# JAPAN'S RENEWABLE ENERGY POLICY AND PERSPECTIVES ON THE NEXT-GEN DISTRIBUTED POWER GRID SYSTEMS

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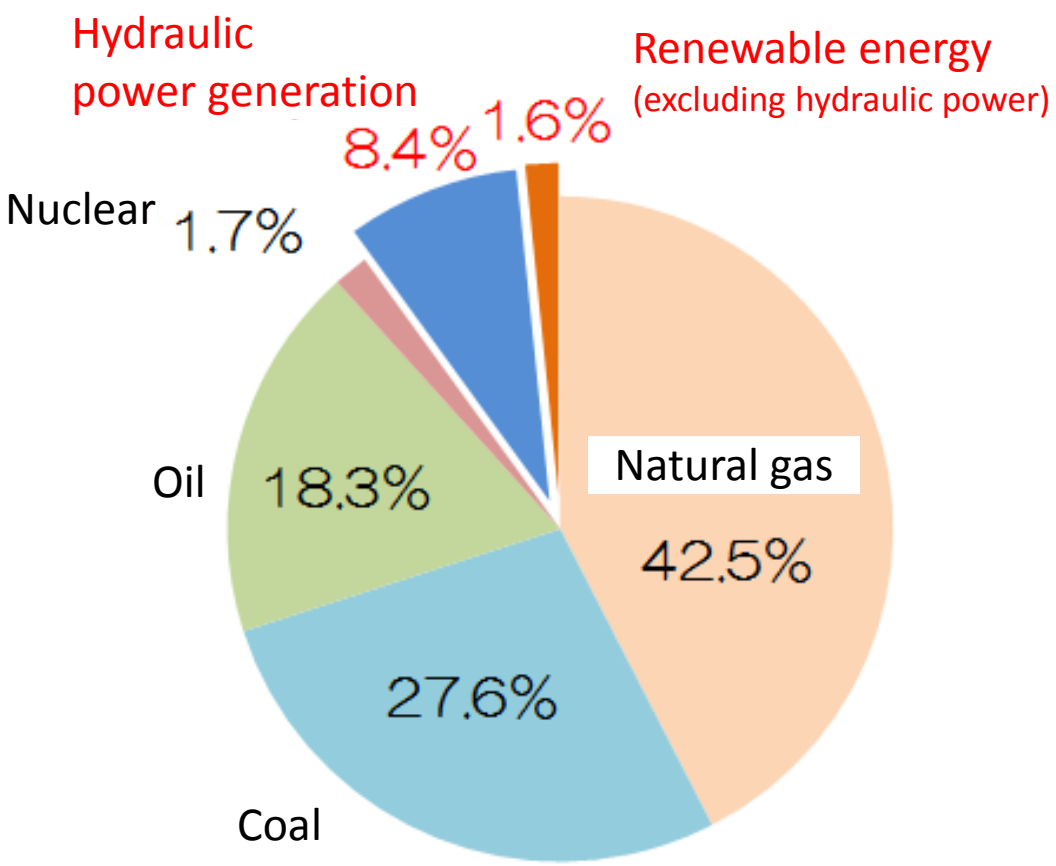
# Topics:

1. Current Status of Renewable Energy in Japan
2. Japan’s Renewable Energy Policy
3. the Next-Gen Distributed Power Grids

# 1. Current Status of Renewable Energy in Japan

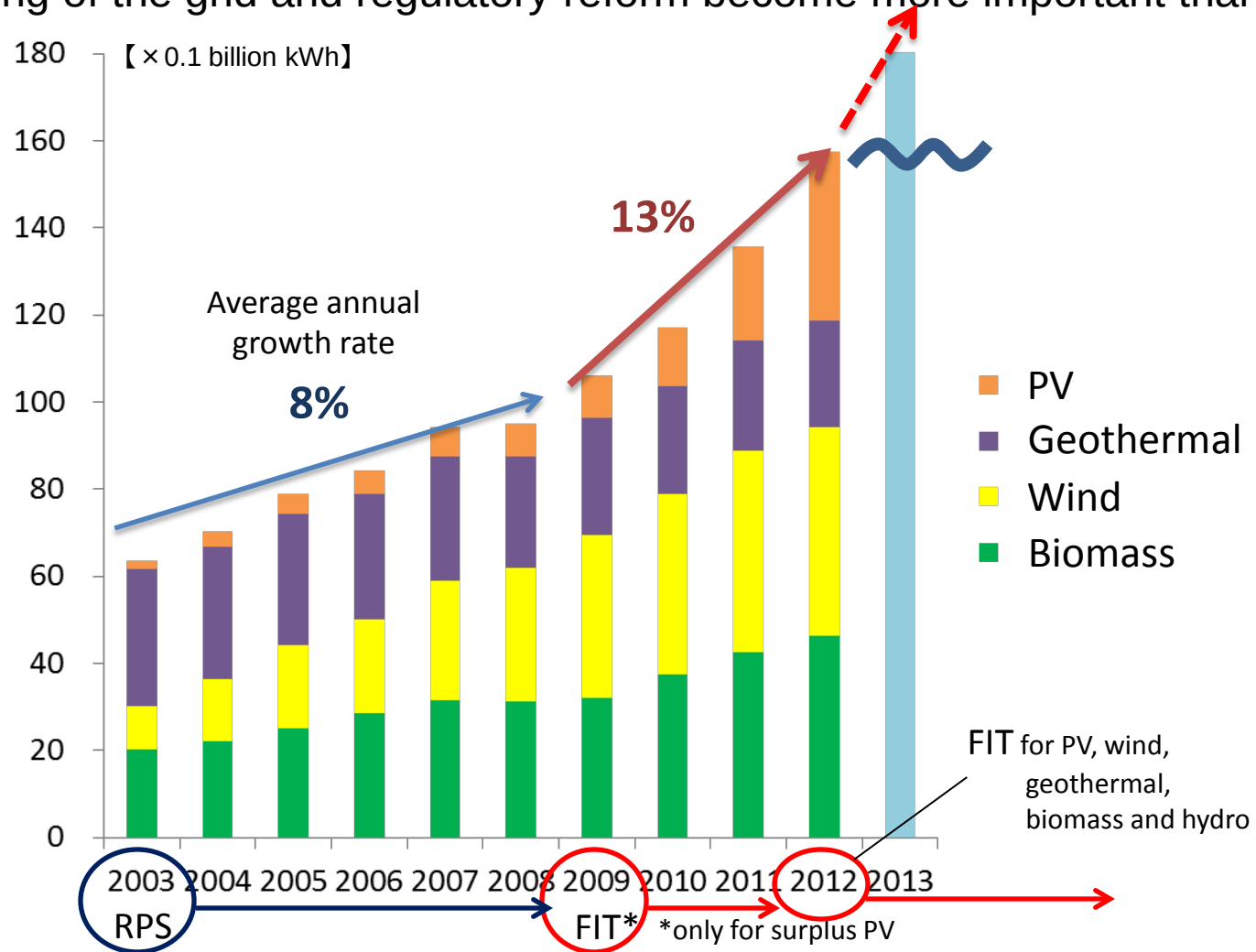
# Composition of annual energy generated in Japan (FY2012)

- Among the total electricity generated in fiscal 2012, renewable energy (RE) accounted for approximately 10%.
- Renewable energy accounts for only 1.6% if exclude hydraulic, most part of which comes from large dams.

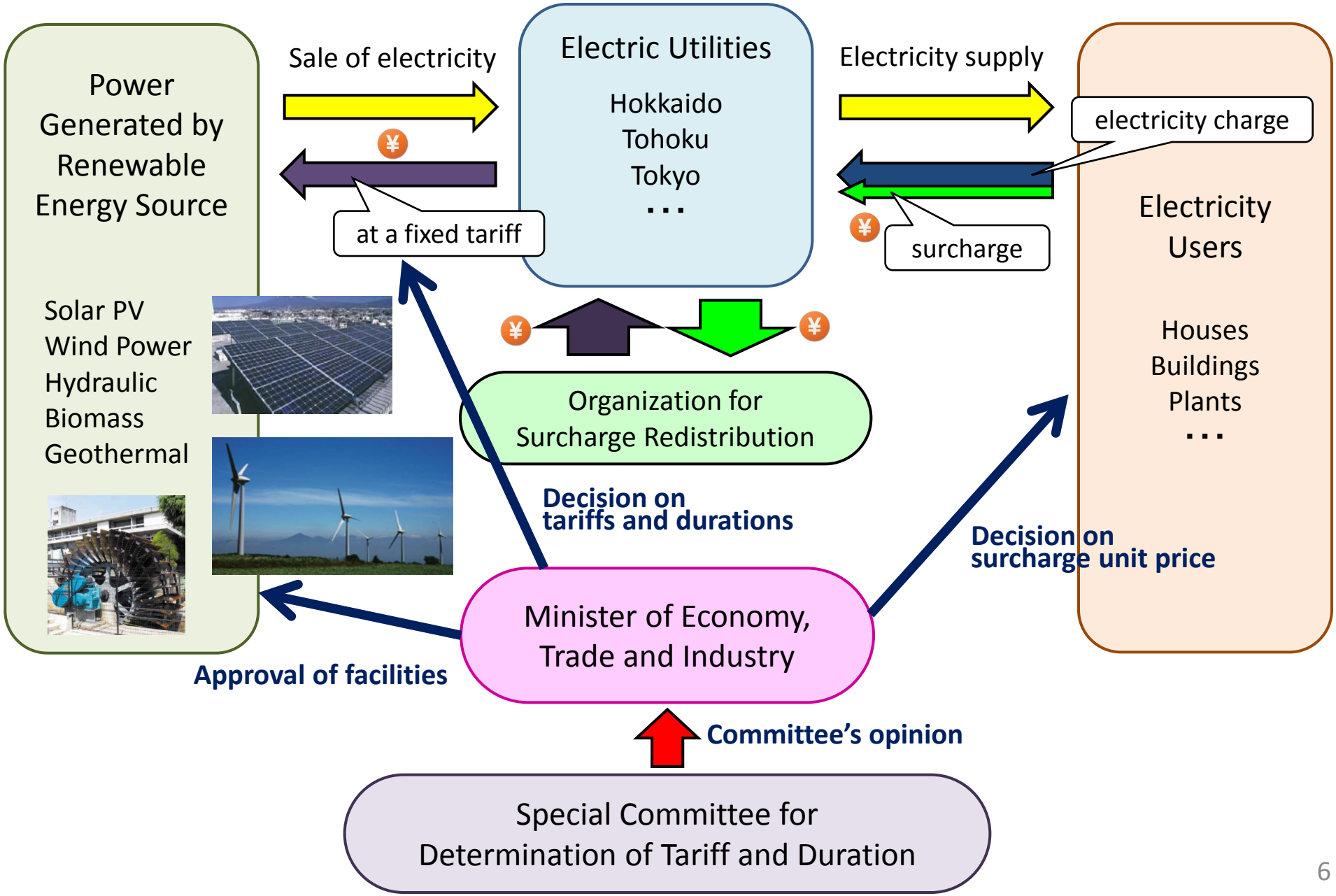


# History of Japan's renewable energy promotion measures

- Subsidies began in 1997.
- The main driver shifted to RPS in 2003, and then, to Feed-in Tariff in 2009.
- As business environment from the financial point of view was improved, investment in RE has been stimulated. In these surroundings, extension and upgrading of the grid and regulatory reform become more important than ever.



# Feed-in tariff scheme has started in July 2012



# Deployment of renewable energy since FIT 2012 started

- Thanks to FIT, 6,500MW of RE capacity has been deployed by the end of October 2013.
- 28% increase in the total RE capacity within two years .
- More than 95% of the capacity comes from solar PV, which added 100% of the existing solar capacity.

| | Accumulated capacity before FIT started | Deployed capacity after FIT as of the end of October 2013 |
|---|---|---|
| Solar PV ( < 10 kW ) | 4,700 MW | + 1,839 MW |
| Solar PV ( > 10 kW) | 900 MW | + 3,827 MW |
| Wind Power | 2,600 MW | + 70 MW |
| Hydraulic | 9,600 MW | + 5 MW |
| Biomass | 2,300 MW | + 112 MW |
| Geothermal | 500 MW | + 1 MW |
| **Total** | 20,600 MW | + 5,852 MW |

# New tariffs and durations updated in April 2013

## Solar PV

| | 10kW or more | Less than 10kW |
|---|---|---|
| Tariff | 42 JPY ➡ **37.8 JPY** | 42 JPY ➡ **38 JPY** (before tax) |
| Duration | 20 years | 10 years |

## Wind Power

| | 20kW or more | Less than 20kW |
|---|---|---|
| Tariff | 23.1 JPY | 57.75 JPY |
| Duration | 20 years | 20 years |

## Geothermal

| | 15,000kw or more | Less than 15,000 kW |
|---|---|---|
| Tariff | 27.3 JPY | 42 JPY |
| Duration | 15 years | 15 years |

## Hydraulic

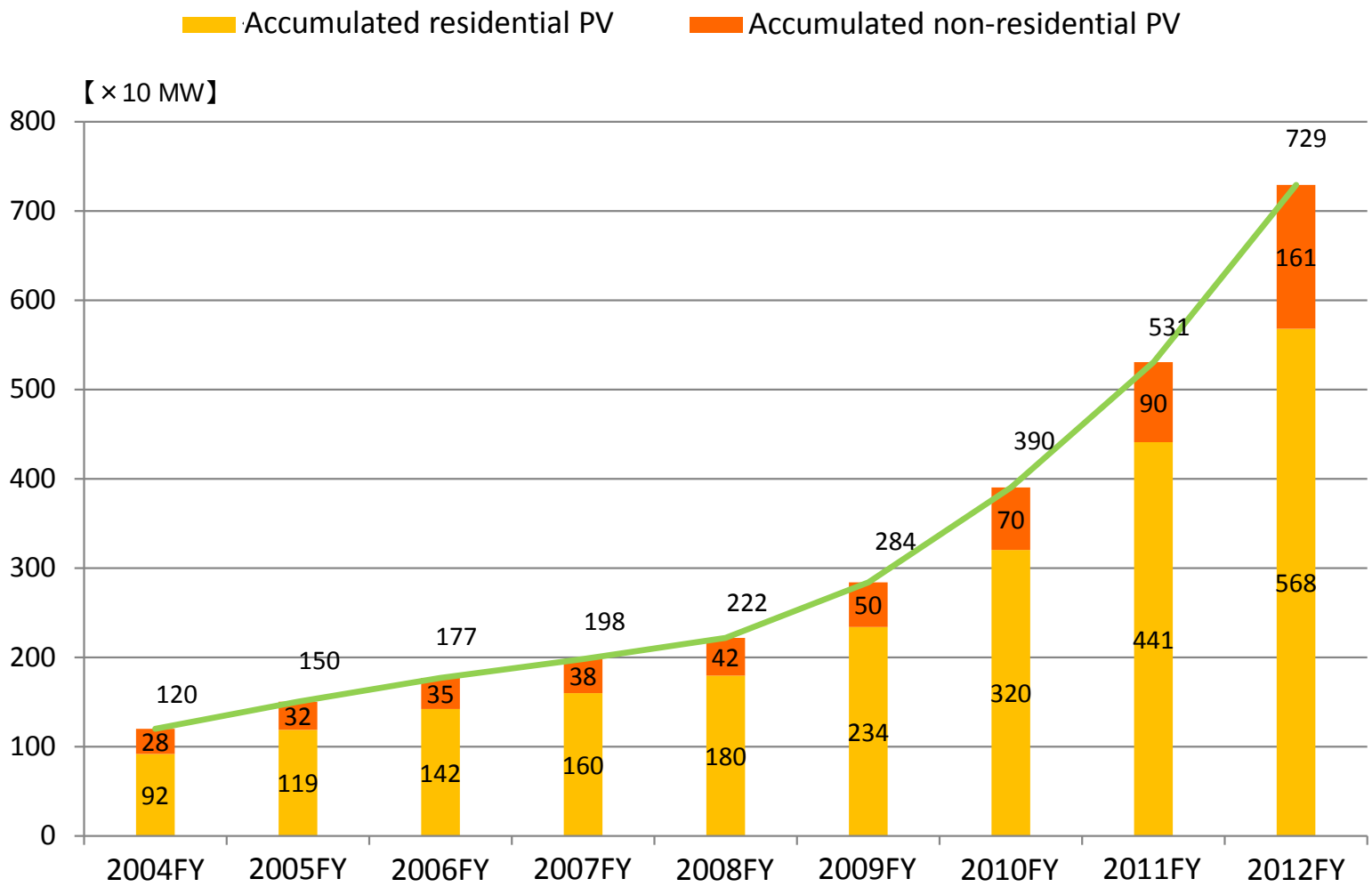
| | From 1,000kW to 30,000 kW | From 200kW to 1,000 kW | Less than 200kW |
|---|---|---|---|
| Tariff | 25.2 JPY | 30.45 JPY | 35.7JPY |
| Duration | 20 years | 20 years | 20 years |

## Biomass

| | Biogas | Timber from forest thinning | Other woody materials | Wastes (Excl. woody waste) | Recycled wood |
|---|---|---|---|---|---|
| Tariff | 40.95 JPY | 33.6 JPY | 25.2 JPY | 17.85 JPY | 13.65 JPY |
| Duration | 20 years | 20 years | 20 years | 20 years | 20 years |

# Updates on PV deployment

- By the end of 2012FY, accumulated PV capacity reached 7,300MW.
- Around 80% of the capacity comes from residential, but non-residential proportion has been increasing.




Source: METI and Japan Photovoltaic Energy Association (JPEA)

# Market expansion of PV as “distributed power source”

- PV is re-valued as a distributed power source locally produced and consumed, since it can be introduced even in small area equivalent to several dozens kW.
- Indeed, recent market drivers are small and medium sized PVs located at idle land or rooftop of schools and factories.

| Capacity | # of facilities deployed |
|---|---|
| 10-50kW | 3,588 |
| 50-500kW | 108 |
| 500-1,000kW | 18 |
| > 1,000kW | 35 |

Small and medium sized PV

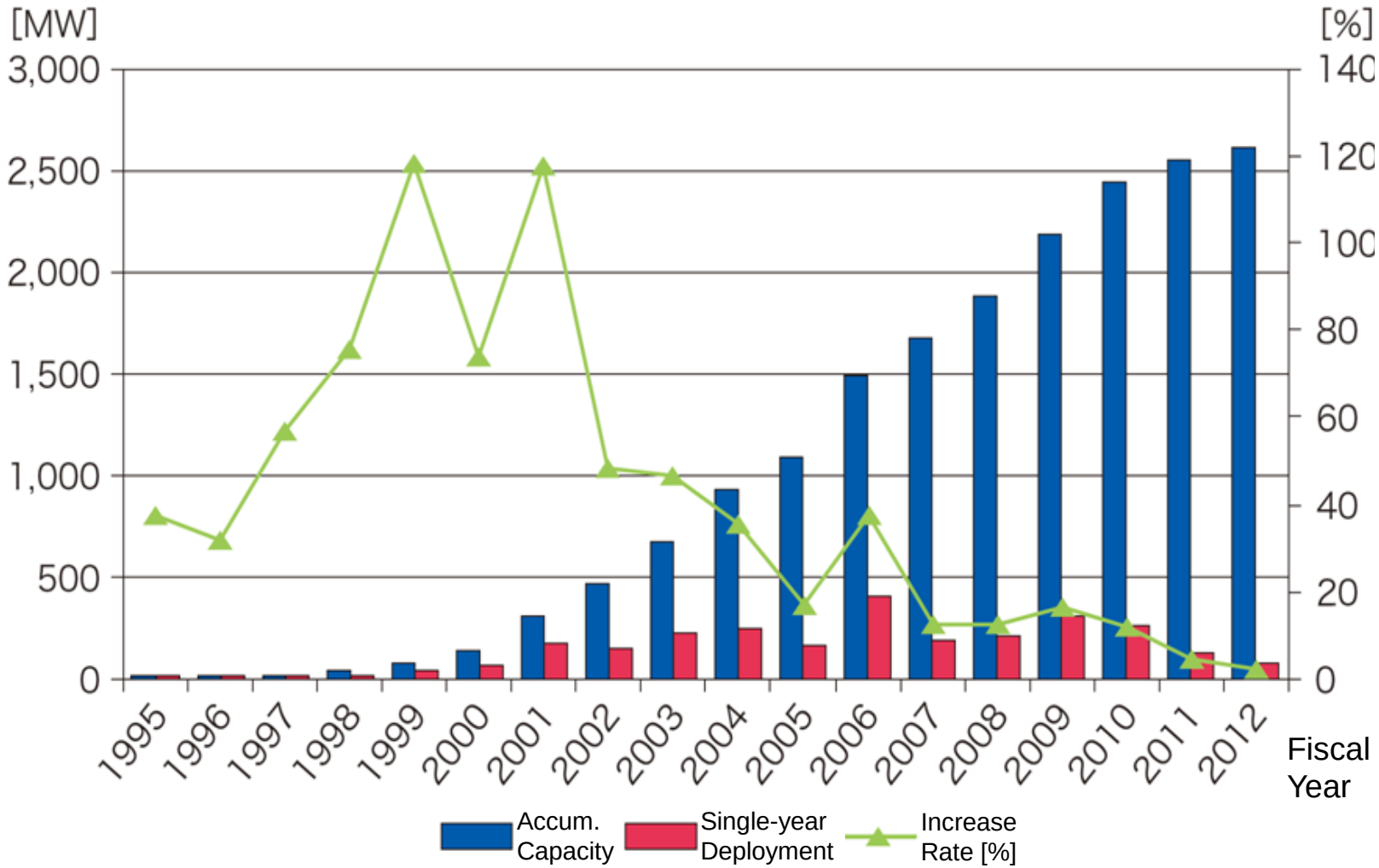
Source: Special Committee for Determination of Tariff and Duration

Roadside station (22kW)

Kindergarten (30kW)

# Updates on “onshore” wind

- Wind power capacity in Japan started to be introduced since late 1990’s, finally reaching 2,641MW as of 2012FY.
- Its growth rate in these five years, however, is as low as around 10%.



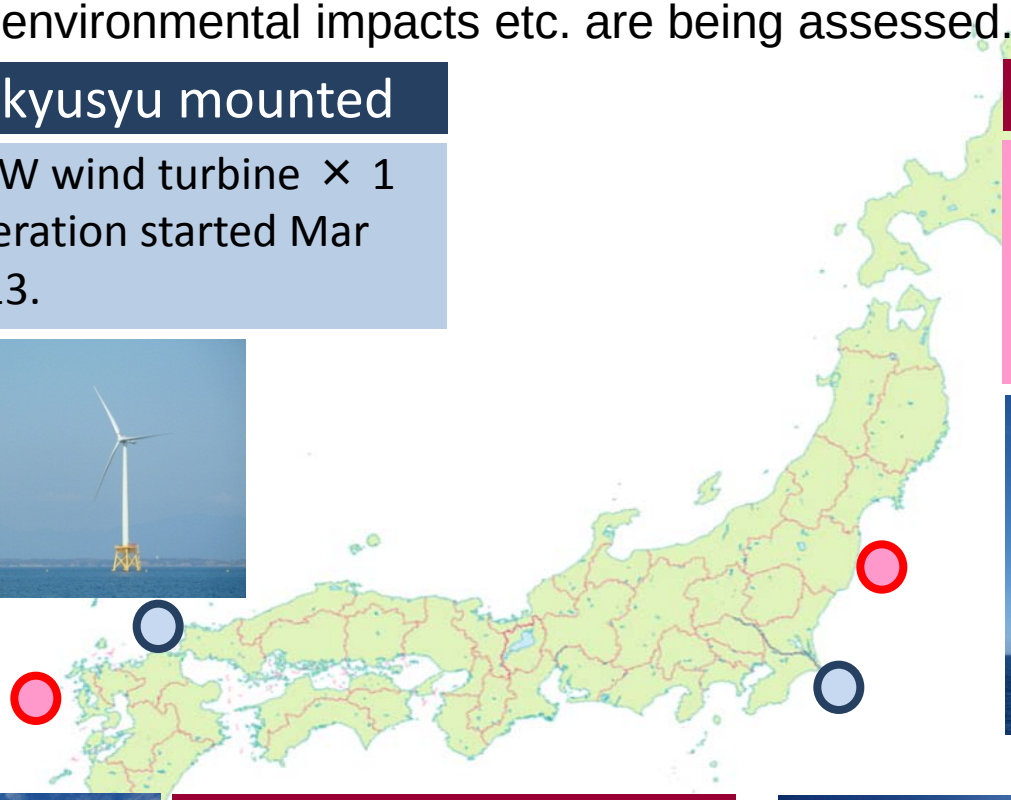

Source: NEDO

# Updates on “offshore” wind

- Offshore wind is one of key areas so as to increase RE in the country.
- Four different demonstration projects are going on: Two are bottom-mounted, and another two are floating wind turbines.
- Construction cost, weather condition, location requirements, and environmental impacts etc. are being assessed.

## Kitakyusyu mounted

- 2MW wind turbine × 1
- Operation started Mar 2013.



## Fukushima floating

- Floating substation × 1
- 2MW wind turbine × 1
- 7MW wind turbine × 2 (planned)
- Operation started Nov 2013.

## Nagasaki floating

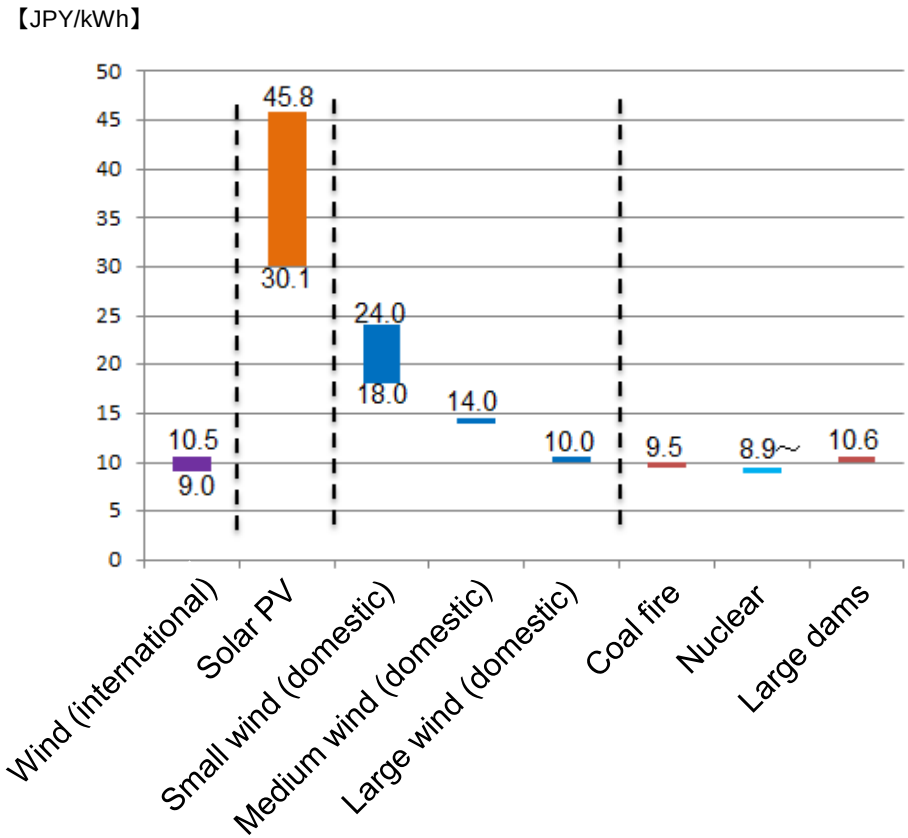
- 2MW wind turbine × 1
- Operation started Oct 2013.

## Choshi mounted

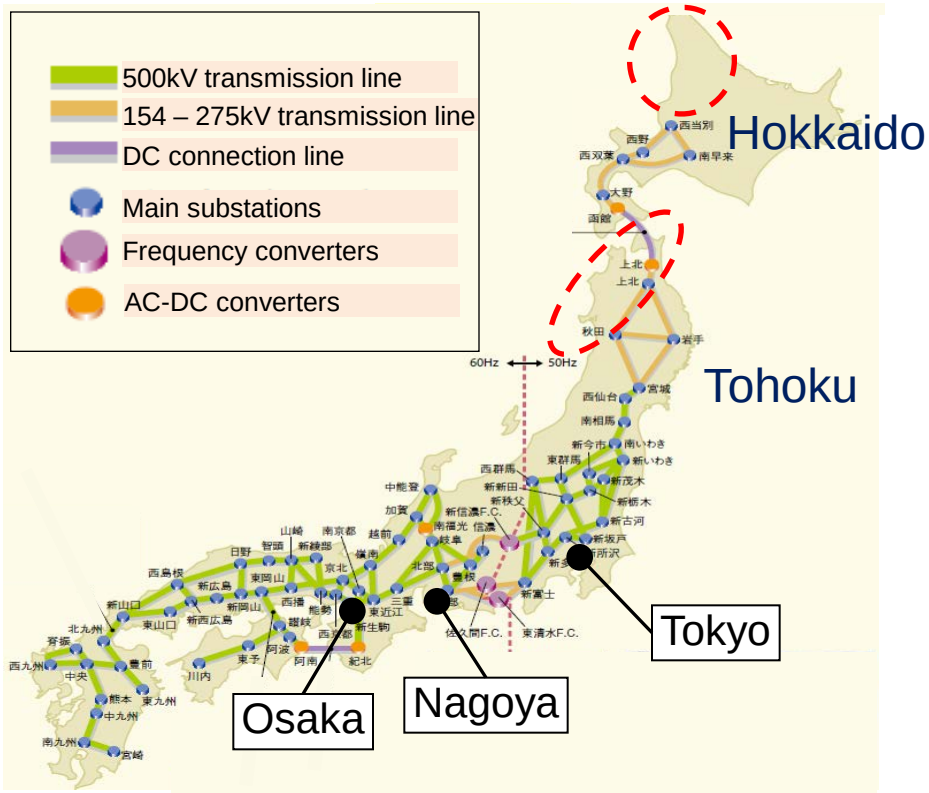
- 2.4MW wind turbine × 1
- Operation started Feb 2013.

# Opportunities and challenges of “onshore” wind

- If developed as a large wind farm, its unit cost is well competitive with coal, nuclear and hydro.
- But windy, vast areas which are suitable for large development are concentrated in particular regions – Hokkaido (41%) and Tohoku (21%), where the grid is considerably weak due to small population.




Comparison of power generation cost

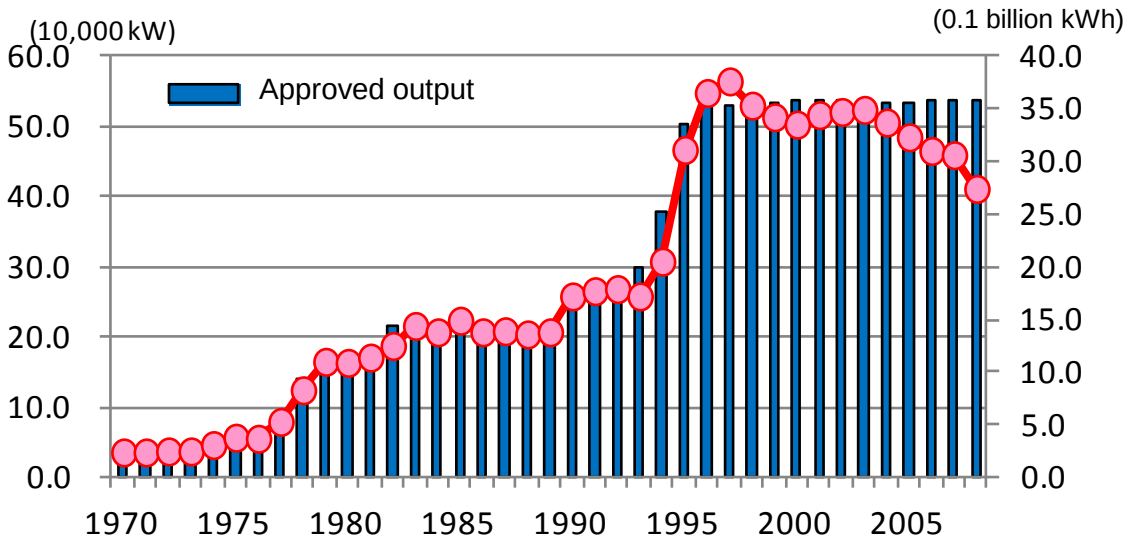



Map of transmission lines [as of 2010]

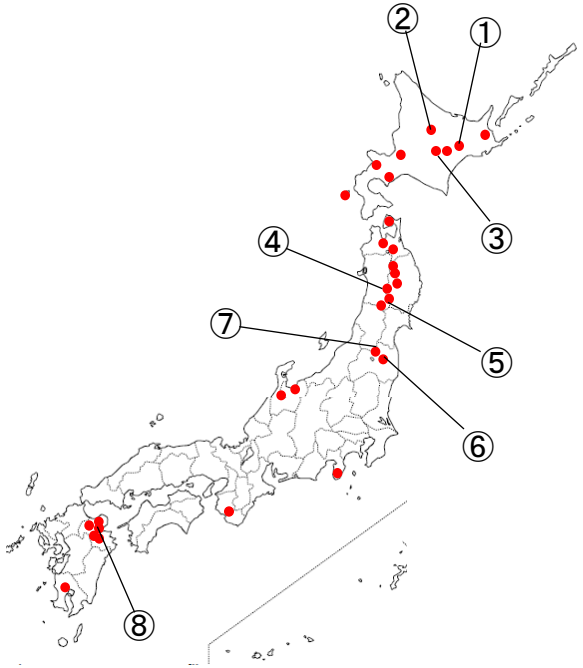
Source: Cost Verification Committee, World Energy Outlook 2009 (IEA), and NEDO

# Updates on geothermal power

- Currently 17 geothermal power plants(520MW) are operated.
- Because of antiquated equipment issues, the total power generation(kWh) has been decreasing while the total capacity of facilities(kW) are unchanged.
- Newly 30 projects are observed to be under development, eight of which sit in the national park deregulated in 2012 and may be required to pass the environment impact assessment processes.




Geothermal power generation trend in Japan

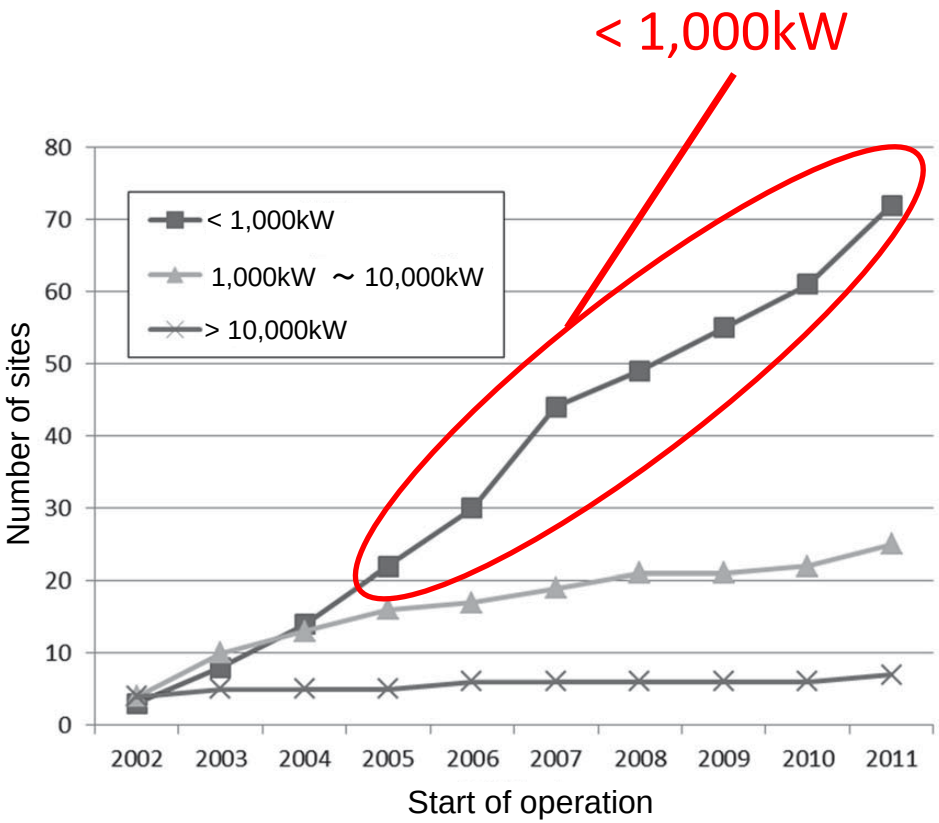


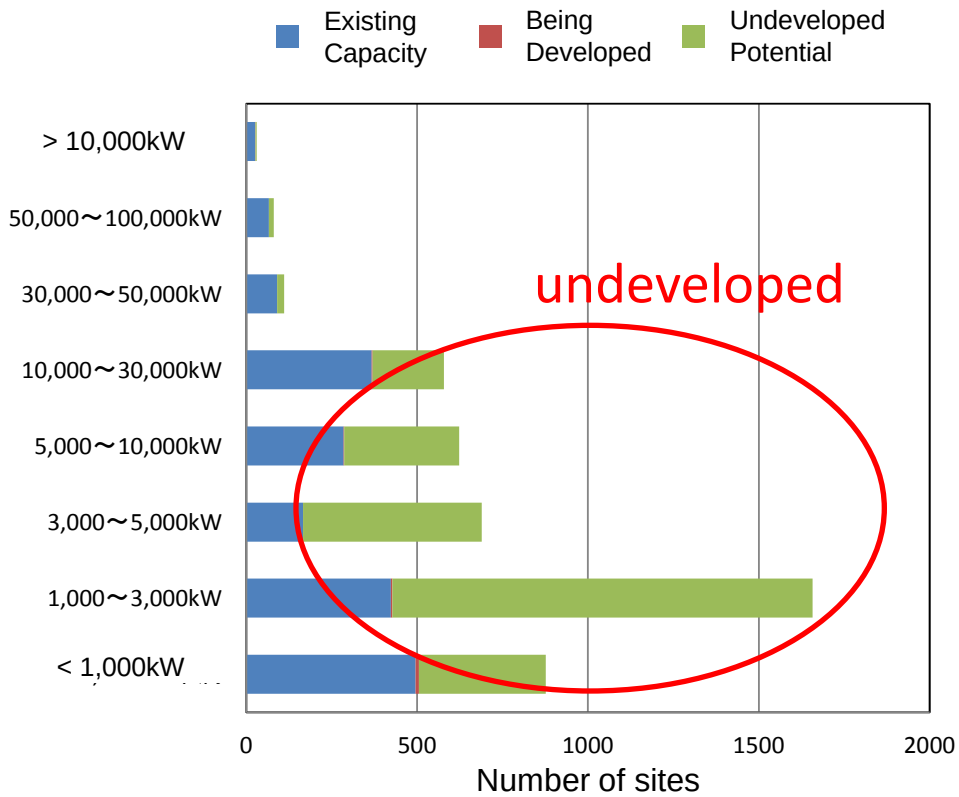

①～⑧：Development sites which sit in the national parks deregulated in 2012

Source: Energy White Paper 2013

# Updates on small and medium sized hydraulic power

- The total capacity of hydraulic power plants less than 30,000kW accounts for 9,627MW as of May 2013.
- In these ten years, 1,000kW or smaller plant development becomes more popular while there left almost no potential for larger plant development.

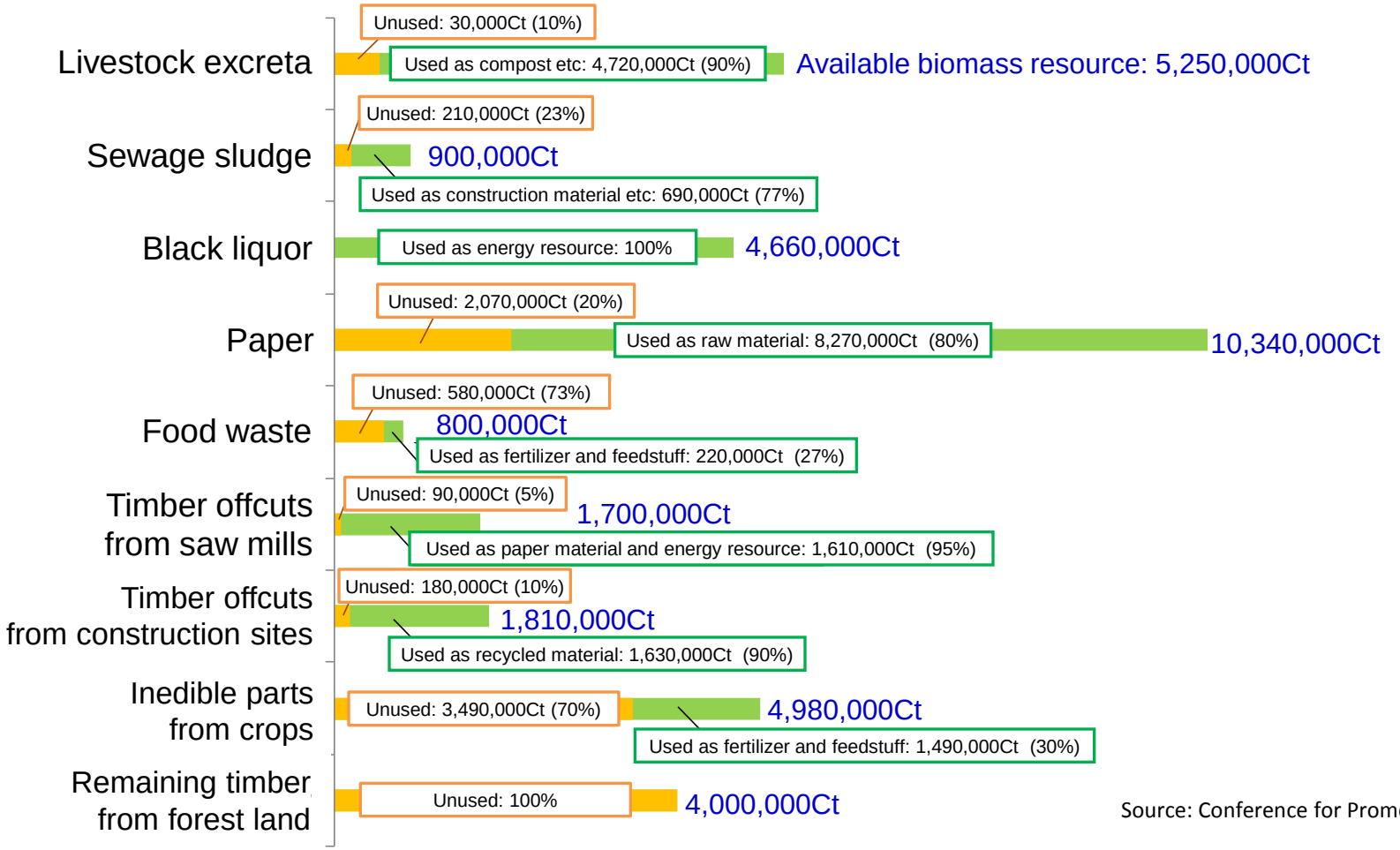



Source: NEDO

# Updates on biomass power

- Biomass power generation can derive from various types of feedstock such as coal-biomass mix combustion, wooden chip, or livestock excreta gas etc.
- There always exist challenges such that the pursuit for scale merit faces the tradeoff with ensuring stable feedstock supply, existing utilization method as raw materials.




Source: Conference for Promoting Biomass Utilization

※本資料の賦存量は「バイオマス活用推進基本計画」（平成22年12月閣議決定）に記載されている数値をもとに炭素トン換算にした

# Emerging issues (1/2) : physical limitation of the grid capacity

- For solar PV connection, the physical limitation of Hokkaido Electric Power's grid was announced in April last year together with some countermeasures.
- Likewise, Okinawa Electric Power's limit for PV connection was also announced in Dec last year.
- Countermeasures include:

(1) Only for Hokkaido region, the rule applied when RE requests to connect with the grid be changed such that power business companies will be able to curtail the electricity output for more than 30 days without any compensation.

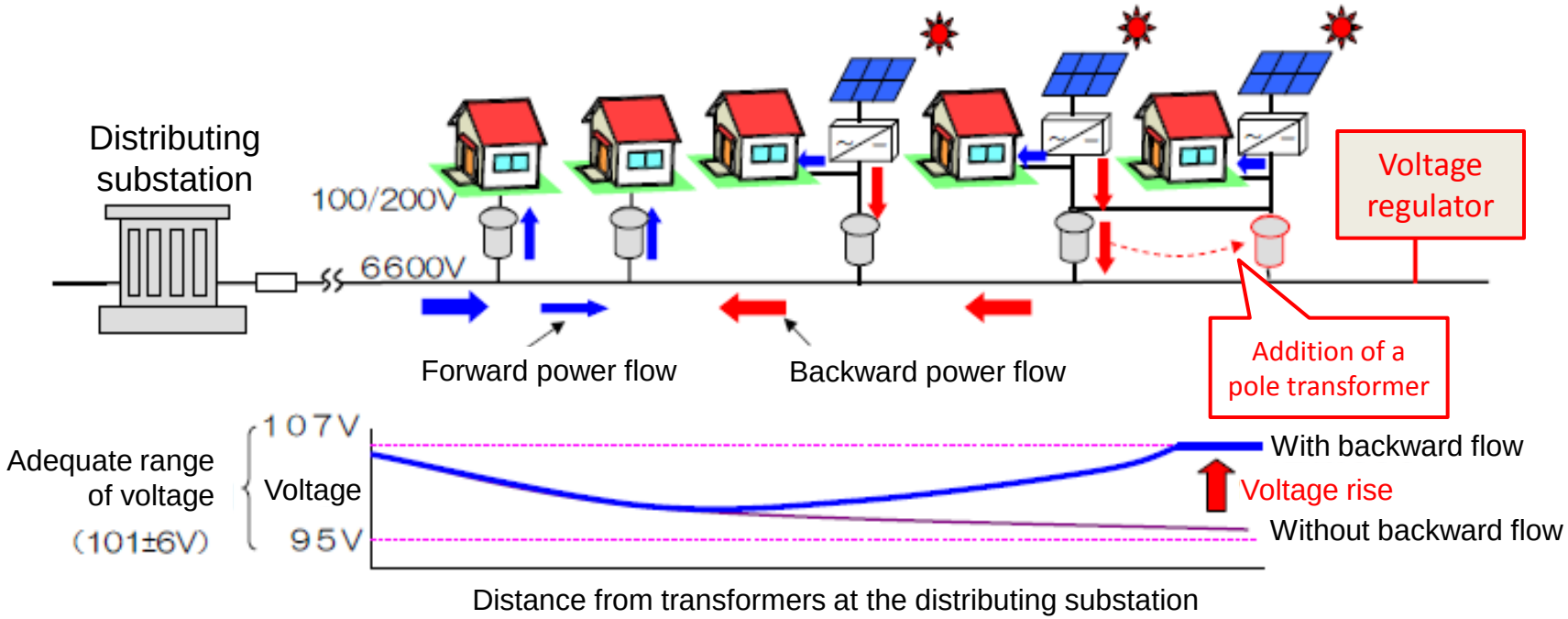
(2) Large size battery system be installed so as to be able to accept more RE. ( → discussed in later slides.)

(3) Country-wide demand and supply adjustment be adopted and additional interregional transmission lines be constructed in order to accept more RE.

(4) A new demonstration project be started in which the advanced weather forecasting technology would be developed and combined with large battery control and optimum curtailment technology, and as a result, such an advanced transmission operation may potentially increase the upper limit of PV connection. ( → discussed in later slides.)

# Emerging issues (2/2) : backward flow in the distribution grid

- In the distribution grid within particular regions, as a volume of residential PVs get connected, the higher voltage at the end of feeders occurs.
- This causes the backward flow in the feeders, which hinders the electricity properly delivered to each house.
- To avoid this issue, power utilities would request the RE generation businesses to switch the feeder they want to connect with, or to purchase high-priced voltage regulator equipment.




Source: Study Group of Next-generation Transmission and Distribution Networks

# Future direction of government policy

- First of all, we would keep a stable and coherent enforcement of Japanese version of FIT, with the appropriate undercut of tariff for PV.

- Second, regulatory reform would be continuously needed while some of regulations are already eased.
  - ex) Acceleration of the environmental impact assessment process

- Third, strengthening of the transmission grid and further optimization of the grid operation should be realized.
  - ex) Private sector driven construction and engineering of the grid for more wind
  - ex) Large sized battery systems located at the central load dispatching office
  - ex) More advanced, sophisticated optimization of the operation both at the transmission grid and distribution grid

- Fourth, further RE promotion especially in Fukushima and other affected area and new R&D on RE

## 2. Japan’s Renewable Energy Policy

# Promotion Measures for Renewable Energy Deployment

- In addition to FIT, METI takes all available policy and measures including subsidies, preferential taxation, and R&D in order to boost RE.

| | For residence | For non-residence |
|---|---|---|
| **Subsidy** | **PV system for residence**<br>○ Aid 15,000 or 20,000 JPY/kW | **RE generator for non-residence**<br>○ Grant up to 33% of total cost of facilities for business operators, or 50% for municipalities, NPO etc. |
| **Tax** | **PV system for residence**<br>○ Income tax deduction if PV system introduced as a part of energy saving renovation | **RE generator approved by FIT**<br>○ 7% tax exemption for smaller business<br>○ Special initial depreciation up to 100%<br>○ Reduction of 1/3 of property tax |
| **R&D** | **PV system:** Highly advanced cells, low-cost manufacturing technologies<br>**Wind power generation system:** Very large floating wind generators<br>**Storage batteries:** Advanced EV batteries, battery systems for the power grid<br>**Geothermal turbine:** Advanced binary generating system<br>**Small hydraulic:** Demonstration of power generation on complicated terrain<br>**Biofuel:** Demonstration of production of cellulosic ethanol, algae-biofuel, etc.<br>**Oceanic energy:** Generator activated by tidal power, wave power etc. | |

# Ongoing flagship demonstration projects are …

- Three flagship demonstration projects has just kick-started in order to accommodate more RE within the grid:

**A) Massive battery system for the power grid**

- absorbing the fluctuation of RE generation.

**B) Buildup of the super-long power line for the wind power**

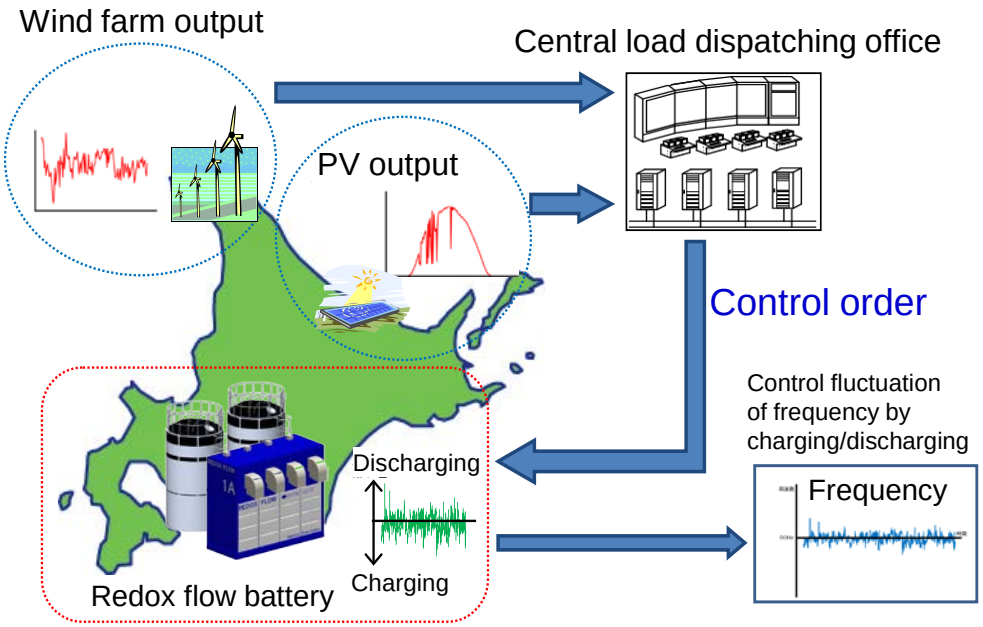
- transmitting the electricity from the wind turbines at the windy, but under-populated area.

**C) Floating offshore wind farm demonstration**

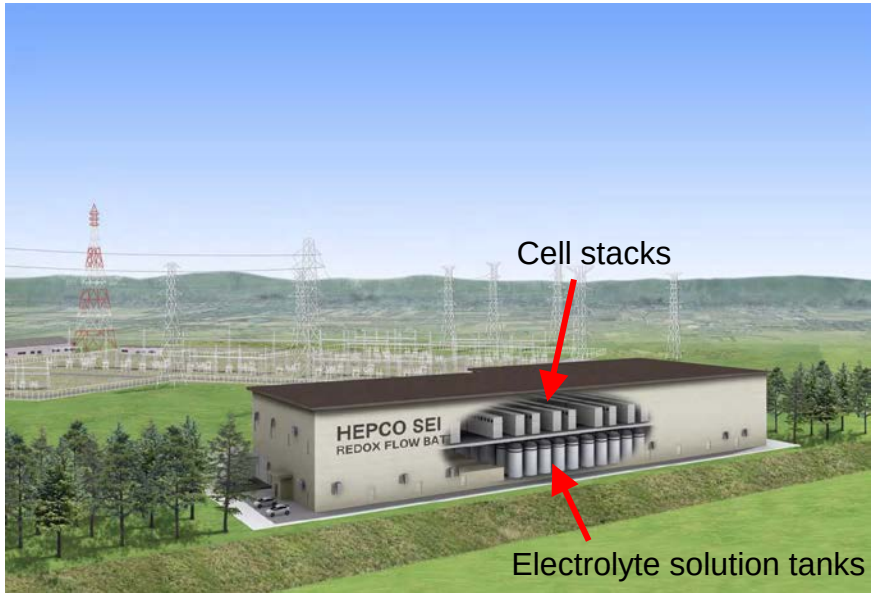
- first-ever multiple floating wind turbine and substation demonstation.


# Massive battery system for the power grid

- Hokkaido and Tohoku introduce enormous battery systems nearby their central load dispatching office for the purpose of frequency control and supply-demand adjustment.
- With this effort, they would be able to accept more RE within the grids.




Demonstration Plan of Hokkaido Elec. Power and Sumitomo



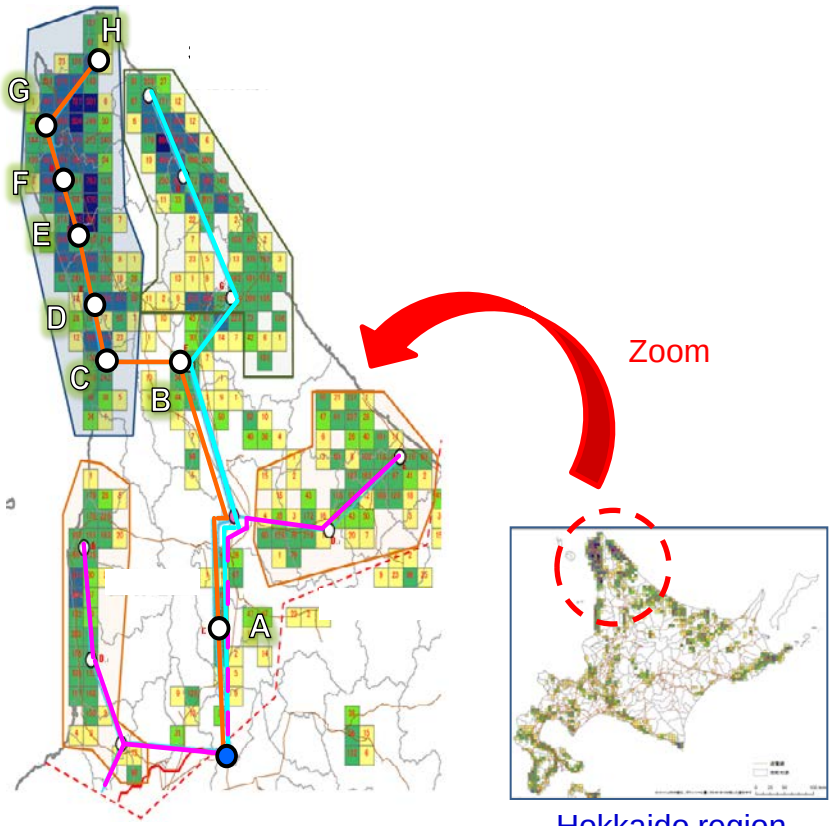

Appearance View of Large Battery Facility

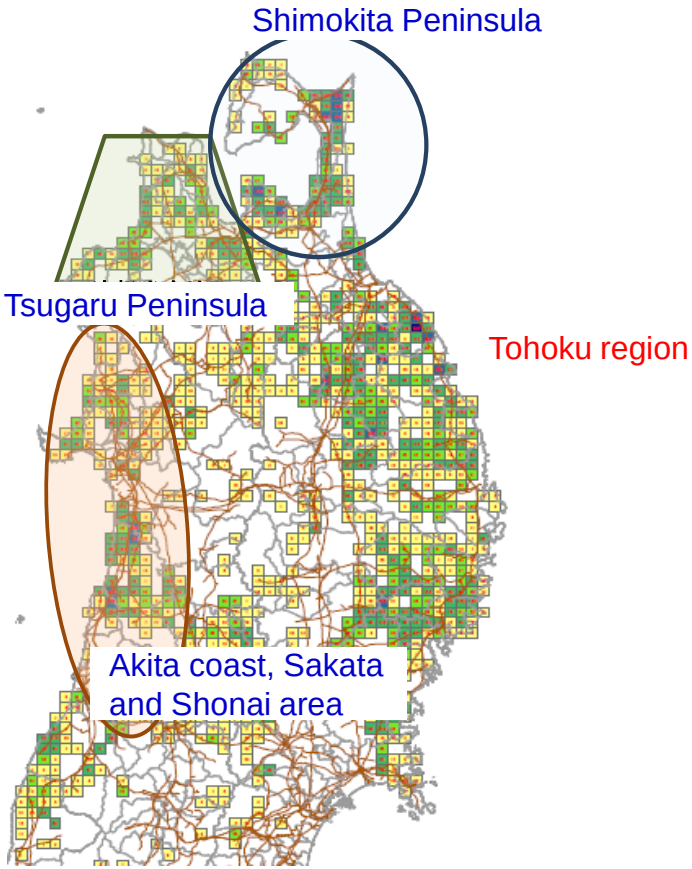
Source: Hokkaido Electric Power Company

| Operator | Battery Type | Capacity [kWh] | Location |
|---|---|---|---|
| Hokkaido Electric Power<br>Sumitomo Electric | Redox flow battery | 60,000 kWh | Minami-Hayakita Substation |
| Tohoku Electric Power | Li-ion Battery | 20,000 kWh | Nishi-Sendai Substation |

# Buildup of the super-long transmission line for the wind power

- In order to promote private capital's building transmission lines that convey the wind electricity from wind abundant area, and to verify necessary technologies, METI subsidizes SPC's building such a transmission lines in fore-mentioned Hokkaido and Tohoku area.
- SPC is required to be sponsored by wind power generation businesses, who agree to pay fee to the SPC  for transmitting services.



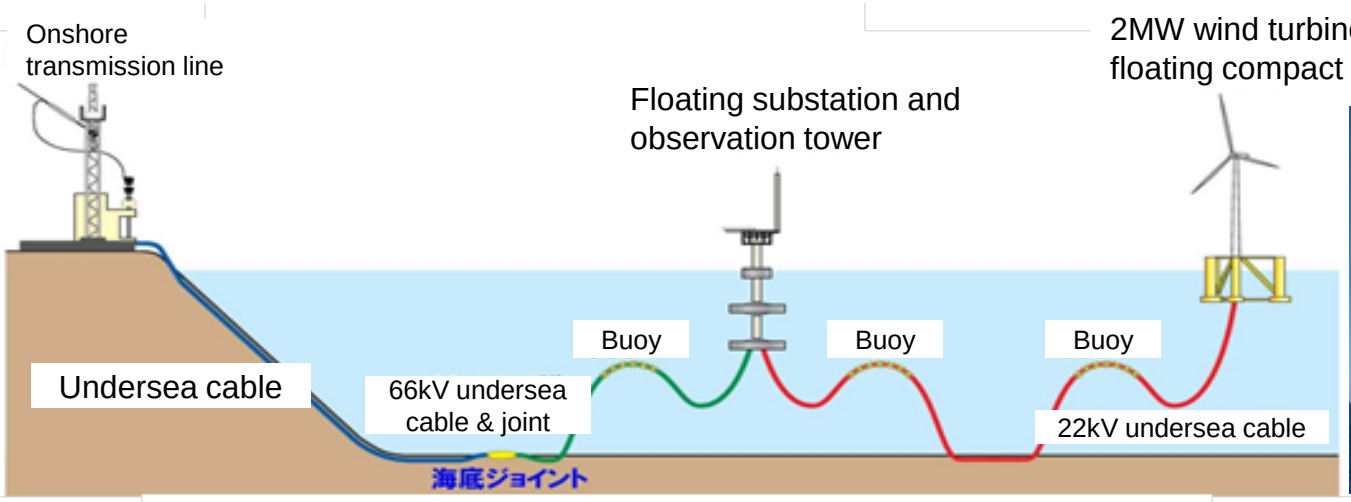

Source: Study Group of the Master Plan for Strengthening Regional Transmission Lines etc.

# Strategic Future Investment for the Next-Gen Wind Power

- The 2MW “ floating ” wind turbine and “floating” substation appeared around 20 km offshore from Fukushima last summer.

## Fukushima Floating Offshore Wind Farm Demonstration Project

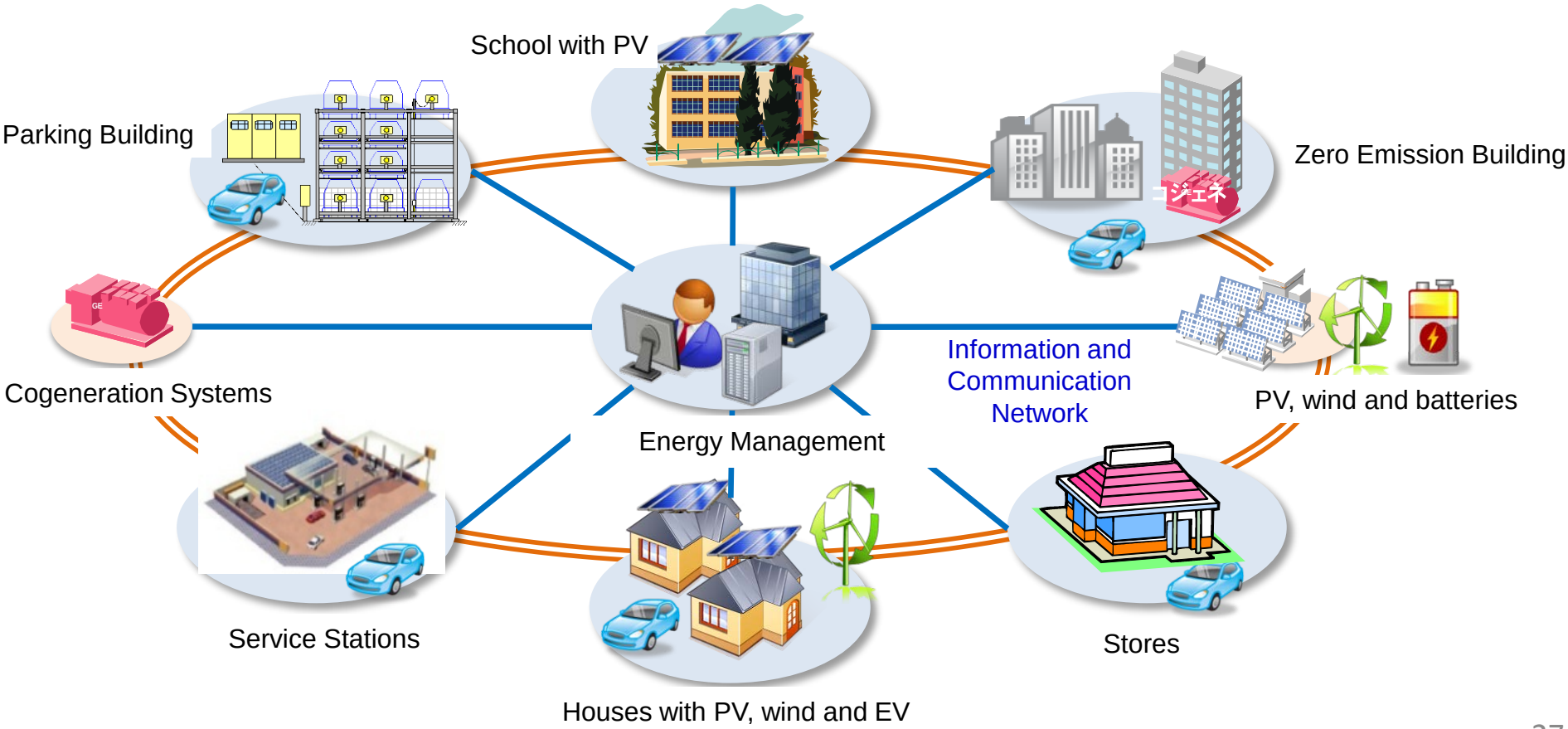
- Three floating wind turbines and a floating substation tower by 2015
- Restoration of Fukushima
- Wind power industry’s competitiveness




# 3. The next-gen distributed power grids

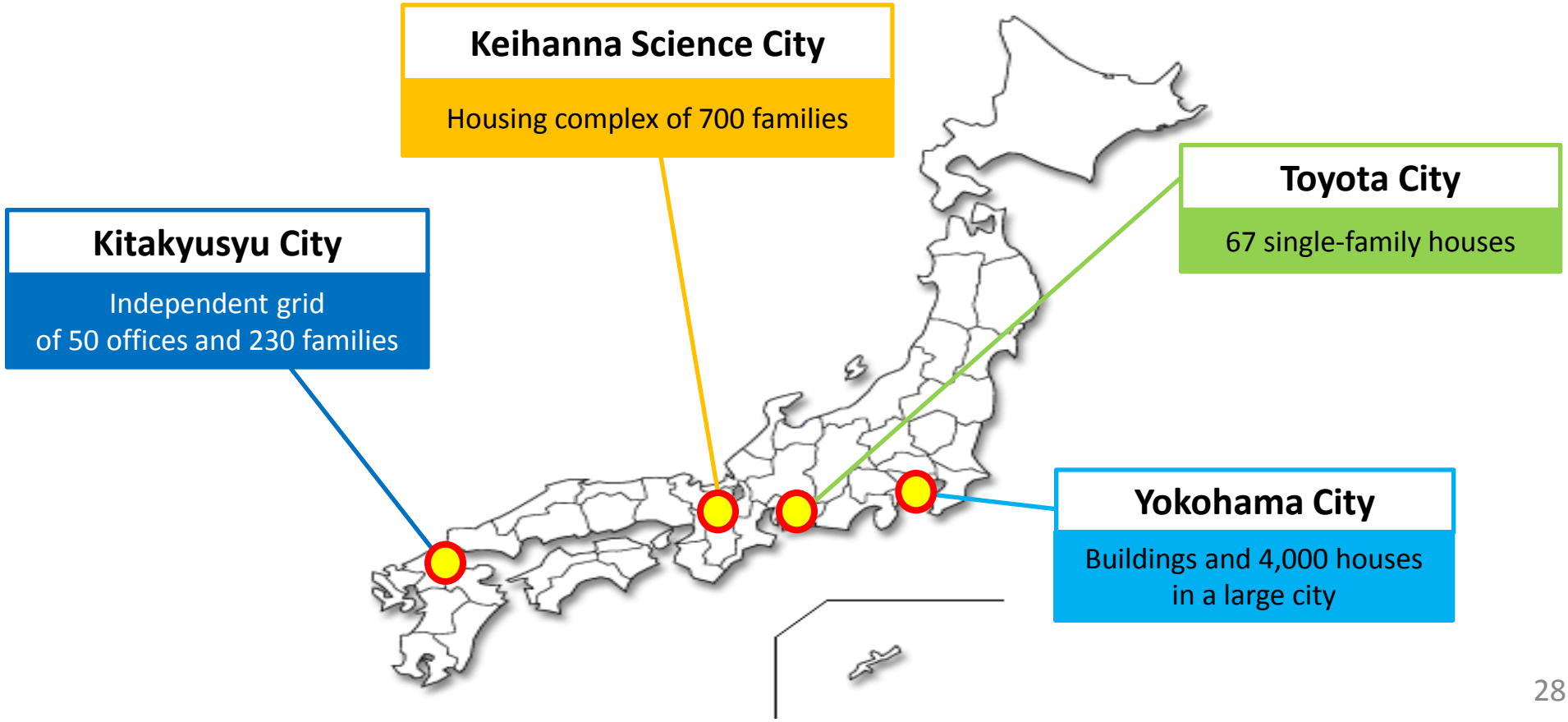
# “Smart Community”

- Smart community is not merely a demonstration of various novel technologies, but also does own twofold aim.
  (1) Increase exports as a whole system or infrastructure, supported by Japanese government and private sector partnership.
  (2) As seen in the example of demand response, it is a sort of social experiment which probes human behavior characteristic.



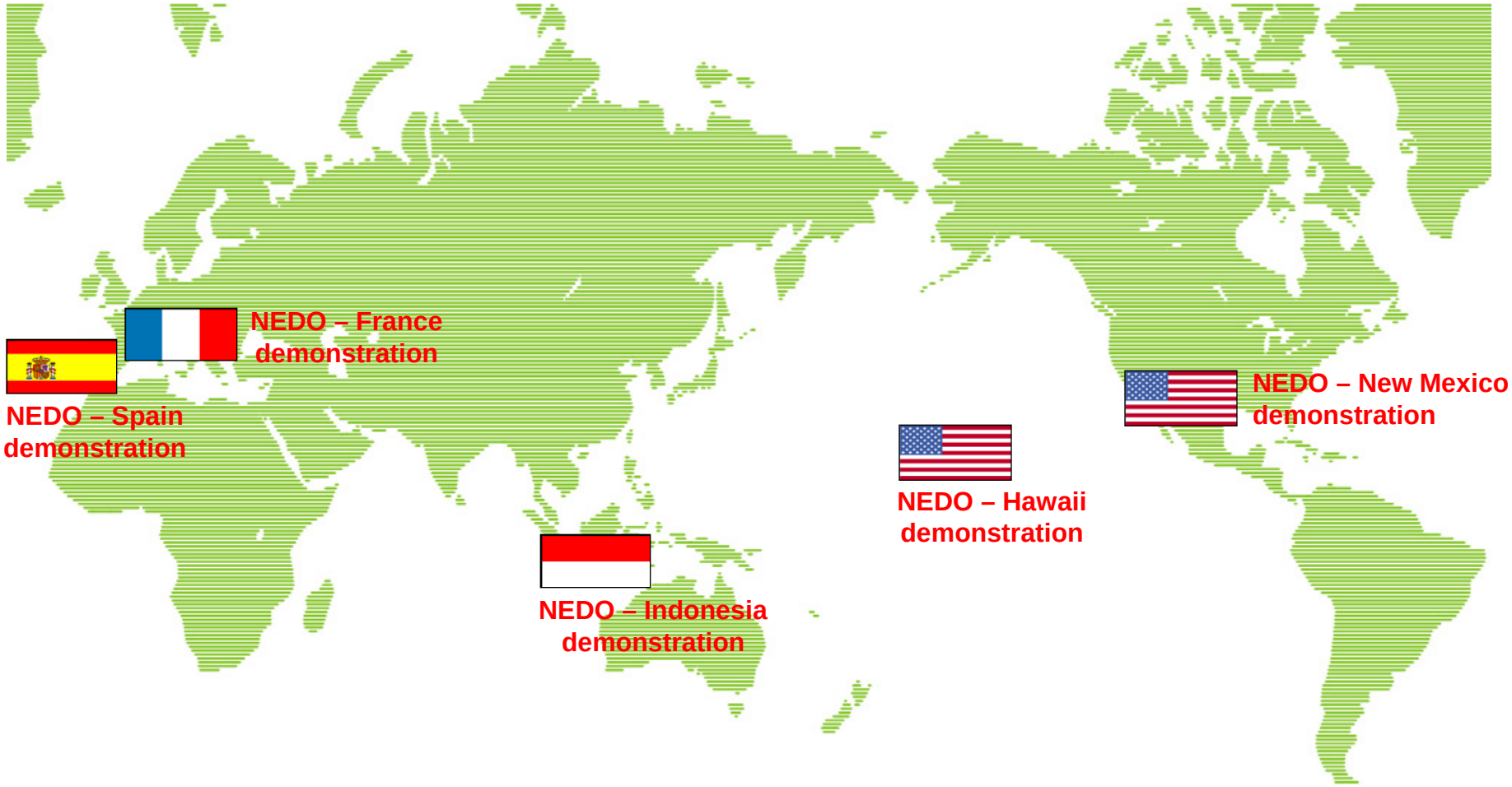
# Domestic smart community demonstration projects

- Since the Great East Japan Earthquake in 2011, the need for a decentralized, rather than centralized, energy network based on distributed power sources has become pronounced.
- With the goal of developing technologies for a “smart community” that implements these concepts, field trials are underway in Yokohama, Toyota, Keihanna Science City, and Kitakyushu to establish energy management systems and power storage technologies.



# Internationally cooperated smart community demonstration projects

- NEDO has been tackling to launch internationally cooperated smart community demonstration projects all over the world.



# What comes next ?

- In the government budget planned for 2014FY, two brand-new projects were included.

**A) Developing technology for forecasting wind power fluctuation**

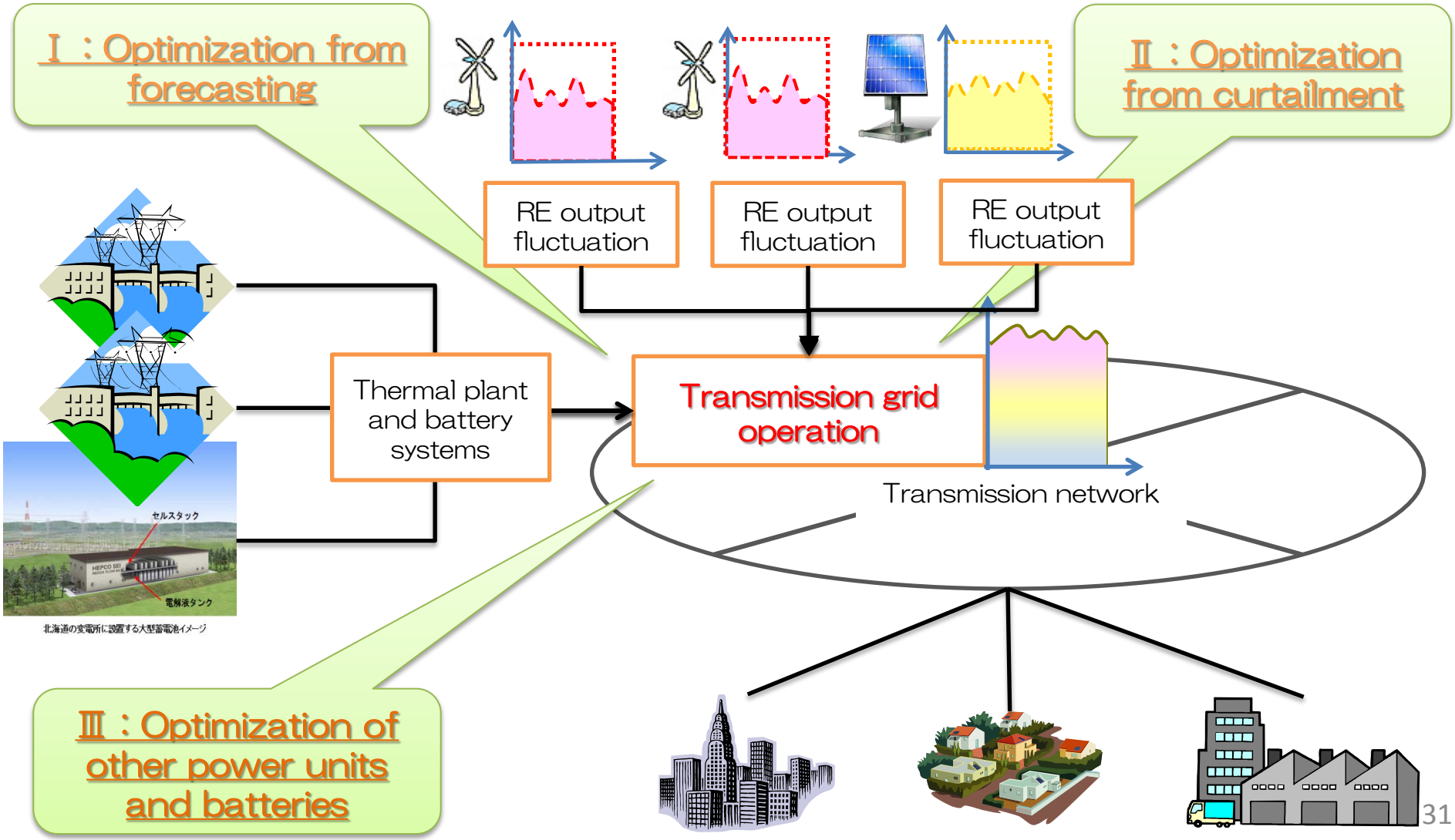
- figuring out the way of optimization from three point of view --- 1) forecast, 2) storing, and 3) curtailment controls.

**B) Developing advanced voltage regulators using power electronics**

- taking advantage of SiC device to realize a low-cost, lightweight, and reliable distribution grid equipment.

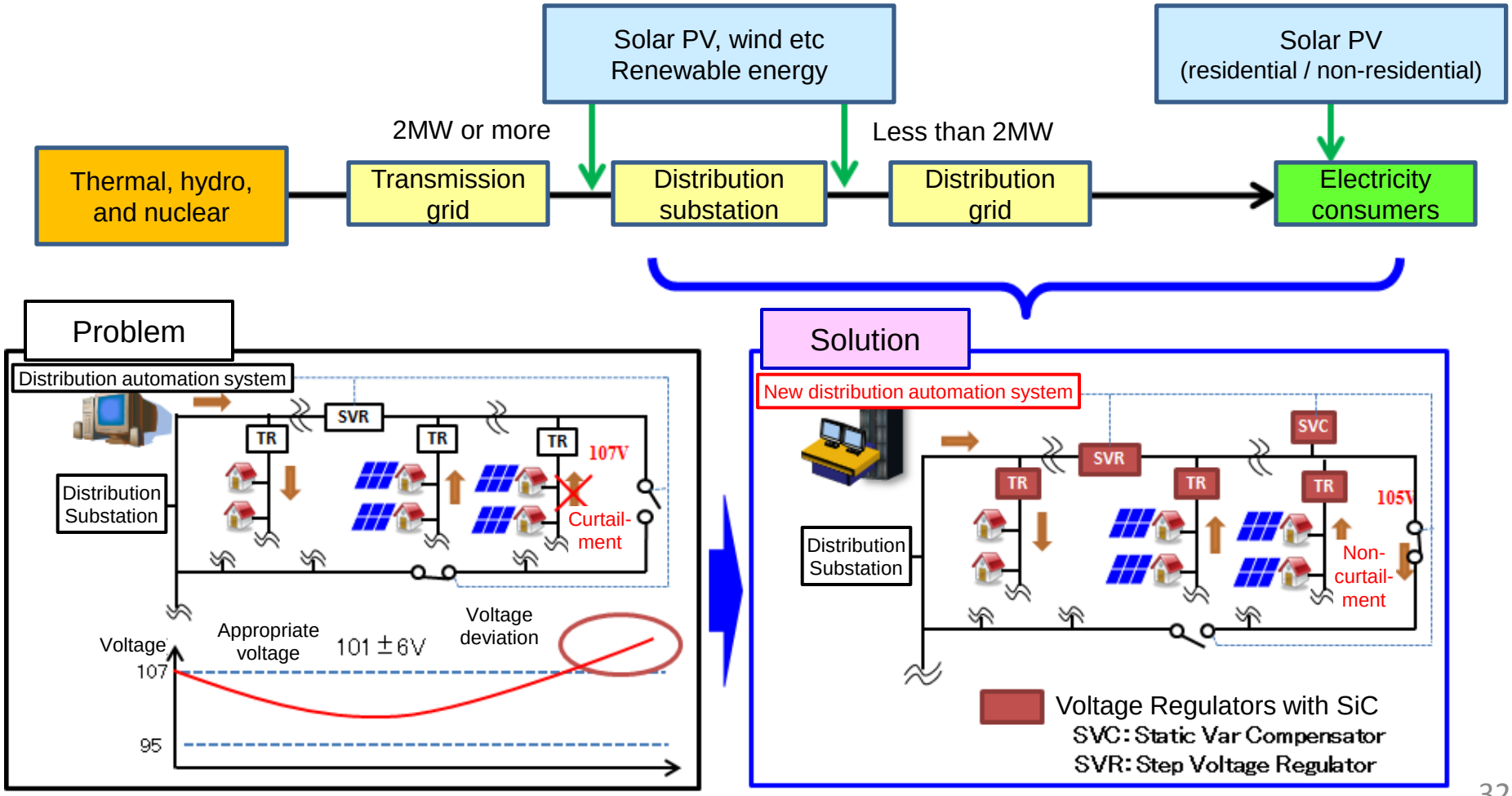
# Developing technology for forecasting wind power fluctuation

- By taking full advantage of forecasting technology of wind power fluctuation, efficient combination with thermal power plants and battery systems, and minimum curtailment of wind farms all at once, an advanced grid operation simulator system will be developed.



# Developing advanced voltage regulators using power electronics

- To solve issues of voltage rises and electricity flow's unbalance in the distribution grid, advanced distribution equipment such as voltage regulators integrated with SiC devices will be developed.
- Once the low-cost, lightweight equipment was developed, it will contribute RE generation businesses try to connect to the grid with minimum extra cost.



**Thank you for your attention**