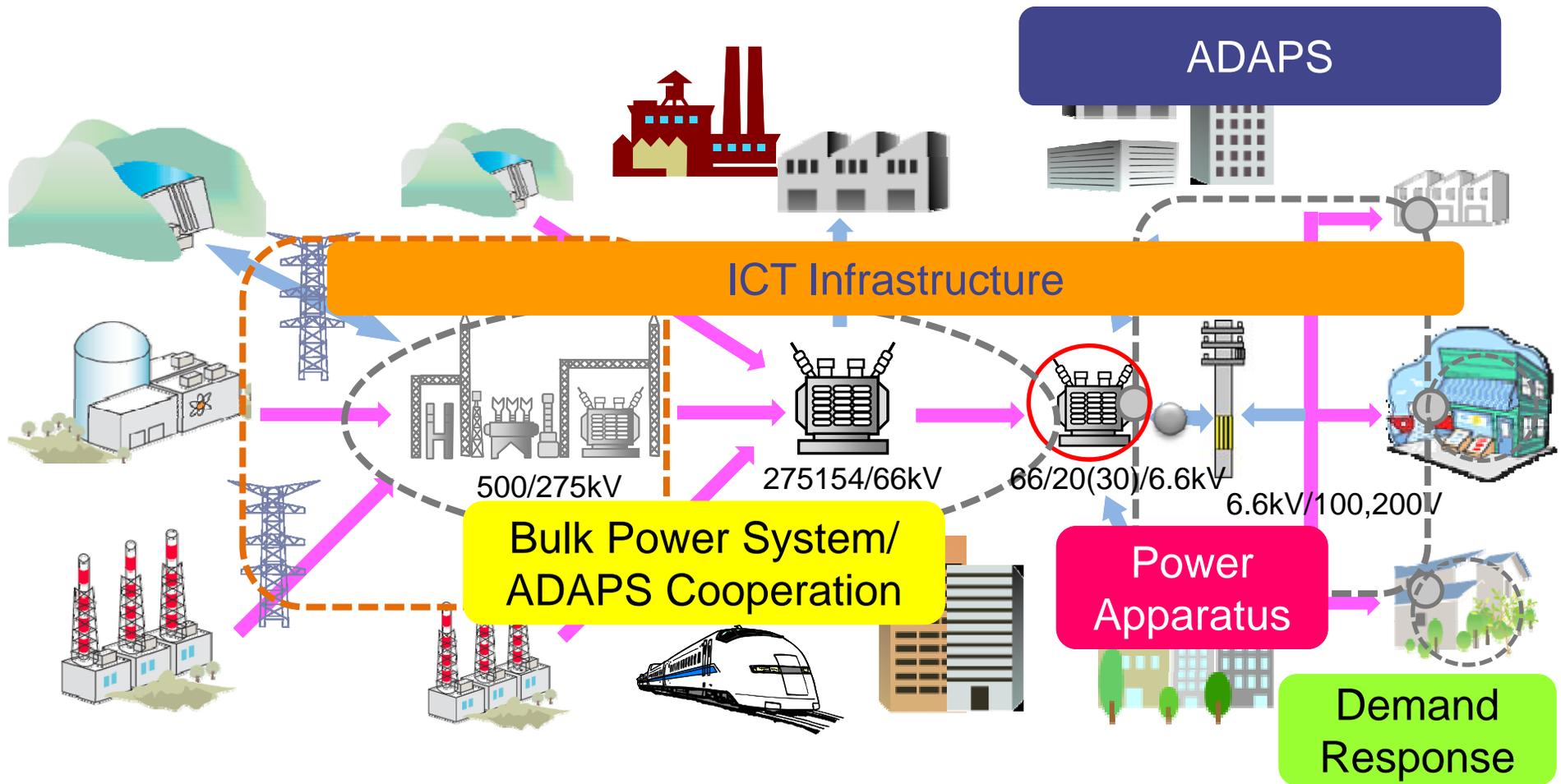


Comments, questions?

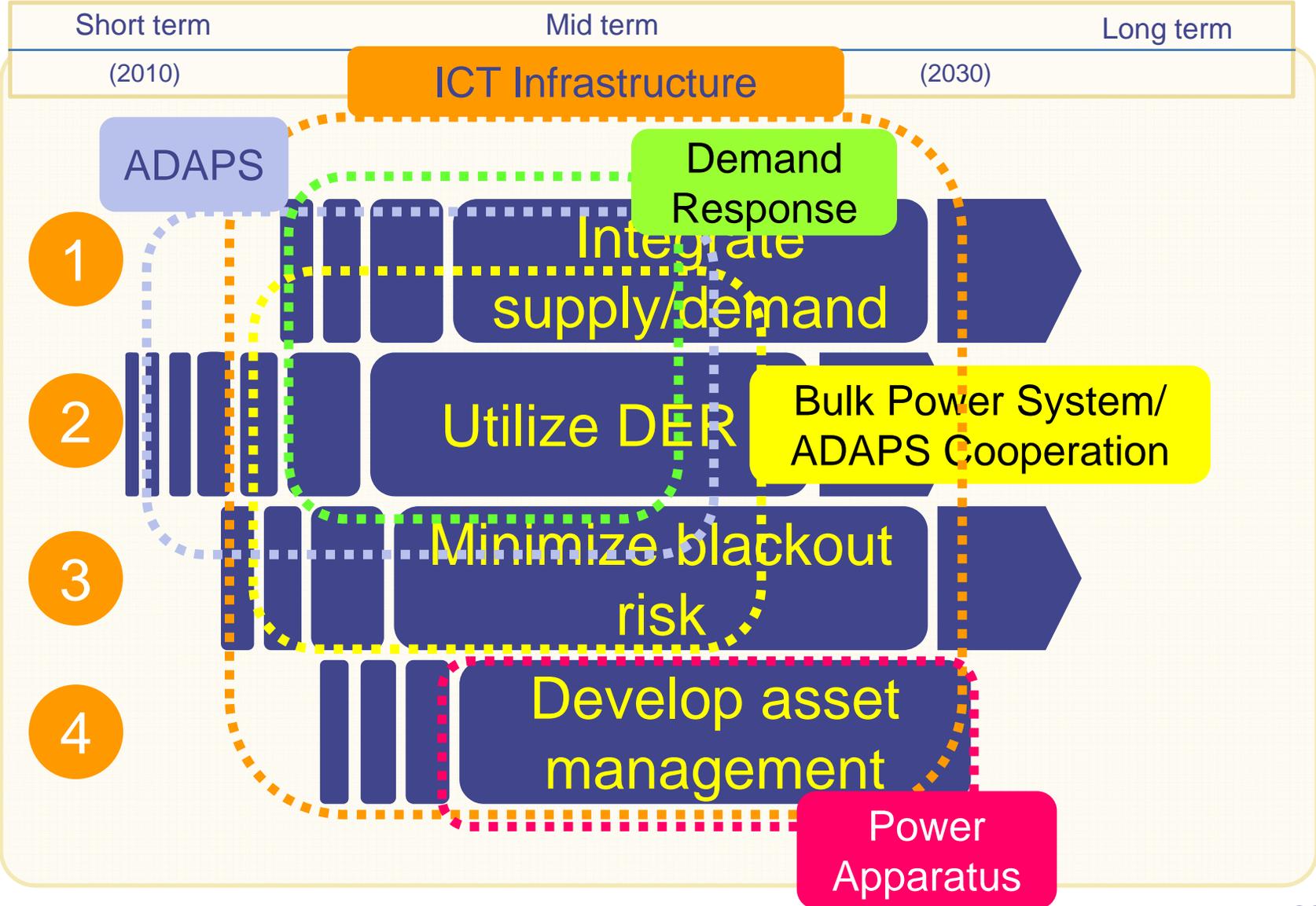
Trends toward 2050



5 Research Areas on TIPS



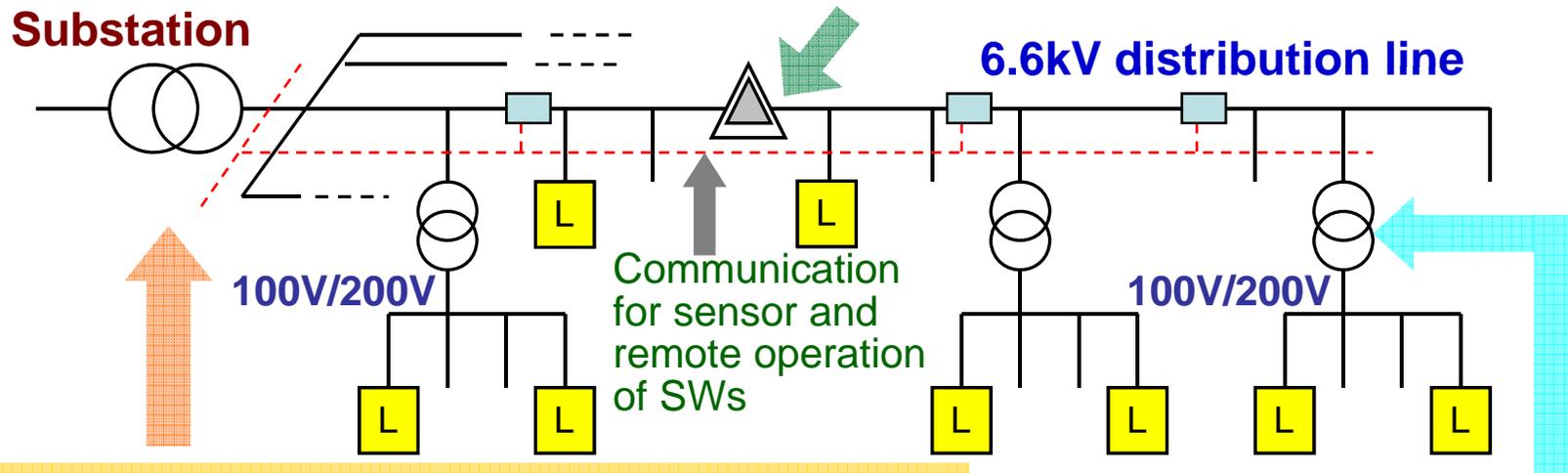
5 Research Areas on TIPS



Japanese typical distribution system

Proper supply voltage range for customer is regulated within **101+/- 6V** in 100V system and **202+/- 20V** in 200V system by Japanese electrical utility's law.

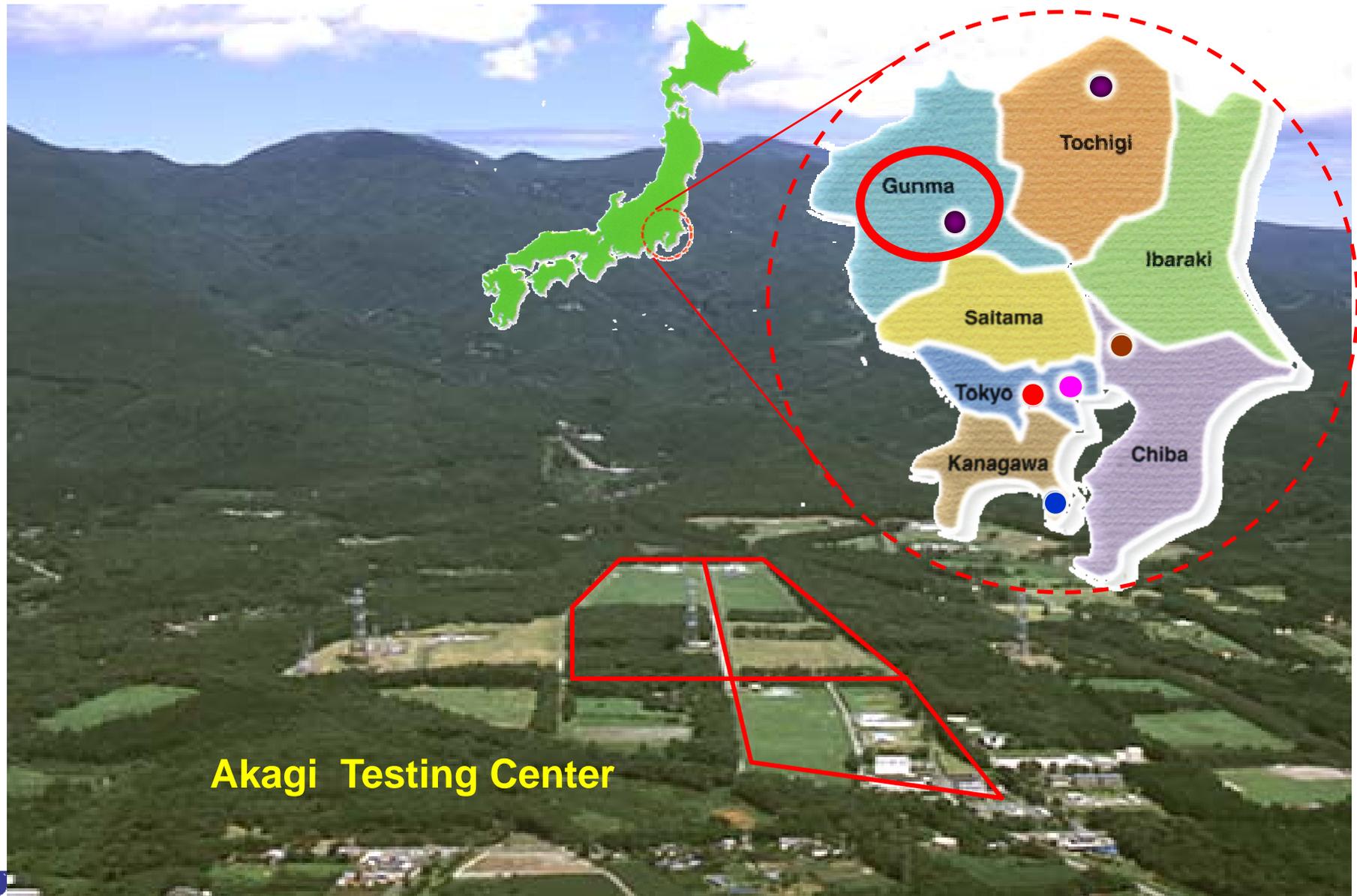
SVR (Step voltage regulator) :
-installed when D.L. length more than about 5km.



Tap changing of main transformer
LDC (Line voltage drop compensator); controlling sending voltage automatically according to feeder current.
Program control; sending voltage is programmed beforehand.

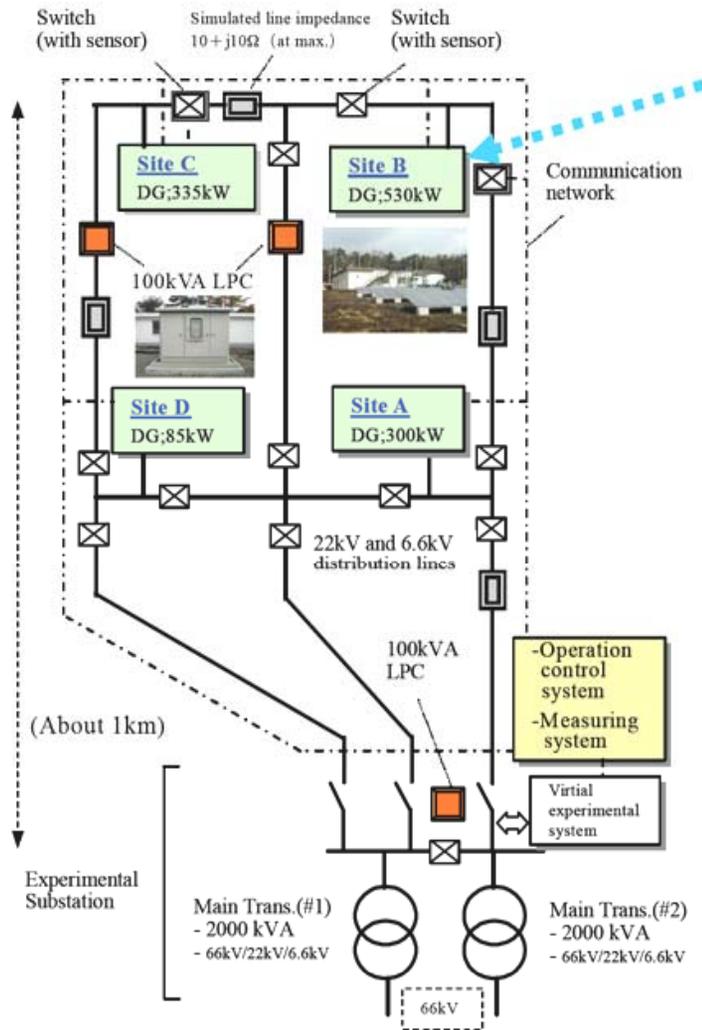
Tap ratio adjustment of pole mounted transformer by manual setting.

Testing and Demonstration Site



Akagi Testing Center

Testing and Demonstration Site



Whole configuration of the test facility

Distributed power generations in a site



150kW rotating type generator (simulates WP, Co-generation)



20kW Inverter type generator (simulates PV, FC, etc.)



4 to 5 kW power conditioner for PV power generation

Composition of distributed power generators

Rotating generator	150kW etc.	6 units	600kW
PV system	5kW etc.	16 units	80kW
Simulated FC, PV, Storage battery	20kW	12 units	240kW
	100kW	3 units	300kW
MGT	30kW	1 unit	30kW
Total			1250kW

Wide-area Emergency Control System

