Chubu Electric Power's initiatives for the deployment and expansion of renewable energy

May 9, 2013

Chubu Electric Power Co.,Inc.

Status of Renewable Energy Initiatives

: Currently in operation

: Currently under construction or in planning

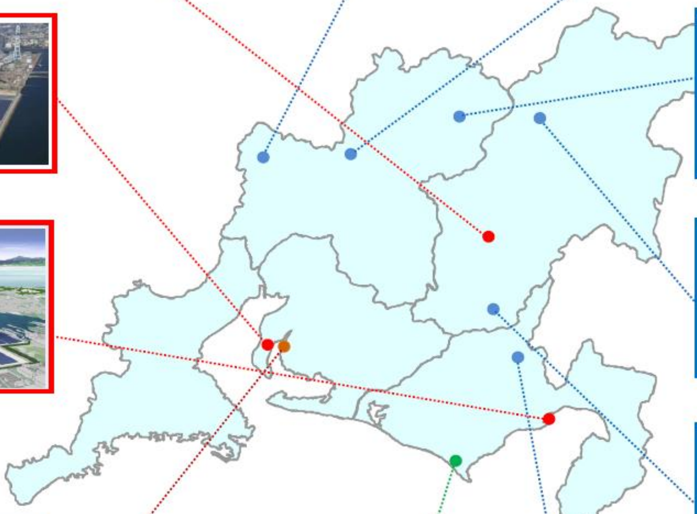
Mega Solar Iida
(Iida City, Nagano Prefecture)
•Max output 1 MW
•January 2011: Start of operations

Tokuyama Hydroelectric Power Station
(Ibigawa-cho, Ibi-gun, Gifu Prefecture)
•Max output 153,400 kW
•June 2014: Start of operations planned

Atagi Hydroelectric Power Station
(generating power from residual flow discharge)
(Shirotori-cho, Gujo City, Gifu Prefecture)
•Max output 190 kW
•FY 2015: Start of operations planned

Mega Solar Taketoyo
(Taketoyo-cho, Chita-gun, Aichi Prefecture)
•Max output 7.5 MW
•October 2011: Start of operations

Nyukawa Hydroelectric Power Station
(generating power from residual flow discharge)
(Nyukawa-cho, Takayama City, Gifu Prefecture)
•Max output 350 kW
•FY 2016: Start of operations planned



Mega Solar
(Shimizu-ku, Shizuoka City, Shizuoka Prefecture)
•Max output 8 MW
•FY2014: Start of operations planned

Susado Hydroelectric Power Station
(generating power from previously unused head)
(Azumino City, Nagano Prefecture)
•Max output 240 kW
•September 2010: Start of operations

Irozawa Hydroelectric Power Station
(generating power from unutilized head)
(Iida City, Nagano Prefecture)
•Max output 250 kW
•June 2003: Start of operations

Hekinan Thermal Power Station (Units 1-5: max output 4.1 GW)
(Hekinan City, Aichi Prefecture)

○Woody biomass fuel mixed combustion
•Mixed combustion rate about 3%
•September 2010: Start of operations

Biomass fuel facility

○Sewage sludge fuel mixed combustion
•Participating with METAWATER Co., Ltd. in a sludge-to-fuel project at the Kinuura East Purification Center
•April 2012: Start of operations

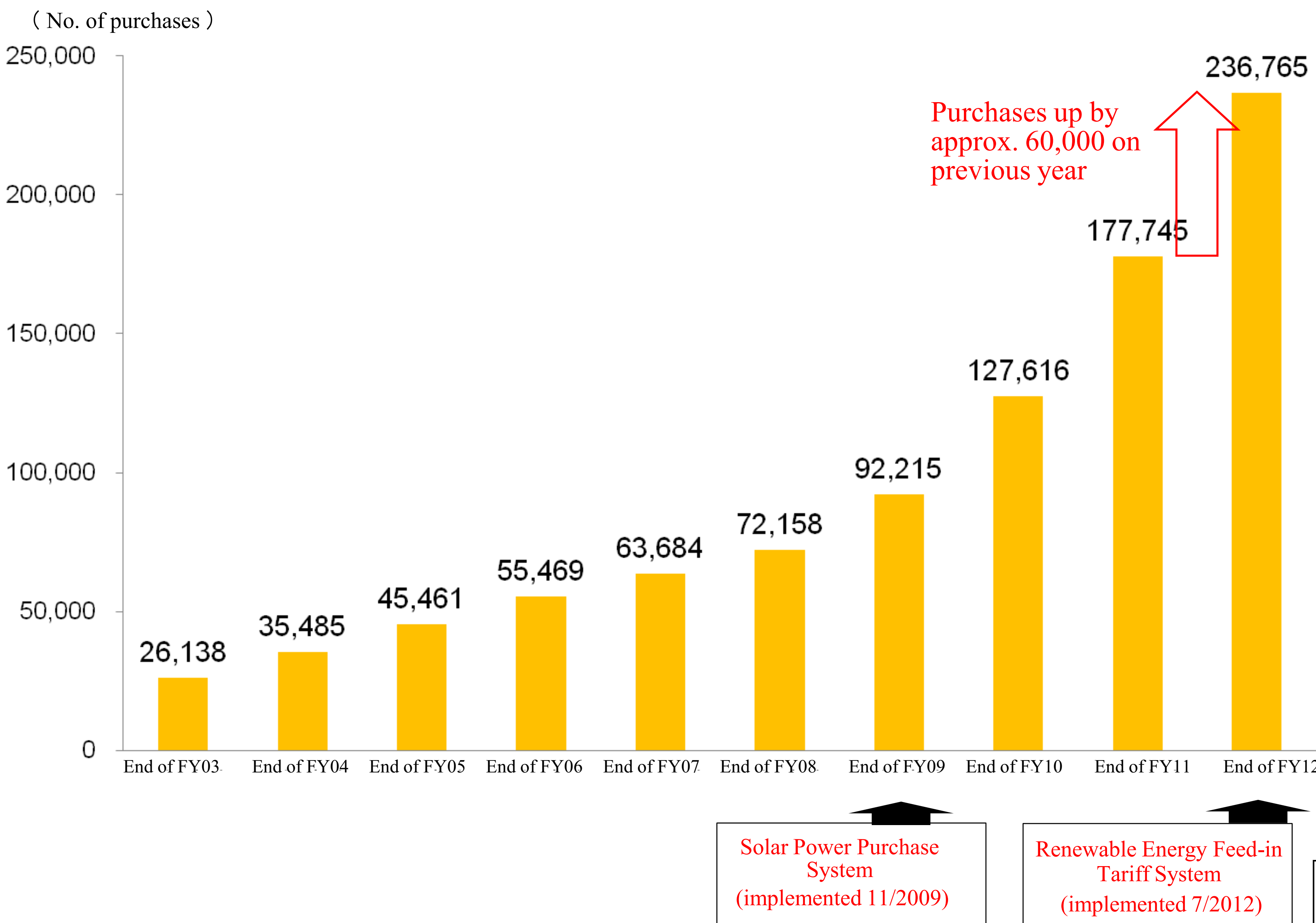
Sludge-to-fuel facility

Higashigouchi Hydroelectric Power Station
(generating power from residual flow discharge)
(Aoi-ku, Shizuoka City, Shizuoka Prefecture)
•Max output 170 kW
•February 2001: Start of operations

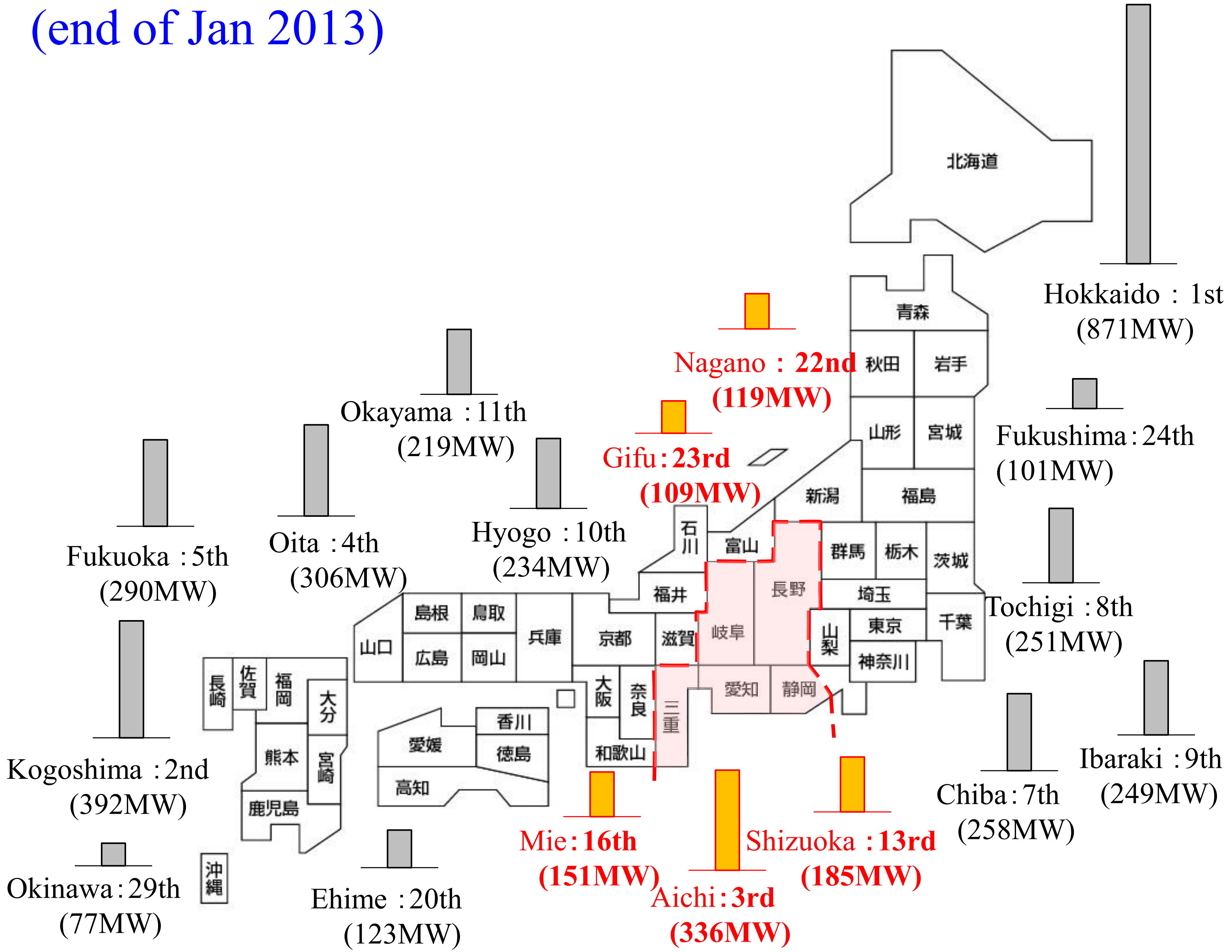
Omaezaki Wind Power Station
(Omaezaki City, Shizuoka Prefecture)
•Max output 22 MW
•January 2011: Start of operations

*Existing general hydroelectric power facilities: Total of 177 locations, about 1,859 MW

The trend in our purchases of electricity from solar power generation



Certified output of solar power generation facilities in Japan (end of Jan 2013)

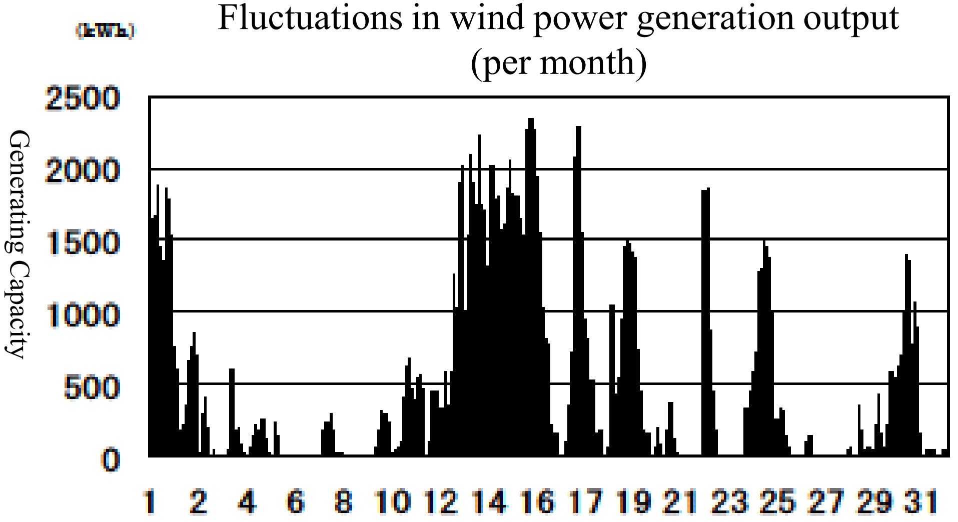


Stability of renewable energy output（1）

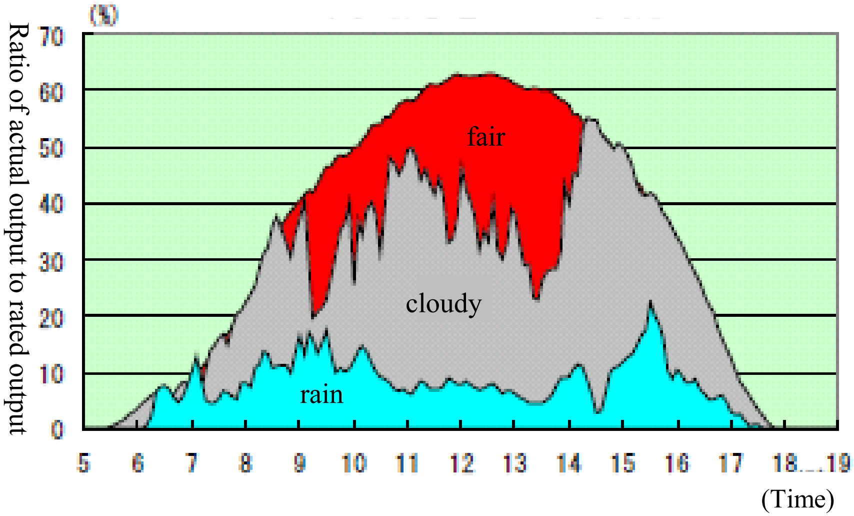
○ Solar and wind power depend on wind quantity, weather and other atmospheric conditions, so their generation output is unstable

○ With no mechanism for adjusting the supply of solar and wind power to demand, output cannot be adjusted to demand

Fluctuations in wind power generation output (per month)



Fluctuations in solar power generation output

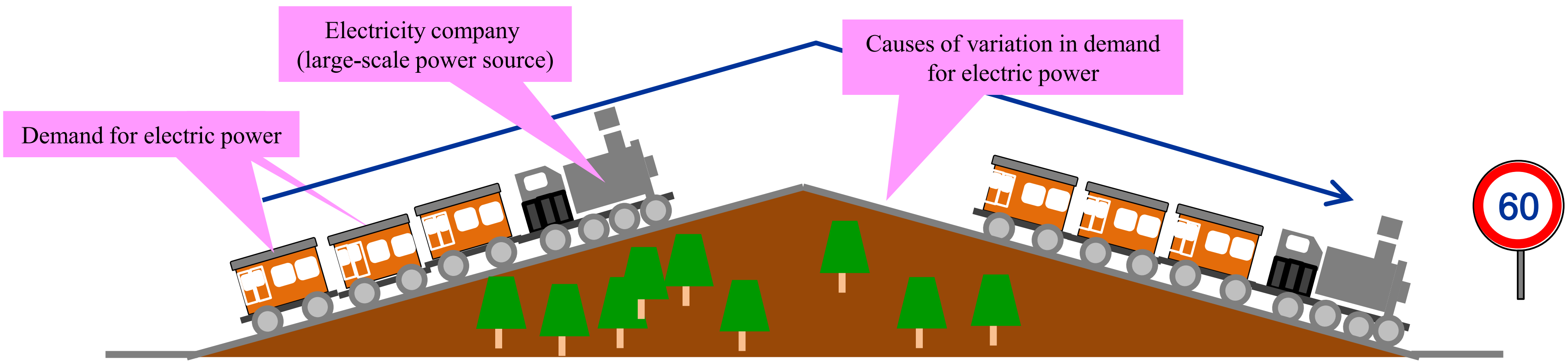


Source: documents from the New and Renewable Energy Subcommittee of the Advisory Committee for Natural Resources and Energy

Implications of large-scale deployment of renewable energy (illustrated with a steam locomotive)

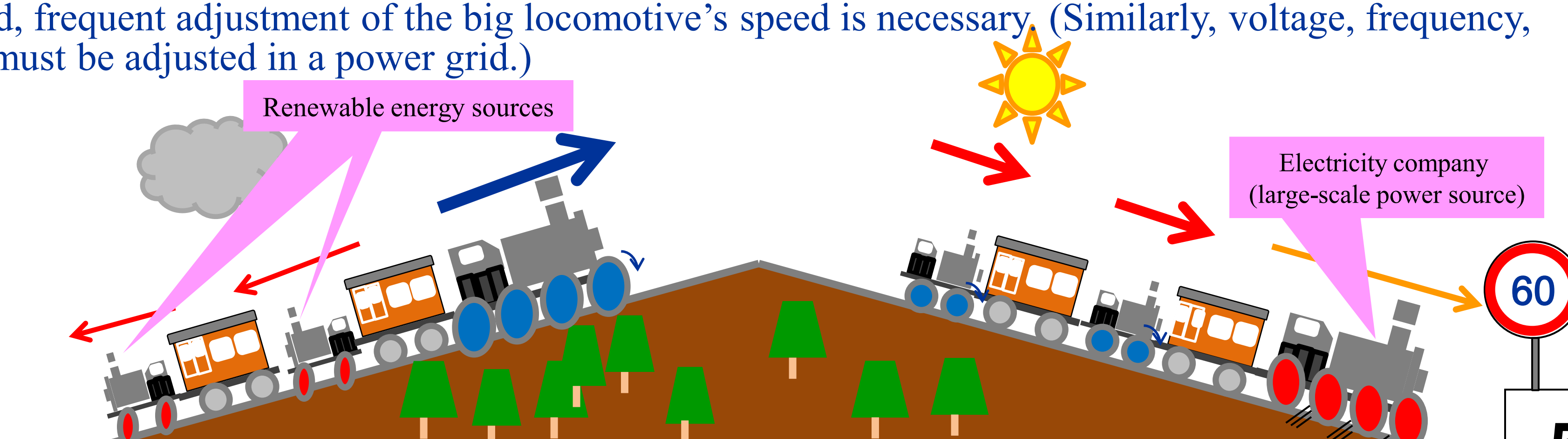
(In the past)

○Pulled by the big locomotive, the train maintained a steady speed (60 km/h for example)



(After large-scale deployment of renewable energy)

○Movements of the added small locomotives are not constant, so, to keep the whole train at a constant speed, frequent adjustment of the big locomotive's speed is necessary. (Similarly, voltage, frequency, etc. must be adjusted in a power grid.)



Stability of renewable energy output（2）

○Solar and wind power have unstable output. As a result, the large-scale deployment of solar and wind power could lead to the following problems/effects, which we must address

Main problems associated with large-scale deployment of renewable energy	Effects (examples)	Power grid response
Voltage spike in power distribution system	○Electrical devices ・Breakdowns and malfunctions may occur. ・Rev. speed of motors and other revolving devices may vary. ○Solar power generation systems ・Output restrictions are activated.	・Upgrade of voltage controllers
Surplus electric power production	○If renewable energy is deployed on a large scale, electric power supply will exceed demand, especially when demand is low in spring and autumn (causing output restrictions to be activated).	・Solar power generation output restrictions ・Installation of storage batteries, use of pumped storage
Frequency fluctuations	○Clocks may go faster or slower; defects may occur in products manufactured by automated equipment. ○Lights may flicker.	・Installation of storage batteries, use of pumped storage ・Development of systems for predicting solar power output

Source: Based on documents from the New and Renewable Energy Subcommittee of the Advisory Committee for Natural Resources and Energy

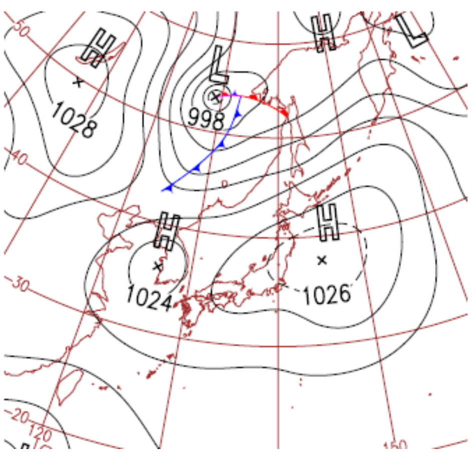
Government verification project on the prediction of solar power generation output

(project sponsored by the Agency for Natural Resources and Energy; principal company: Chubu Electric Power)

○10 electric power companies collected data from actinometers and other devices installed at 321 locations nationwide (61 in the Chubu Electric Power service area)
○This data was used to analyze fluctuations in solar power generation output after large-scale deployment of solar power generation (FY2009-11).

○To maintain quality of power supply regardless of fluctuations in solar power generation output, a total of 17 organizations including 10 electric power companies, Tokyo University and the Japan Weather Association have been working on the development of techniques to predict solar power generation output (FY2011-13).

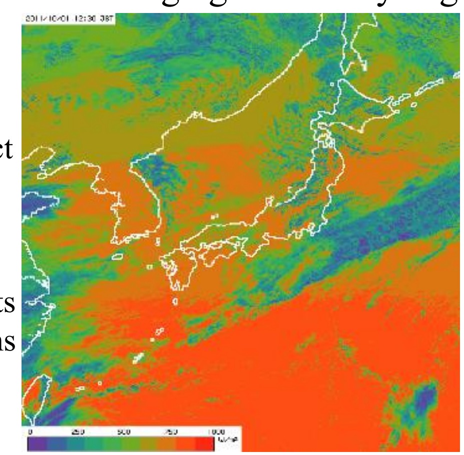
～A possible method of predicting solar power output～



Source: Japan Meteorological Agency
http://www.jma.go.jp/

- Weather forecasting techniques are used to predict cloud thickness, area and height
- Predicting speed and direction of cloud movements allows us to predict variations in light at ground level

Predicting light intensity at ground level



Data source: Japan Weather Association

Predicting solar power generation output

<Relevant factors>
- rated output
- solar panel inclination
- solar panel orientation
- output decrease due to temperature
- panel type, etc.

Note: Weather map and predicted results map are for different days.

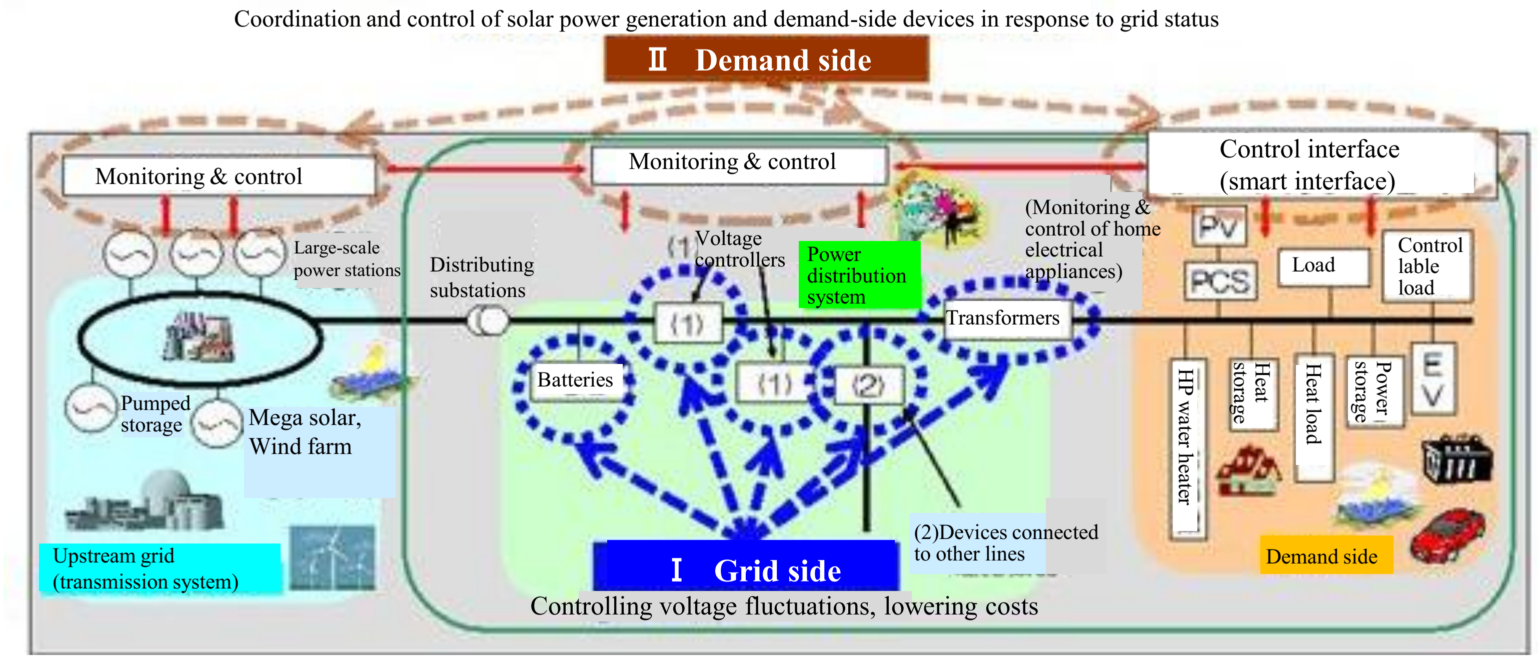
Participation in a verification project for optimal control technologies in next-generation power transmission and distribution systems

○28 participating organizations including Tokyo University, Tokyo Institute of Technology, electricity companies and electronic device manufacturers
○Development of technologies and devices for managing voltage spikes in power lines, and surplus electric power generation, etc.

■Verification of a fully controllable, coordinated system for very reliable, high-quality, low-carbon electric power supply from large-scale power sources to homes.
■To address the large-scale deployment of solar power generation, we are working on the following four grid-side and demand-side technology development issues:

Ⅰ Grid side: ①Development of technologies to control voltage fluctuations in power distribution systems
②Development of low-loss, low-cost devices that utilize next-generation converter technology

Ⅱ Demand side: ③Development of technologies to control demand-side devices in response to grid status
④Review of supply and demand planning and control, and transmission infrastructure for the entire grid.



Nationwide connectable volume of wind power generation

(unit：MW)

		Existing connected volume ※1	Connectable volume
50Hz	Hokkaido	289	560
	Tohoku	506	1580
	Tokyo	349	(No limit)
60Hz	Chubu	225	(No limit)
	Hokuriku	146	450
	Kansai	81	(No limit)
	Chugoku	299	620
	Shikoku	166	450
	Kyushu	342	1000
	Okinawa	14	25
	Total	2419	4685

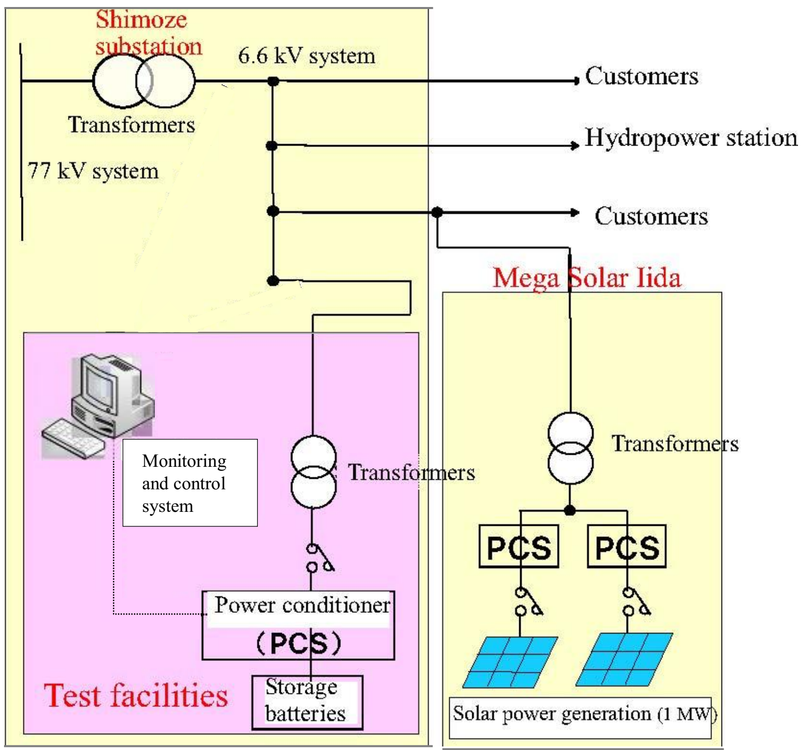
Interchange of connectable volumes

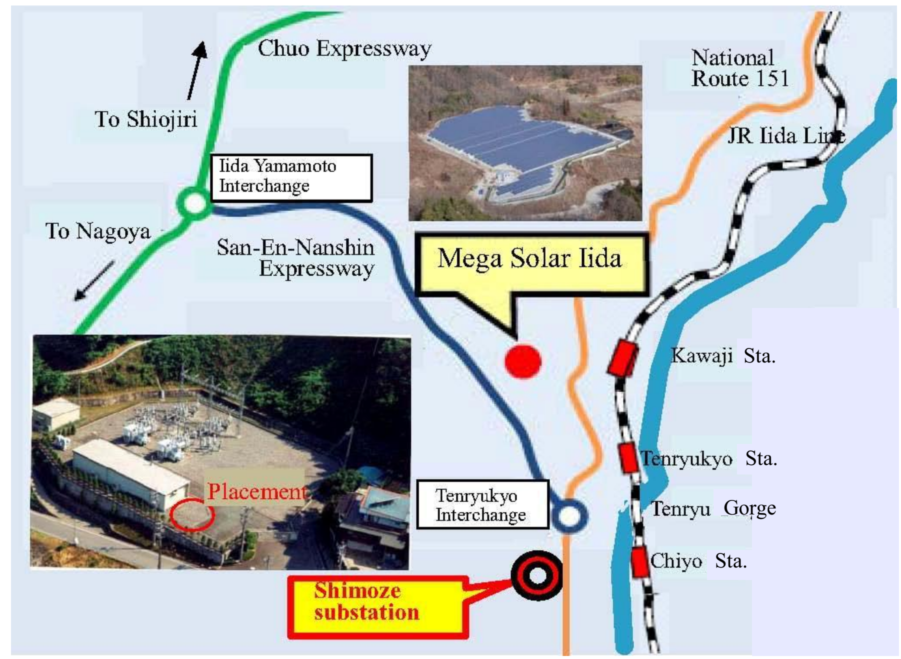
※1： Connected volume as of end-2011
These figures do not include wind power generation on isolated islands not connected to the main grid, fixed-output and other wind power generation considered to lie outside the scope of the connectable volume or generation facilities awaiting or under construction

Testing of voltage fluctuation control in preparation for large-scale deployment of solar power generation

○ Verification testing is under way at Shimoze distributing substation, which is connected both to Mega Solar Iida (1 MW) and to numerous domestic solar power generation facilities.

〈 Configuration of test equipment 〉





Power storage system: lithium-ion cells (25 kWh capacity)

PCS（Power conditioner）: Output 250kW

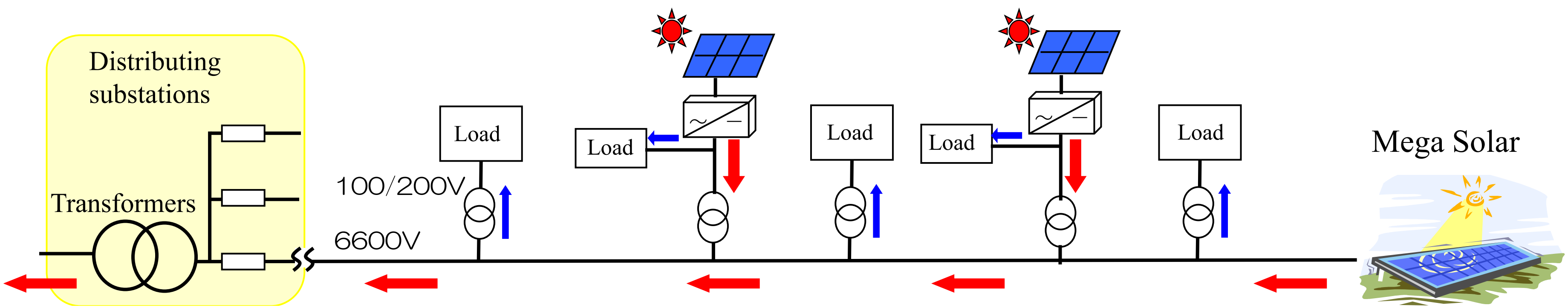
○Investigating controlled charge and discharge of storage batteries to limit voltage fluctuations due to short-cycle fluctuations in solar power generation output

The problem of reverse power flow in distributing transformers resulting from the large-scale deployment of renewable energy

≪The restriction on reverse power flow in distributing transformers≫

○Reverse power flow in distributing transformer banks is restricted by the "Interpretation of technical standards for electrical equipment," "Grid-interconnection Technical Requirement Guidelines on Electric Power Quality," "Grid Interconnection Code," etc. This is because reverse power flow in transformers at distributing substations can cause problems with grid voltage management and safety.

○For example, if there is an accident involving a power line upstream of a distributing substation while solar electricity is being generated, reverse power flow from the substation to the accident location may cause secondary accidents such as electrocution.



Reverse power flow (solar power generation output flows back to the grid)

【"Interpretation of technical standards for electrical equipment," Article 228】

○ When distributed energy sources are connected to a high-voltage power grid, the transformers at the distributing substations that connect the distributed energy sources to the grid shall not allow any reverse flow.

○ The restriction on reverse power flow in distributing transformers may be an obstacle to the large-scale deployment of renewable energy, so the government is considering easing the regulations