NEDO's Grid Connection Related Research Activities

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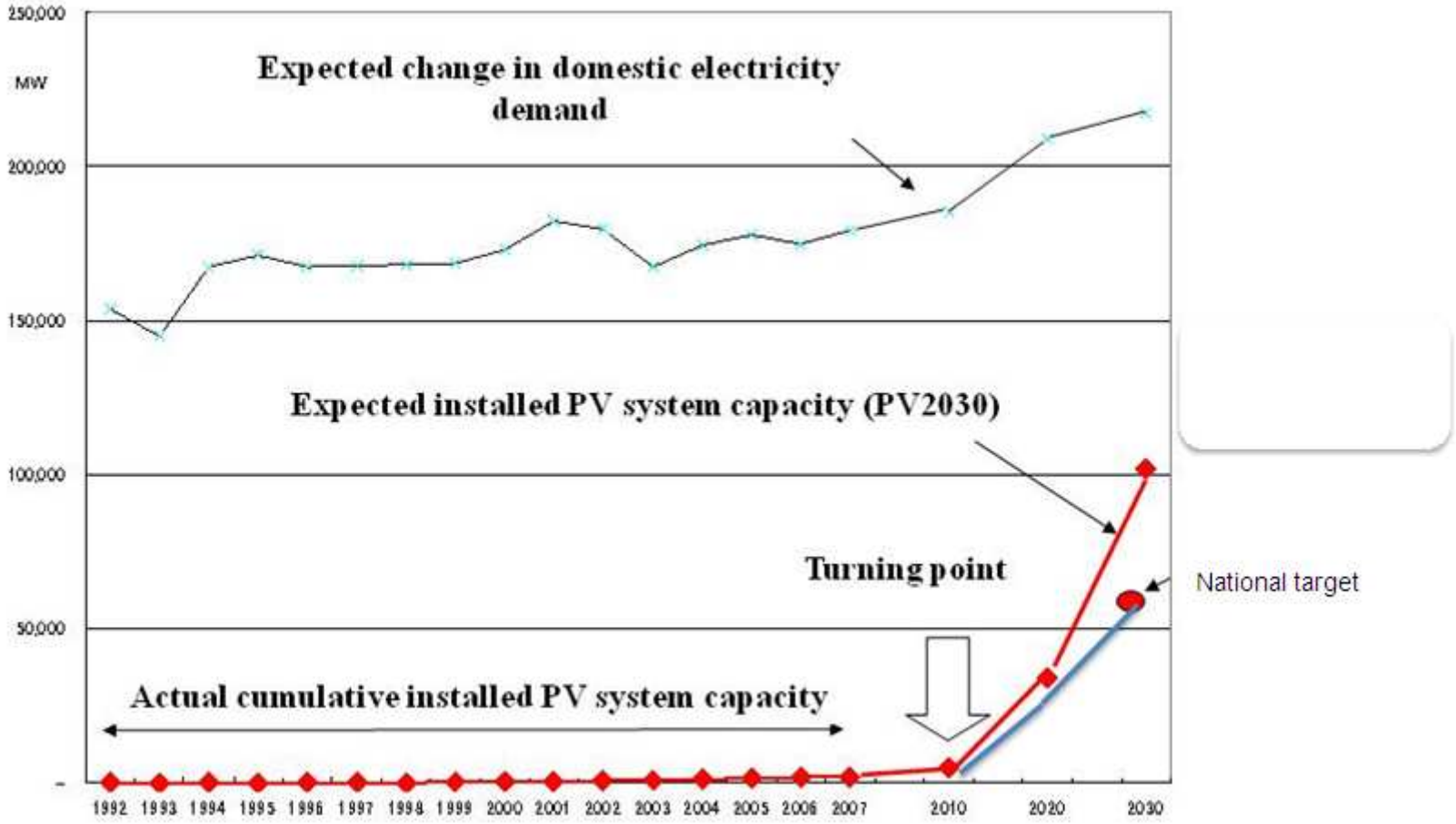
Why grid connecting technologies are important?

Expectation of high penetration of PV in Japan

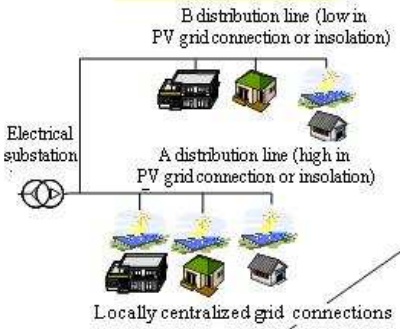


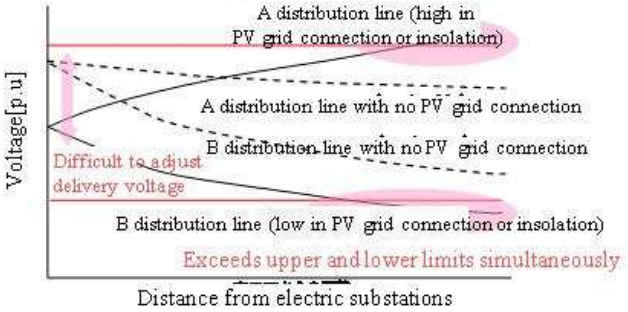
After year 2010, generated energy cost will become cheaper than average residential electricity price.
Therefore, NEDO expects high penetration of PV will come after year 2010 in Japan.

Expectation of future problem on the grid

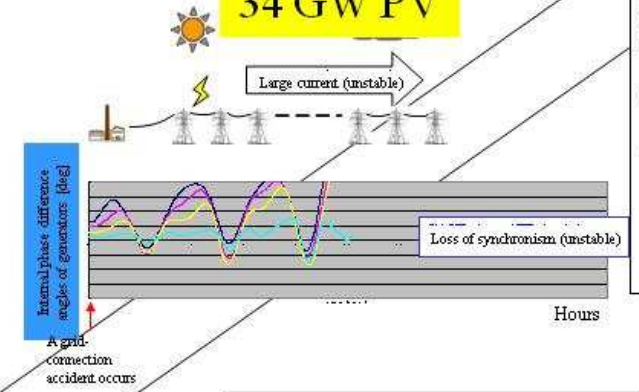
NEDO has begun creating a forecast of needs for grid connection technology related to renewable energy

Year 2010
4 GW PV



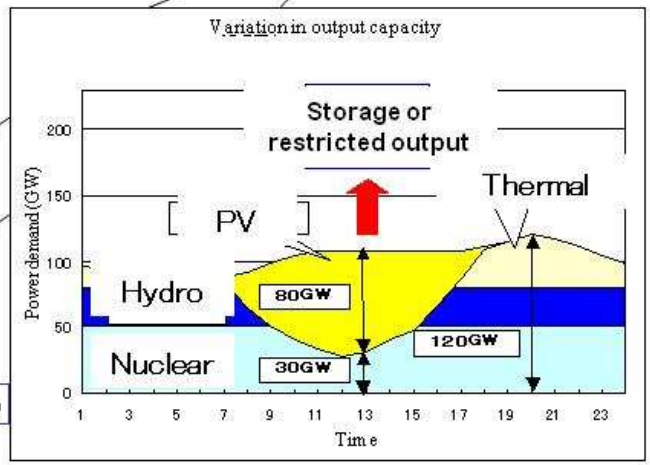


Year 2020
34 GW PV



Increased instability

Year 2030
100 GW PV



Uncertainty of balancing

Increase in voltage limit violations

NEDO has strategy for PV interconnection

History of grid connecting technology development in Japan

Before year 2000
Technology development for single renewable energy
(Through " Sunshine Project" or other project)

Year 2000-2010
Developing grid-connecting technologies for
multiple or large scale renewable energy

After 2010
Demonstrating "Smart Community" related technologies including social needs

NEDO's Grid-connection Related Projects 2000-2010

FY2005 and Before | FY2006 | FY2007 | FY2008 and After

Voltage control technology for clustered PV systems

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

Power control technology for wind farm

Wind Power Stabilization Technology Development Project
(FY2003-2007)

Control of supply system with multiple new energy and dispersed generation

Demonstrative Project of Regional Power Grids with Various New Energies
(FY2003-2007)

Interconnection technology for large-scale PV generation system

Demonstrative Project on New Power Network Systems
(FY2004-2007)

Voltage control technologies for distribution system when multiple diesel generators are connected. Development of supply system with different power quality.

Energy storage system for new energy

Verification of Grid Stabilization with Large Scale PV Power Generation Systems
(FY2006-2010)

Development of an Electric Energy Storage System for Grid-connection with New Energy Resources **(FY2006-2010)**

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

Background

Installation of clustered photovoltaic systems on distribution networks is anticipated.

The output from PV systems causes tangible problems, including overvoltage resulting from reverse power flows.

Objectives

-To develop technology to eliminate restrictions on PV system output.

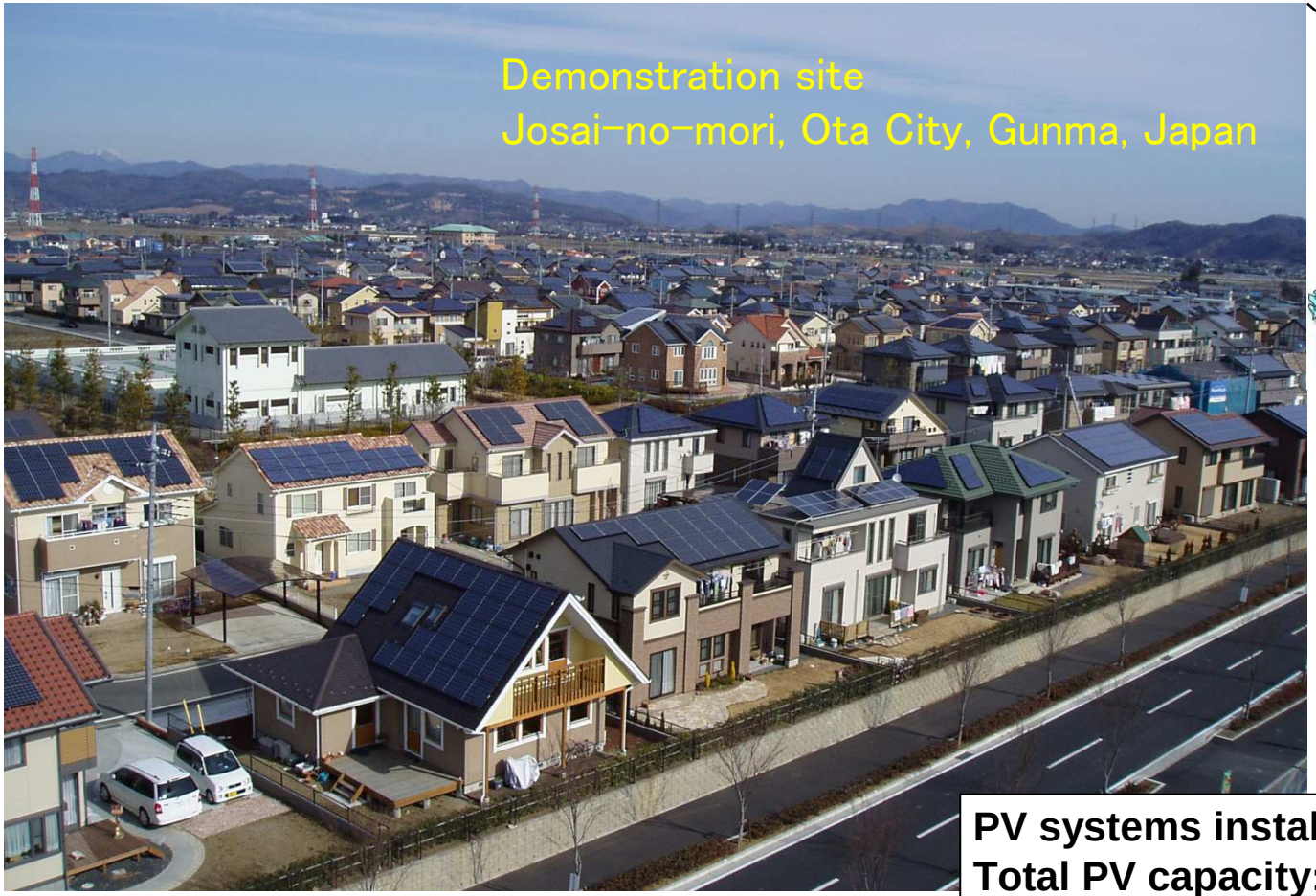
-To develop a method to detect unintentional islanding.

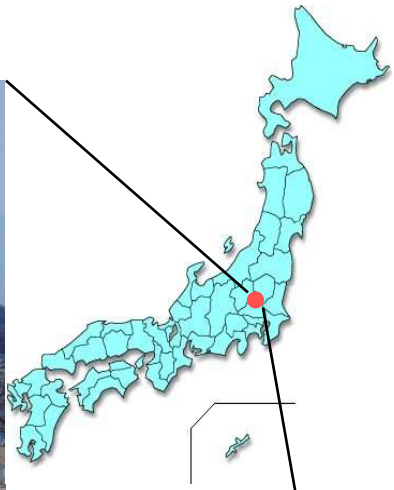
-To develop applied simulation technologies.

Results

-550 PV systems were installed.
-Effects of using batteries to control voltage on distribution line were studied.
-Possibility for interference among the equipment used to prevent islanding was detected.
-New equipment that can avoid such interference is now being developed.

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





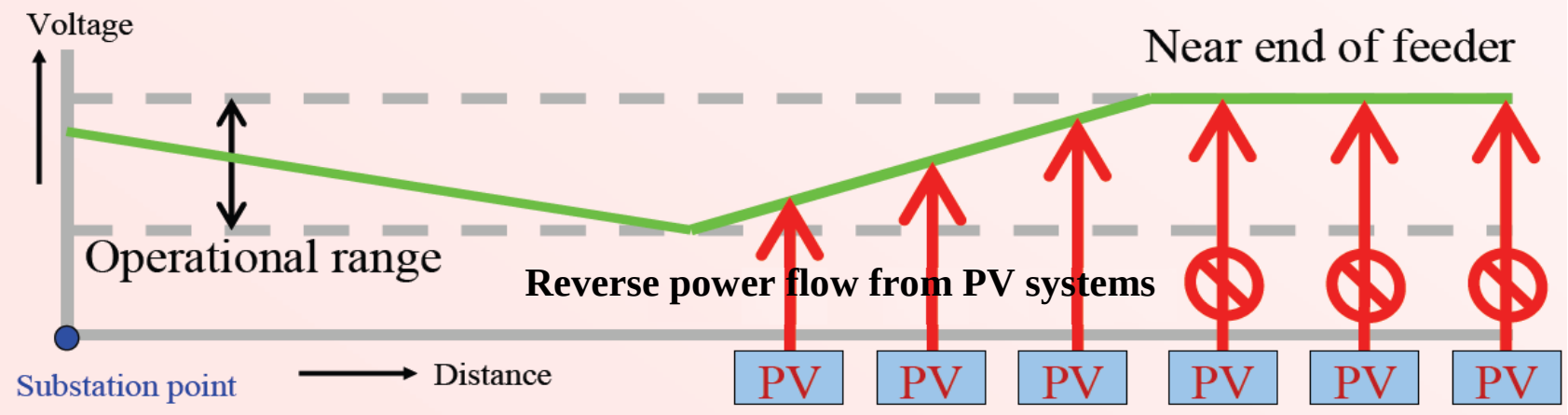
PV systems installed: 553
Total PV capacity: 2,129 kW
Avg. system capacity: 3.85 kW

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

Development of technology to eliminate restrictions on PV system output

The voltage on distribution lines sometimes exceeded the maximum nominal voltage of 107V or 222V because of excessive output from PV systems.

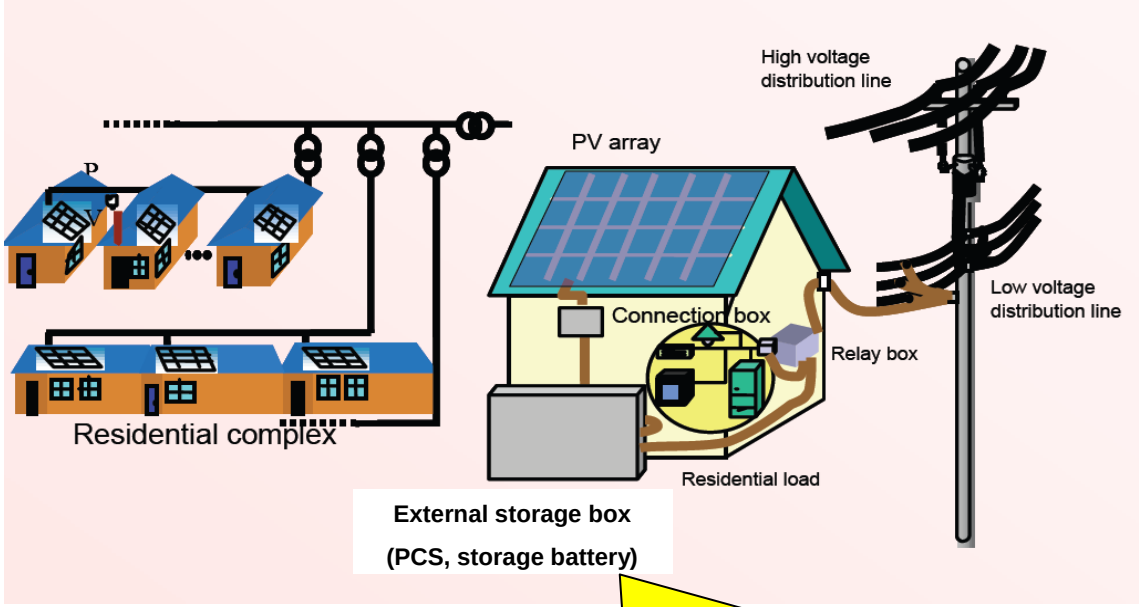
Output of PV must be restricted to keep line voltage within operational range (101±6V, 202±20V).



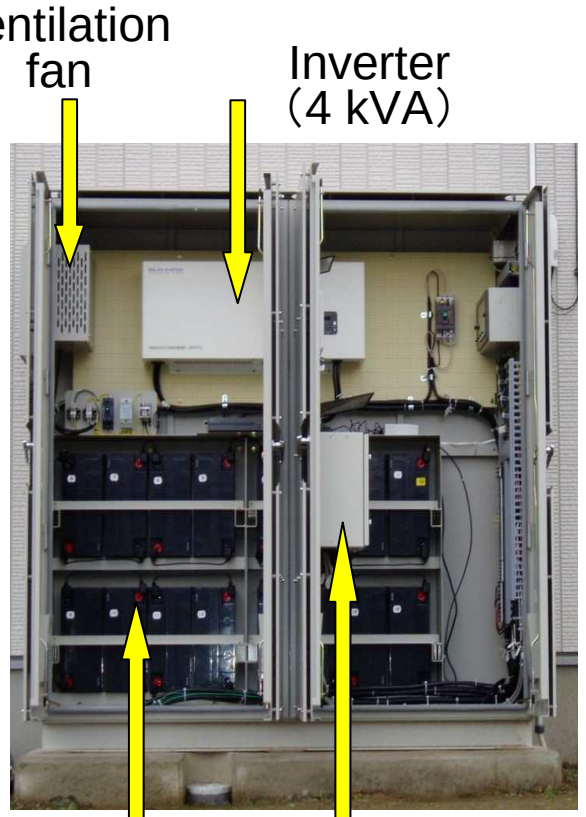
Several battery operating modes to reduce reverse power flow were developed in this project.

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

Image of battery storage system



A storage box connected to the PV system of each residence houses an inverter, battery and measuring instruments.



External storage box

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

Development of function to detect unintentional islanding

- **A function to detect islanding disconnects the PV system from the power grid in the event of service interruptions. Interference among the islanding detection equipment arises when PV systems are installed in a cluster.**
- **Methods to prevent this from happening have been developed and verified through demonstration testing.**

- ✓**Developing new islanding detection method**
- ✓**Testing this method at test facility in Maebashi City**
- ✓**Installing field-test equipment at demonstrative site in Ota City**
- ✓**Installing improved devices at demonstrative site in Ota City**

Test facility in Maebashi

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

Background

If PV gains market acceptance, more large (MW-scale) PV power stations will be built and connected to power grids.

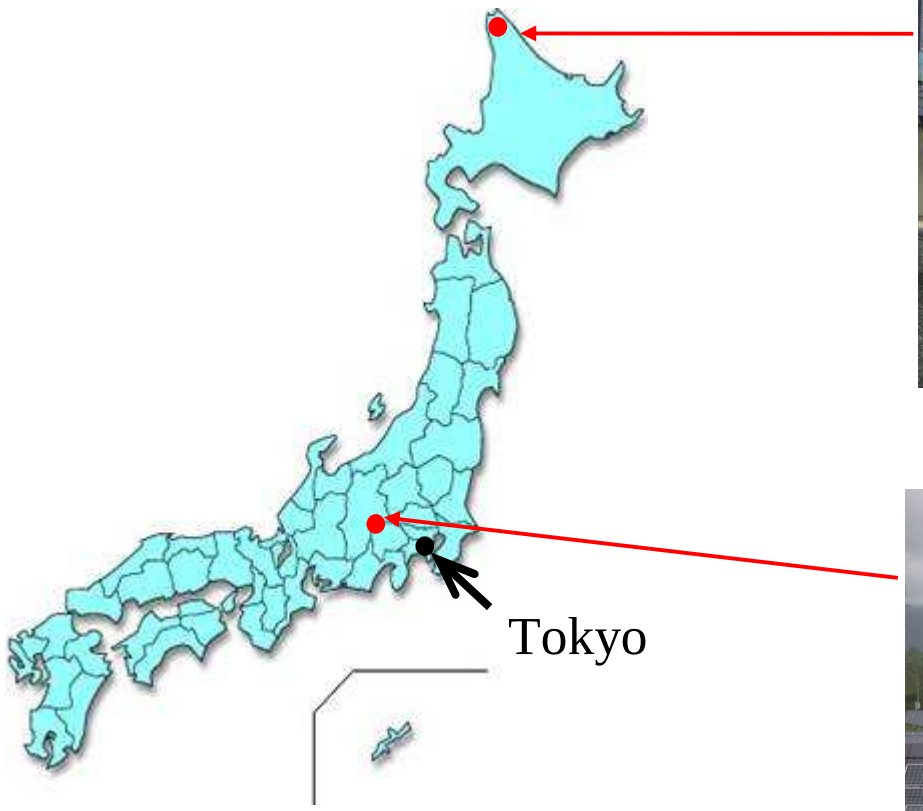
It is possible that such large-scale PV power stations may impact voltage and frequency on utility systems.

Objectives

(1) To demonstrate battery storage system technology to reduce voltage and frequency fluctuations using. Also, countermeasures for harmonics will be developed and demonstrated.

(2) To develop simulation methods related to the technologies mentioned above.

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

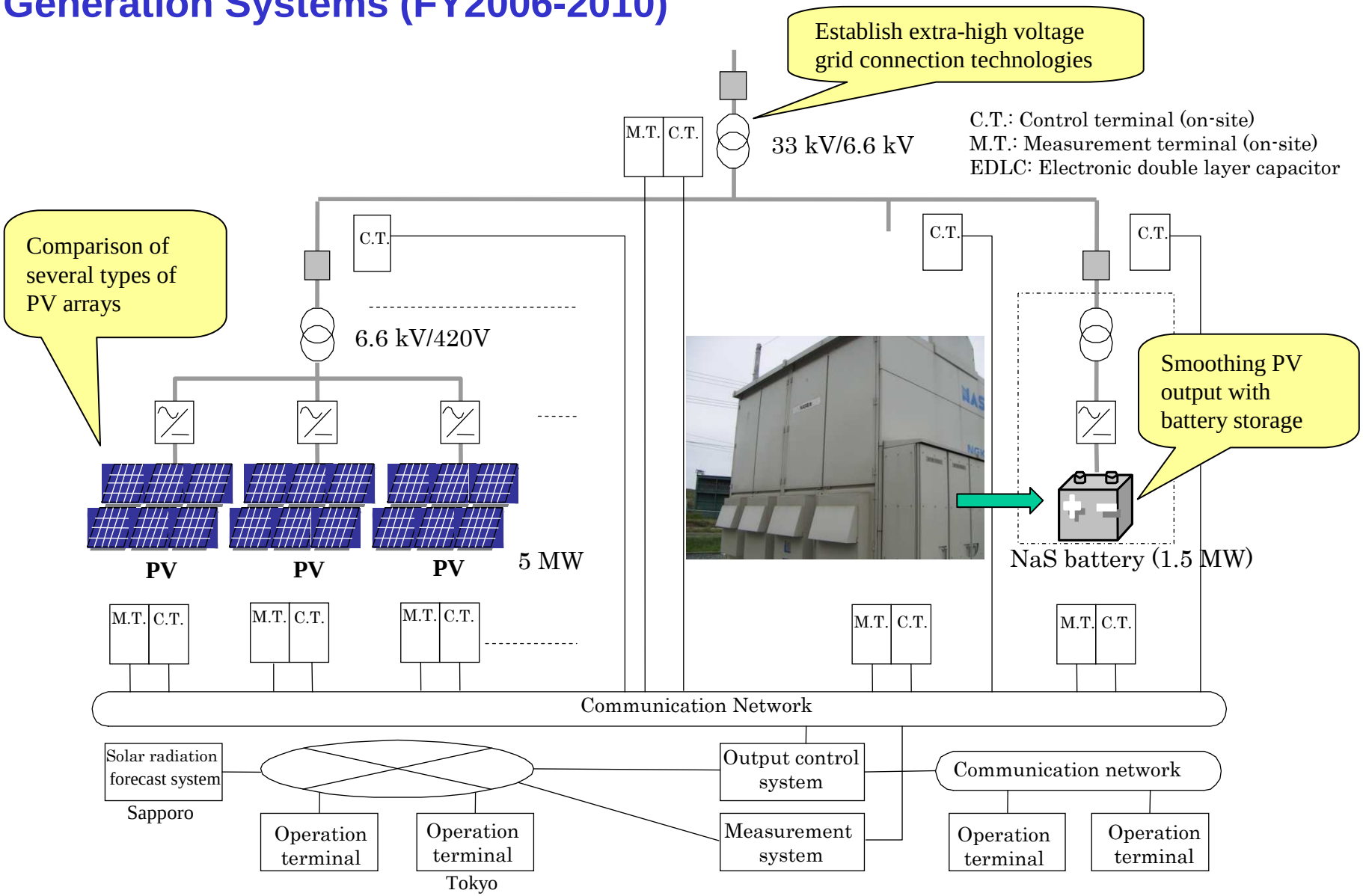


Rendered image of Wakkanai site

Rendered image of Hokuto site

The first mega-solar systems installed in Japan

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)

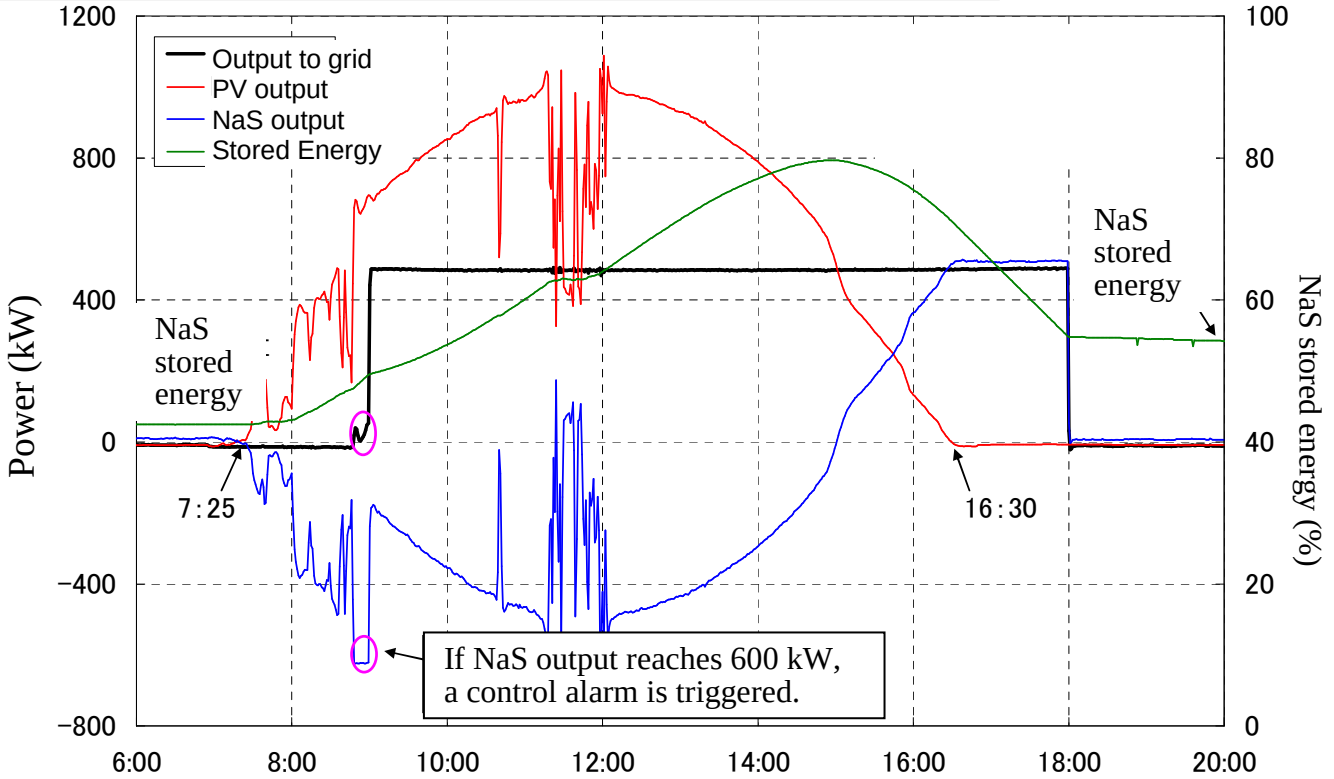
Mega-solar system comparison

	Wakkanai City	Hokuto City
PV capacity	Max. 5 MW	Max. 2 MW
Module type	Mainly Crystalline	Various advanced modules
Energy storage	NaS: 1.5 MW – 11.8 MWh	–
PCS	1000kW (250kW*4unit)	400 kW (Reactive power control, reducing harmonic and addingFRT)
Grid connection	33 kV transmission line	66 kV transmission line
Forecasting	Solar radiation forecast	–

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

Stabilization of mega-solar output: typical planned operation

Date: 2008/2/10
Operation schedule
9:00-18:00 (9 hours)
500 kW constant transmission

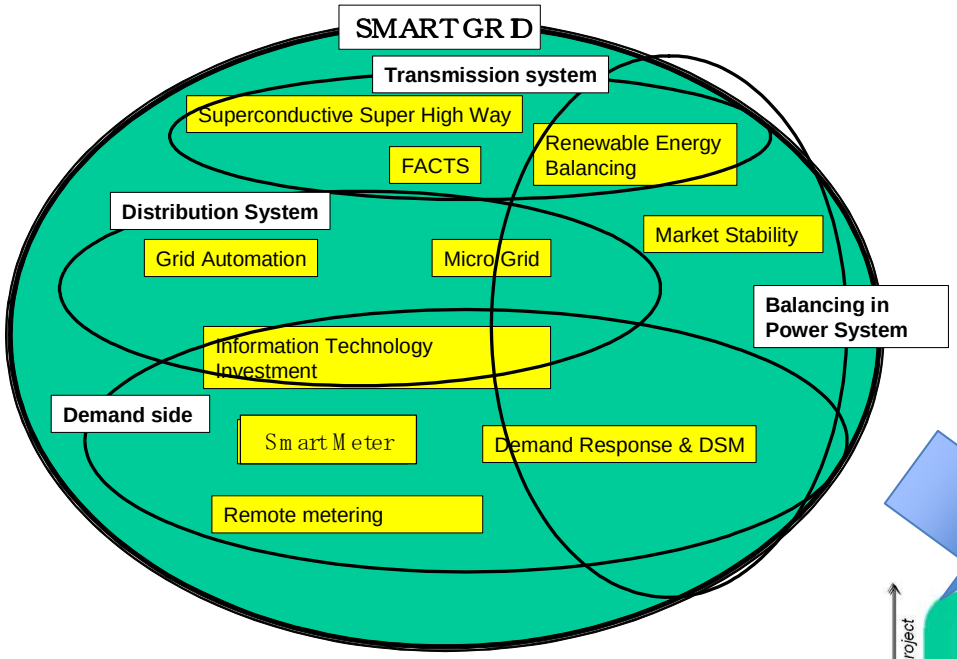


Comment:

We succeeded in meeting our planned output control, which was 500 kW constant transmission from 9:00 to 18:00.

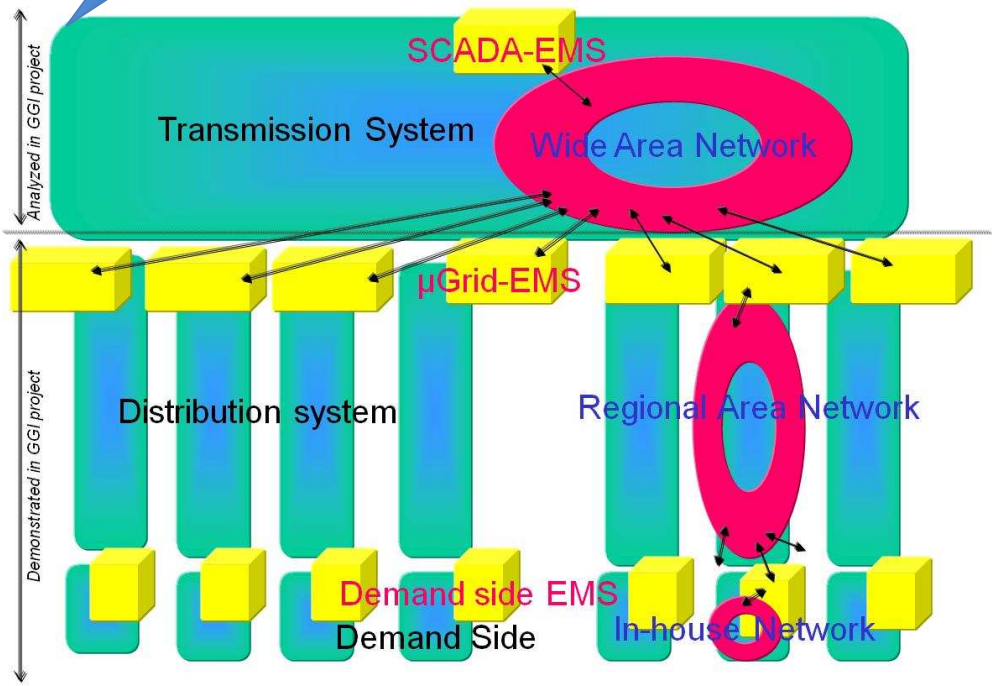
Toward smart community

Smart Grid



At first, term of “smart grid” means political term involving several grid related technologies.

Technically, smart grid consists power system and communication system which have bidirectional function. Mainly, it focus on IT application on distribution and customer side.



Smart Grid activity after 2010

Domestic Project

Developing smart grid technologies through demonstration projects

Area Smart community demonstration

Mainly 4 area in Japan

International Project

Showing the future smart grid related technologies through demonstration project

New Mexico Smart Grid collaboration project

Demonstration projects in other area in the world
Ex. US, Europe, Asia ----

NEDO Started the first smart grid project in NM

Demonstration at sites

1) Los Alamos County

NEDO Demo feeder

NEDO Demo House

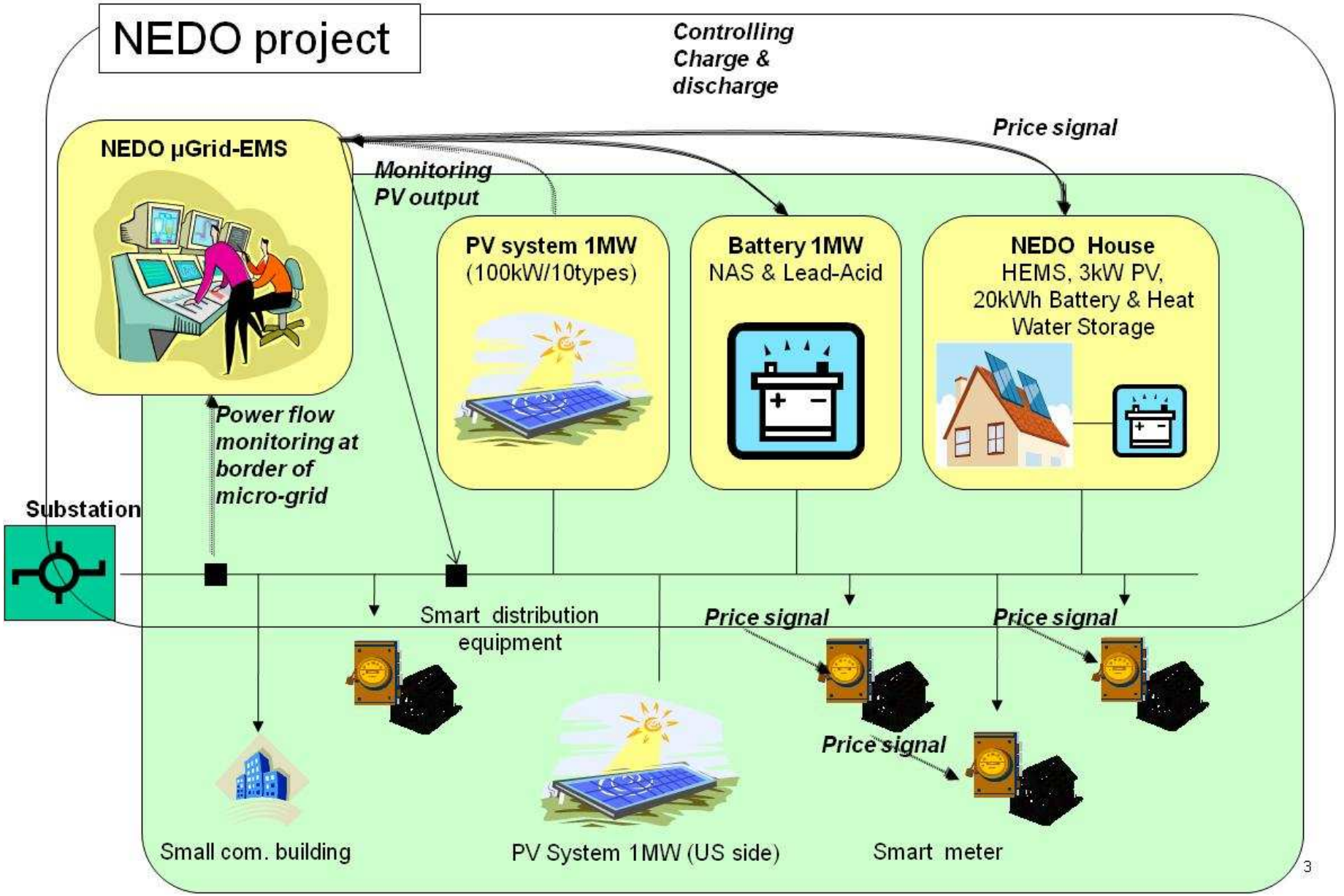
2）Albuquerque

NEDO Demo EMS and commercial building

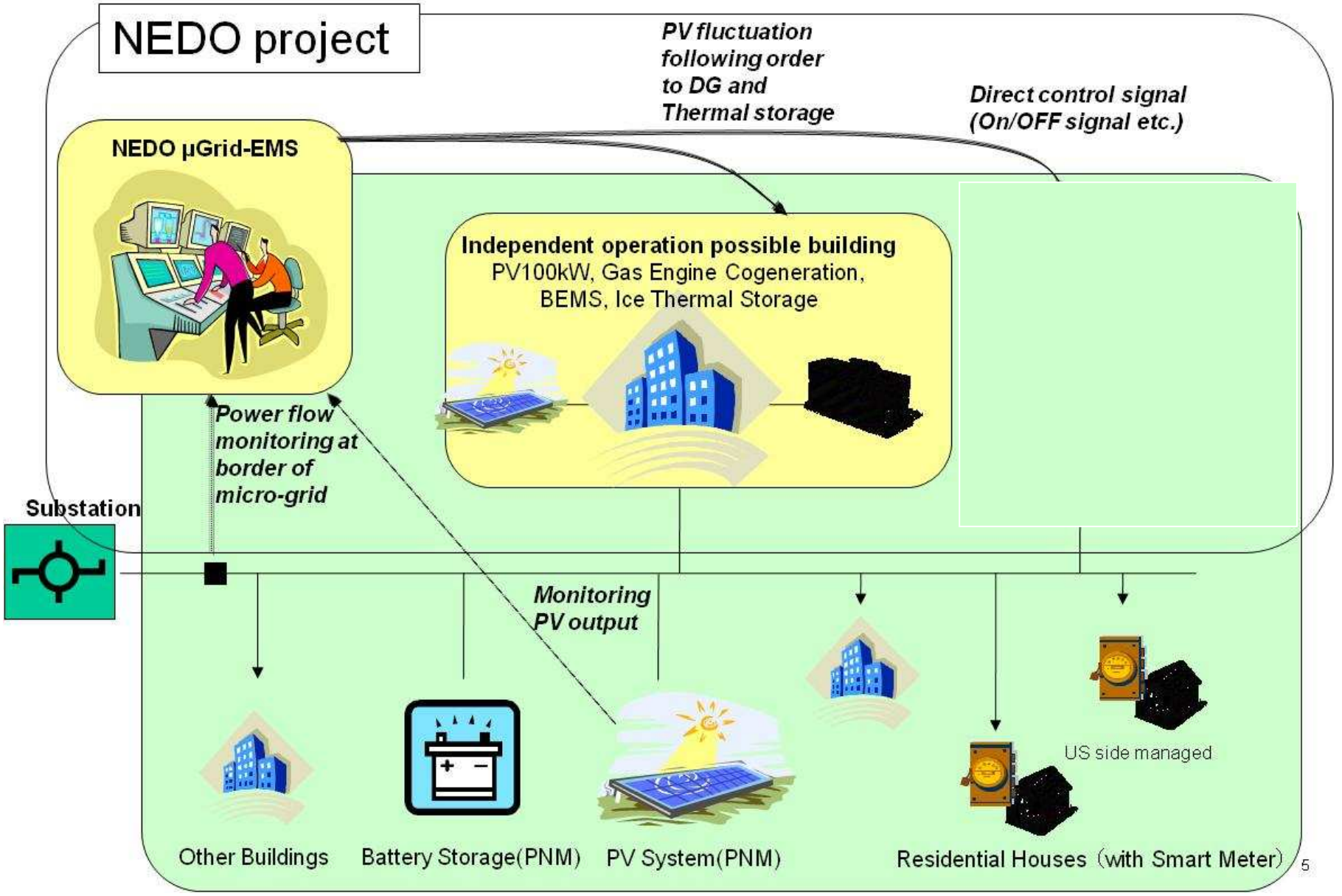
NEDO Second demo house (Future Option)

3）Research and Study

NEDO micro-grid in LAC

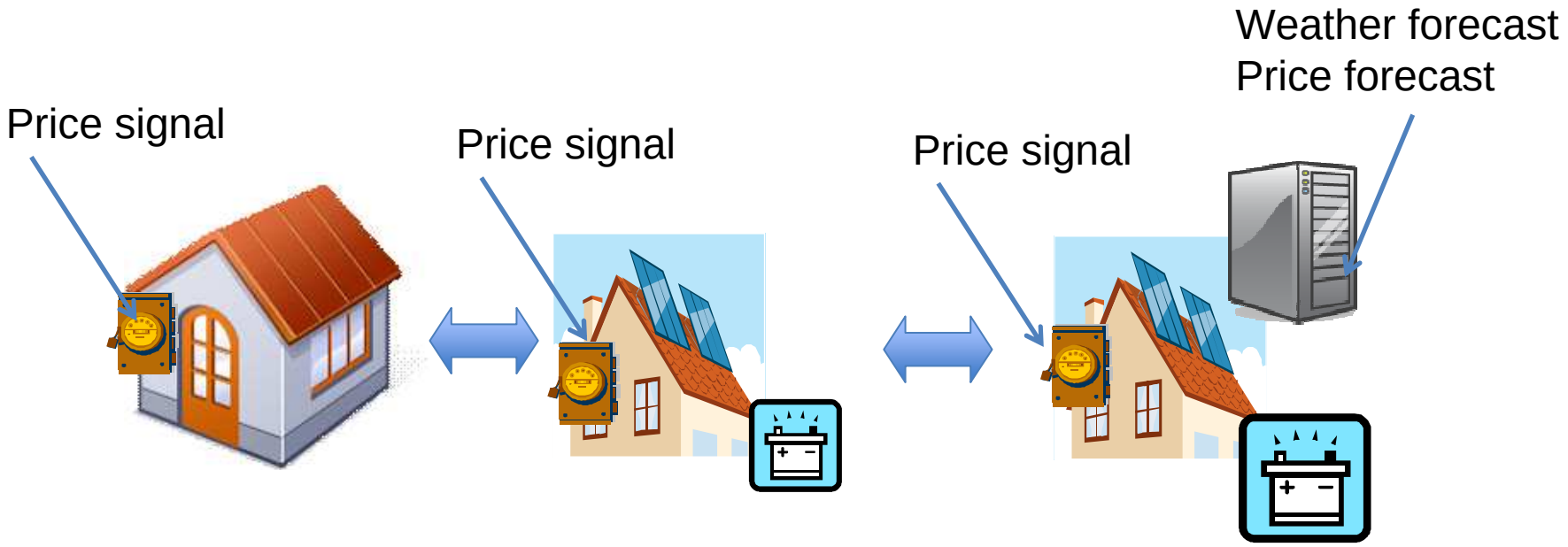


NEDO micro-grid in ABQ



NEDO demonstration house

Comparison demand response (especially increase side) among houses.



House only has smart meter

House has smart meter, PV and battery

House has smart meter, PV , battery and intelligence

NEDO House


Thank
You!