Smart Grid and NEDO's Experience Through Several Projects in Japan

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New Energy and Industrial Technology Development Organization (NEDO)

Japan

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IPRW Ⅱ

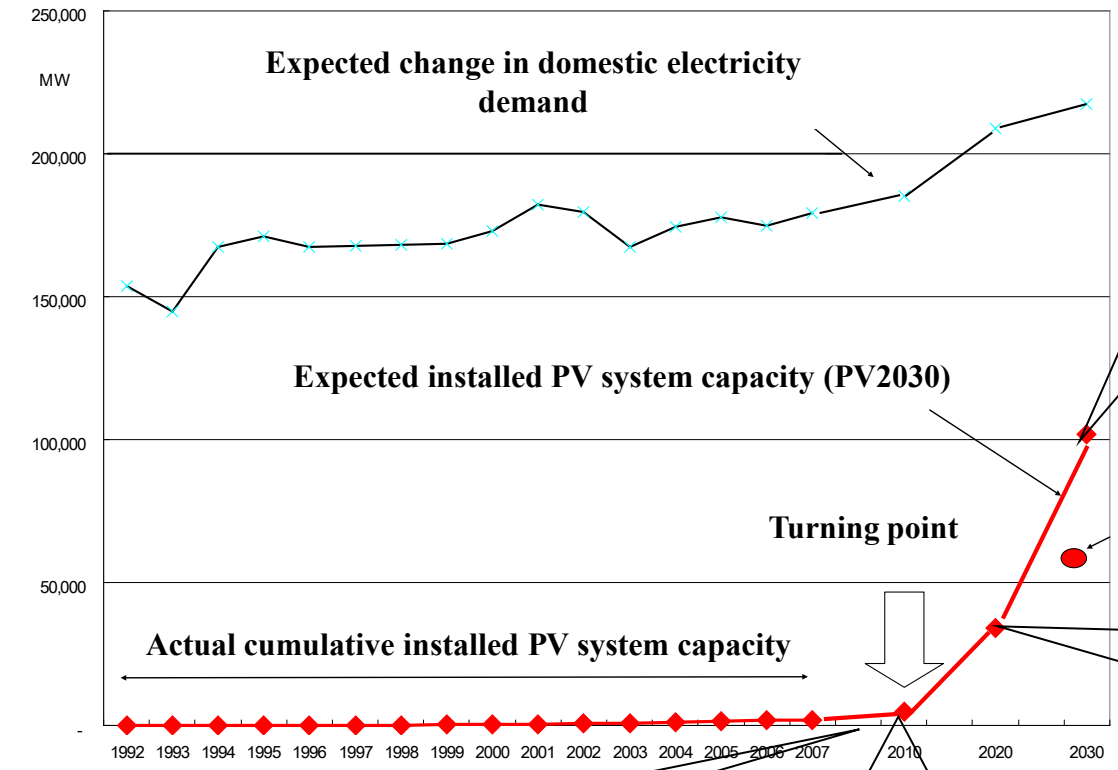
What is NEDO?

The New Energy and Industrial Technology Development Organization (NEDO) is Japan's largest public R&D management organization for promoting the development of advanced industrial, environmental, new energy and energy conservation technologies.

One important objective of NEDO's R&D is resolving problems that arise when distributed and renewable resources are connected to power grids.

1) Frequency stabilization
2) Voltage control
3) Protection
4) Other power quality issues
5) Technology development

Estimation of Japanese PV penetration in 2030



Imbalance of output from PV systems and existing systems may influence frequency on utility systems.

Expectation in Fukuda Vision

Expanding installation of PV systems may influence the stability of extra-high voltage transmission systems.

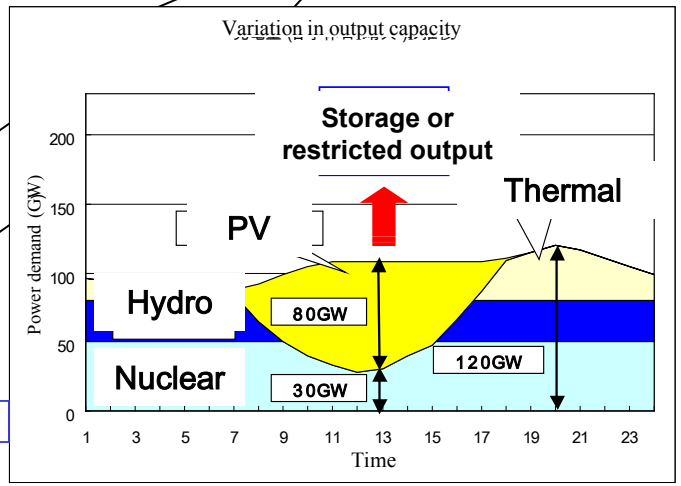
Development of function to detect unintentional islanding

Development of technology to avoid restricting PV system output

Influence on Power System

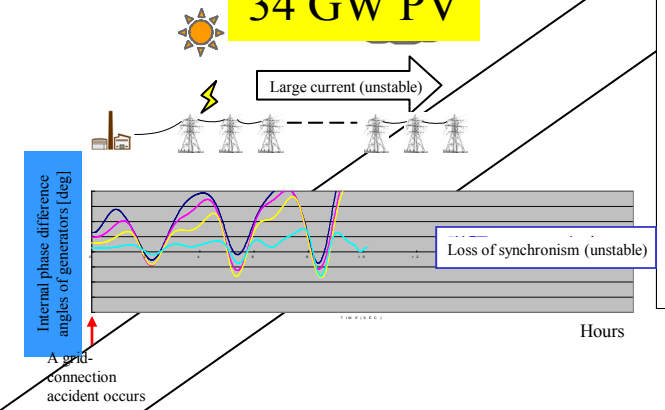
NEDO has begun creating a forecast of needs for grid connection technology related to renewable energy

Year 2030
100 GW PV



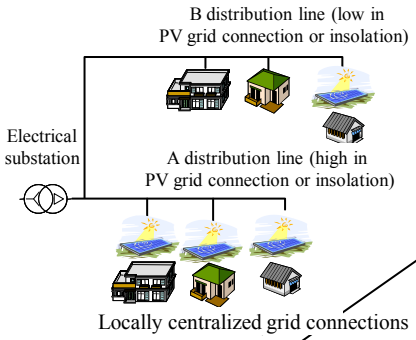
Uncertainty of balancing

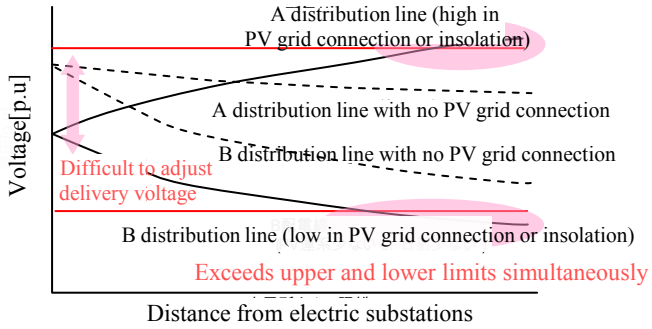
Year 2020
34 GW PV



Increased instability

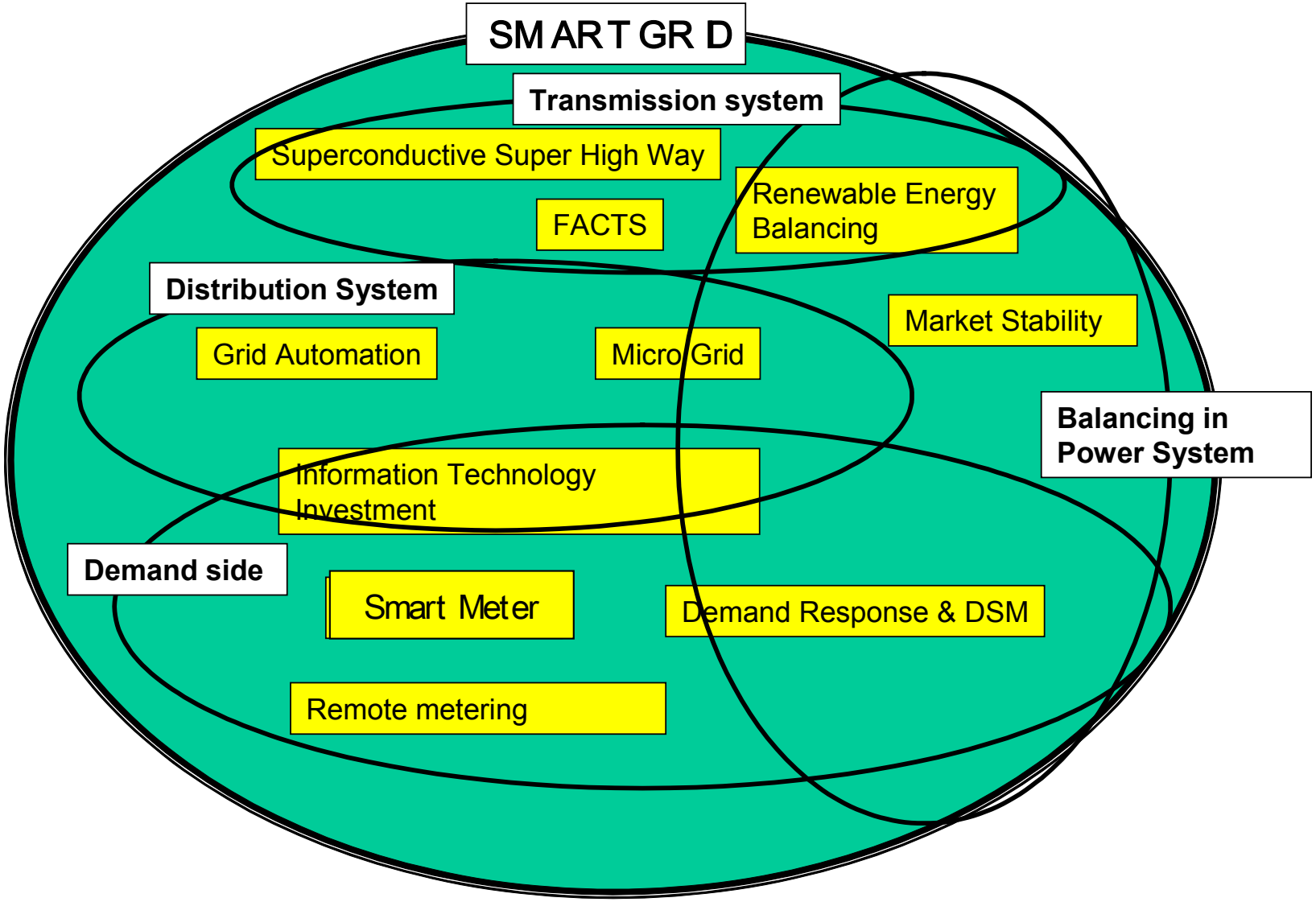
Year 2010
4 GW PV



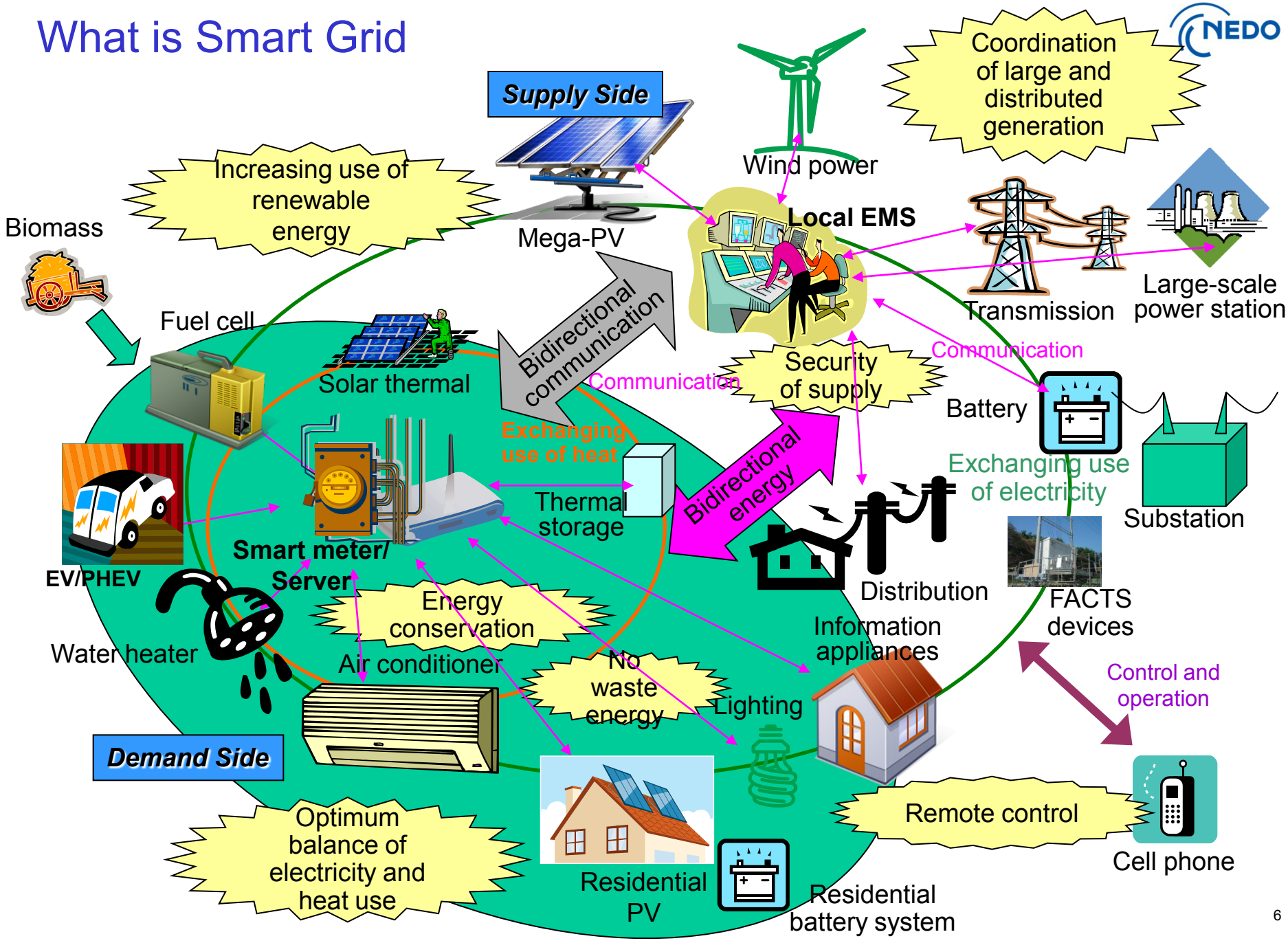


Increase in voltage limit violations

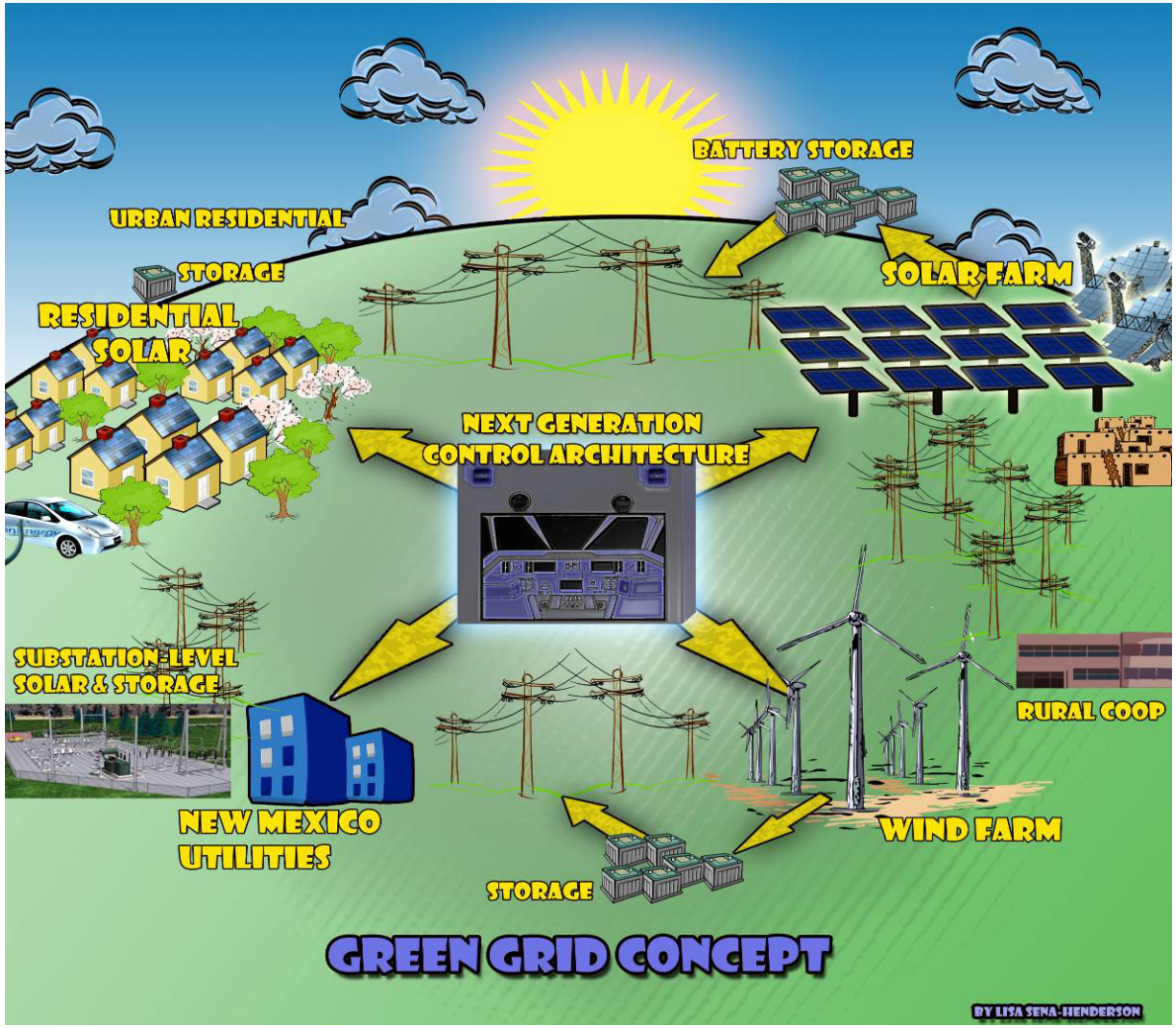
What is Smart Grid?



What is Smart Grid



NM GGI project



Distribution-Scale Systems (~ 5 MW)

- ◆Energy generation
- ◆PV, concentrating solar, combined solar power and heating,
- ◆geothermal, wind, biomass
- ◆Energy storage
- ◆Electrical, physical, thermal, chemical, geothermal
- ◆ Smart switch
- ◆Micro grid energy management system
- ◆Feeder protection
- ◆ Communication and cyber systems
- ◆Smart appliances
- ◆Modeling and Simulation*
- ◆Regulatory and policy
- ◆Green manufacturing*

NEDO's proposal to NM GGI project

Work Shop overview

Name of WS："US-Japan Collaboration New Mexico Green Grid Project, NEDO/Industry Meeting with New Mexico Officials and US Industry "

Date ：April 13-15, 2009

Site：Albuquerque Marriott

Sponsorship： The State of New Mexico government, NEDO

Participants： a little less than 100. 19 companies participate from Japan.

NEDO's proposal to NM GGI project - Target

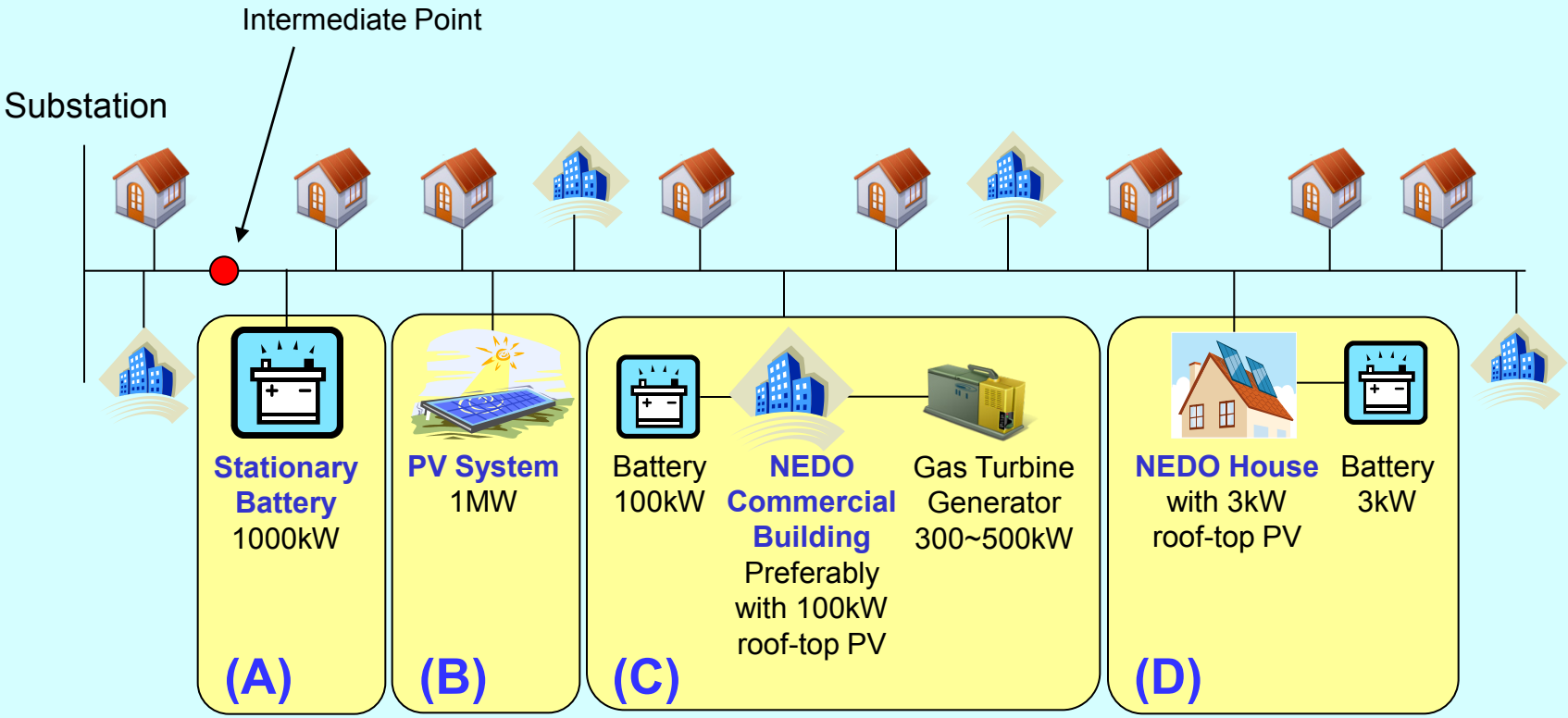
- Develop and demonstrate technology for optimum matching of electricity supply and demand that uses information technology to communicate and control appliances and power generation systems, thereby promoting global environmental measures through increased use of renewable energy and energy conservation, new services that arise from the integration of energy and information communications, and reliability improvement of power grid systems.

- Contribute to establishing the rapidly advancing concept of a "smart grid" through demonstration research with an actual power grid in the U.S.

NEDO's proposal to NM GGI project - Demonstration Micro Grid

Overall Environment;

- Residential User： about 500 houses
- Commercial User：about 5 offices (≥500Kw)
- Smart Meter Installed：Over 100 Houses ← Not necessary on one feeder



NEDO's proposal to NM GGI project - Target

● **Constitution of a Smart Grid**

Construct a smart grid that can be operated in three ways:

- 5 MW microgrid with a PV introduction rate of 25%; operate a microgrid considering a substation terminal (feeding point) as the connecting point --- analyze supply-demand balance and necessary power storage volume.
- 2.5 MW microgrid with a PV introduction rate of 50%; operate a microgrid considering an intermediate switch as the connecting point --- analyze supply-demand balance and necessary power storage volume.
- Customer microgrid; introduce a distributed power source for a large commercial customer (approximately 500 kW) and consider it as a mini-microgrid that can operate independently --- conduct plug-in/plug-out experiments that cannot be carried out in Japan (connect and isolate an operating microgrid to/from a conventional power grid).

- ✓ Monitoring and control of microgrid will be performed not by using a dedicated network, but based on the Internet (ensuring security), which is less acceptable in Japan.
- ✓ A 1.2 MW PV system and a 1 MW battery (approximate outputs) will be installed downstream from an intermediate switch of the feeder.
- ✓ As for a PV system, a cluster type (megasolar) is preferred because of the issue of asset transfer.
- ✓ The battery installation will use a hybrid system of multiple batteries (to absorb fluctuations in different cycles).
- ✓ One large commercial customer and one household customer will be involved as model customers.
- ✓ Install smart meters as necessary, and test energy demand data measurement by combining PLC and optical communications, which is difficult to test in Japan.
- ✓ Analyze the influence of microgrid operation on the entire power grid and electricity market mechanisms, and conduct research for overall evaluation.

NEDO's proposal to NM GGI project - Target

Commercial building or the like (a new customer is preferable)

- Select a 500 kW-class customer.
- Introduce cogeneration technology (CHP such as fuel cells) and thermal storage heat pumps, and optimize the energy use.
- Install a distributed power source that can be isolated from the conventional power grid.
- Demonstrate that a building can operate independently as if being an isolated microgrid and contribute to improvement of the power supply reliability (in this regard, the capability of isolation and connection during operation is important)

Residential house (acquire and modify an existing house)

- Establish a model of a typical residential house.
- Introduce PV, smart meters, Internet-connected home appliances, thermal storage heat pumps, EV/PHEV, residential power storage equipment and energy-saving home appliances which will be controlled via a home energy management system, and conduct an examination of their effectiveness (energy saving and demand response effects).
- Conduct various communication experiments with the supply side (including PLC).
- Perform a meteorological forecast and other studies for PV management and optimum operation between PV and power/heat storage.

➢ Smart meters will also be installed as necessary in the test area to measure residential energy demand.

Overview of NEDO Project in Japan

Positioning of NEDO's grid-connection related projects

Islanding detection

Over voltage control

Clustered Photovoltaic Power Generation Systems(Ohta-city)

Residential distributed generation

Short term fluctuation reduction

Long term fluctuation reduction

Large Scale PV Power Generation Systems (Wakkanai-city、Hokuto-city)

Large scale new-energy generation

Wind Power Stabilization Technology（Tomamae)

Demonstrative Project of Regional Power Grids with Various New Energies

Micro-grid

Distribution System

Coexistence with the power system

Transmission system

Independent from the power system

Security

Voltage

Frequency

Demonstrative Project on Grid-interconnection of clustered Photovoltaic Power Generation (FY2002-2007)

Background

Clustered installation of Photovoltaic on the distribution network is expected.

There are tangible problems, such as voltage swell by output from PV systems .

Objects

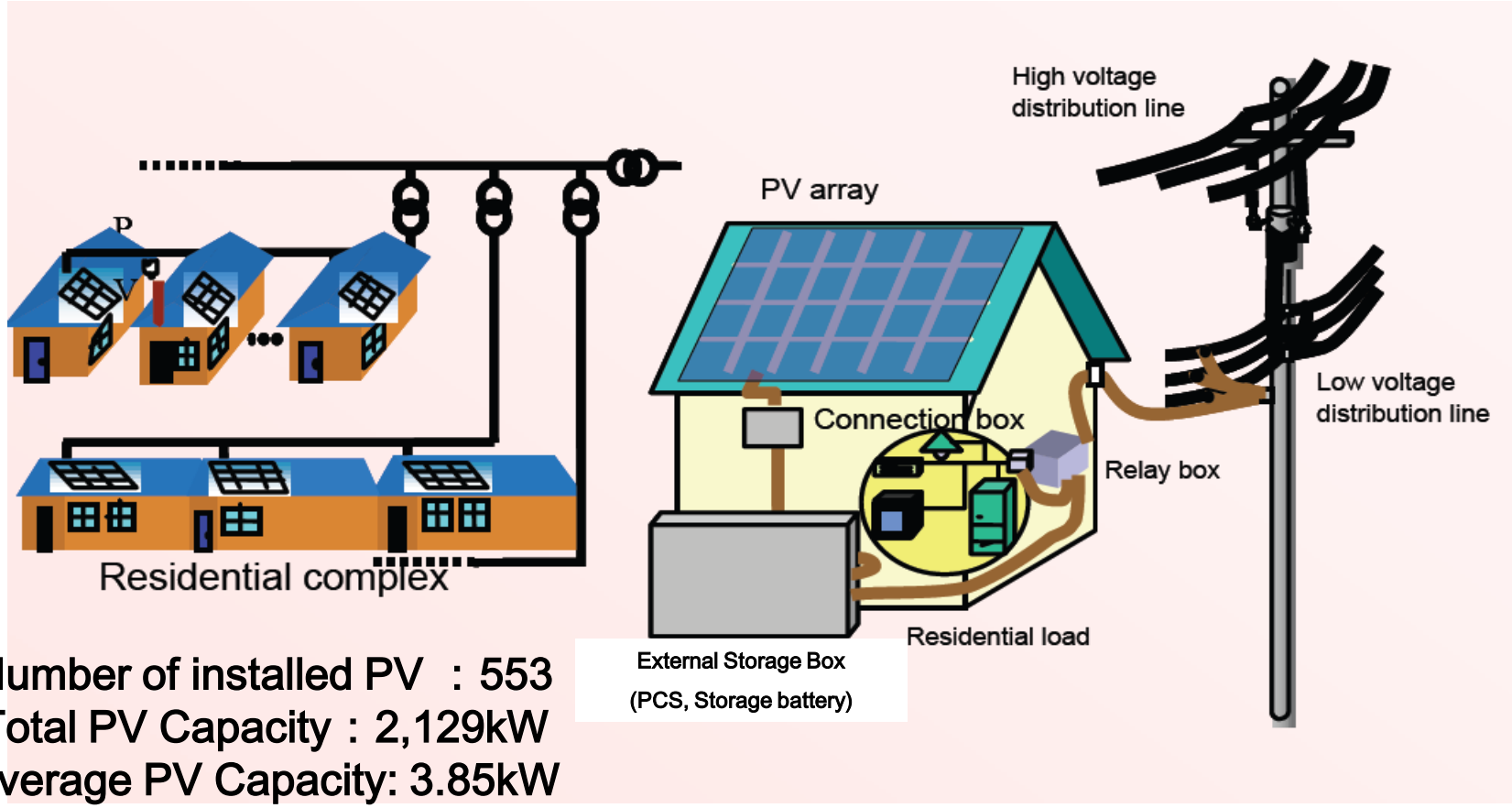
- Development of the technology to avoid restriction of PV system output.

-Development of function to prevent unintentional islanding.

Demonstrative Project on Grid-interconnection of clustered Photovoltaic Power Generation (FY2002-2007)

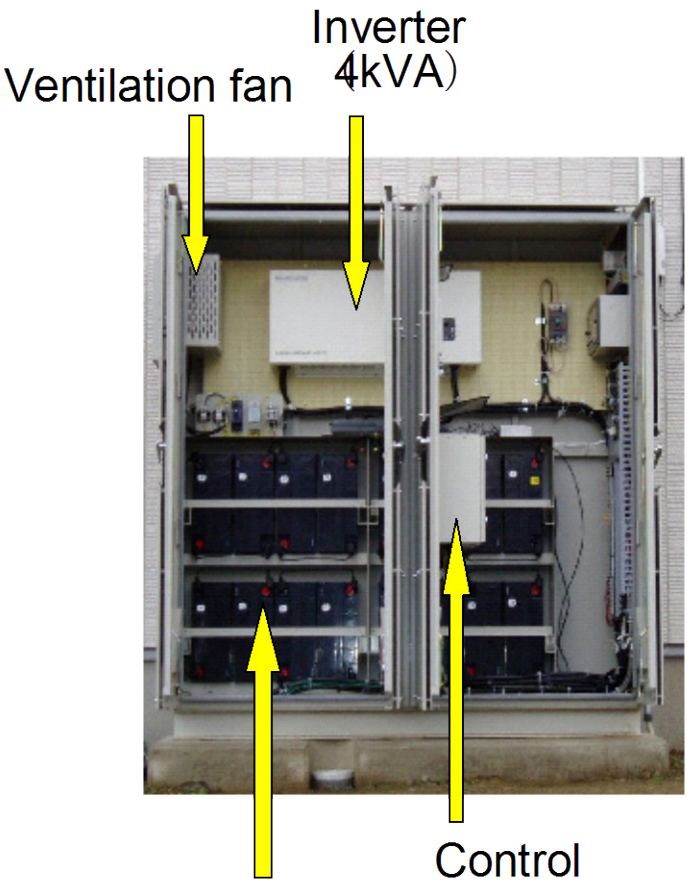
Demonstrative Project on Grid-interconnection of clustered Photovoltaic Power Generation (FY2002-2007)

Concept of battery storage system



Number of installed PV ：553
Total PV Capacity：2,129kW
Average PV Capacity: 3.85kW

Demonstrative Project on Grid-interconnection of clustered Photovoltaic Power Generation (FY2002-2007)



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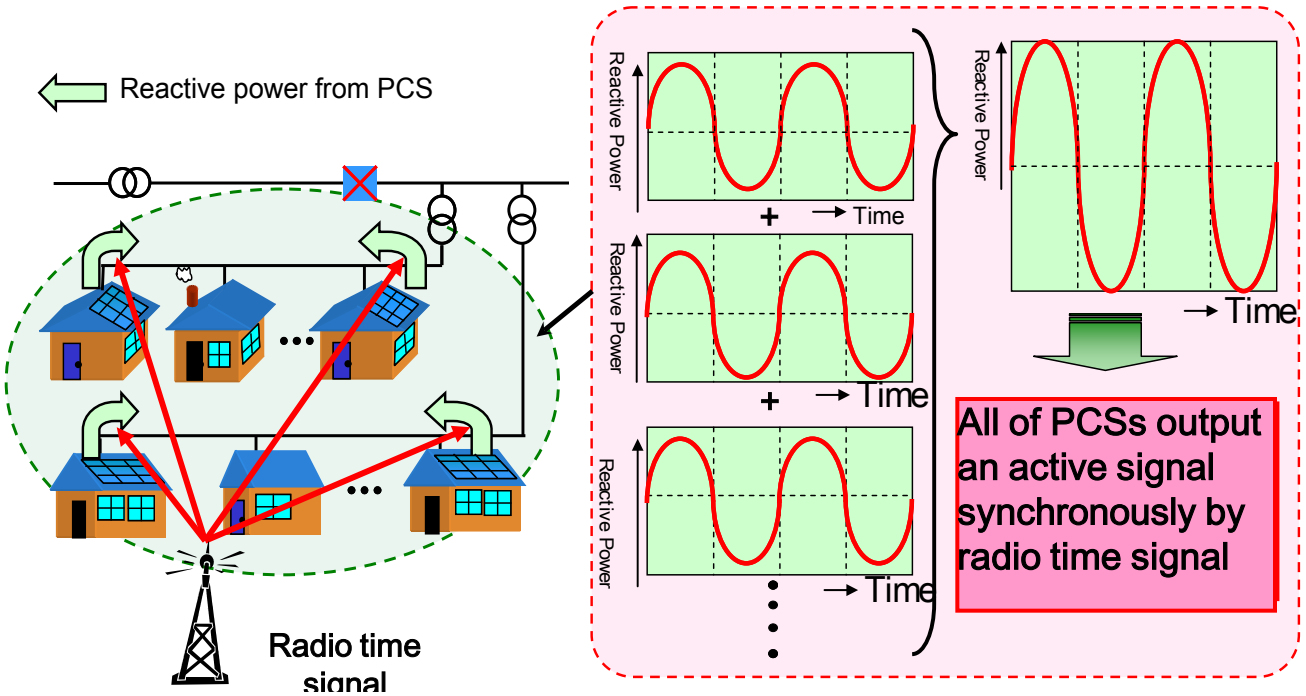


Verification of Grid Stabilization with large-scale PV Power Generation Systems (FY2006-2010)

Background

If PV becomes popular in future, large scale (MW level) PV power station will be introduced to power system.

It is possible that such large scale PV power station may influence voltage and frequency in the utility system.

Objects

Technology for reduction of fluctuation of voltage and frequency using battery storage will be demonstrated. Also, countermeasure of harmonic will be developed and demonstrated.

Demonstrative projects site

Wakkanai site
4000kW
(5000kW Will be installed finally)
Most of PVs are crystal type.
NAS (Sodium-Sulfur) battery : 1500kW-7.2hr

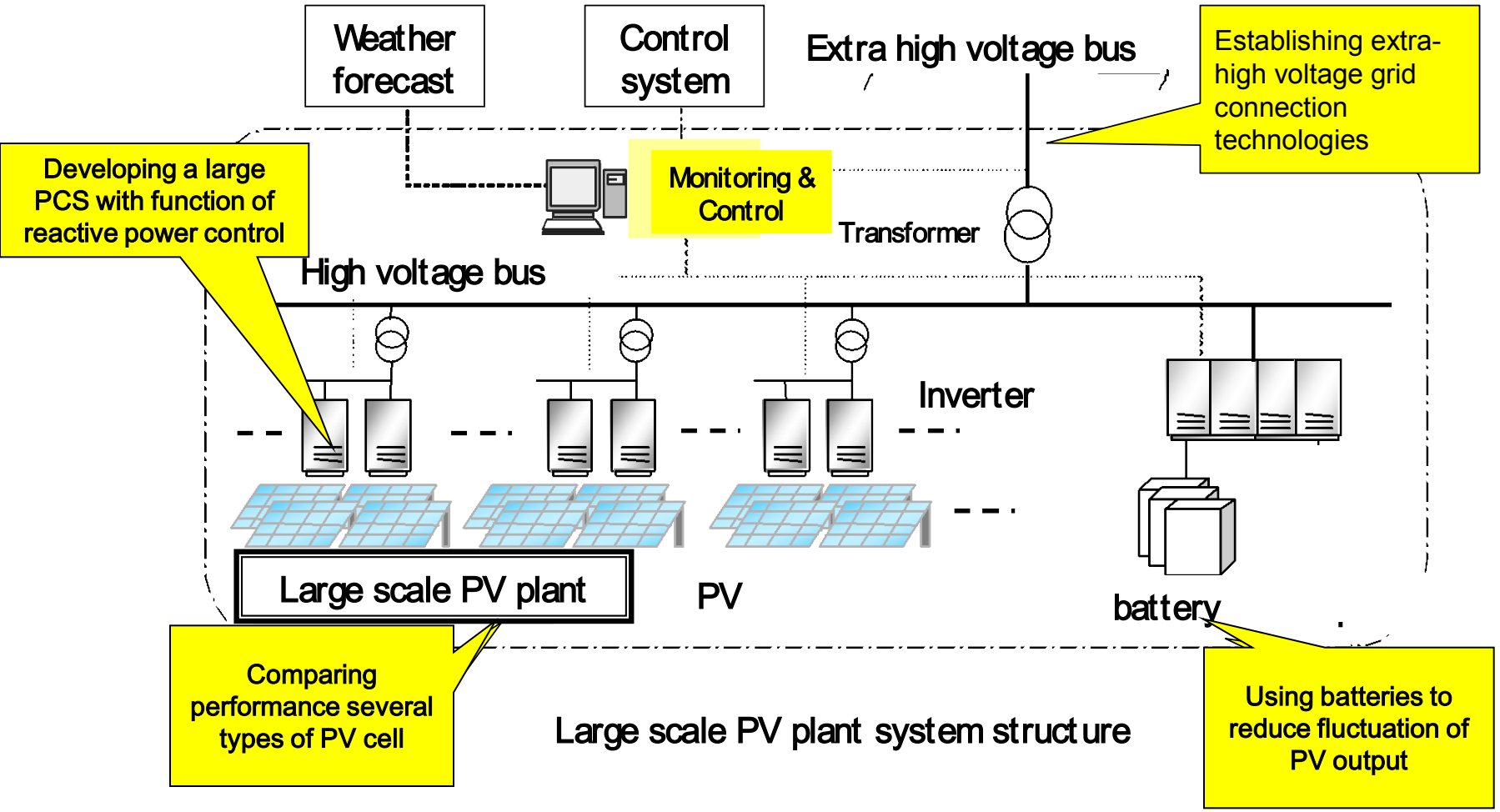
Wakkanai Site completion forecast figure

Hokuto site
600kW
(2000kW will be installed finally)
26 types of PVs were installed.

Hokuto Site completion forecast figure

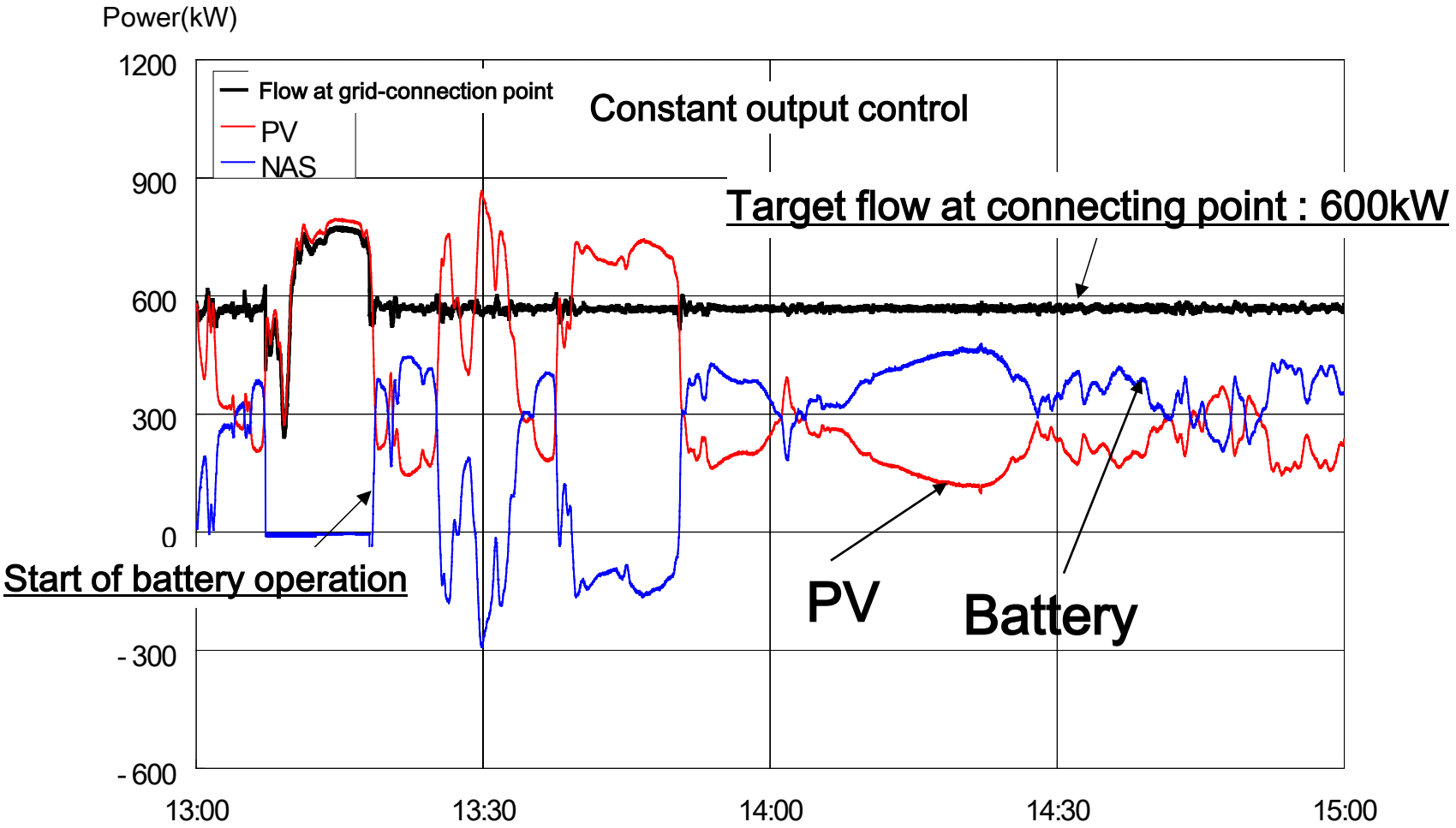
The first Japanese Mega-Solar

Verification of Grid Stabilization with large-scale PV Power Generation Systems (FY2006-2010)



Verification of Grid Stabilization with large-scale PV Power Generation Systems (FY2006-2010)

Appling battery storage to make power flow form PV power station as constant




Thank
You!